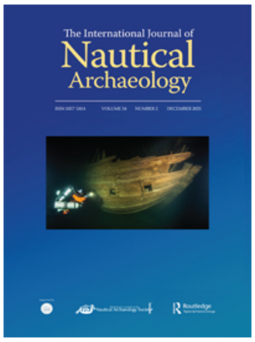

Routledge
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International Journal of Nautical Archaeology

ISSN: 1057-2414 (Print) 1095-9270 (Online) Journal homepage: www.tandfonline.com/journals/rjna20

Sourcing Wood for Early Mediterranean Ships in the Late Bronze and Iron Ages

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INTERNATIONAL JOURNAL OF NAUTICAL ARCHAEOLOGY
https://doi.org/10.1080/10572414.2026.2659656

Sourcing Wood for Early Mediterranean Ships in the Late Bronze and Iron Ages

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ABSTRACT
Mediterranean shipwrecks from 1500–500 BC seldom preserve wooden elements, and previous scholarship has favoured construction techniques over materials. This paper introduces a novel methodology to understand human-environment interactions in shipbuilding and repair. Using chorological data to examine the overlap of natural ranges of tree species used to construct ships, we identify new and evocative narratives of maritime life in the pre-Classical Mediterranean. Local wood was often used to construct ships, although sometimes it came from trade or recycling. This investigation forms part of the Practical Mariner Project's work package exploring the environmental foundations of sea-journeys: constructing and repairing ships.

KEYWORDS
ship construction; Mediterranean; wood; trees; shipwrecks; dendroprovenancing

L'approvviggionamento del legno per la costruzione delle navi antiche nel Mediterraneo nel Tardo Bronzo e nell'Età del Ferro

RIASSUNTO
Materiale dello scafo si preserva raramente nei relitti del Mediterraneo datati 1500-500 a.C.; gli specialisti si sono concentrati sulle tecniche costruttive piuttosto che sui materiali. Questo articolo introduce una nuova metodologia per comprendere le interazioni uomo-ambiente concernenti costruzione e riparazione di imbarcazioni. Attraverso l'uso di dati corologici per analizzare la distribuzione delle specie arboree identificate nelle imbarcazioni, elaboreremo nuove, evocative narrazioni circa le tradizioni marittime nel Mediterraneo pre-classico. Il legno, solitamente, era locale, anche se talvolta importato o riciclato. Questo studio è parte della sezione del Practical Mariner Project sulla base di ogni viaggio per mare: costruzione e riparazione delle imbarcazioni.

PAROLE CHIAVE
costruzione navale; Mediterraneo; legno; alberi; relitti; dendroprovenienza

Προμήθεια ξύλου στα αρχαία πλοία της Μεσογείου στην Ύστερη Εποχή του Χαλκού και στην Εποχή του Σιδήρου

Περίληψη
Στα αρχαία ναυάγια της Μεσογείου (1500–500 π.Χ.) σπάνια διασώζεται το σκαρί. Πολλές φορές η έμφαση δίνεται στις τεχνικές ναυπήγησης παρά στα χρησιμοποιηθέντα υλικά. Το άρθρο παρουσιάζει νέα μεθοδολογία κατανόησης σχέσεων ανθρώπου-περιβάλλοντος αναφορικά στην κατασκευή σκαφών. Χρησιμοποιώντας κορολογικά δεδομένα για την διανομή τύπου δέντρων αναγνωρισμένων στα σκάφη, θα δημιουργήσουμε καινούργια και υποβλητικά διηγήματα για την ναυτική παράδοση στην προ κλασική Μεσόγειο. Το ξύλο ήταν συνήθως ντόπιο, αλλά, μερικές φορές, ήταν εισαγόμενο ή ανακυκλωμένο. Αυτή η έρευνα αποτελεί μέρος του συνόλου εργασίας του Practical Mariner Project σχετικά με την εξερεύνηση των περιβαλλοντικών στοιχείων οποιουδήποτε θαλάσσιου ταξιδιού: ναυπήγηση και επισκευή πλοίων.

Λέξεις κλειδιά
ναυπηγική; Μεσόγειος; ξύλο; δένδρα; ναυάγια; δενδροπροέλευση

Abastecimiento de madera para embarcaciones tempranas del Mediterráneo en la Edad del Bronce tardía y la Edad del Hierro

RESUMEN
los pecios del Mediterráneo datados entre 1500 y 500 a.C. raramente conservan elementos de madera, y las investigaciones previas han privilegiado las técnicas constructivas por sobre los materiales. Este artículo introduce una metodología novedosa para comprender las interacciones entre humanos y ambiente en la construcción y reparación de embarcaciones. Mediante el uso de datos cronológicos para examinar la superposición de áreas de distribución naturales de especies arbóreas utilizadas en la construcción naval, identificamos nuevas y evocativas narrativas sobre la vida marítima en el Mediterráneo preclásico. Frecuentemente se empleaba madera local para construir embarcaciones, aunque en algunos casos también provenía de comercio o reciclaje. Esta investigación forma parte del paquete de trabajo del proyecto Practical Mariner que explora los fundamentos ambientales de los viajes marítimos: la construcción y reparación de embarcaciones.

PALABRAS CLAVE
construcción naval; Mediterráneo; madera; árboles; pecios; dendro-procedencia

关键词
船舶建造; 地中海; 木材; 树种; 沉船; 树木年轮溯源法

關鍵詞
船舶建造; 地中海; 木材; 樹種; 沉船; 樹木年輪溯源法

الكلمات الدلالية
بناء السفن
البحر المتوسّط
الأخشاب
الأشجار
حطام السفن
التحديد الجغرافي للأخشاب z

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青铜时代晚期及铁器时代的早期地中海船舶所用木材探源

摘要

公元前1500年至前500年间的地中海沉船遗存中，极少有木质构件留存，而且既往研究多侧重于建造技术，而对材料本身关注不足。本文提出一种新的研究方法，旨在探讨造船与修船过程中人与环境之间的互动关系。通过引入树种分布数据，分析用于造船的不同树种自然分布区的重叠情况，从而为理解前古典时期地中海海上生活提供新的启发性视角。船舶建造多依赖本地木材，但在某些情况下，木材也可能来源于贸易或再利用。本研究目属于"实验航海研究计划"（Practical Mariner Project）的一部分，该研究计划致力于探讨海上航行的环境基础，并关注船舶的建造与维修。

青銅時代晚期及鐵器時代的早期地中海船舶所用木材探源

摘要

公元前1500年至前500年間的地中海沉船遺存中，極少有木質構件留存，而且既往研究多側重於建造技術，而對材料本身關注不足。本文提出一種新的研究方法，旨在探討造船與修船過程中人與環境之間的互動關係。通過引入樹種分佈數據，分析用於造船的不同樹種自然分佈區的重疊情況，從而爲理解前古典時期地中海海上生活提供新的啓發性視角。船舶建造多依賴本地木材，但在某些情況下，木材也可能來源於貿易或再利用。本研究目屬於「實驗航海研究計劃」（Practical Mariner Project）的一部分，該研究計劃致力於探討海上航行的環境基礎，並關注船舶的建造與維修。

تأمين الأخشاب لبناء السفن في البحر المتوسّط خلال العصرين البرونزي المتأخر والحديدي

المُستخلص

نادراً ما تُحفَظ العناصر الخشبية في حطام سفن البحر المتوسّط المؤرَّخة بين ١٥٠٠ و٥٠٠ قبل الميلاد، وقد أولت الدراسات السابقة اهتماماً أكبر لتقنيات البناء مقارنة بالمواد المستخدمة. يقدّم هذا البحث منهجية جديدة لفهم تفاعلات الإنسان والبيئة في سياق بناء السفن وصيانتها. ومن خلال استخدام بيانات كورولوجية لدراسة التداخل بين النطاقات الطبيعية لأنواع الأشجار المستخدمة في بناء السفن، نكشف عن سرديات جديدة ومعبّرة للحياة البحرية في البحر المتوسّط قبل العصر الكلاسيكي. وغالباً ما كان يتم استخدام الأخشاب المحلية في بناء السفن، رغم أنّ بعضها كان يأتي أحياناً عبر التجارة أو من إعادة التدوير. ويشكّل هذا البحث جزءاً من حزمة العمل الخاصة بمشروع "الملاح العمليّ" التي تستكشف الأسس البيئية للرحلات البحرية، بما في ذلك بناء السفن وإصلاحها.

Introduction

The Practical Mariner Project (2024–27) at the University of Oxford is a new three-year project, spearheaded by Dr Linda Hulin, that investigates the making and breaking of seafaring routes in the Mediterranean on either side of the Late Bronze Age (LBA) collapse event (*ca.* 1200 BC). In order to understand the changes and processes that took place during those transitionary centuries, we adopt a *longue durée* approach by examining the practices of seafaring and route-making – and the resources that go into them – during the thousand-year interval between 1500 and 500 BC. In order to think about the resources needed to build, maintain, and repair ships, we start with the evidence from shipwrecks, which provide the most concrete evidence for ship construction in the ancient Mediterranean. However, ships' cargo has often been of more interest to scholars than the scant remnants of hulls. Consequently, where ship remains have been examined in detail, the primary focus was almost always on construction techniques rather than the character of the wood itself.

Pre-Classical shipwrecks are rare, and wrecks with surviving evidence of the ship's wooden structure are even rarer: we know of 20 ships before 500 BC (Table 1); of those, 15 have at least one wooden element from which the wood type has been identified. Often, attempts at using the distribution of wood type from shipwrecks to identify the ship's origins have been hampered by the fact that today many of the most common trees used in ancient shipbuilding are distributed across the Mediterranean basin (e.g. Akkemik & Kocabaş, 2013, pp. 39–40; Bound, 1991a). Some studies have used pollen sampling as a tool to connect the woods found on ships to specific sites (e.g. Giachi et al., 2003), but this first requires an already precise understanding of the ship's origins. With modern datasets and computational ability, it is now possible to consider the origins of ships in a more nuanced way. Given that nearly all ships in our study were found to use more than one wood, the regions where the largest number of species are concentrated may be used to suggest the areas in which they were constructed or repaired.

Experimental reconstructions and replications of ancient ships also provide useful information as to the scale of wood extraction that was required to build a ship. The Ma'agan Mikhael II ship (16.6 × 4.3 m), for example, is a replica of a late 5th-century BC merchantman which sunk off the coast of modern Israel. It was constructed using 42 Calabrian pines (*Pinus brutia* Ten.), two oaks (*Quercus* sp.), and two cypresses (*Cupressus* sp.) (Cvikel & Hillman, 2021, p. 113). Forty-six trees for a single ship[1] highlight not only the amount of natural resources which went into constructing and maintaining ancient ships, but also the capital investment required for

Table 1: Tree Species and associated parts from ancient Mediterranean shipwrecks 1500–500 BC.

