# ForSEAdiscovery. Forest resources for Iberian Empires: Ecology and Globalization in the Age of Discovery (16th-18th centuries)

# ForSEAdiscovery. Los recursos forestales para los Imperios ibéricos: ecología y globalización en la era de los descubrimientos (siglos XVI al XVIII)

**Ana Crespo-Solana**
Científica del CSIC
Instituto de Historia, Consejo Superior de Investigaciones Científicas (CSIC), Madrid, Spain
ana.crespo@cchs.csic.es

**Nigel Nayling**
Professor of Archaeology
University of Wales Trinity Saint David (UWSTD), Lampeter, Wales, United Kingdom
n.nayling@uwtsd.ac.uk

**Abstract:** In the Early Modern Age (16th-18th centuries) the construction of ocean-going ships was paramount to the development of cultural encounters during European expansion. In the case of the Iberian Empires, the establishment of new trade routes brought the need for armed merchantmen, galleons and smaller vessels, placing unprecedented demands on Iberian forests for the supply of construction timber. Forestry and sea power became inextricably linked, creating new geopolitical tensions, alliances and forest regulations. This paper outlines the methodologies and objectives of a major multidisciplinary project funded through a Marie Curie Actions grant (2014-18) which will see collaboration between universities, state research centres, and maritime archaeology companies.

**Key words:** Nautical archaeology, dendrochronology, historical GIS, Iberian Empires, shipbuilding.

**Resumen:** durante la Edad Moderna (siglos XVI al XVIII) la construcción naval fue la base principal para el desarrollo de la expansión europea. Para los Imperios ibéricos el establecimiento de nuevas rutas marítimas implicó la necesidad de construir y armar barcos mercantes, galeones y

pequeños navíos imponiendo una demanda sin precedentes sobre los recursos forestales en la península ibérica con el objeto de surtir de madera a las necesidades navales. Bosques y poder naval se convirtieron así en dos caras cuestiones relacionadas que crearon nuevas tensiones geopolíticas, alianzas y regulaciones sobre los recursos forestales. Este artículo describe metodologías y objetivos del más importante proyecto multidisciplinar financiado por el Programa Marie Curie Actions (2014-1018) que cuenta con una amplia colaboración entre universidades, centros de investigación y empresas de arqueología marítima.

**Palabras clave:** Arqueología náutica, dendrocronología, SIG histórico, Imperios ibéricos, construcción naval.

## The ForSEAdiscovery Project, a historiographical framework

Historical studies have been looking into so-called «Environmental History» only for the last few decades. It can be said that social sciences has created a paradigm about the relation between human societies and nature throughout the centuries in which social, economic and political cooperation and competition have been employed for the exploitation of natural resources. However, one of the most relevant aspects of the first global age has not attracted the attention of the environmental social scientist, the evolution of maritime empires and its impacts in shipbuilding and forest resources. The primary assumption is that the history of deforestation in Europe is linked to economic development and military expansion (Williams, 2006). However, few authors make reference to the relationship between deforestation, how timber resources were used and traded, the monopoly held by contemporary financial lobbies, and shipbuilding. John Richards mentions an activity that could well be related to timber (Richards, 2006: 36).

> «A prevailing sense of scarcity and doubt about sustaining local resources that leads organized groups to push commercial and political activities into new frontiers».

Richards sets out in this work to correct what he sees as a prevailing notion in environmental history that such organized human activities in the early modern era resulted in:

> «an unrelieved tragedy of remorseless ecological degradation and accelerating damage.»

Wood was the first and most important natural resource for building and arming navies for the expansion and conquest of new territories, as well as for subsequent merchant operations. In this respect, the use and exploitation of forest resources over the modern period is comparable to the use of oil since the Industrial Revolution in terms of its strategic importance. This paradigm is especially important in the naval history of Spain and Portugal during the Early Modern Ages (Urteaga, 1987).

