SAGVNTVM

PAPELES DEL LABORATORIO DE ARQUEOLOGÍA
DE VALENCIA
EXTRA-13

WOOD AND CHARCOAL
EVIDENCE FOR HUMAN AND NATURAL HISTORY

ERNESTINA BADAL – YOLANDA CARRIÓN – MIGUEL MACÍAS – MARÍA NTINOU
(COORDINATORS)

VNIVERSITAT DE VALÈNCIA
FACULTAT DE GEOGRAFIA I HISTÒRIA
Departament de Prehistòria i d'Arqueologia

2012

SAGVNTVM
PAPELES DEL LABORATORIO DE ARQUEOLOGÍA DE VALENCIA

EXTRA – 13

2012

Wood and charcoal
Evidence for human and natural History

Ernestina Badal, Yolanda Carrión, Miguel Macías, María Ntinou
(Coordinators)

VNIVERSITAT DE VALÈNCIA

Departament de Prehistòria i Arqueologia

Title: Wood and charcoal. Evidence for human and natural History
Series: SAGVNTVM Extra

Coordinators:
Ernestina Badal
Yolanda Carrión
Miguel Macías
María Ntinou

Information and exchanges:
Departament de Prehistòria i d'Arqueologia
Facultat de Geografia i Història
Blasco Ibáñez 28 – Valencia 46010 (España)
Fax 963983887
Dep.prehistoria.i.arqueologia@uv.es

All titles of this series are available from:
Sevei de Publicacions
Universitat de València (PUV)
C/ Arts Gràfiques, 13, 46010 València
publicaciones@uv.es

Published by: UNIVERSITAT DE VALÈNCIA
Departament de Prehistòria i Arqueologia de la Facultad de Geografía i Història.
Funded by MINISTERIO DE CIENCIA E INNOVACIÓN.

Book with international referee system

Design and layout by Coordinators.
Printed by La Imprenta.

Print I.S.B.N.: 978-84-370-9062-7
Online I.S.B.N: 978-84-370-9061-0

Print Legal deposit: V-3631-2012
Online Legal deposit: V-3630-2012

CONTENTS

LIST OF AUTHORS

Natàlia ALONSO
Dpt. de Història. Universitat de Lleida. 25003. Lleida, Spain.
nalonso@historia.udl.cat

Eleni ASOUTI
Department of Archaeology, Classics and Egyptology, University of Liverpool. Brownlow Street, L69 3GS Liverpool, UK.
E.Asouti@liverpool.ac.uk

Agustín AZKARATE
University of the Basque Country (UPV/EHU). Tomás y Valiente s/n. 01006 Vitoria-Gasteiz, Spain.
agustin.azkarate@ehu.es

Ernestina BADAL
Department of Prehistory and Archaeology. University of Valencia. Avda. Blasco Ibáñez, 28, 46010 Valencia, Spain.
Ernestina.badal@uv.es

Amparo BARRACHINA
Servicio de Arqueología de la Diputación de Castellón. Av. Hermanos Bou, 28 12003 Castellón, Spain.
abarrachina@dipcas.es

Iouri BERMOND
UMR 5140 Archéologie des Sociétés Méditerranéennes. DRAC Languedoc-Roussillon. Service Régional de l'Archéologie. 5 rue de la Salle-L'Évêque. CS 49020. 34967 Montpellier cedex 2, France.
iouri.bermond@culture.gouv.fr

Nuno BICHO
Universidade do Algarve, Faculdade de Ciências Humanas e Sociais, Campus de Gambelas, 8005-139 Faro, Portugal.
nbicho@ualg.pt

Helena BONET ROSADO
Servicio de Investigación Prehistórica, Museo de Prehistoria, Diputación de Valencia, C/Corona 36, 46003, Valencia, Spain.
helena.bonet@dival.es

Charlène BOUCHAUD
UMR 7209, Archéozoologie, Archéobotanique. Sociétés, Pratiques, Environnements (Muséum national d'histoire naturelle). 55, rue Buffon 75005 Paris, France.
charlene.bouchaud@gmail.com

Valentina CARACUTA
Laboratory of Archaeobotany and Palaeoecology (L.A.P.). University of Salento-Lecce. Via Birago 64, 73100, Lecce. Italy. Department of Human Science. University of Foggia. Via Arpi, 71100, Foggia. Italy.
v.caracuta@alice.it

Yolanda CARRIÓN MARCO
Department of Prehistory and Archaeology. University of Valencia. Avda. Blasco Ibáñez, 28, 46010 Valencia, Spain.
Yolanda.carrion@uv.es

Raffaella CASSANO
Department of Antiquity, University of Bari, Italy.
r.cassano@lettere.uniba.it

Lucie CHABAL
CBAE UMR 5059 CNRS Univ. Montpellier 2 EPHE. Institut de Botanique. 163 rue A. Broussonnet. 34090 Montpellier, France.
chabal@univ-montp2.fr

Giampiero COLAIANNI
Laboratory of Archaeobotany and Palaeoecology. University of Salento. Via Dalmazio Birago 64, 73100 Lecce, Italy.
charcoal@unile.it

Carme CUBERO I CORPAS
Museu Arqueològic de l'Esquerda. 08510 Roda de Ter, Spain.
ccubero@uoc.edu

Sonia DE HARO POZO
Cl. Enseñanza, 11, 12001 Castellón, Spain.
sonideharo@gmail.com

Arturo DE LOMBERA-HERMIDA
Grupo de Estudos para a Prehistoria do NW Ibérico (GEPN). Departamento de Historia I. USC. 15782 Santiago de Compostela, Spain.
Institut Català de Paleoecologia Humana i Evolució Social (IPHES), C/ Marcel·lí Domingo s/n Campus Sescelades URV (Edifici W3) 43007, Tarragona, Spain.
Area de Prehistoria, Universitat Rovira i Virgili, Av. Catalunya 35, Tarragona 43002, Spain.
alombera@iphes.cat

Patrícia DIOGO MONTEIRO
Núcleo de Arqueologia e Paleoecologia da Universidade do Algarve. Faculdade de Ciências Humanas e Sociais da

Universidade do Algarve, Campus de Gambelas, 8005-139 Faro, Portugal.
pamonteiro@ualg.pt

Alexa DUFRAISSE
CNRS, UMR 7209 "Archéozoologie, archéobotanique", 55 rue buffon 75005 Paris, France.
dufraisse@mnhn.fr