Shipwreck	Date (BC)	Ship Part	Wood Types	Source
Athlit A	700–600	Hull fragments	-	Raban, 1985, p. 35.
Bajo de la Campana	620–600	Plank fragment	Softwood	Polzer, 2012, p. 28.
Bon Porté	540–510	Keel	*Pinus* sp. (pine)	Joncheray, 1976, pp. 23–33; Polzer, 2009, pp. 196–205, tables 3.1, 4.1–7.
		Garboards	-	Joncheray, 1976, pp. 23–33; Polzer, 2009, pp. 196–205, tables 3.1, 4.1–7.
		Starboard strake	-	Joncheray, 1976, pp. 23–33; Polzer, 2009, pp. 196–205, tables 3.1, 4.1–7.
		Port strake	-	Joncheray, 1976, pp. 23–33; Polzer, 2009, pp. 196–205, tables 3.1, 4.1–7.
		Frames	'Conifer'	Joncheray, 1976, pp. 23–33; Polzer, 2009, pp. 196–205, tables 3.1, 4.1–7.
		Mast step	Softwood (white)	Joncheray, 1976, pp. 23–33; Polzer, 2009, pp. 196–205, tables 3.1, 4.1–7.
Cala Sant Vicenç	520–500	Keel	*Quercus ilex* L. (holm oak)	Piqué i Huerta, 2009, p. 335; Nieto & Santos, 2009, pp. 40–41.
		Planking	*Pinus sylvestris* L. (Scots pine)	Piqué i Huerta, 2009, p. 335.
		Made-frames	*Pinus pinaster* Aiton (maritime pine)*	Nieto and Santos, 2009, p. 30; Polzer, 2009, p. 198, table 4.7A
		Peg	*Buxus sempervirens* L. (boxwood)	Piqué i Huerta, 2009, p. 332.
		Pegs	*Cornus* sp. (dogwood)	Piqué i Huerta, 2009, p. 332.
		Dowel	*Cornus* sp. (dogwood)	Piqué i Huerta, 2009, p. 332.
		Planking (associated with the frames)	*Cedrus* sp. (cedar)	Piqué i Huerta, 2009, p. 332.
		'Pin fixing the ropes to the planks'	*Alnus* sp. (alder)	Piqué i Huerta, 2009, p. 332.
		False keel	*Quercus ilex* L. (holm oak)	Kahanov & Pomey, 2004, pp. 14–15; Nieto & Santos, 2010, p. 49.
		False elements for frames	*Quercus* subg. *Quercus* (deciduous oak)	Piqué i Huerta, 2009, pp. 335–336.
Cape Gelidonya	*ca.* 1200	Treenails	-	Bass, 1967, p. 48.
		Worked timbers	*Quercus* sp. (oak)	Western, 1967, p. 168; Liphschitz & Pulak, 2007/2008, p. 74.
		Planking fragment	*Pinus brutia* Ten. (Calabrian pine)	Liphschitz & Pulak, 2007/2008, p. 74; Liphschitz, 2015, p. 606.
		Planks	*Cedrus libani* A.Rich (cedar of Lebanon)**	Liphschitz & Pulak, 2007/2008, p. 74.
		Tenons	*Quercus* sp. (oak)***	Bass, 1999, p. 22.
César 1****	510–500	Keel	-	Pomey, 2001, pp. 429–430; Polzer, 2009, pp. 71–72.
		End-post	-	Pomey, 2001, pp. 429–430; Polzer, 2009, pp. 71–72.
		Garboard	-	Pomey, 2001, pp. 429–430; Polzer, 2009, pp. 71–72.
		Strakes	-	Pomey, 2001, pp. 429–430; Polzer, 2009, pp. 71–72.
		Frames	-	Pomey, 2001, pp. 429–430; Polzer, 2009, pp. 71–72.
Dor L2	700–550	Anchor stock	-	Yasur-Landau et al., 2025, pp. 1009–1011.
Gela 1	500–480	Floor timbers	*Pinus pinea* L. (stone pine)	Panvini, 2001, p. 20; Terranova & Lo Campo, 2001, p. 111.
		Pegs	-	Panvini, 2001, p. 20.
		Keel	*Pinus pinea* L. (stone pine)	Panvini, 2001, p. 21; Terranova & Lo Campo, 2001, p. 111.
		Mast step	-	Panvini, 2001, pp. 21, 24.
		Floor timber supports	-	Panvini, 2001, p. 21.
		Strakes	*Pinus pinea* L. (stone pine)	Panvini, 2001, p. 22.
		Dowels	-	Panvini, 2001, p. 22.
		Keelson	*Pinus pinea* L. (stone pine)	Panvini, 2001, p. 24; Terranova & Lo Campo, 2001, p. 111.
		Sternpost	-	Panvini, 2001, pp. 25–26.
		Unknown	*Salix* sp. (willow)	Terranova & Lo Campo, 2001, p. 112.
Giglio*****	600–580	Planking	*Pinus sylvestris* L. (Scots pine)	Bound, 1991b, p. 43.
		'Construction and fittings'	*Abies alba* Mill. (silver fir)	Bound, 1991a, p. 34.
		'Construction and fittings'	*Buxus sempervirens* L. (boxwood)	Bound, 1991a, p. 34.
		'Construction and fittings'	*Quercus* sp. (oak)	Bound, 1991a, p. 34.
		'Construction and fittings'	*Quercus ilex* L. (holm oak)	Bound, 1991a, p. 34.
		'Construction and fittings'	*Ulmus campestris* L./*minor* Mill. (common elm)	Bound, 1991a, p. 34.
		'Construction and fittings'	*Olea europaea* L. (olive)	Bound, 1991a, p. 34.
			Corylus avellana L. (hazel)	Bound, 1991a, p. 34.

(*Continued*)

Table 1: Continued.

Shipwreck	Date (BC)	Ship Part	Wood Types	Source
		'Construction and fittings'		
		'Construction and fittings'	*Phillyrea latifolia* (phillyrea)	Bound, 1991a, p. 34.
		Pegs	*Olea europaea* L. (olive)	Abbate Edlmann & Giachi, 1989, p. 242.
		Pegs	*Corylus avellana* (hazel)	Abbate Edlmann & Giachi, 1989, p. 242.
		Pegs	*Phillyrea latifolia* L. (phillyrea)	Abbate Edlmann & Giachi, 1989, p. 240.
		Pulley block	*Quercus ilex* L. (holm oak)	Abbate Edlmann & Giachi, 1989, p. 241.
		Pulley block	*Buxus sempervirens* L. (boxwood)	Abbate Edlmann & Giachi, 1989, p. 241.
Golo	600–500	Unknown	*Alnus* sp. (alder)	Pomey, 2012, p. 24.
		Unknown	*Castanea sativa* Mill. (sweet chestnut) or *Aesculus hippocastanum* L. (horse chestnut)	Pomey, 2012, p. 24.
		Pegs	'White wood'	Pomey, 2012, p. 24.
		Tenons	'White wood'	Pomey, 2012, p. 24.
		Keel	-	Pomey, 2012, p. 24.
		Planking	-	Pomey, 2012, pp. 21–24.
		Frames	-	Pomey, 2012, pp. 21–24.
		Mast step	-	Pomey, 2012, pp. 21–24.
Grand Ribaud F	500–490	Stanchion	*Quercus* sp. (deciduous oak)	Long et al., 2006, p. 482, table 16.8.
		Frames	*Quercus* sp. (deciduous oak)	Long et al., 2006, p. 482, table 16.8.
		Sternpost fragment	*Quercus* sp. (deciduous oak)	Long et al., 2006, p. 482, table 16.8.
		Keelson	*Quercus* sp. (deciduous oak)	Long et al., 2006, p. 482, table 16.8.
		Strake	*Abies alba* Mill. (silver fir)	Long et al., 2006, p. 482, table 16.8.
		Tenons	*Salix alba* L. (white willow)	Long et al., 2006, p. 482, table 16.8.
		Dowels	*Salix alba* L. (white willow)	Long et al., 2006, p. 482, table 16.8.
		Small mortises	*Abies alba* Mill. (silver fir)	Long et al., 2006, p. 482, table 16.8.
		Dowels	*Abies alba* Mill. (silver fir)	Long et al., 2006, p. 482, table 16.8.
		Starboard rudder (axial stock)	*Quercus* sp. (deciduous oak)	Long et al., 2006, p. 482, table 16.8.
		Starboard rudder (front element)	*Abies alba* Mill. (silver fir)	Long et al., 2006, p. 482, table 16.8.
		Starboard rudder (rear element)	*Quercus* sp. (deciduous oak)	Long et al., 2006, p. 482, table 16.8.
		Rudder yoke	*Quercus* sp. (deciduous oak)	Long et al., 2006, p. 482, table 16.8.
Jules-Verne 7	525–510	Keel	*Quercus ilex* L. (holm oak)	Pomey, 1998, p. 151, n. 6; Long et al., 2002, p. 123.
		Planking	*Pinus halepensis* Mill. (Aleppo pine)	Pomey, 1998, p. 151, n. 6; Long et al., 2002, p. 123.
		Frames	*Alnus glutinosa* (L.) Gaertn (black alder)	Pomey, 1998, p. 151, n. 6; Long et al., 2002, p. 123.
		Frames	*Pinus* sp. (pine)	Pomey, 1998, p. 151, n. 6; Long et al., 2002, p. 123.
		Tenons	*Olea europaea* L. (olive)	Pomey, 1998, p. 151, n. 6.
		Pegs	*Olea europaea* L. (olive)	Pomey, 1998, p. 151, n. 6.
Jules-Verne 9	525–510	Frame	*Pinus halepensis* Mill. (Aleppo pine)	Pomey, 1998, p. 150, n. 3; Long et al., 2002, p. 121; Pomey & Poveda, 2019, p. 418.
		Keel	*Quercus* sp. (deciduous oak)	Pomey, 1998, p. 150, n. 3.
		Planking	*Pinus halepensis* Mill. (Aleppo pine)******	Pomey, 1998, p. 150, n. 3.
		Treenails	*Olea europaea* L. (olive)	Pomey, 1998, p. 150, n. 3; Pomey & Poveda, 2019, p. 418.
		Pegs	*Olea europaea* L. (olive)	Pomey, 1998, p. 150, n. 3; Pomey & Poveda, 2019, p 418.
Mazarrón 1	650–600	Keel	*Cupressus sempervirens* L. (cypress)	Negueruela, 2004, pp. 236–237; 2006, p. 25; Cabrera Tejedor, 2018, p. 301.
		Strakes	*Pinus* sp. (pine)	Negueruela, 2004, pp. 236–237; 2006, p. 25; Cabrera Tejedor, 2018, p. 304.
		Frames	*Ficus carica* L. (fig)	Negueruela, 2004, pp. 236–237; 2006, pp. 25, 29; Cabrera Tejedor, 2018, p. 308.
		Tenons	*Olea europaea* L. (olive)	Negueruela, 2004, pp. 236–237; 2006, p. 25; Cabrera Tejedor, 2018, p. 304.
		Pegs	*Olea europaea* L. (olive)	Negueruela, 2004, pp. 236–237; 2006, p. 25; Cabrera Tejedor, 2018, p. 304.
Mazarrón 2	625–570	Frames	*Juniperus* sp.	Miñano, 2014, p. 9.
		Anchor	*Pinus halepensis* Mill. (Aleppo pine) and *Phillyrea* sp. (phillyrea) or *Rhamnus* (buckthorns)	Miñano, 2014, p. 10; Doménech-Carbó, 2024.
		Stern post	*Pinus halepensis* Mill. (Aleppo pine)	Miñano, 2014, p. 7.
		Through-beams	*Pinus halepensis* Mill. (Aleppo pine)	Miñano, 2014, p. 7.
		Strakes	*Pinus halepensis* Mill. (Aleppo pine)	Miñano, 2014, p. 6.
		Mast step	*Pinus halepensis* Mill. (Aleppo pine)	Miñano, 2014, p. 7.
		Tenons	*Olea europaea* L. (olive)	Miñano, 2014, p. 7.
		Pegs	*Olea europaea* L. (olive)	Miñano, 2014, p. 7.
Pabuç Burnu	570–560	Planks	*Pinus nigra* J.F. Arnold (black pine)	Greene et al., 2008, pp. 700–701.
		Tenon	*Quercus* sp. (evergreen oak)*******	Greene et al., 2008, pp. 700–701; Polzer, 2009, p. 59.
		Repair dowels	*Nerium oleander* L. (oleander)	Greene et al., 2008, pp. 700–701; Polzer, 2009, pp. 47–48.
		Pegs	*Alnus* sp. (alder)	Polzer, 2004, p. 8.

(*Continued*)

Table 1: Continued.