It is this historiographical framework which delineates the ForSEAdiscovery project, a Marie Curie Initial Training Network (ITN) funded by the European Commission with a consortium of fourteen participating institutions from eight different countries. This interdisciplinary project utilises history, underwater archaeology and dendrochronology to examine shipbuilding industries and timber use in the Early Modern Iberian Empires (16th to 18th centuries)[1]. It is set in the Atlantic history during the first global age and has a dual objective: to collect bibliographic and documentary information as well as other literature on naval construction

[1] ForSEAdiscovery (Marie Curie Programme, FP7-People, 2013, ITN, Multipartner). This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement n.º PITN-GA-2013-607545.

and the use of timber within the political, administrative and economic framework in which the trade, distribution and utilization of forest resources was conducted in the Iberian empires; and to complement this with analysis of the archaeological evidence collected from Iberian shipwrecks, timber and other artefacts. Dendroarchaeology, complemented by a range of analytical techniques, will be applied to samples from selected shipwrecks that are thought to have been built in Iberia. Dendrochronology has the potential to determine the year in which the trees used for ship timber production were cut, and also to determine the geographical origins of these parent trees (Nayling, 2009). This adds value to historical knowledge of these shipwrecks and to validate the information from historical sources. It will be important to know how timber trade networks were organized to deliver forest resources to shipbuilding locations. Given the wealth of information available in historical databases on how wood was transported from Northern and Eastern Europe to the Iberian Peninsula between the sixteenth to eighteenth centuries, it would be reasonable to suppose that we should identify at least a proportion of the timber found in shipwrecks as being of non-Iberian origin (through dendro-provenancing).

The interplay between innovation and technological change in shipbuilding from the end of the medieval period through the Early Modern Era and scarcity of raw materials (in particular timber, whether this scarcity was perceived or real) has been the subject of both historical and archaeological discourse (Adams, 2013; Albion, 1926; Bamford, 1956; Wing, 2015). There is no doubt that the sixteenth century saw significant technological changes in shipbuilding on the Atlantic Iberian coast. To what extent the challenges of timber supply played a part in encouraging innovation remains less clear. Equally, the question of whether the shipbuilding demands for timber resulted in sustainable change of forestry practices in the Iberian Peninsula or deforestation and increasing dependence on timber imports cannot be readily resolved. It has been argued that by the eighteenth century conservation policies and resource organization, at least in the Spanish case, had developed sustainable levels of forest exploitation (Martinez González, 2013). We should not be surprised however to find both national and regional variation in woodland management, forestry practice, modes of resource control and delivery in support of shipbuilding industries for state navies and more localised private enterprise. Such complexity is best investigated through a multi-disciplinary approach drawing on the complementary approaches of history, archaeology and wood science.

Therefore, this research project is divided into three research work packages: historical wood supply and dynamic trade networks (history, GIS); nautical archaeology and shipbuilding (history and archaeology); and wood provenance (dendrochronology, wood anatomy, and wood chemistry). ForSEAdiscovery is an example of a cooperative effort to be made by the members of the Consortium headed by the Consejo Superior de Investigaciones Científicas (CSIC) in Madrid (Spain), seven laboratories from prestigious academic institutions (Universidade Nova de Lisboa; Universidad de Santiago de Compostela, University Wales Trinity Saint David, Universiteit Wageningen, Universiteit Leiden, Rijksuniversiteit Groningen and University of Lorraine) and one private company (Maritime Archaeology Ltd.) in five European countries (Spain, Portugal, France, United Kingdom and The Netherlands). This network of full participants is supported by another five associated partners: two key academic institutions (Nicolas Copernicus University in Poland and Texas A & M University in USA). Three small-sized companies also form part of the Consortium: Archeonauta S.L., specialised in the archaeological survey of shipwrecks, DendroDK, a sole-trader company specialised in dendroprovenancing of shipwrecks; and Dixit International, specialised in documentaries and audio-visual research[2].

[2] See web page of the Project: http://forseadiscovery.eu/.

The Consortium is supervising and developing fifteen individual subprojects with specific research objectives:

1. To create an inventory based on archival information of the sources of oak and pine used for shipbuilding in the Iberian Peninsula.