Michelle ELLIOTT
UMR 8096 "Archéologies des Amériques", CNRS. Maison René Ginouvès. 21, allée de l'Université. F-92023 Nanterre Cedex, France.
Michelle.Elliott@mae.u-paris10.fr

Laurent FABRE
INRAP Méditerranée, 561 Rue Etienne Lenoir, Km Delta, 30900 Nîmes, France
Thau agglo, Jardin antique Méditerranéen, Rue des Pioch, 34540 Balaruc les Bains, France
CBAE, CNRS /Univ. Montpellier 2/EPHE, Montpellier, France
l.fabre@thau-agglo.fr

Ramón FÁBREGAS VALCARCE
Grupo de Estudos para a Prehistoria do NW Ibérico (GEPN). Departamento de Historia I. USC. 15782 Santiago de Compostela, Spain.
ramon.fabregas@usc.es

Gina FARACO BIANCHINI
Departamento de Antropologia, Museu Nacional, Universidade Federal do Rio de Janeiro. Quinta da Boa Vista, 20940-040, Rio de Janeiro, Brazil.
ginabianchini@ufrj.br

Isabel FIGUEIRAL
INRAP Méditerranée, 561 rue Etienne Lenoir, km Delta, 30900 Nîmes, France.
CBAE UMR 5059 CNRS Univ. Montpellier 2 EPHE. Institut de Botanique. 163 rue A. Broussonnet. 34090 Montpellier, France.
isabel.figueiral-rowe@inrap.fr

Custode Silvio FIORIELLO
Department of Antiquity, University of Bari, Italy.
s.fioriello@lettere.uniba.it

Girolamo FIORENTINO
Laboratory of Archaeobotany and Palaeoecology (L.A.P.). University of Salento-Lecce. Via Birago 64, 73100, Lecce. Italy.
girolamo.fiorentino@unisalento.it

María Soledad GARCÍA MARTÍNEZ
Departamento de Prehistoria, Arqueología, Historia Antigua, Historia Medieval y Ciencias y Técnicas Historiográficas, Facultad de Letras, Universidad de Murcia. C/ Santo Cristo, 1. 30001-Murcia, Spain.
msgarmar@um.es

Anna Maria GRASSO
Laboratory of Archaeobotany and Palaeoecology, Università del Salento, 73100 Lecce, Italy.
grasso_annamaria@libero.it

Robert HOFMANN
Graduate School "Human Development in Landscapes", Christian-Albrecht-University (CAU) D-24098 Kiel, Germany.
Institute for Pre- and Protohistoric Archaeology CAU, D-24098 Kiel, Germany.
robert.hofmann@ufg.uni-kiel.de

Jesús F. JORDÁ
Dpto. de Prehistoria y Arqueología. UNED. 28040 Madrid, Spain.
jjorda@geo.uned.es

Maria LITYŃSKA-ZAJĄC
Institute of Archaeology and Ethnology Polish Academy of Sciences, Krakow Branch, Sławkowska 17, 31-016 Kraków, Poland.
marialitynska@gazeta.pl

Thomas LUDEMANN
University of Freiburg, Faculty of Biology, Dept. of Geobotany. Schaenzlestrasse 1, D-79104 Freiburg, Germany.
thomas.ludemann@biologie.uni-freiburg.de

Susan LYONS
Department of Archaeology, University College Cork, Cork, Ireland.
lyons.su@gmail.com

Bernat MARTÍ OLIVER
Museu de Prehistòria de València-SIP. C. de la Corona 32, 46003 València, Spain.
Bernat.Marti@dival.es

María MARTÍN-SEIJO
GEPN-Grupo de Estudos para a Prehistoria do Noroeste Ibérico. Dpto. Historia I. Universidade de Santiago de Compostela. Praza da Universidade s/n. 15782, Santiago de Compostela, Spain.
maria.martin.seijo@gmail.com

Fraser **J.G.** MITCHELL
Botany Department, School of Natural Sciences, Trinity College Dublin, Ireland.
fmitchell@tcd.ie

Johannes MÜLLER
Graduate School "Human Development in Landscapes", Christian-Albrecht-University (CAU) D-24098 Kiel, Germany.
Institute for Pre- and Protohistoric Archaeology CAU, D-24098 Kiel, Germany.

johannes.mueller@ufg.uni-kiel.de
Nils MÜLLER-SCHEESSEL
Roman-Germanic Commission, Plamgartenstr. 10-12, 60325 Frankfurt a.M., Germany.
muellerscheessel@rgk.dainst.de

Oliver NELLE
Institute for Ecosystem Research CAU, D-24098 Kiel, Germany.
onelle@ecology.uni-kiel.de

Maria NTINOU
Hellenic Open University, Aggelou Sikelianou 2, GR – 452 21 Ioannina, Greece.
maria.ntinou@uv.es

Ellen OCARROLL
Botany Department, School of Natural Sciences, Trinity College Dublin, Ireland.
eocarro@tcd.ie

Lorna O'DONNELL
14 Rockstown Park, Tooban, Burnfoot, County Donegal, Ireland.
odonnell.lorna@gmail.com

Daniela ORRICO
Laboratory of Archaeology "M. Napoli", University of Salerno. Via Ponte don Melillo, 84084 Fisciano (Salerno), Italy.
alab@unisa.it

Arne PAYSEN
Institut für Ökosystemforschung der CAU Kiel, Olshausenstr. 75, 24118 Kiel, Germany.
isentosamballerer@gmx.de

Christophe PELLECUER
UMR 5140 Archéologie des Sociétés Méditerranéennes. DRAC Languedoc-Roussillon. Service Régional de l'Archéologie. 5 rue de la Salle-L'Évêque. CS 49020. 34967 Montpellier cedex 2, France.
christophe.pellecuer@culture.gouv.fr

Manuel PÉREZ-RIPOLL
Department of Prehistory and Archaeology. University of Valencia. Avda. Blasco Ibáñez, 28, 46010 Valencia, Spain.
Manuel.perez@uv.es

Raquel PIQUÉ
Dpt. de Prehistòria. Universitat Autònoma de Barcelona. 08193 Cerdanyola del Vallès, Spain.
raquel.pique@uab.cat

Angela PONTRANDOLFO
Laboratory of Archaeology "M. Napoli", University of Salerno. Via Ponte don Melillo, 84084 Fisciano (Salerno), Italy.
alab@unisa.it