Shipwreck	Date (BC)	Ship Part	Wood Types	Source
		Treenail	*Pinus nigra* J.F. Arnold (black pine)	Polzer, 2009, p. 42.
		Unknown	*Euphorbia* spp. (spurge)	Polzer, 2009, p. 40.
Point Iria	*ca.* 1200	Plank with mortise	-	Vichos, 1999, pp. 78–79.
Pointe Lequin 1A	520–510	Rudder	*Fagus* sp. (beech), *Abies* sp. (fir)	Long & Rival, 2007, pp. 106–107.
Uluburun	*ca.* 1300	Planking	*Cedrus libani* A.Rich (cedar of Lebanon)	Pulak, 1998, pp. 210–213; Rich et al., 2016, p. 517.
		Tenons	*Quercus coccifera* L. (kermes oak)	Pulak, 1998, p. 213; Pulak, 2010, p. 873.
		Pegs	*Quercus coccifera* L. (kermes oak)	Pulak, 1998, p. 213; Pulak, 2010, p. 873.
		Planks	*Quercus cerris* L. (Turkey oak)	Liphschitz & Pulak, 2007/2008, pp. 75, 81, Table 6; Rich et al., 2016, pp. 517–518.
		Keel	*Cedrus libani* A.Rich (cedar of Lebanon)	Pulak, 1998, pp. 210–213; Rich et al., 2016, p. 517.
		Sweeps/oars?	*Populus alba* L. (white poplar) or *Populus nigra* L. (black poplar)	Liphschitz & Pulak, 2007/2008, p. 78; Pulak, 1998, p. 213.
		Plank	*Tamarix* sp. (tamarisk/salt cedar)	Liphschitz & Pulak, 2007/2008, p. 78.
		Unknown	*Pinus nigra* J.F. Arnold (black pine)	Liphschitz & Pulak, 2007/2008, p. 78.
		Unknown	*Cupressus sempervirens* L. (cypress)	Liphschitz & Pulak, 2007/2008, p. 78.
Zambratija	1125–925	Strakes	*Ulmus* sp. (elm)	Ferreira Domínguez et al., 2019, p. 123.
		Plank fragments	*Ulmus* sp. (elm)	Ferreira Domínguez et al., 2019, p. 123.
		Floor timbers	*Alnus* sp. (alder)	Ferreira Domínguez et al., 2019, p. 123.
		Floor timbers	*Pyrus communis* L. (wild pear)	Ferreira Domínguez et al., 2019, p. 123.
		Pegs	*Alnus* sp. (alder)	Ferreira Domínguez et al., 2019, p. 123.
		Laths	*Abies alba* Mill. (silver fir)	Ferreira Domínguez et al., 2019, p. 123.
		Pegs	*Populus* sp. (poplar)	Ferreira Domínguez et al., 2019, p. 123.

*Potentially stone pine (*Pinus pinea* L.) (Nieto & Santos, 2009, p. 30; Polzer, 2009, p. 198, table 4.7A).
**Originally identified as cypress (*Cupressus* sp.) by Western (1967, p. 128).
***This is speculation by Bass as the wood samples from Cape Gelidonya could not be attributed to specific ship parts from the original excavations.
****Although not mentioned in any of the excavation reports or publications of the César 1, Marlier & Sibella (2002, p. 167, n. 6) claim that oak (*Quercus* sp.) was used for some repair elements of the ship, citing personal communication with P. Pomey.
*****It is unclear if the ship parts identified by Abbate Edlmann & Giachi (1989) are the only examples from the ship of each type of wood or if there were other parts not identified.
******See note 6.
*******Likely kermes oak (*Quercus coccifera* L.), but possibly holm oak (*Q. ilex* L.) or golden oak (*Q. alnifolia* Poech) (Greene et al., 2008, pp. 700–701; Polzer, 2009, p. 59). We have used *Quercus coccifera* L. for the analyses presented in this paper.

both the resources and labour. The *Tale of Wenamun* (11th century BC, written in Late Egyptian) recounts that once the king of Byblos received his proper payment, 300 men and 300 oxen were dispatched to the forests of the Lebanon to fell trees (Lichtheim, 2019, pp. 190–191). While these figures may be exaggerated, they speak to the resources that these ports and coastal cities had at their disposal.

This paper will demonstrate the effectiveness of examining the distribution of the natural ranges of tree species in uncovering new and evocative narratives of maritime life in the pre-Classical Mediterranean.

Methodology

A database of all known Mediterranean shipwrecks from between 1500 and 500 BC was created by the Practical Mariner Project and included the complete range of materials used in the construction and repair of these ships: wood, metal, plant fibres, cloth, stone, and caulking.[2] This paper focuses on the data related to the wooden remains of shipwrecks.

The starting point for the catalogue of wrecks was Parker's (1992) *Ancient Shipwrecks of the Mediterranean and the Roman Provinces.*[3] The database has added a further 28 wrecks that were only discovered after the publication of Parker's catalogue, bringing the total of known wrecks from this period up to 53 (Figure 1). The section of the database concerning wood from shipwrecks consists primarily of published site reports and dendroarchaeological studies, when available, and was supplemented by secondary sources when necessary. However, very few pre-Classical shipwrecks have been published with a full inventory of their construction elements. Twenty wrecks reported preserved wooden elements from the ship (Table 1, Figures 2 and 3), but only 15 wrecks had at least one element identified to the genus of tree.

Dating shipwrecks can be difficult as so much depends on the underwater conditions to preserve datable material; if wooden remains are found, dendrochronology can be instructive, but there may be a discrepancy between the dates for the felling of the trees, the construction of the ship, and the wrecking date. A wreck's chronology is often updated from its initial dating in the light of new studies, and while there is enough evidence on some wrecks to arrive at a single date, most have been placed within a date range on the basis of their finds or the method of construction (though this can be a dubious exercise). The wrecks are divided into three basic eras: Late Bronze Age (1500–1200 BC), Iron Age I (1200–1000 BC), and Iron Age II (1000–500 BC). This broadly follows the Levantine/Phoenician chronology, although Mediterranean chronologies differ from region to region and our eras only serve as simple, general categories. In order to be easily comparable, and to avoid

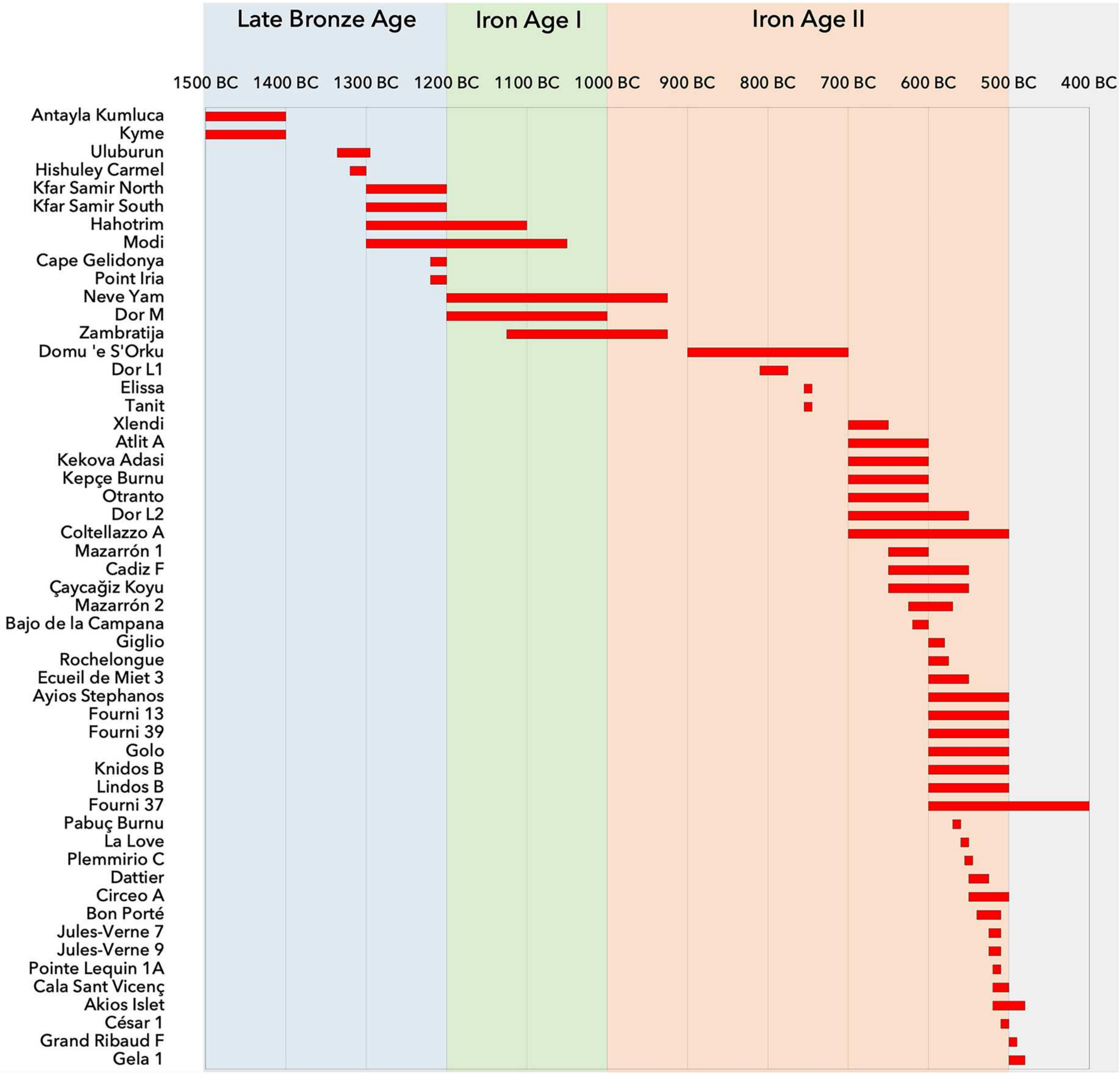

Figure 1. Chronology of Mediterranean shipwrecks from 1500 to 500 BC. M. MacDonald © Practical Mariner Project.

confusion, the chronological scheme is applied regardless of regional differences in terminology. The Zambratija ship, for example, which wrecked on the Istrian Peninsula in Croatia between 1125–925 BC is recorded as an Iron Age I (IA I) wreck, even though within the Croatian chronological scheme it is regarded as LBA, since there this period lasted until *ca.* 800 BC. Figure 1 demonstrates that the chronological distribution of shipwrecks between 1500 BC and 500 BC is uneven; ten ships are potentially LBA in date, with some wrecks spanning the gap between the LBA and IA I. Only three wrecks fall within Iron Age I (IA I), while 40 ships are likely Iron Age II (IA II). The data are perhaps too limited to argue that this reflects the amount of sea-traffic across the entire Mediterranean during each period, although this is often accepted (but cf Wilson, 2011).

Our knowledge of the exact distribution of tree species across the Mediterranean basin in antiquity is difficult to assess, since much of the evidence is derived from localised palynological studies that are themselves unequally distributed across the region. Consequently, we have used modern data as a proxy, while recognising that they are generalised and large scale, and do not necessarily reflect the reality of the forests of the ancient world exactly. Chorological maps of European woody species produced by the European Commission's Joint Research Centre (JRC) were used as the main source for the 'natural' distribution of trees from each recorded shipwreck (Beck et al., 2023; Caudullo et al., 2017; Caudullo et al., 2024). The dataset draws on 'numerous and heterogenous' sources, from academic monographs and articles to regional geodatabases, and provides the polygon shapefiles for both the 'natural' and 'synanthropic' (species which are known to have been introduced through human intervention) distributions for each *taxon*, as well as point features for isolated populations. The dataset does not purport to demonstrate the exact location of each species; it represents the natural distribution of tree species at the 'continental scale' for Europe, Asia, and Africa. These distributions