2. To collate historical and archaeological information regarding construction features of specific Iberian ships.

3. To investigate how the supply of timber and its dynamic trade network were organized

4. To synthesize results and to develop a Historical GIS based model combining information from the different disciplines involved in the project.

The research team aims to provide answers to a range of pertinent questions. Did Iberian forestry resources suffice to cover the high demand for shipbuilding during the centuries of European expansion? What was the nature and extent of trade that supplied timber from Northern Europe, mainly from the Baltic and Scandinavian areas? How did trade networks organise themselves around this timber trade? Was there a relation at all amongst the various monopolies of these networks? How was the exploitation of domestic timber resources arranged? How were these administered and employed by the lobbies that operated around the governments of these empires? This project tries to relate the history of naval construction and the progress of Atlantic maritime trade with deforestation and the value of timber resources, and to find out if all this had an impact on shipbuilding between the 16th to the 18th centuries.

## Merchant networks and high speculation over wartime control of timber resources

In the Early Modern Era, 16th-18th centuries, shipbuilding fuelled the building of the empires. Building techniques evolved to make ships capable of oceanic explorations. Also, in a very short period of time, the design and the way merchant ships and warships were rigged evolved, and naval organisation itself underwent major changes. This investigation cannot be conducted without a truly interdisciplinary approach. Portugal and Spain pioneered the design and building of ocean-going ships, and these advances made possible the transition from Mediterranean-style vessels to a totally new approach to shipbuilding. The Iberian empires became a unique model in terms of political, cultural, economic and social interaction in the Atlantic first, and then at a global scale. The Iberian expansion was a dynamic spatial model evolving into self-sustaining locational structures. This spatial structure affected the logistics developed by other powers as they settled on the borders with a view to furthering their own expansions (Crespo, 2014: 71-91). For a few years Spain and Portugal became the Iberian Union from 1580 to 1640. During that time a combination of cooperation and competition took place. Both commerce and naval technology were part of a mutually beneficial exchange between both nations.

It was a time of great expansion for Hispano-Portuguese networks when new trade routes were explored and opened, and also for the development of an «integrated seagoing artillery» to be built into newly designed prototypes of heavily armed vessels, galleons and other smaller ships. This state-of-the-art technology at the time affected not only the way these maritime societies developed but also the way natural resources were managed. These new processes took place in port cities which somehow became the cradle of new financial and commercial activities from the 16th century. Docks and other facilities for rigging and repairing ships were integrated in the maritime cities, many of which became institutionally-appointed shipyards.

Forestry resources were regarded as the prime raw material for building navies and the foundations for the expansion of the empires. Forestry issues and maritime strength became two inextricably linked questions which led to geopolitical alliances and animosities that were reflected in the treaties signed at the time, in laws, forestry-related regulations, and in the emergence of new attitudes toward forestry management. In the 18th century Spain we saw an increase in forestry-related policies and in the interest shown by the State in safeguarding forests, as proven by the existing documentation (Martínez González, 2013). Also, at least hypothetically, a rise in the import of timber from Northern Europe was seen. The utilisation of wood from the Baltic and other distant areas was an ongoing practice in the whole of the Early Modern Era, and trading networks from Flanders and the Netherlands brought it to Spain and Portugal. Despite much research conducted into these commercial networks, the true nature of the relationship between this timber trade and the naval ventures of these two empires has not yet been elucidated. Another related question is the timber trade and the networks responsible for cutting down the trees and transporting them to the nodal points or ports for export. The new technological, economic and social scenes led to an all-time high in the demand for timber suitable for naval construction from the Iberian forests and form other areas. Oak (*Quercus spp.* ) and pine (*Pinus spp.* ) were the most sought-after types of wood, and traders were put under much pressure to keep up supply and develop new networks to ensure continuity.