Xosé Pedro RODRÍGUEZ-ÁLVAREZ
Institut Català de Paleoecologia Humana i Evolució Social (IPHES), C/ Marcel·lí Domingo s/n Campus Sescelades URV (Edifici W3) 43007, Tarragona, Spain.
Area de Prehistoria, Universitat Rovira i Virgili, Av. Catalunya 35, Tarragona 43002, Spain.
xprodriguez@iphes.cat

Mª Oliva RODRÍGUEZ-ARIZA
Instituto Universitario de Arqueología Ibérica. Universidad de Jaén. Edif. C-6, 23071 Jaén, Spain.
moliva@ujaen.es

Mónica RUIZ-ALONSO
Grupo de Investigación Arqueobiología (CCHS, CSIC). Albasanz, 26-28. 28037 Madrid, Spain..
monica.ruiz@cchs.csic.es

Alfonso SANTORIELLO
Laboratory of Archaeology "M. Napoli", University of Salerno. Via Ponte don Melillo, 84084 Fisciano (Salerno), Italy.
alab@unisa.it

Francesco SCELZA
Laboratory of Archaeology "M. Napoli", University of Salerno. Via Ponte don Melillo, 84084 Fisciano (Salerno), Italy.
alab@unisa.it

Rita SCHEEL-YBERT
Departamento de Antropologia, Museu Nacional, Universidade Federal do Rio de Janeiro. Quinta da Boa Vista, 20940-040, Rio de Janeiro, Brazil.
scheelybert@mn.ufrj.br

Werner H. SCHOCH
Labor für quartäre Hölzer, Unterrütistrasse 17, 8135 Langnau a. A. Schweiz.
holz.schoch@woodanatomy.eu
www.woodanatomy.eu

Tim M. SCHROEDTER
Graduate School "Human Development in Landscapes", Christian-Albrecht-University (CAU) D-24098 Kiel, Germany.
Institute for Ecosystem Research CAU, D-24098 Kiel, Germany.
tschroedter@ecology.uni-kiel.de

José Luis SOLAUN
University of the Basque Country (UPV/EHU). Tomás y Valiente s/n. 01006 Vitoria-Gasteiz, Spain..
joseluis.solaun@ehu.es

Angela STELLATI
Laboratory of Archaeobotany and Palaeoecology, Department of Cultural Heritage, University of Salento, via D. Birago 64, 73100 Lecce.
Department of Antiquity, University of Bari, Italy.

angela.stellati@libero.it

Giovanni STRANIERI
Centre d'histoire et d'archéologie médiévales - Université Lumière Lyon 2, 69365 Lyon, France.
giovanni.stranieri@univ-lyon2.fr

Georgia STRATOULI
IZ´ Ephorate of Prehistoric and Classical Antiquities, Aristotelous 16, GR – 582 00 Edessa, Greece.
59strat@otenet.gr

Ingelise STUIJTS
Discovery Programme, 63 Merrion Square, Dublin 2, Ireland.
ingelise@discoveryprogramme.ie

Christophe TARDY
INRAP Méditerranée, 561 Rue Etienne Lenoir, Km Delta, 30900 Nîmes, France.
christophe.tardy@inrap.fr

Andrés TEIRA BRIÓN
Grupo de Estudos para a Prehistoria do NW Ibérico (GEPN). Departamento de Historia I. USC. 15782 Santiago de Compostela, Spain.
andresteirabrion@gmail.com

Margareta TENGBERG
University of Paris 1, UMR 7209, Archéozoologie, Archéobotanique. Sociétés, Pratiques, Environnements (Muséum national d'histoire naturelle). 55, rue Buffon 75005 Paris, France.
margareta.tengberg@mnhn.fr

Romain THOMAS
Université de Picardie Jules Verne. Ecologie et Dynamiques des Systèmes Anthropisés – 1 rue des Louvels 80037 Amiens cedex, France.
romain.thomas@u-picardie.fr

Guillermo TORTAJADA COMECHE
Servicio de Investigación Prehistórica, Museo de Prehistoria, Diputación de Valencia, C/Corona 36, 46003, Valencia, Spain.
g.tortajada@hotmail.com

Sílvia VILA MOREIRAS
Dpt. de Història. Universitat de Lleida. 25003 Lleida, Spain.
svila2@homail.com

Valentín VILLAVERDE
Department of Prehistory and Archaeology. University of Valencia. Avda. Blasco Ibáñez, 28, 46010 Valencia, Spain.
Valentin.villaverde@uv.es

Jaime VIVES-FERRÁNDIZ SÁNCHEZ
Servicio de Investigación Prehistórica, Museo de Prehistoria, Diputación de Valencia, C/Corona 36, 46003, Valencia, Spain.
jaime.vivesferrandiz@dival.es

Lydia ZAPATA
University of the Basque Country (UPV/EHU). Tomás y Valiente s/n. 01006 Vitoria-Gasteiz, Spain.
lydia.zapata@ehu.es

João ZILHÃO
ICREA Research Professor at the University of Barcelona, Spain.
joao.zilhao@ub.edu

ERNESTINA BADAL[1], YOLANDA CARRIÓN MARCO[1], JESÚS F. JORDÁ[2]

Charcoal analysis at the San Chuis hill fort (Allande, Asturias, Spain)

1 Dpto. de Prehistòria i Arqueologia. Universitat de València. Avda. Blasco Ibáñez, 28 46010 Valencia, Spain. Ernestina.badal@uv.es, Yolanda.carrion@uv.es

2 Dpto. de Prehistoria y Arqueología. UNED. 28040 Madrid, Spain. jjorda@geo.uned.es

***Summary**: The archaeological site of the San Chuis hill fort (Allande, Asturias, Spain) is located in the central part of the western Cantabrian Range. The site was occupied between 920 - 480 cal BC (2870 - 2430 cal BP) and 100 cal BC - 540 cal AD (2050 - 1410 cal BP). Repeated and long-lasting occupation resulted in the overlapping of architectural structures from the first and second Iron Ages and the Roman Period. The study of the wood charcoal remains from these structures allows us to distinguish two groups of wood remains. Those timbers used in the construction of the buildings and those used as firewood.*

***Key words**: Hill fort, Iron Age, Roman period, firewood, timber, woodland exploitation.*

INTRODUCTION AND ARCHAEOLOGICAL BACKGROUND

The San Chuis hill fort (Allande, Asturias, Spain) is located in the western part of the Cantabrian Mountains at an elevation of 780-800 m a.s.l. and 35 km from the coast (Fig. 1). The site is situated between the Eucolino and Submontano bioclimatic levels and within the vegetation series of *Quercus robur* and *Quercus pyrenaica*. Between 600 and 1200 m a.s.l., the average annual rainfall exceeds 1000mm and it is here that *Quercus pyrenaica* woodland is found, including *Corylus avellana*, *Acer campestre*, and *Fraxinus excelsior*. In the clearings, various shrubs of the *Genista*, *Erica*, *Cytisus*, etc. genera are also present (Costa *et al*. 2005).