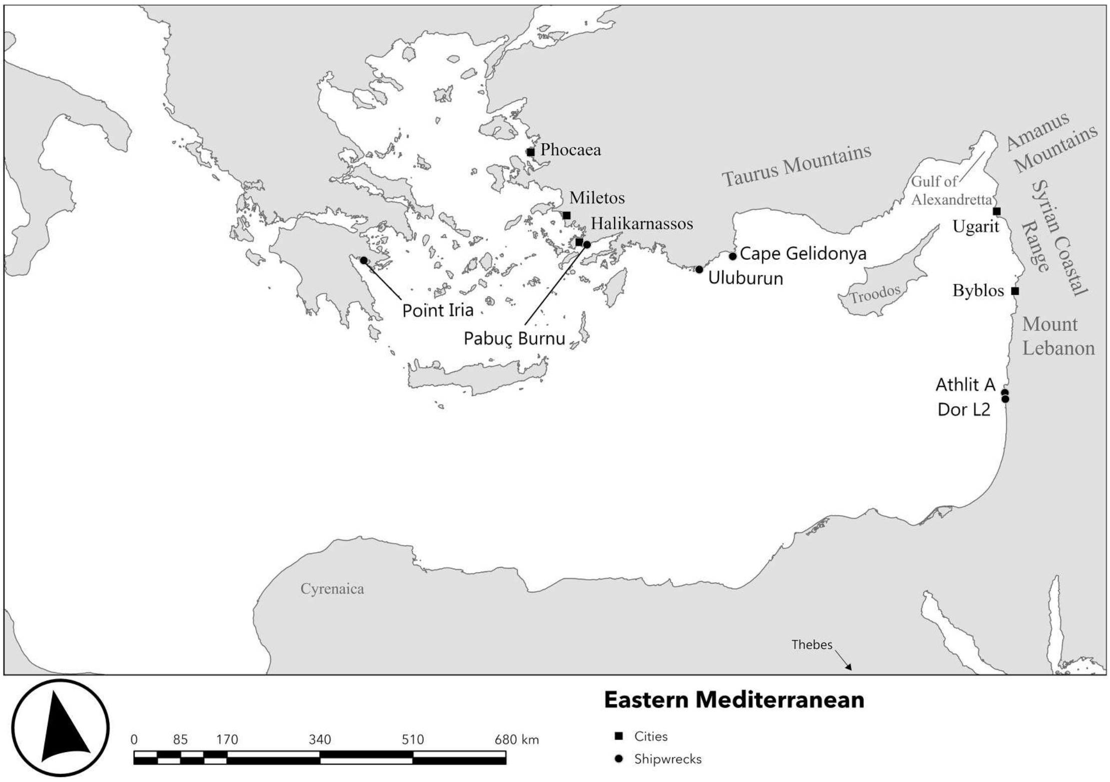

Figure 2. Eastern Mediterranean sites mentioned in the text. M. MacDonald © Practical Mariner Project.

thus serve as a heuristic device for thinking about the places where these tree species *might* have grown, rather than an absolute range. For example, there is disagreement about whether Aleppo pine (*Pinus halepensis* Mill.) grew in abundance in the southern Levant during the Bronze Age. Liphschitz and Biger (2001) argue that Aleppo pine is a recent introduction to the region of present-day Israel, mainly during the last century, while Lev-Yadun and Weinstein-Evron (2002) have argued that charred remains and palynological evidence from Tell Megiddo suggest that the Mount Carmel region, at least, was home to a Bronze Age Aleppo pine population. In the JRC dataset, Aleppo pine is considered naturally occurring in Israel and we have therefore accepted that that the species *might* have grown in that area. While the JRC dataset might want for detail at the local regional scale, future studies could adapt the methods discussed here to focus on a regional or national level where more precise data is available (e.g. Stephan et al., 2025 for Lebanon).

A few woods from the shipwrecks database were not included in the JRC's chorological maps, including fig (*Ficus carica* L.), oleander (*Nerium oleander* L.), phillyrea (*Phillyrea latifolia* L.), wild pear (*Pyrus communis* L.), and tamarisk (*Tamarix* sp.). In these cases, polygons were created using sources referred to by the creators of the JRC dataset, especially Meusel, Jäger, and Weinert (1965) and Meusel et al. (1978).[4] Maps from those volumes were scanned and georeferenced using ArcGIS Pro to match the JRC chorological dataset. Once each wood type found on our shipwrecks had a corresponding chorological map, a cumulative hexagon map was created using ArcGIS Pro to display the overlapping natural distributions of the specific tree species present on each ship.

This approach has been attempted in the past, but with limited scope (e.g. Guibal & Pomey, 1999, pp. 99–100; Liphschitz & Pulak, 2007/2008; Wicha & Girard 2006). Liphschitz (2004), in her study of the wood from the Ma'agan Mikhael wreck, identified northwestern Anatolia as the location where the most species overlap for the wreck; however, the study relied on modern distribution rather than historic, natural ranges like those provided by the JRC dataset. In another example, individual timbers from three French shipwrecks near Arles were successfully correlated to specific regions in the Saône Valley through dendrochronological analysis (Guibal et al., 2021; see also Visser & Vorst, 2023). More scientific, lab-based analyses of ship timbers would likely produce more precise results (e.g. Rich et al., 2017), but these procedures are often costly and not easily applied to legacy data.

The Timber Trade and the Construction of Ships Before 500 BC

Cedar of Lebanon (*Cedrus libani* A.Rich) held a special position in shipbuilding throughout the Bronze Age in both Egypt and the Near East. The Egyptians famously imported the wood from the coastal cities beneath

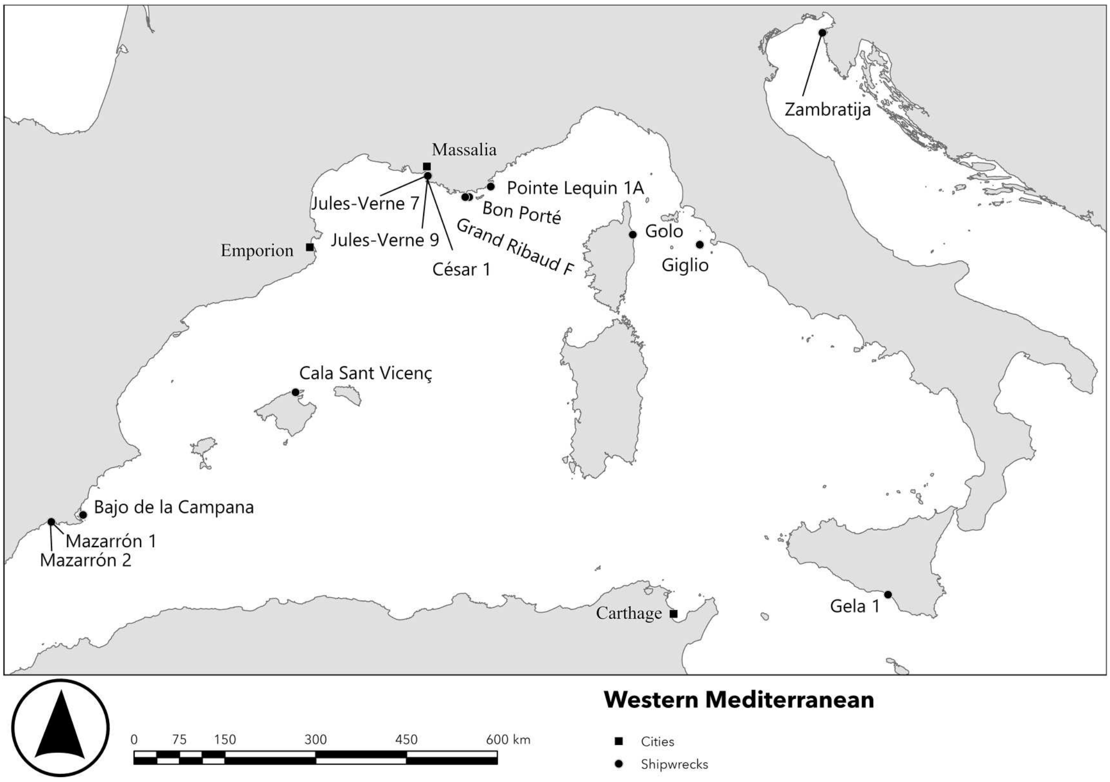

Figure 3. Western Mediterranean sites mentioned in the text. M. MacDonald © Practical Mariner Project.

Mount Lebanon, especially Byblos, throughout the Bronze Age. The cedar wood from the so-called Carnegie funerary boat of Senwosret III (1878–1839 BC) was subjected to strontium isotope analysis and was found to have originated from, or close to, the Horsh-Ehden Forest near Byblos (Rich et al., 2016). In another example, during an expedition into the Near East, Tuthmosis III (1481–1425 BC) ordered the construction of cedar ships at Byblos in order to cross the Euphrates (Meiggs, 1982, pp. 64–66).

Both the Uluburun (*ca.* 1300 BC) and Cape Gelidonya (*ca*. 1200 BC) wrecks, the two most well-known LBA Mediterranean shipwrecks, were constructed, at least in part, from cedar of Lebanon. Despite its name, cedar of Lebanon's natural range is not limited to the slopes of Mount Lebanon. It grows also in the Amanus and Syrian Coastal Ranges, in the Taurus Mountains of southern Anatolia, and a variant, *Cedrus libani* var. *brevifolia* Hook.f., grows on Cyprus in the Troodos Mountains. The Uluburun ship's hull planking and keel were both made of *Cedrus libani* A.Rich, and thus the location of cedar forests has played into the discussion about the origins of the ship (Liphschitz & Pulak, 2007/2008, p. 74; Rich et al., 2016). Planking on the Cape Gelidonya wreck was originally identified as cypress (*Cupressus* sp.), but it has since been re-examined and found to be almost entirely cedar (Liphschitz & Pulak, 2007/2008; Rich, 2016, p. 156, n. 688).

Following the destructions throughout the eastern Mediterranean in the years surrounding 1200 BC, the *Tale of Wenamun* describes an Egyptian envoy's journey from Thebes to Byblos to acquire cedar for the royal barge, demonstrating cedar's enduring prominence and relationship with pharaonic shipbuilding.[5] The Phoenician coast and the forests of Mount Lebanon – which included other strong shipbuilding woods such as oaks, cypresses, and junipers – continued to play an important role in the regional politics of the Near East. For example, a letter attributed to Sargon II (721–705 BC) states that he levied taxes on wood brought down from Mount Lebanon by sending tax-collectors to all the quays in Phoenicia and banned the sale of wood to Egypt (Meiggs, 1982, pp. 74–75). Treumann (2009) suggests that the Phoenician arrival in southern Iberia during the 8th and 7th centuries BC was, in part, based on a desire to exploit the oak and pine forests near the coast for the construction of ships, far away from Assyrian restrictions and taxation.

As the Iron Age progressed, cedar wood for ships becomes much rarer in the archaeological record, and only one wreck in the seven centuries following the end of the Bronze Age – the Cala Sant Vicenç wreck, which sank off Mallorca around 520 BC – contains any evidence of cedar wood. Rich (2016) attributes this to the changes in Levantine religious and spiritual attitudes towards the cedar forests themselves: as the Mediterranean world expanded beyond its eastern littoral, Mount Lebanon lost its exulted status and other forested areas such as Macedon and southern Italy, provided the pine (*Pinus* spp.) and fir

(*Abies* spp.) that was required for lighter and faster warships.

It is almost certain that all of the known shipwrecks from the period of interest to the Practical Mariner Project were merchantmen or fishing vessels and not specialised warships. Theophrastus (*HP* 5.7.1) states that fir was the best timber for warship construction and that pine was used by those without access to quality fir wood. Fir is usually found at higher altitudes and is both lightweight and tall. However, the ancient sources and the archaeological record do not align on the importance of fir for shipbuilding (see Rival, 1991, p. 40), and only four shipwrecks before 500 BC have attested fir elements on board. Pines and oaks (*Quercus* spp.), unlike firs, are not restricted to higher altitudes, and grow abundantly across the northern littoral of the Mediterranean as well as the Levant and parts of North Africa. The multiple varieties of pine and oak that grow in the Mediterranean are thus some of the best indicators for the origins of ships.

The maritime trade of timber, especially in the eastern Mediterranean operated through several different mechanisms, with most of the evidence for the trade coming from the area of Mount Lebanon, as Egypt relied on Phoenicia for its cedar wood throughout the Bronze and Iron Ages. Semaan (2015) describes the process of wood acquisition in Lebanon from the felling process to the movement of timber by river to the coast and its transport around the eastern Mediterranean. In order to prepare a log to become ship's timber it must be felled, stripped, seasoned, moved, and worked. Felling and the stripping of branches and bark usually took place in winter to take advantage of the snowmelt and increased volume of the rivers; the logs were then moved to the coast via multiple means such as hauling by humans and oxen, as well as by the river. On the coast, logs could be seasoned and worked by Phoenician craftspeople before being traded as finished products — this is the situation in the *Tale of Wenamun*, as the wood is delivered to Egypt from Byblos already in the form of ship timbers (Lichtheim, 2019, p. 190; Semaan, 2015, p. 102). The international export of timber was not confined to Phoenicia, as ships from *Keftiu* (Crete), for example, are recorded as bringing timber, among other goods, to Egypt, while records from Egyptian naval yards during the reign of Amenhotep II (15th century BC) imply that *Keftiu* ships were either built or repaired in Egypt (Knapp, 2018, pp. 188–189). In another instance, Amarna Letter EA 35 records the king of *Alašiya* (Cyprus) requesting money for wood which the king of Egypt took from him (Meiggs, 1982, p. 66; Moran, 1992, p. 107). All these examples indicate that the Egyptians were actively engaged in a complex regional exchange network for the procurement of timber that stretched across the eastern Mediterranean.