## Nautical Archaeology and Shipbuilding

A key source material in any study of timber usage in Iberian shipbuilding is hull remains that have been subjected to archaeological investigation. The project aims to expand and update existing databases on Iberian shipwreck sites with surviving hull remains. Many suspected Iberian shipwrecks do nots include surviving timbers as a result of site formation processes. In other cases, sites known as a result of treasure hunting or looting where the focus was on recovery of artefacts without appropriate study of any surviving structures, and little or nothing is known about ship timbers. Nonetheless, numerous sites have been subjected to systematic archaeological investigation and less frequently detailed study of the scantling, morphology, mode and method of conversion, wood species and tree ring structure of timbers forming the ship's structure and fittings.

A number of *in situ* shipwreck sites will be selected for recording of hull structure, including details of exposed timber elements, and the recovery of samples for a range of analytical studies. A key focus for this aspect of the project will be suspected Iberian ships located off the Galician coast which have been under investigation by network partners for some years. Possible sites include the suspected 16th century galleon in Ribadeo, vessels associated with the AD 1596 Armada in Finisterre, then the 18th century frigate *La Santa María Magdalena* in Viveiro. As part of developing an effective diving team of young researchers capable of operating in a wide range of environments (including differing diving regulations for archaeological purposes), suspected Iberian sites lying off the coast of the United Kingdom will also be considered. A prime candidate is the protected Yarmouth Roads wreck which was subjected to selective excavation, provisional recording of surviving hull and the recovery of a substantial ceramic assemblage in the 1980s (Watson/Gale, 1990).

A further source of ship timber assemblages suitable for recording and analysis, with a focus on determining the nature of wood selection and usage, are collections held in storage or on display in museums and exhibitions. Examples range from the conserved Western Ledge material held in store in Bermuda (Bojakowski, 2011), the conserved and displayed Urbieta ship (Rieth, 2006), and the substantial collection of ship timbers held in Lisbon from underwater and urban excavations undertaken over decades. A demonstration project completed on the Arade

1 ship from this collection in Lisbon showed that the timbers came from mature oak trees felled in western France (Domínguez-Delmás *et alii*, 2013). This does not resolve whether the ship itself was French built or constructed in Iberia from imported timber. It is to be hoped that, where underwater archaeologists outside of the network are undertaking investigation of suspected Iberian shipwrecks, during the life cycle of the ForSEAdiscovery project, that we can collaborate to maximise the potential of such sites and recover selected samples for appropriate analysis.

Prime objectives of the project include the development of protocols for best practice in the recording, sampling and analysis of timbers from Iberian ships, whether *in situ* or following excavation and recovery. In recent years there has been widespread uptake of digital methods of recording including digital photogrammetry of *in situ* structures, and 3D contact digitising and laser scanning of collected timbers. The Newport mediaeval ship, arguably the first Iberian ship to have been dated by dendrochronology, provides a useful case study on the potential of the development of approaches to achieve the full potential of Iberian ship structures (Nayling/Jones, 2014). In this instance, following *in situ* recording of this clinker-built 15th-century ship, found in Wales, United Kingdom, the hull was dismantled and recovered for detailed recording. Three-dimensional contact digitising of individual timbers included recording of timber grain, knots and other morphological features of the wood were complemented by collection of data on annual ring counts and average ring widths. How such 3D records of characteristics of the parent trees used in timber production can best be utilised to produce digital 3D reconstructions of the parent trees will form one aspect of the ForSEAdiscovery project. Substantial numbers of samples were taken from those timbers with the best potential for dendrochronological dating (mostly radially split oak hull planks, and hewn oak framing timbers). Mean ring-width series derived from the hull planks were eventually cross-matched against tree ring series derived from historic buildings located in the hinterland of the northern Spanish (Basque) coast. The results not only confirmed and refined the 15th century construction date for the ship, but also by inference suggested a northern Iberian origin for the ship (Nayling/Susperregi, 2014).