The hill fort was discovered in 1952 and excavated by Professor Francisco Jordá Cerdá during the 1960's and 1980's, while over the last ten years excavations have continued by one of the authors (Jordá 2009). The sequence covers a long period of time from 920 to 480 cal BC (2870 - 2430 cal BP) and from 100 cal BC to 540 cal AD (2050 - 1410 cal BP) (Fig. 1). The minimum span of this occupation is 1160 years. The chronology of the settlement is finely defined by nine radiocarbon dates (Jordá *et al*. 2002; Marín *et al*.

2008). Three occupation phases were distinguished on the basis of the dates, the stratigraphy, the overlapping structures and the materials recovered. The two earliest phases are associated with indigenous populations and the latest with the Roman reoccupation of the area.

The earliest settlement is located in the upper quarter of the hill fort, where the remains of a timber structure built over the rocky substrate was uncovered. The structure, which was dated to between 890 and 530 cal BC, contained burnt seeds and pottery of the first Iron Age. The following occupation phase was characterized by the construction of circular stone structures in

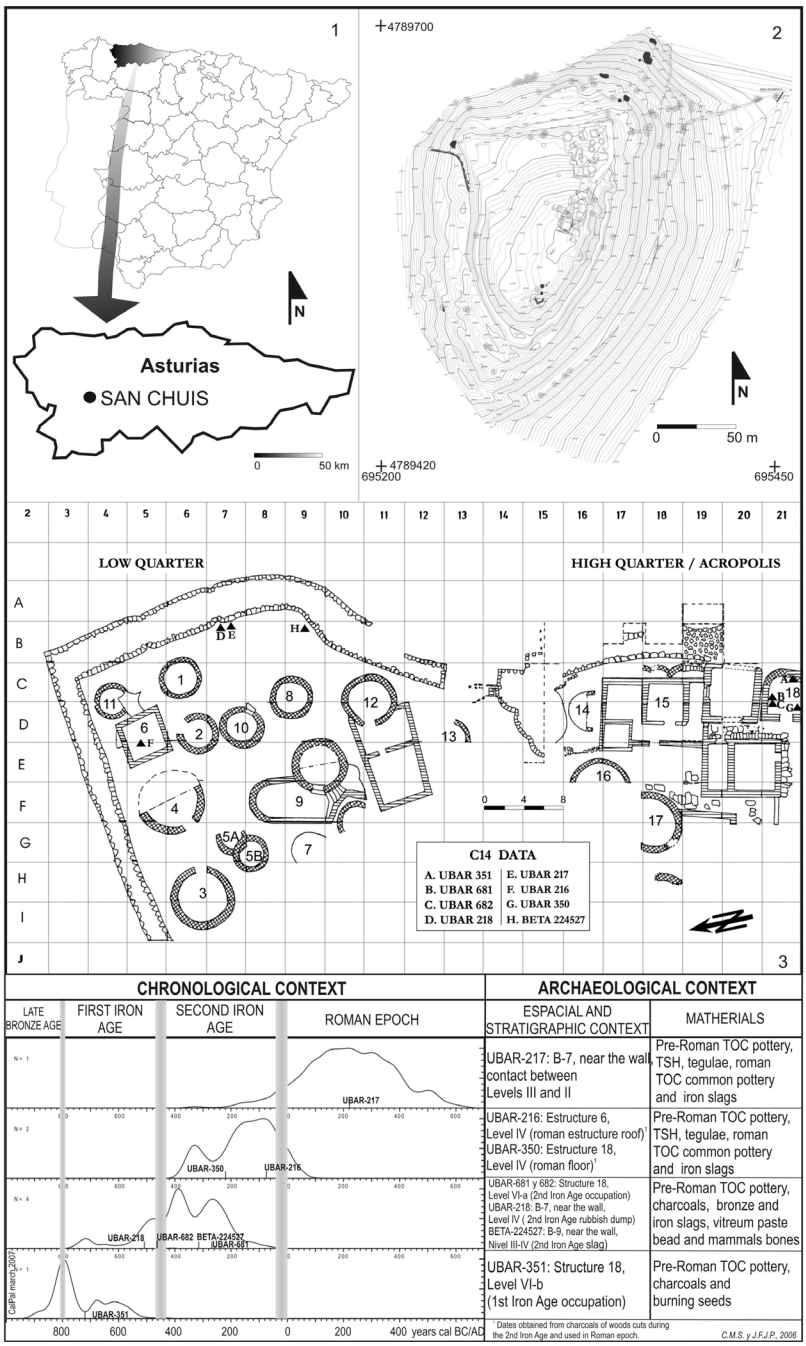


Figure 1. Location and chronological sequence of San Chuis hill fort.

both the upper and lower quarters of the fort, and was dated between 710 and 130 cal BC. Associated with these structures was pottery of the Second Iron Age and remains associated with metallurgical activities. The third occupation phase was dated to the Roman period between 110 cal BC and 530 cal AD. It is characterized by rectangular stone structures, densely built in the upper quarter, either over the previous circular ones or on new foundations. Pre-Roman pottery, *Terra Sigillata Hispanica*, *tegulae*, along with significant quantities of Roman pottery and iron slag was found in this settlement.

The recovery and analysis of wood charcoal samples from San Chuis is significant in the study of Asturian hill forts. There are a small number of other palaeoenvironmental analyses from archaeological sites in the area, including La Campa Torres (Buxó and Echave 2001), Camoca, Moriyón and Olivar (Camino 1999). The new data from San Chuis will enrich our knowledge of the past vegetation and use of timber in these types of hill fort sites.

METHOD AND MATERIALS

The wood charcoal samples presented in this paper were recovered during the excavations of the early 1980's. The aim of their collection was to obtain radiocarbon dates and sampling was therefore restricted to those layers and structures that needed to be dated. Part of the charred material recovered at that time was processed for radiocarbon dating without previously obtaining botanical identification of the wood charcoal remains. The analysis of the rest of the material is presented here, thirty years after its recovery during excavation. For these reasons, the results of the analysis relate only to certain parts of the site, and not to systematic sampling of the whole excavated area.