The Evidence from the Shipwrecks

Fifteen shipwrecks have produced at least one type of wood that has been identified to genus level (Figure 4). In most cases, wrecks with over three identified species have yielded interesting results. At least one ship from each era has recorded over five wood *taxa*, but the LBA and IA I are obviously outnumbered by the IA II wrecks.

No wood type was dominant in any ship part studied (Figure 5). In fact, almost no tree species appears to have been used for the same ship part more than once or twice. This suggests that shipbuilding was done mostly at a local scale, based on local availability, and that there was no Mediterranean-wide standard for which woods to use. The exceptions to this are the tenons and pegs, which were very often made of olive wood (*Olea europaea* L.) starting in the 7th century BC, while both the Uluburun and Cape

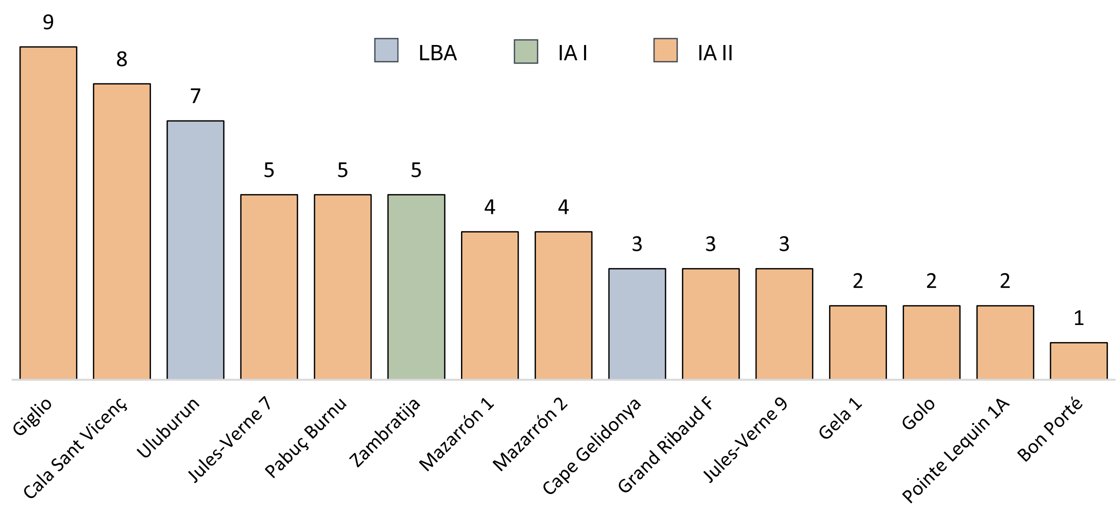

Figure 4. Number of unique identified tree species per shipwreck. M. MacDonald © Practical Mariner Project.

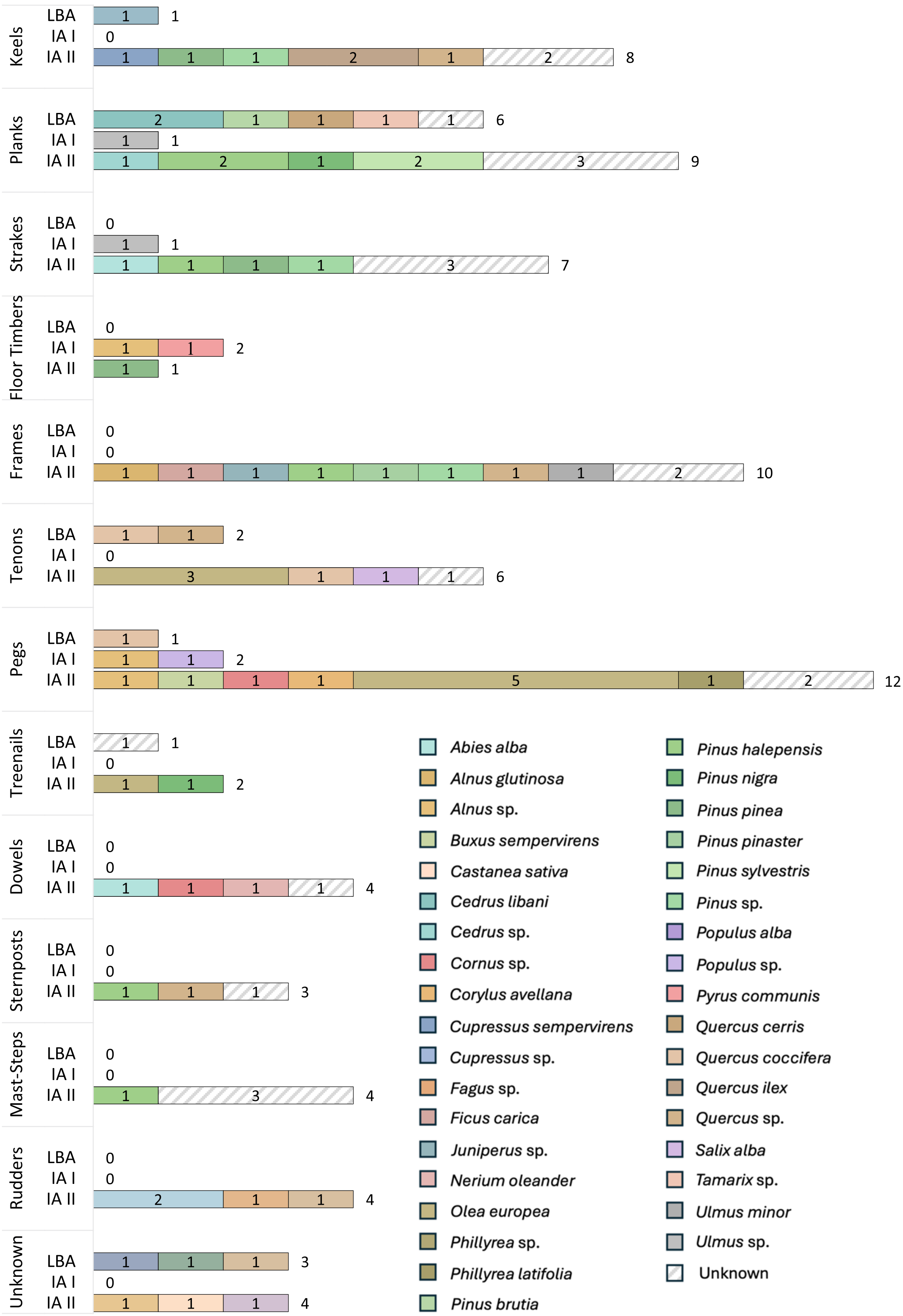

Figure 5. Ship parts with more than three examples by tree species and era. (LBA = Late Bronze Age, IA I = Iron Age I, IA II = Iron Age II). M. MacDonald © Practical Mariner Project.

Gelidonya wrecks had tenons made of oak. This is understandable, as tenons and pegs are elements of a ship that require hard and strong wood to prevent breakages. In all other categories, most ship parts have no uniformity across wood types or time.

It has sometimes been remarked that specific species of wood are less important than their functional characteristics, particularly whether hardwood or softwood was used (e.g. Guibal & Pomey, 1999; Rival, 1991). Hardwoods are angiosperm plants; they flower for reproduction and are usually broadleafed and deciduous. Because of this broad definition, plants such as fig (*Ficus carica* L.) and oleander (*Nerium oleander* L.), for example, are classified as hardwoods even though they are not well suited for construction and are not particularly hard. However, most hardwoods are usually dense, durable, and strong. Softwoods, on the other hand, usually come from coniferous trees, often growing at higher altitudes. They are faster growing than most hardwoods and are usually more flexible. Certain softwoods, like cedar, can also be extremely durable and strong, especially when exposed to saltwater. The conventional wisdom that softwoods were preferred for the planking and major hull components, while hardwoods were used for the axial carpentry, does not seem to hold much water in this early period of ship construction (Figure 6). For example, the planking of the Zambratija wreck was made from elm (*Ulmus* sp.), a hardwood (Ferreira Domínguez et al., 2019, p. 123). Similarly, while dowels are usually associated with hardwood, softwood silver fir (*Abies alba* Mill.) dowels were used on the Grand Ribaud F ship (500–490 BC, Long et al., 2006, p. 482, table 16.8). Whether these were emergency repairs or intentional construction choices is unclear, but it suggests that there was always more than one way of constructing and maintaining a ship. This is a theme that has remained constant from this analysis of shipwrecks, since the choice of woods appears to have been unique to each vessel.

Case Studies

The following discussion will present the geographical distribution of wood types present on individual wrecks using cumulative chorological maps for each ship. Each hexagon represents a 50 km^2 area and its colour represents the number of tree species found on the wreck which grow naturally within that hexagon. It can be assumed that the more species present within an area, the higher the likelihood that the ship was constructed nearby. There are, of course, many potential reasons why this may not be the case – such as a long-distance timber trade that would provide types of wood outside their natural habitat, or the inaccessibility of that habitat. However, the results do often support the initial findings and thus each wreck has been grouped into two categories. Group A includes wrecks where the analysis broadly supports the current interpretation of the origins of each ship, whereas Group B discusses the wrecks where our analysis produced unexpected results.

Group A: Expected Results

Cape Gelidonya

The Cape Gelidonya ship (Figure 7) sank off the coast of southern Anatolia at some point near the end of the 13th century BC carrying a modest cargo of ingots and scrap metal, and has long been interpreted as an example of cabotage trade or 'tramping,' travelling port to port, picking up new wares and selling them on (e.g. Bachhuber, 2020, pp. 1097–1098; Bass, 1967; Gould, 2011, p. 156; Tartaron, 2013, p. 44).

Only three different species of wood have been identified from the wreck. Originally, the hull

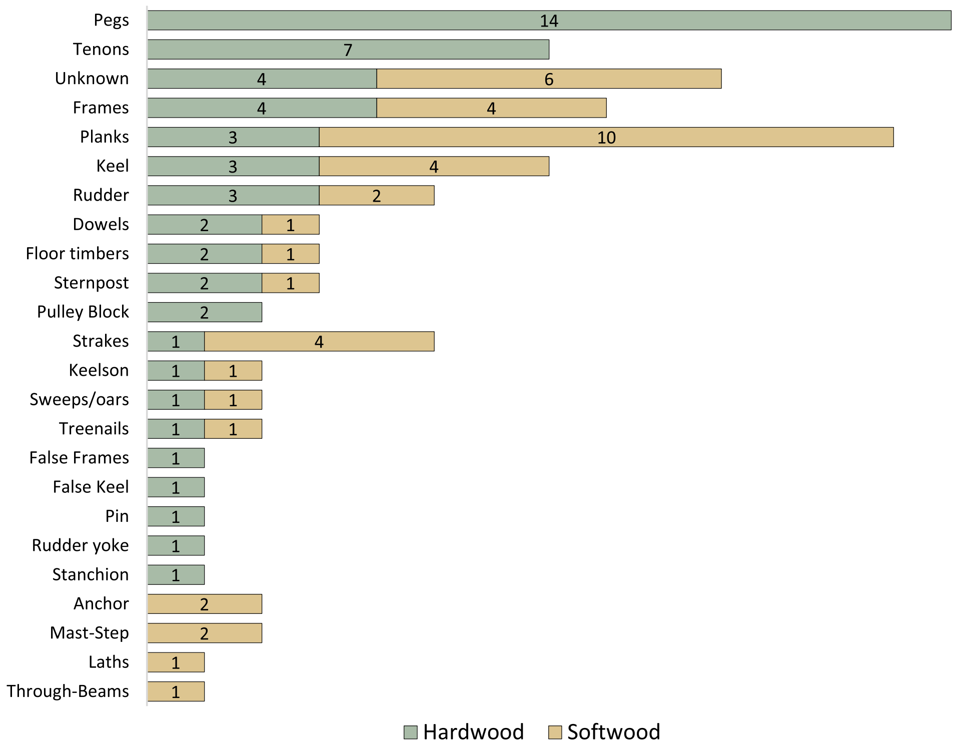

Figure 6. Comparison of ship parts made with hardwoods (green) versus softwoods (brown). M. MacDonald © Practical Mariner Project.