## Wood Provenance

The establishment of a dense network of tree-ring chronologies covering much of Europe has enabled dendrochronology to become the primary method of determining both the date of construction of excavated ships, and also the geographical origins of the timber used in their construction (Daly, 2007). This methodology has also provided direct evidence for timber trade such as the importation of Baltic timber for use in ship construction (Wazny, 2005). In contrast, the development of such chronologies in the Iberian Peninsula is less well developed, and the use of dendrochronology to characterise archaeological and historical material such as shipwrecks and buildings has been sporadic. Combining recent reviews of the present status of tree-ring chronologies in the Iberian Peninsula (Domínguez-Delmás *et alii*, 2015), with historical documentary evidence for the geographical sources of timber used in Iberian shipbuilding, the project aims to create or improve tree-ring chronologies in selected regions to encourage application of dendro-archaeological approaches in nautical archaeology. The construction of multi-century oak and pine tree-ring chronologies derived from living trees and historical buildings in regions known to have supplied timber to shipyards will provide a much needed reference dataset for Iberian Peninsula. It should be appreciated however that the development of such long chronologies in Europe has taken decades of research effort on the part of numerous dendrochronology laboratories. Hence, the strategy is to be very targeted in development of new ring-width chronologies in Iberia and to complement this approach with a range of additional analytical techniques.

A significant challenge in characterising the nature of archaeologically recovered ship timbers are the limitations of microscopic wood anatomy in the discrimination of the range of deciduous oak and pine species often used in Iberian shipbuilding in the Early Modern Era. Mechanisms for attempting discrimination of pine or oak species with known Iberian distributions (e.g. *Quercus faginea, Q. pyrenaica*) from those with more widespread distributions (e.g. *Quercus petrea/robur*) on anatomical grounds will be explored. Similarly, the potential of variation in geochemical composition of archaeologically recovered wood, as a reflection of variations in the physical environment (local soils, lithological materials, rainfall water) where the wood was formed will be examined through a range of analytical techniques (e.g. Pyrolysis-GC/MS, FTIR-ATR, Strontium isotopes). The application of such techniques has proved effective in determining the origin of timber including ship timber in other regions where dendrochronology is still in the development phase (English *et alii,* 2001; Rich, 2013).

## Conclusions

This brief paper has summarised the main aims and objectives of this multi-disciplinary research project and considered the main lines of enquiry which are envisaged over a four year period. From an archaeological perspective, how might we judge the success of this project? In line with the intentions of the Marie Curie Actions programme, the development of a cohort of early stage researchers with core specialist skills complemented by an ability to excel within an interdisciplinary research environment will be seen as a priority. A highly desirable impact on the practise of underwater and nautical archaeology in Iberia would be a change in the perceived value of wood studies. In his masterful publication of the Pepper Wreck, Castro in describing the hull of this early-seventeenth century Portuguese Indiaman, noted that beyond selective species identification «Since there is no dendrochronological series for Portugal, no further analysis was conducted on the wood from this vessel» (Castro, 2005). By the end of this decade, if those working on Iberian shipwrecks are routinely undertaking scientific analysis of the timbers forming the hull assemblages being studied, the ForSEAdiscovery project could be seen to have played its part in a significant development in the practice of nautical archaeology.

## References

Adams, J. (2013): *A Maritime Archaeology of Ships: Innovation and Social Change in Late Medieval and Early Modern Europe*. Oxford, Oxbow Books.

Albion, R. G. (1926): *Forests and Sea Power: The Timber Problem of the Royal Navy, 1652-1862*. Cambridge, Harvard University Press.

Bamford, P. W. (1956): *Forests and French Sea Power, 1660-1789*. Toronto, University of Toronto Press.

Bojakowski, P. (2011): «The Western Ledge Reef Wreck: continuing research on the late 16th-/early 17th-century Iberian shipwreck from Bermuda». In *Post-Medieval Archaeology*, vol. 45, n.º 1, pp. 18-40.

Castro, F. (2005): *The Pepper Wreck: a Portuguese Indiaman at the mouth of the Tagus river*. College Station, Texas A&M University Press.

— (2008): «A Group for the Study of Iberian Seafaring». In *Edge of Empire. Proceedings of the Symposium «Edge of Empire» held at the 2006 annual Meeting of the Society for Historical*

*Archaeology, Sacramento Ca*. Edited by de Castro, F. V., and Custer, K. Casal de Cambra, Caleidoscópio, pp. 7-22.