Wood charcoal samples from the indigenous settlement (level VI) were found at the bottom of circular structures and in a waste pit that correspond to the earliest occupation of the hill fort (UBAR-351: 2600±60 BP). The charred wood remains originate from the clearing out of domestic hearths and they represent firewood collection within the catchment of the site (Table 1).

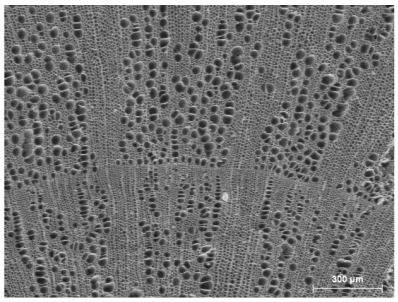
Wood charcoal samples from the Roman period are scarce; with two found scattered in the Roman occupation level IV and one in the collapse layer of an observation tower (level IIIb – UNBAR-216: 2050±50 BP). This latter sample was of construction timber from the tower, which was destroyed by fire and eventually collapsed.

For the taxonomic identification of the specimens we used a Nikon Optiphot-100 dark/bright field incident light microscope with 50-500x magnifications, specialized plant anatomy bibliography and the reference collection of modern charred woods of the Laboratory of the Dept. of Prehistory and Archaeology, University of Valencia, Spain.

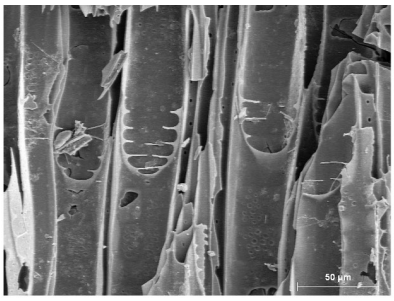
Photography and detailed observation was carried out using a Hitachi S-4100 Field Emission Scanning Electron Microscope and the EMIP 3.0 (Electron Microscope Image Processing) software at the Service for the Support to Experimental Research (SCSIE), Universitat de València.

Period	Indigenous		Roman	
Level	SC 1, N VI		SC 3, N IV	SC 5-4, N III
Square	C21, D21	C7	B7, E5	D4, D5
Taxa/Context	Feature fill	Landfill	Occupation	Roof collapse
Corylus avellana	1	2		8
Erica sp.			1	107
cf. *Erica* sp.				9
Ficus carica				5
Fraxinus sp.	7			
Fabaceae	6			28
Pinus nigra-sylvestris	2			
Quercus sp. deciduous	22	1	1	90
Rosaceae	3			
Salix sp.	1			
Non-identifiable	1			5
Total	43	3	2	252

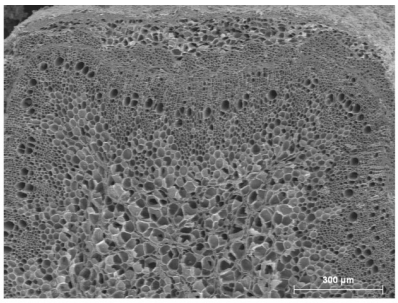
Table 1. Plant taxa identified at San Chuis.



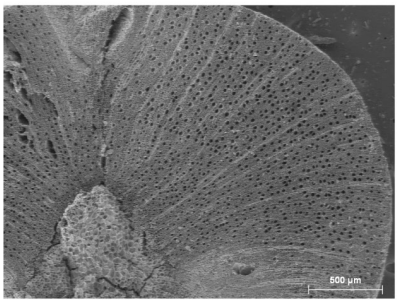
Corylus avellana (cross section X70) from the Roman construction layer



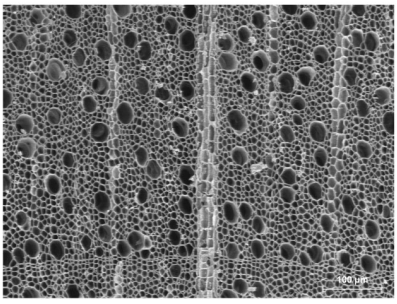
Corylus avellana (tangential section X500) from the Roman construction layer



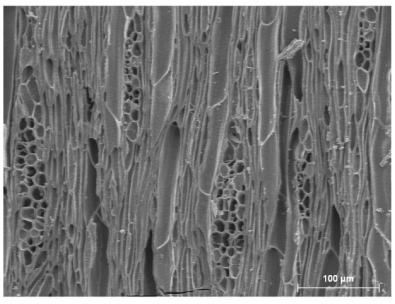
Corylus avellana branche (cross section X90) from the Roman construction layer



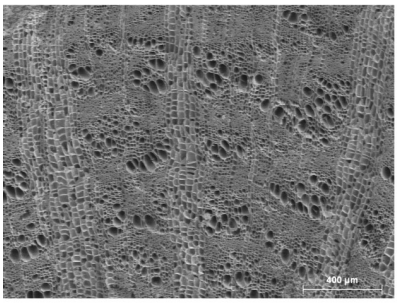
Erica sp. branche (cross section X45) from the Roman construction layer



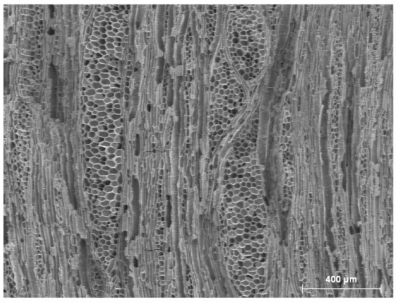
Erica sp. (cross section X180) from the Roman construction layer



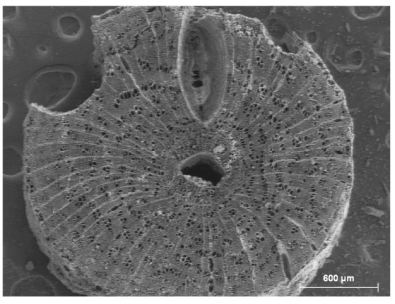
Erica sp. (tangential section X250) from the Roman construction layer



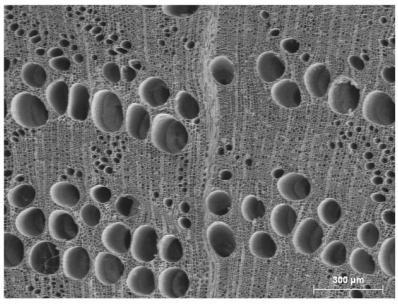
Fabacea (cross section X60) from the Roman construction layer