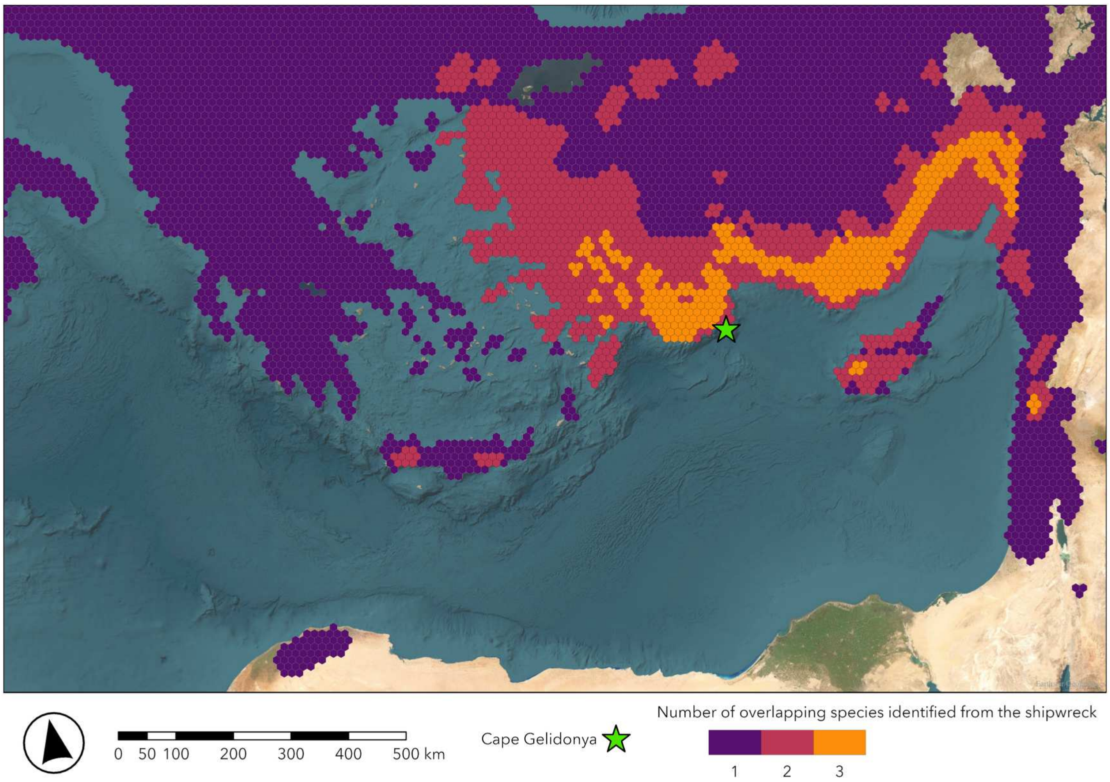

Figure 7. Distribution of overlapping tree species from the Cape Gelidonya wreck. M. MacDonald © Practical Mariner Project.

planking was considered to be made of cypress (*Cupressus* sp.) (Bass, 1999, p. 22; Western, 1967), but re-evaluation of the remaining wood from the excavations has shown that it was built almost entirely of cedar of Lebanon (*Cedrus libani* A.Rich) (Liphschitz & Pulak, 2007/2008, p. 74; Rich, 2016, p. 156, n. 688). The ship was constructed in the pegged mortise-and-tenon joinery system, although this was not understood until after the excavations at Uluburun (Bass, 1999). Wood samples from the Cape Gelidonya wreck included oak (*Quercus* sp.), but the context of the samples has been lost; Bass speculated that some of the ship's oak samples might have come from the ship's tenons, since similar samples were used in the construction of the Uluburun (Bass, 1999, p. 22). Liphschitz and Pulak (2007/2008, p. 74) also identified at least one plank fragment made of Calabrian pine (*Pinus brutia* Ten.), which is native to western and southern Anatolia, the Aegean islands, Cyprus and the mountains of the Levant. Whether the pine fragment is an anomaly in the construction of the ship or part of a later repair job is unclear.

There has been speculation about the potential origins of the Cape Gelidonya ship. Originally, Bass had suggested the Levant based on the alleged personal items of the crew, which all seem to have come from the Near East, mostly northern Syria, but he also left open the possibility of a Cypriote origin (Bass, 1973, p. 36, 2010, pp. 800–801). After identifying of the ship's planks as cedar, Liphschitz and Pulak (2007/2008, p. 74), suggested that it was probably constructed in the same general region as the Uluburun ship – the northern Levant, between Lebanon and the Amanus Mountains. However, Bass (2010, p. 802) returned to the possibility that the ship originated in Cyprus (see also Knapp, 2018, pp. 161–162), after re-examination of some of the personal items found on the ship, as well as the pottery and stone anchor. Certainly, all of the wood identified from the ship could have been sourced on Cyprus – even cedar of Lebanon, albeit its variant, the Cyprus cedar (*Cedrus libani* var. *brevifolia* Hook.f.). With only three known identified wood types, the results are coarse, but highlight Mount Lebanon, Cyprus and southern Anatolia as potential places where all three species overlap – although it must be remembered that there was an extensive international maritime timber trade in the eastern Mediterranean during the LBA (Meiggs, 1982, pp. 63–66; Semaan, 2015; Wachsmann, 1998, pp. 310–113).

Zambratija

The Zambratija shipwreck, excavated between 2008–2013 on the western coast of the Istrian Peninsula, Croatia, is the only wreck belonging to the IA I group to have preserved wooden elements. Having sunk between 1125 and 925 BC, the ship offers a very different view of seafaring and maritime construction than the earlier LBA wrecks of the eastern Mediterranean. Besides being the earliest example of the sewn boat-building tradition in the Mediterranean (Boetto & Pomey, 2019), the wood used in its construction is starkly different from other early Mediterranean wrecks on either side of the Bronze Age transition. Its planking and strakes were constructed out of elm (*Ulmus* sp.), a hardwood. The only other wreck to contain elm was the Giglio wreck (*ca*. 600 BC), although which part of the ship was not recorded by its excavators. Elm was an uncommon wood in the Mediterranean throughout antiquity, with the exception of the Adriatic, where its presence on several wrecks suggest that it was used at least from the first millennium BC into the medieval period. Ferreira Domínguez et al. (2019, p. 125) suggest that this was partly due to local availability, but also to the fact that the natural shape of elm trunks is well suited to the keel-like timbers at the bottom of Adriatic boats, which were otherwise built without a traditional keel. The Zambratija boat is also the only ship in the present study to contain wild pear wood (*Pyrus communis* L.), which was used, along with alder (*Alnus* sp.), for the floor timbers (Ferreira Domínguez et al., 2019, pp. 126–27, fig. III.13). When all of the species present on the Zambratija are combined and viewed together (Figure 8a), it is clear that wood used in the ship is widely available in central Europe as well as on both coasts of the Adriatic Sea. Silver fir (*Abies alba* Mill.), used for laths to cover the seams of the sewn planks, is the only species not immediately present on the coast of Istria but grows at higher altitudes in nearby mountains. This distribution gives the impression that the Zambratija wreck was a local ship that operated or, at the very least, sank well within the local coastscapes and maritime small world of the Adriatic.

Pabuç Burnu

The Pabuç Burnu shipwreck has been interpreted as an Archaic Greek merchant ship transporting a cargo wholly of eastern Aegean amphorae, as well as perishable agricultural products (Greene, Lawall, and Polzer, 2008, p. 703). It sunk between 570 and 560 BC off the coast of Halikarnassos (modern Bodrum, Türkiye).

The hull was constructed out of wood from trees found throughout the Aegean basin, and in particular the western coast of Anatolia (Figure 8b). Previous attempts to provenance the ship suggested that it was constructed in Anatolia because of the use of kermes oak (*Quercus coccifera* L.), which grows mainly in Anatolia (Liphschitz & Pulak, 2007/2008, p. 75). The places with the greatest overlap of all of the ship's species is in northwestern Anatolia with smatterings of other potential locations across the Aegean (and even possibilities in the far west of the Mediterranean). The extremely 'local' character of the ship's cargo

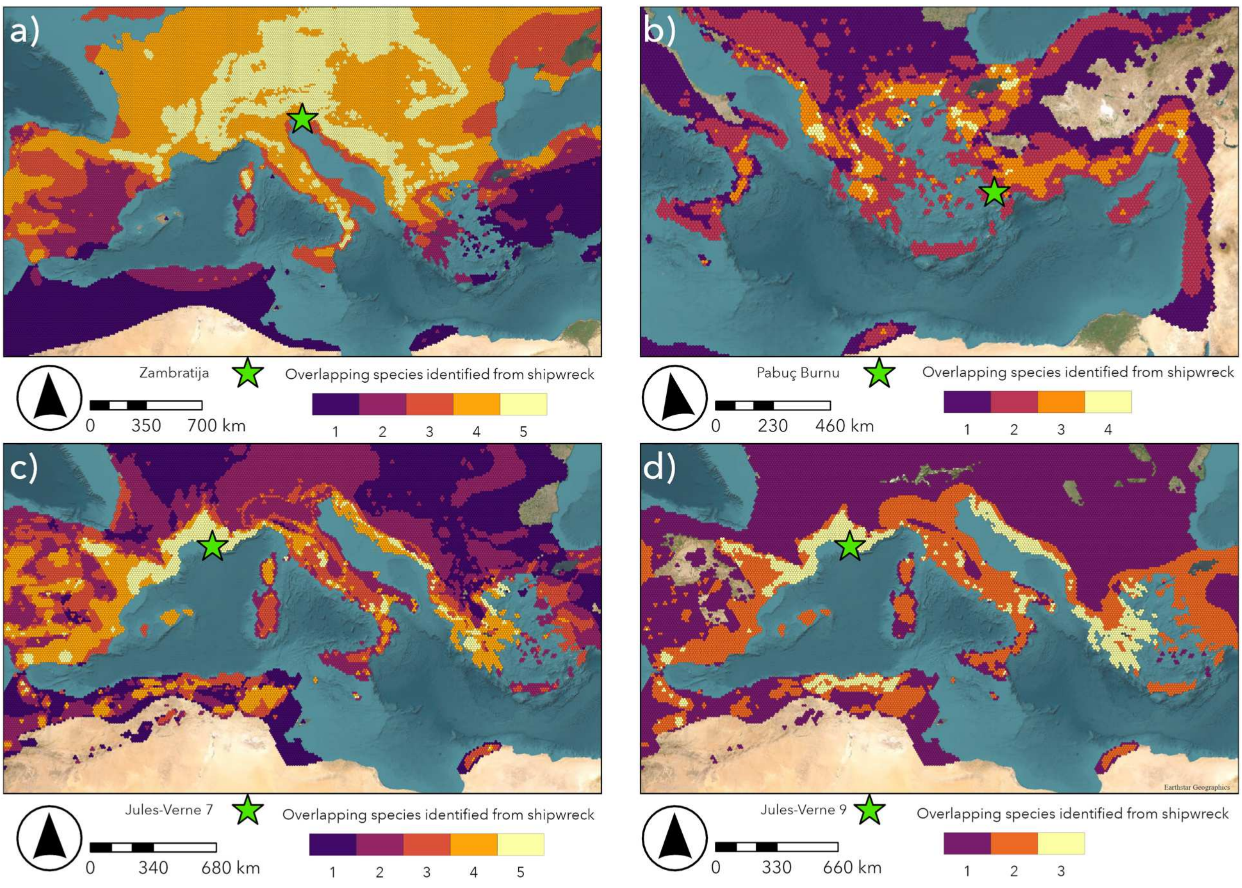

Figure 8. Distribution of overlapping tree species from the a) Zambratija, b) Pabuç Burnu, c) Jules-Verne 7, d) Jules-Verne 9. M. MacDonald © Practical Mariner Project.

suggested to the excavators that the Pabuç Burnu ship operated mainly in the waters between Halikarnasos and Rhodes (Greene et al., 2008, pp. 703–704). All the species found on the ship are also present in the hinterlands of southwestern Asia Minor, accessible to both Halikarnassos as well as Miletos, highlighting the possibility that the ship was sourced entirely from southwestern Asia Minor for the purpose of short distance trade along that coastline and the nearby Aegean islands.