Crespo Solana, A. (2014): «The formation of a social Hispanic Atlantic space and the integration of merchant communities following the Treaties of Utrecht». In *Culture & History. Digital Journal*, vol. 3, n.º 1, pp. 71-91.

Daly, A. (2007): *Timber, Trade and Tree-rings. A Dendrochronological Analysis of Structural Timber in Northern Europe, c. AD 1000 to c. AD 1650*. University of Southern Denmark, PhD Dissertation.

Domínguez-Delmás, M. *et alii* (2015): «Tree-rings, forest history and cultural heritage: current state and future prospects of dendroarchaeology in the Iberian Peninsula». In *Journal of Archaeological Science*, n.º 57, pp. 180-196.

— (2013): «Dendrochronological Dating and Provenancing of Timbers from the Arade 1 Shipwreck, Portugal». In *International Journal of Nautical Archaeology*, 42, n.º 1, pp. 118-136.

English, N. *et alii* (2001): «Strontium isotopes reveal distant sources of architectural timber in Chaco Canyon, New Mexico». In *Proceedings of the National Academy of Sciences of the United States of America,* vol. 98, n.º 21, pp. 11891-11896.

Martínez González, A. J. (2013): «Bosques y política naval atlántica: las reformas normativas e institucionales de José Patiño (1717-1736)». In *Revista Hispanoamericana. Revista Digital de la Real Academia Hispanoamericana de Ciencias, Artes y Letras*, n.º 3. (Availabe at: http://revista.raha.es/).

Nayling, N. (2009): «The Application of Dendrochronology to Underwater Archaeology». In *International Symposium on Underwater Archaeology*, Taiwan, 2008. Edited by Tsang, C. Taiwan, pp. 64-73.

Nayling, N., and Jones, T. (2014): «The Newport Medieval Ship, Wales, United Kingdom». In *International Journal of Nautical Archaeology*, vol. 43, n.º 2, pp. 239-278.

Nayling, N., and Suspérregi, J. (2014): «Iberian Dendrochronology and the Newport Medieval Ship». In *The International Journal of Nautical Archaeology*, vol. 43, n.º 2, pp. 279-291.

Rich, S. (2013): *Ship Timber as Symbol? Dendro-provenancing & Contextualizing Ancient Cedar Ship Remains in the Eastern Mediterranean*. University of Leuven, PhD Dissertation.

Richards, J. F. (2006): *The Unending Frontier. An Environmental History of the Early Modern World*. Los Angeles, University of California Press.

Rieth, E. (2006): «L'épave d'Urbieta (Gernika): une embarcation à clin du milieu du xve siècle. Étude préliminaire». In *Itsas Memoria.Revista de Estudios Marítimos del País Vasco*, n.º 5, pp. 603-616.

Urteaga, L. (1987): *La Tierra esquilmada. Ideas sobre la conservación de la naturaleza en la cultura española del siglo xviii*. Barcelona, Madrid, Ediciones del Serval S.A. y CSIC.

Watson, K. and Gale, A. (1990): «Site evaluation for marine sites and monuments records: the Yarmouth Roads Wreck investigations». In *The International Journal of Nautical Archaeology*, vol. 19, n.º 3, pp. 183-192.

Wazny, T. (2005): «The origin, assortments and transport of Baltic timber: historic dendrochronological evidence». In *Constructing Wooden Images: Proceedings of the Symposium on the Organization of Labour and Working Practices of Late Gothic Carved Altarpieces in the Low Countries*. Brussels 25-26 October 2002. Edited by Van de Velde, C., *et alii*. Brussels, VUB Press, pp. 115-126.

Williams, M. (2006): *Deforesting the Earth. From Prehistory to Global Crisis: An abridgement*. Chicago, University Chicago Press.

Wing, J. T. (2015): *Roots of Empire: Forests and State Power in Early Modern Spain, c. 1500-1750*. Leuven, Brill.