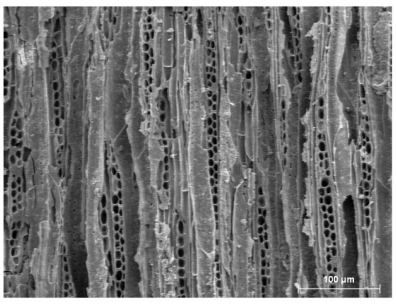
Fabacea (tangential section X60) from the Roman construction layer



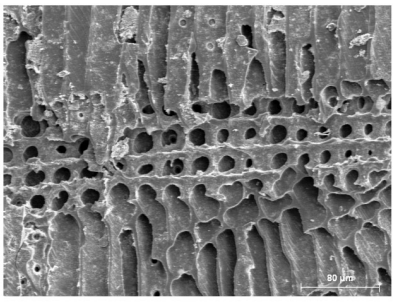
Fabacea branche (cross section X60) from the Roman construction layer



Quercus sp. deciduous (cross section X70) from the Roman construction layer



Rosacea Maloidea (tangential section X250) from the Indigenous feature fill



Pinus nigra-sylvestris (radial section X300) from the Indigenous feature fill

Figure 2. SEM photographies of some plant taxa identified at San Chuis.

DATA AND RESULTS

The following taxa were identified in the indigenous and Roman levels. *Quercus* sp. deciduous type (oak), *Corylus avellana* (hazel tree) and Fabaceae (legume undershrubs). *Pinus nigra and/or P. sylvestris* (black-Scotts pine), *Fraxinus* cf. *excelsior* (ash), Rosaceae (the rose family) and *Salix* sp. (willow) were also identified in the indigenous level. Another two taxa were present in the assemblage from the Roman level, *Erica* sp. (heather), and *Ficus carica* (fig tree) (Table 1; Fig. 2). The material studied can be differentiated as firewood from domestic hearths, and construction timber from the observation tower.

FIREWOOD

The charred firewood remains of the indigenous settlement were collected from different fill layers. The results were not quantified since only 42 fragments belong to these levels. However, the flora recorded and the ecological requirements of the identified taxa reflect the natural vegetation that would have been exploited for firewood. *Quercus* sp. deciduous type woodland would have grown around the hill fort. At present, *Quercus robur* expands from the Cantabrian cordillera to the costal lowlands while *Quercus pyrenaica* grows at higher elevation, usually accompanied by *Corylus avellana* (Costa *et al.* 2005). Given that San Chuis is located at the point of intersection between these two species, we may suggest that mixed deciduous oak woodland with an undestorey of Fabacea and Rosacea would have existed in the area. Riverside vegetation is reflected in the presence of ash and willow.

The conifers are represented by *Pinus*. Although it has been impossible to distinguish the pine species, it is almost certain that cryophilous types are present. Thus, the wood charcoal from level VI may originate from *Pinus sylvestris* or *Pinus nigra*. Both species grow in the coldest bioclimatic zones of the Iberian mountains. *Pinus sylvestris* is more cold-adapted and humidity sensitive than *P. nigra*. Extended *Pinus sylvestris* forests exist in the Pyrenees and the mountains of northern Iberia. *P. nigra* is restricted to the eastern mountains from the Pyrenees to Andalucía and does not reach Asturias.

During the Roman occupation some of the indigenous structures were reused (with the addition of rectangular walls) and new ones were built. From the habitation floors of these structures there are only two wood charcoal fragments, documenting the presence of *Erica* sp. and *Quercus* sp. deciduous type.

TIMBER

Level III corresponds to the collapse of walls and stone structures of the 2nd century AD. The wood charcoal associated with the observation tower of the Roman period, dated to 2050±50 BP (UBAR-216) was analyzed, provided evidence for the plant species used for the construction of the walls and roof.

200 wood charcoal fragments were collected from the remains of the roof while only 52 fragments belong to the collapsed walls. *Erica* sp., Fabaceae and *Quercus* sp. deciduous type wood was selected for the construction of the roof. *Erica* is the taxon mostly used, followed by *Quercus*. For the construction of the walls *Corylus avellana, Erica* sp., *Ficus carica* and *Quercus* sp. deciduous type were used. In Figure 3 the proportion of the different taxa used in the construction of the roof and walls is presented.

The morphology of the wood charcoal allows us to distinguish two categories of wooden structural elements. Large caliber trunks would have formed the structure of the tower. Squared surfaces were present in some charcoal samples but due to the high degree of fragmentation it was difficult to count with precision the annual growth rings and estimate the minimum age of the trees used. All the larger structural elements were identified as *Quercus* sp. deciduous. The second category includes small diameter branches that in many cases preserved bark. This allowed us to calculate the diameter of the branches and to determine

the caliber of those selected for the roof.

The diameter of 100 branches from the roof was measured. The column charts in Figure 4 show the percentages for each taxon, together with the distribution of the taxa in different diameter categories (<5; 5-10; 11-15 and >15 mm). Selection of *Erica*, Fabaceae and *Quercus* branches with diameters between 5 and 10 mm is indicated. However, the diameters of *Erica* branches are more variable and this may be due to the indiscriminate use of all the branches of plants of this genus since they are adequate for roofing material.

Preservation of the bark on many branches allowed us to estimate the cutting season. This information was obtained by observing the characteristics of the last annual growth ring in relation to the bark. The presence of latewood in the last annual ring indicates that the branch was cut during the least favorable season for plant growth, which is after the summer. When earlywood starts to form this indicates that the cutting season was in spring.

The growth of the last annual ring was observed in 41 branches. Figure 5 shows that the wood was predominantly cut when earlywood was forming during the most favorable season for tree growth, the spring. Only *Corylus* was cut when latewood was forming. The branches of Fabaceae were all cut in the favorable season as was also the case for *Quercus* with only one exception (Fig. 5).