The ship's hull was coated in pitch, which was identified as pine tar originating from Aleppo pine (*Pinus halepensis* Mill.) (Greene et al., 2008, pp. 700–701, n. 62), which is not native to western Anatolia, suggesting that the ship's most recent waterproofing had been undertaken somewhere in the western Aegean (or beyond) or with imported pitch. There is evidence for pitch as a maritime trading good, as pitch cargoes have been found on several ships throughout antiquity (Parker, 1992, p. 19). One example from our period comes from the 7th century BC wreck at Bajo de la Campana in southern Spain, which was carrying jars of pitch for its own repair and refurbishing work (see also Meiggs, 1982, pp. 467–471; Polzer, 2012, p. 29).

Jules-Verne 7 and Jules-Verne 9

Both the Jules-Verne 7 and Jules-Verne 9 wrecks were discovered in 1993 in the Place Jules Verne, in the old port of Marseilles (ancient *Massalia*), southern France. They both date to the very end of the 6th century BC, but likely performed two very different functions for the Phocaean colony. Neither were found with associated cargo, which suggests abandonment over time rather than a violent wrecking. Jules-Verne 7 (Figure 8c) is the larger ship and has been interpreted as a merchant vessel which could have travelled further distances than its smaller counterpart, Jules-Verne 9 (Figure 8d) which was used for coastal and short-hop voyages (Pomey, 2001). On the Jules-Verne 9, small fragments of red coral (*Corallium rubrum* L.) were discovered trapped within the ship's caulking resin towards the stern of the vessel, suggesting that it was used for coral fishing (Pomey, 2000). Red coral was often used as an inlay in ancient jewellery and until recently was abundant in the coastal waters around Marseilles.

The planks and frames of Jules-Verne 9 were made out of Aleppo pine (*Pinus halepensis* Mill.),[6] the keel was constructed from deciduous oak (*Quercus* sp.), and olive wood (*Olea europaea* L.) was used for the treenails and pegs (Pomey, 1998, p. 150, n. 3). All these trees were present in the southern French landscape around *Massalia* and still grow in the woods near the city today. The wood for the modern replica of Jules-Verne 9 – *Gyptis* – was wholly sourced from within a 50 km radius of Marseilles (Pomey & Poveda, 2018, p. 48). Despite different construction methods for the two ships – Jules-Verne 7 was built with pegged mortise-and-tenon joinery while Jules-Verne 9 was sewn – they were both constructed out of an almost identical range of wood, although the keel of Jules-Verne 7 was evergreen holm oak (*Quercus ilex* L.), rather than the deciduous variety used in the Jule-Vene 9. Jules-Verne 7 also had some rib frames made of black alder (*Alnus glutinosa* (L.) Gaertn.).

Figures 8c and 8d highlight the southern French coast as the most likely source for the tree species used in their construction, undoubtably local wood readily available along the coast of Marseilles and its immediate hinterlands. Both ships also were inscribed with the same carpenter's marks, suggesting that the same shipyard or shipwright was responsible for their construction (Long et al., 2002, p. 123). It is interesting that those same woods are also present in Greece and the Aegean, though not around Phocaea, the colony's mother city. Perhaps we can infer some Aegean traditional familiarity with these wood species.

Group B: Unexpected Results

Uluburun

The Uluburun wreck is the richest and most studied shipwreck within the chronological focus of the Practical Mariner Project. It is also one of the oldest, sinking around the end of the 14th century BC off the southern coast of Anatolia (Pulak, 1998). It operated within the world described in the Amarna letters and its cargo has been interpreted as valuable enough to represent a royal gift exchange similar to the practices described in the tablets (Pulak, 2008).[7] The origins of the ship have often been assumed to be one of the ports on the Levantine coast, while the destination was more than likely one of the Aegean polities on Crete or mainland Greece (Cline & Yasur-Landau, 2007).

The nature of the cargo found on the Uluburun suggests that it picked up its last shipment somewhere along the Carmel coast (Pulak, 2010, pp. 870-871). This is unlikely to have been the location of the shipyard in which it was constructed however, as the southern Levant lacks many of the tree species used in the ship's construction (*Cedrus libani* A.Rich, *Quercus cerris* L., and *Pinus nigra* J.F. Arnold). A combination of petrographic analysis on the galley-ware as well as on several of the stone anchors has been used to suggest that the central Levantine coast – somewhere between southern Lebanon and northern Israel – was the ship's 'home port' or at least, the origin point of its final journey (Pulak, 2008, p. 299, 2010, p. 874). However, when searching for the origin of the ship's tree species, Liphschitz and Pulak (2007/2008, p. 74) found that the wood types more closely align with the northern Levant: either the Gulf of Alexandretta or northern Syria. To explain this, they suggest that the kermes oak (*Quercus coccifera* L.) tenons and pegs of the ship could have been imported. While it is entirely possible that this was the case, as the Levant had an established maritime timber trade (see above), the JRC's chorological dataset suggests that kermes oak is native to both the Lebanon and Syrian Coastal Range. Rich et al. (2016) have analysed the 87Sr/86Sr isotope ratio of the cedar of Lebanon wood from Uluburun in order to determine its provenance; they compared the strontium ratios of the cedar timbers from the wreck to samples taken in the central Taurus Mountains in Turkey, the Troodos Mountains in Cyprus, and various forests in Lebanon. The results did not conclusively point to any one area as the most likely source of the timbers, but the authors stated that by process of elimination the Syrian Coastal Range or the south-central Amanus Range (since they were unable to collect samples from those regions) could be the source of the wood instead.

At first glance, the hexagon map of the wreck's tree species (Figure 9) might suggest that the southern coast of Anatolia, rather than the central Levant, was the only place where all of the ship's tree species existed together, and that consequently a reassessment its origin might be needed. There are, however, a few caveats to highlight here. The first is that only cedar and kermes oak have been conclusively identified as belonging to the ship's hull construction, both of which could have been sourced the central Levant. The Turkey oak (*Quercus cerris* L.) and tamarisk (*Tamarix* sp.) planks probably belonged to other parts of the ship such as the ceiling, deck planking, or some sort of superstructure on deck (Liphschitz & Pulak, 2007/2008, p. 74). Cypress (*Cupressus sempervirens* L.) is also listed as present on the wreck and could have been used for a similar purpose. All of these species grow in the central Levant but one: Black pine (*Pinus nigra* J.F. Arnold). Black pine was identified in one sample from the wreck which was not positively identified with any particular part of the ship (Liphschitz & Pulak, 2007/2008, p. 78, table 1). It does grow in the far north of the Levant, in the Amanus Range as well as in parts of southern Anatolia. If it was part of the ship's original construction, it might reflect the maritime timber trade along the northern Levantine coast, perhaps within the sphere of the Kingdom of Ugarit (see Monroe, 2010, pp. 24–25).

Finally, either white poplar (*Populus alba* L.) or black popular (*Populus nigra* L.) was used for the ship's sweeps/oars (Liphschitz & Pulak, 2007/2008, p. 78, table 1). White poplar (*Populus alba* L.) is pervasive throughout the Mediterranean, while black poplar (*Populus nigra* L.) has a more limited range in the hinterlands of Anatolia, scattered in the Aegean Islands, and in the northern Aegean interior; we have opted to use white poplar for the analysis in Figure 9. Oars and sweeps are some of the most replaceable parts of a ship, and also some of the most likely parts to be lost during voyages. Oars might therefore have been an item that, when lost or broken, would have been sought out by the crew *en route*. If the example

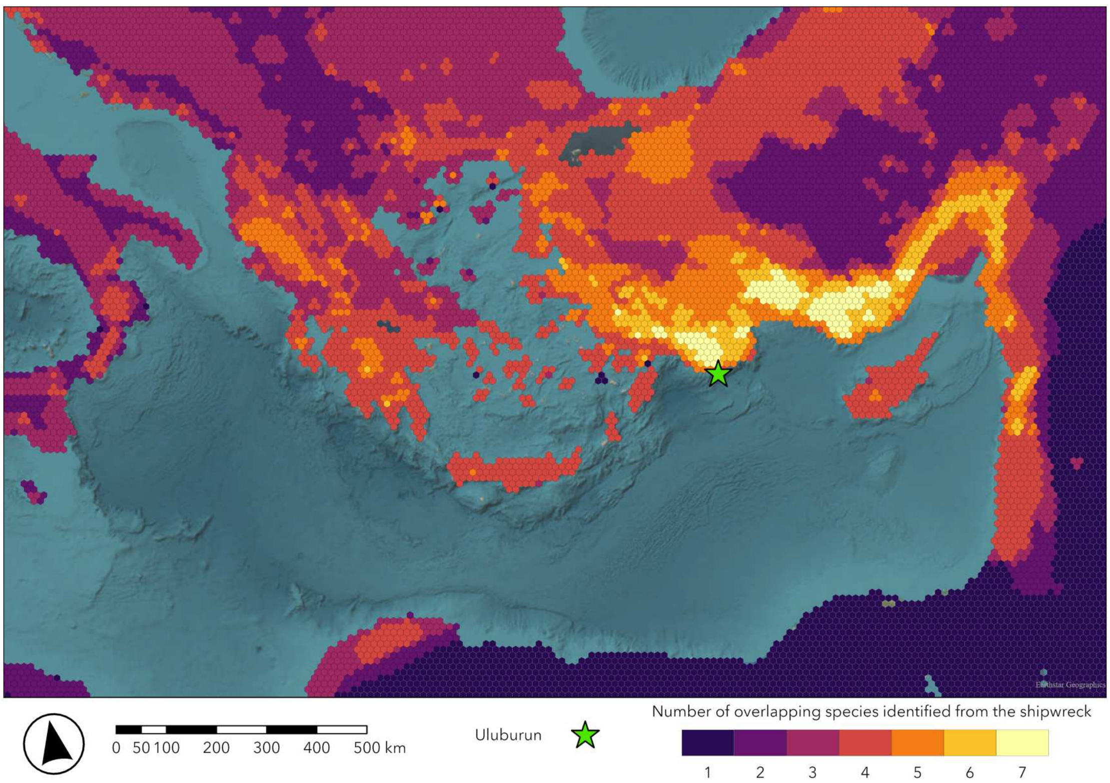

Figure 9. Distribution of overlapping tree species from the Uluburun wreck. M. MacDonald © Practical Mariner Project.

found on the Uluburun ship was indeed black poplar rather than white, it might indicate that it was a replacement piece acquired at an earlier point in the ship's life. Similarly, another type of oar – steering oars or quarter rudders – were a common feature of Levantine ships (Wachsmann, 1998, pp. 50–54). These were usually attached to the stern of a ship to increase its manoeuvrability, and they should be considered as some of the most fragile elements of a ship. We might imagine a scenario similar to the one which played out off the coast of Cyprus in 2023, when the replica ship *Kyrenia-Liberty* capsized after her quarter rudders were broken in high winds (El Safadi, 2023). Strong weather, human error, degradation due to the presence of wood boring animals, and age could all potentially cause irreparable damage, in which case they would have to be replaced mid-voyage. This would have been accomplished through trade or purchase (ready-made or as lumber) at a local harbour, or perhaps some sailors were sent ashore to find suitable trees for the replacement parts. This would have required the crew to have some knowledge of carpentry and the ability to choose the appropriate wood; they would also have needed to understand the properties of the tree species used in the original construction and the ability to recognise compatible qualities in trees that they might find along their routes.