The work of Vitruvius provides evidence of the high degree of knowledge concerning the different mechanical qualities of wood in each season. When rigid wood was required this had to be cut at the beginning of the autumn while in spring the wood would be more porous, fragile and flexible due to the presence of substances associated with the growth of new leaves and fruit (Adam 1984: 91). Therefore, the cutting season would have been adapted to the wood

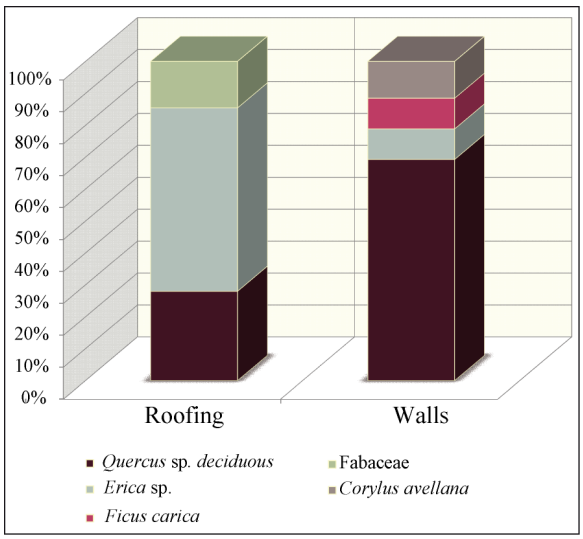


Figure 3. Plant taxa identified in the construction debris of the Roman tower at San Chuis.

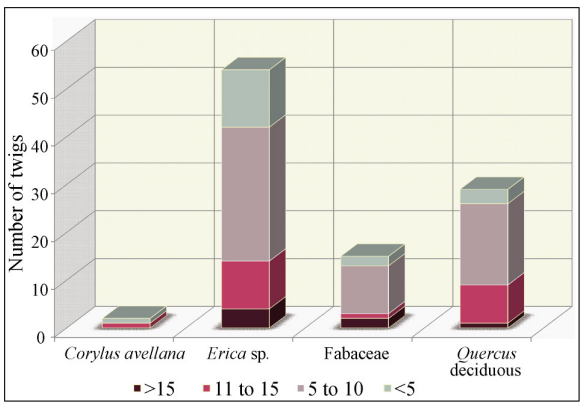


Figure 4. Proportions of various diameter branches of different taxa used for the construction of the Roman tower roof.

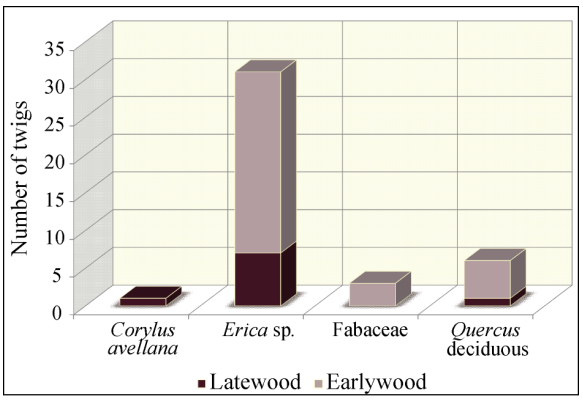


Figure 5. Felling season of the branches used for the construction of the Roman tower roof.

qualities required for different uses.

The sample from San Chuis, although small, indicates that spring was the main cutting season and to a lesser degree others. This would have been deliberately geared to obtaining timbers of variable flexibility or for storage, as construction requires planning and early procurement of raw materials.

DISCUSSION

The results of the wood charcoal analyses from the San Chuis hill fort have provided a snapshot of the flora of Asturias during the Iron Age. They include woody plants used for fuel by the indigenous population and the timber selected for the construction of the Roman observation tower. The results are limited though, since the samples derive from early archaeological work where systematic sampling was not common. However, some interesting results have been provided by the analysis of this small number of wood charcoal samples.

The flora associated with the indigenous settlement indicates that thermo-climatic characteristics then were similar to those prevailing today in the study area. The same plant taxa form the present woodlands in the region although the signs of human impact on the vegetation are more intense. The presence of *Pinus sylvestris* and/or *Pinus nigra* indicates cooler conditions.

The Alto de la Espina (Salas, Oviedo) peat bog which is located at 650 m a.s.l. and close to the San Chuis hill fort has provided a pollen diagram. The wood charcoal results from the fort can be compared with the palynological evidence in order to further develop our regional understanding. According to the pollen diagram the vegetation during the Iron Age was dominated by deciduous *Quercus* sp. and *Corylus avellana*. The most abundant undershrubs belonged to *Erica*, *Calluna* and *Cytisus* (Lopez Merino 2009; Carrión *et al.* 2012). According to López Merino, evidence for human impact on the vegetation can be seen in the increase of *matorral* species, cereal pollen and *Plantago*. The flora identified in the levels of the indigenous settlement at San Chuis is in line with the pollen results. Moreover, at San Chuis we identified specimens of *Pinus sylvetris* and/or *P. nigra* that could have originated from the coldest parts of the region.

From the Roman occupation, only wood charcoal remains from construction timber were available for analysis. Therefore, it is not possible to make inferences as to the natural vegetation of the area since the material was intentionally selected for specific uses. However, we may suggest that the timber used was procured from the local woodland and this is supported by the pollen data from Alto de la Espina, with vegetation characteristics similar to the previous period, i.e. *Quercus* and *Corylus avellana*. The intensification of mining activities during the Roman occupation can be detected in the pollen record by the increase of Cerealia, *Castanea sativa* and *Junglans* (Lopez Merino 2009; Carrión *et al*. 2012).

The wood charcoal remains from the Roman levels at San Chuis provide information about the timbers used in the construction and the criteria for their selection in relation to their function. For structural elements used to support heavy loads, deciduous oak (*Quercus*) lumber was selected. For roof coverings or the wattle structure of walls, *matorral* species were used since these provided twigs and branches of adequate caliber that could be used without thinning. It is for this reason that many branches preserve bark while the majority are of a standard diameter (5-10 mm charred). Similar construction techniques were documented at other sites such as O Castelo (As Laias, Ourense) or Noville (Mugardos, Coruña) (Carrión 2005). In terms of cutting season, the results are similar at all sites, with wood harvested all year long although preferably towards spring.

Woodworking marks were not observed on the timbers from the observation tower at San Chuis due to the high degree of fragmentation of the charcoal. The exception are the *Quercus* poles or beams, on some of which intentional squaring was observed. These timbers would have formed part of the wall or

roof framework. The use of deciduous oak timber in Roman architecture is documented in the *Opus craticium* technique and the wattle. However, we do not have enough evidence to suggest which of these techniques would have been used in the tower.

The branches used for the wattle structure of the walls or for the roof were not prepared in any way. The majority preserve bark and probably only had a transversal cut depending on the desired length. At San Chuis most of the twigs were cut in spring while at other sites there is no clear tendency towards one season or another. Vitruvius writes "timber should be felled between early autumn and the time when Favonius begins to blow. For in spring all trees become pregnant, and they are all employing their natural vigour in the production of leaves and of the fruits that return every year. The requirements of that season render them empty and swollen and so they are weak and feeble because of their looseness of texture. (Vitr. 2.9). It is possible that there was some planning concerning the provison of timber for woodworking and carpentry. Wood would have been cut during the year in order to season before being used for construction. However, the predominance of branches cut in the spring may indicate that flexible and easy to bend materials were needed for the wattle structure of walls and roofs.

CONCLUSIONS

Analysis of the wood charcoal from the San Chuis hill fort has suggested the following:

- A variety of species were used for firewood in domestic hearths in the indigenous settlement, except for *Erica*. Deciduous oak woodland around the site would have included mountain pines, heather, legume undershrub and some riverine taxa (ash and willow).

- For the construction of the Roman tower, heather was mainly used as roofing material, with deciduous oak timbers for the structure, along with some use of *Corylus avellana*, Fabaceae and *Ficus caria*.

-The wood used in the construction shows morphological characteristics which allow us to define two types of timber use. Large oak beams and then twigs or small diameter branches of various taxa, oak included.

- Bark preservation on some twigs shows that the wood used for the construction was mainly cut in the most favorable season for growing and obtaining the best mechanical qualities. However, a small percentage of wood collected during less favorable seasons may suggest either that construction activities were quite long-lasting, or that the collected wood was stored for some time. Alternatively these characteristics may reflect periodic maintenance of roofs and walls.

ACKNOWLEDGEMENTS

This work was carried out with the financial support of the Principality of Asturias.

REFERENCES

ADAM, J.-P. (1984) : *La construction romaine : matériaux et techniques.* Ed. Picard, París.

BUXÓ, R.; ECHAVE, C. (2001): Estudio de los restos paleoarqueológicos del yacimiento de La Campa Torres (Gijón, Asturias). In: J.L. Maya, F. Cuesta eds. *El Castro de La Campa Torres. Período Prerromano*. Serie Patrimonio 6. VTP Ed. y Ayto. de Gijón, 307-310.

CAMINO, J. (1999): Excavaciones arqueológicas en castros de la ría de Villaviciosa. Precisiones cronológicas. *Excavaciones Arqueológicas en Asturias 1995-98* (4), 151-161.

CARRIÓN MARCO, Y. (2005): *La vegetación mediterránea y atlántica de la Península Ibérica: nuevas secuencias antracológicas*. Trabajos Varios 104. Servicio de Investigación Prehistórica, Valencia.

CARRIÓN, J.S.; FERNÁNDEZ, S.; GONZÁLEZ-SAMPÉRIZ, P.; LÓPEZ-MERINO, L.; PEÑA, L.; BURJACHS, F; LÓPEZ-SÁEZ, J.A.; GARCÍA-AN-

TÓN, M.; CARRIÓN MARCO, Y.; UZQUIANO, P.; POSTIGO, J.M.; BARRÓN, E.; ALLUÉ, E.; BADAL. E.; DUPRÉ, M.; FIERRO, E.; MUNUERA, M.; RUBIALES, J.M.; GARCÍA AMORENA, I.; JIMÉNEZ MORENO, G.; GIL ROMERA, G.; LEROY, S.; GARCÍA-MARTÍNEZ, M.S.; MONTOYA, E.; FLETCHER, W.; YLL, E.; VIEIRA, M.; RODRÍGUEZ-ARIZA, M.O.; ANDERSON, S.; PEÑALBA, C.; GIL GARCÍA, M.J.; PÉREZ SANZ, A.; ALBERT, R.M.; DÍEZ, M.J.; MORALES-MOLINO, C.; GÓMEZ MANZANEQUE, F.; PARRA, I.; RUIZ ZAPATA, B.; RIERA, S.; ZAPATA, L.; EJARQUE, A.; VEGAS, T.; RULL, V.; SCOTT, L.; ABEL SCHAAD, D.; ANDRADE, A.; MANZANO, S.; NAVARRO, C.; PÉREZ DÍAZ, S.; MORENO, E.; HERNÁNDEZ-MATEO, L.; SÁNCHEZ BAENA, J.J.; RIQUELME, J.A.; IGLESIAS, R.; FRANCO, F.; CHAÍN, C.; FIGUEIRAL, I.; GRAU, E.; MATOS, M.; JIMÉNEZ ESPEJO, F.; VALLE-HERNÁNDEZ, M.; RIVAS-CARBALLO, R.; ARRIBAS, A.; GARRIDO, G.; MUÑIZ, F.; FINLAYSON, G.; FINLAYSON, C.; RUIZ, M.; PÉREZ JORDÁ, G.; MIRAS, Y. (2012): *Paleoflora y Paleovegetación de la Península Ibérica e Islas Baleares: Plioceno-Cuaternario.* Ministerio de Economía y Competitividad, Madrid. http://paleofloraiberica.net/INICIO.html

COSTA, M.; MORLA, C.; SAINZ, H. (eds.) (2005): *Los bosques ibéricos: una interpretación geobotánica* Ed. Planeta. Barcelona.

LÓPEZ MERINO, L. (2009): *Paleoambiente y antropización en Asturias durante el Holoceno*. PhD Thesis, Universidad Autónoma, Madrid.

JORDÁ, J.F. (2009): Descubriendo el castro de San Chuis (Allande, Asturias). Nuevas aportaciones al conocimiento de la cronología radiocarbónica de los castros asturianos. *Entemu* XVI, 47-63.

JORDÁ, J.F.; MESTRES, J.S.; GARCÍA, M. (2002): Arqueología castreña y método científico: nuevas dataciones radiocarbónicas del Castro de San Chuis (Allande, Asturias). *Croa* 12, 17-36.

MARÍN, C.; JORDÁ, J.; GARCÍA-GUINEA, J. (2008): Arqueometría en el castro de San Chuis (Allande, Asturias, España). *Férvedes* 5, 52-62.

VITRUBIO, M.I. *The Ten Books of Architecture*. Morris Hicky Morgan Ed. (www.Perseus. tufts.edu).

GOBIERNO
DE ESPAÑA

MINISTERIO
DE CIENCIA
E INNOVACIÓN