Comparison of the Uluburun and Cape Gelidonya ships' wood types can also elucidate information about the LBA eastern Mediterranean's culture of ship construction. It is difficult to draw large conclusions about ship construction and the choice of timber from only two shipwrecks dating to the LBA, especially as they were some of the earliest to be excavated in Mediterranean maritime archaeology. The recovery of wood from both wrecks is significant, but limited in terms of its scope. It is also unfortunate that the other known LBA wrecks have not produced any wood for comparison.[8] Both Uluburun and Cape Gelidonya clearly operated at the 'interregional/intercultural scale' of the eastern Mediterranean (Tartaron, 2013, pp. 202–203). Both were built mainly out of cedar of Lebanon, most famous in the Bronze Age for its good qualities for seafaring, such as slow deterioration in salt water, low levels of expansion, and minimal warping. While Egypt and Mesopotamia may have needed to import cedar of Lebanon, Canaan, Syria, Cyprus, and Anatolia (as well as Crete) most likely had their own sources to draw from. Both ships could also have been entirely constructed out of wood from southern Anatolia as all tree species found on each ship grow natively in the Taurus Mountains, especially in Rough Cilicia and Lycia. The deforestation of Rough Cilicia appears not to have occurred before the Classical Period, suggesting that timber from the mountain forests was not heavily exploited during the Bronze Age (Akkemik et al., 2012). The southern coast of Asia Minor is rough and steep with a large variation in elevation and altitude and Lycia, the Bronze Age '*Lukkaland*' was referred to both as a haven for pirates (from the point of view of the eastern Mediterranean states) and as home to one of the so-called 'Sea People' groups; it has abundant forests which could supply all the necessary timbers to construct and maintain ships in the same tradition as the Uluburun and Gelidonya wrecks.

In sum, Figure 9 indicates that there is an area of the Syrian Coastal Range, close to the Bronze Age trading hub of Ugarit, which appears to host all of the necessary trees to construct the Uluburun ship, with the exception of black pine which could be acquired from the Amanus Range to the north. Ultimately, these results reflect the conclusion of Liphschitz and Pulak (2007/2008, p. 74), that the ship was constructed between northern Lebanon and southern Türkiye, but additional nuance has now been added.

Mazarrón 1 and Mazarrón 2

Two of the most well-preserved ships from the first half of the first millennium BC were discovered in the 1990s in Murcia, Spain at Mazarrón (Negueruela et al., 1995). These were designated Mazarrón 1, which sank sometime between 650 and 600 BC, and Mazarrón 2, which sank slightly later between 625 and 570 BC. These ships are presented here together for comparison even though Mazarrón 2 might fit better in Group A. Both ships were discovered close to an offshore islet, and carried cargo related to mining and metal production; Mazarrón 2, for example, was found with 2,800 kg of litharge, which is used in the process of extracting metals such as silver from lead ore. Originally, both ships were proposed by their excavators to be Phoenician vessels, extracting Iberian precious metals for export back to the east or on behalf of one of the Phoenician colonies on the Iberian Peninsula. This interpretation was supported by the fact that the majority of the ceramics on and around the ships was Phoenician in origin. However, this argument has been recently re-evaluated by Cabrera Tejedor (2018; 2022), who studied the construction techniques for the ships, especially Mazarrón 1, in more detail. The Mazarrón 1 wreck was held together by both pegged mortise-and-tenon joinery and stitching or lashing cordage in the sewn boat tradition. Pegged mortise-and-tenon joinery had been employed as a boat-building method in the eastern Mediterranean as early as the Uluburun wreck and is considered to be an indicator of 'Punico-Phoenician influence' (Pomey & Boetto, 2019, pp. 19–22). By the time the Mazarrón boats had sunk at the end of the 7th century BC, the Phoenician colonies of Iberia had already existed for centuries, and the combination of sewn planking and pegged mortise-and-tenon joinery on the ship suggest that this represents a local hybrid style that combined eastern and indigenous techniques that developed over time (Cabrera Tejedor, 2018, pp. 320–321).

Other evidence points to a western origin for the ship. The fibres used for the Mazarrón 1's caulking were made of esparto grass (*Stipa tenacissima* L.), a fibrous plant which grows only in southeastern Spain and northwestern Africa (Cabrera Tejedor, 2018, p. 320; 2022, pp. 112–113). Additionally, both Mazarrón 1 and 2 were only around eight metres long, which would make a trans-Mediterranean journey extremely unlikely (Cabrera Tejedor, 2022, pp. 106–107). These factors suggest that the Mazarrón vessels were constructed and operated in and along the Iberian coast, but with influences from the Phoenician shipbuilding tradition.

Although the two ships were found in the same place, are roughly from the same time period, and carried similar cargo, their comparative hexagonal maps (Figures 10a–10b) highlight their divergent histories and perhaps distinct origins. Mazarrón 1, despite the evidence that it was constructed along the Mediterranean coast of Spain, was not built from local woods alone. The map (Figure 10a) highlights the eastern Mediterranean, southern Greece, and North Africa (i.e. *Cyrenaica* and Carthage) as places where all of the identified wood from the ship grows naturally. The species missing from anywhere in the western Mediterranean is cypress (*Cupressus sempervirens* L.), which has its origins in the eastern Mediterranean, only being naturalised across the entire basin in the Roman period (Liphschitz, 2015). Cypress was identified as the wood used for the Mazarrón 1's keel (Cabrera Tejedor, 2018, pp. 302–303; Negueruela, 2004, pp. 236–237). A cypress keel on the Mazarrón 1 ship could suggest three scenarios: 1) cypress trees were introduced into the Iberian Peninsula during the Bronze or Iron Age through synanthropic means (i.e. being brought over from the eastern Mediterranean by Phoenicians or others); 2) the ship was in fact constructed in the eastern Mediterranean, *Cyrenaica*, or the region around Carthage and brought to Iberia; or 3) the keel was made from recycled timber from an earlier, Phoenician/Punic vessel. Given the evidence discussed above that the ship was built in a mixture of local traditions and Phoenician innovation, it seems plausible to accept the third option as the most likely, although without a more detailed examination of the keel itself any of the options are possibilities.

The Mazarrón 2 boat (Figure 10b), on the other hand, does not have any wood types which would immediately support a link beyond the western Mediterranean. The ship, which sank less than a generation after the Mazarrón 1, was made mostly of Aleppo pine (*Pinus halepensis* Mill.), juniper (*Juniperus* sp.) and

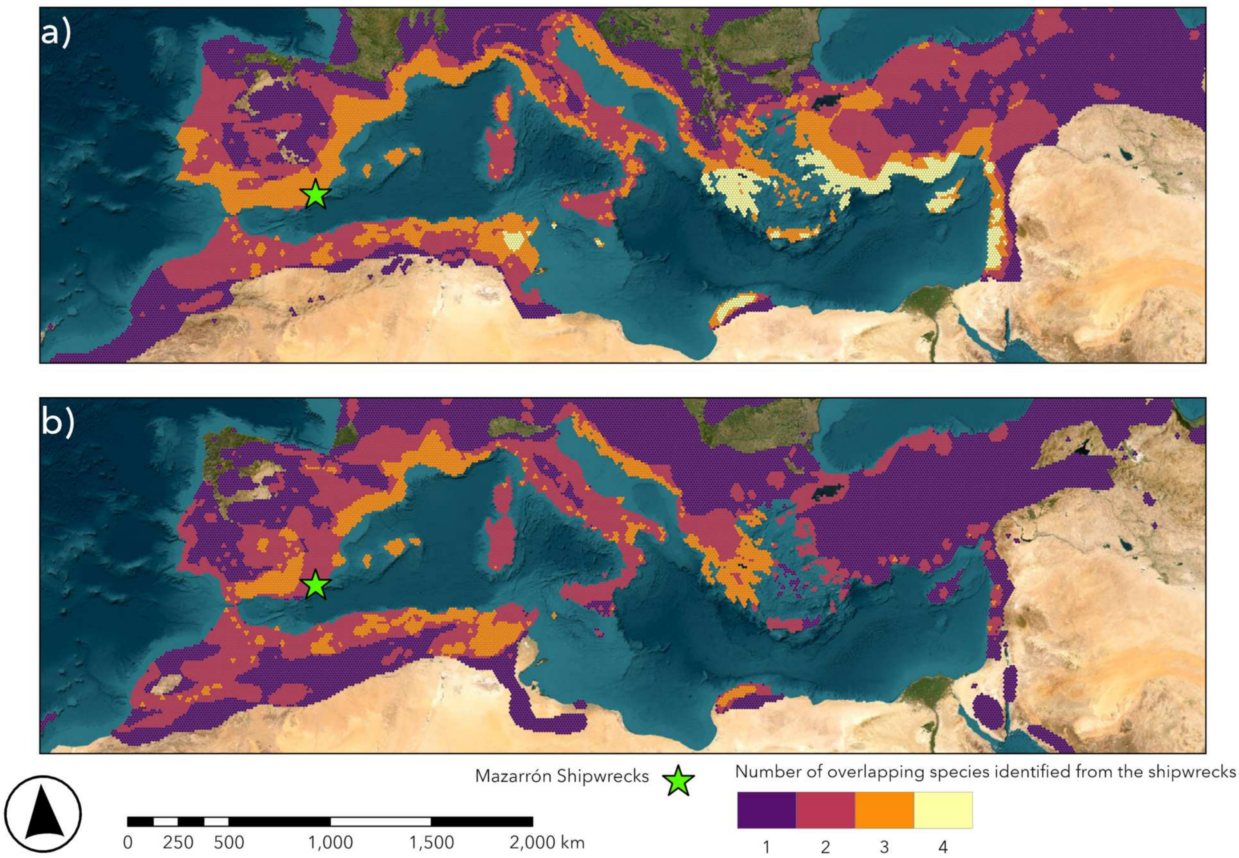

Figure 10. Distribution of overlapping tree species from the a) Mazarrón 1 wreck, and b) Mazarrón 2 wreck. M. MacDonald © Practical Mariner Project.

olive wood (*Olea europaea* L.),[9] which all grow naturally along Spain's Mediterranean coast. If the species of *Juniperus* was discernible, it might be possible to narrow down further the ship's origin. The ship's wooden anchor was constructed with a combination of Aleppo pine and buckthorns (*Rhamnus* sp.) or phillyrea (*Phillyrea* sp.), both of which grow along the Iberian coast (Miñano, 2014, p. 10). Of course, anchors were not a fixed part of the ship and were routinely abandoned along shipping routes, with new ones being acquired as necessary.

Giglio

In the first decades of the 6th century BC, the Giglio ship sank off the small island of the same name in the Tuscan Archipelago off the west coast of Italy; even today the island is well-known for its dangerous waters and risk of shipwreck. The shipwreck, constructed in the sewn/laced planking tradition, was excavated between 1982 and 1986, but has only received preliminary publication (Bound, 1991a). The wreck was tentatively referred to as being of Etruscan origin, based on the numerous Etruscan amphorae found on board (Bound, 1991b). Finds of East Greek and Samian origin were also on board as well as one Phoenician/Punic vessel. In that preliminary publication, the excavator lamented that the identification of wood from the Giglio wreck produced only wood from trees which grew all over the Mediterranean and was thus unhelpful in locating a region in which the ship could have been built (Bound, 1991a, p. 34). This study is able to provide more insights (Figure 11). Nine different wood types were reported as having come from the ship's construction, the most out of any of the wrecks from our period (Figure 4). Scots pine (*Pinus sylvestris* L.) was used for planking (Bound, 1991a, p. 43), olive (*Olea europaea* L.), phillyrea (*Phillyrea latifolia* L.) and hazel (*Corylus avellana* L.) for pegs, and boxwood (*Buxus sempervirens* L.) and holm oak (*Quercus ilex* L.) for pulley blocks (Abbate et al., 1989). The cumulative map of the Giglio's wood suggests that the ship's wood did not grow naturally in one area anywhere near the Tuscan islands or Etruria. All the species on board the ship grew natively in the mountains of Liguria and Provence and indeed in several places in southern France and even the northeastern coast of Iberia. The species absent from the Etruscan coast and heartland are the mountain species found on the ship, i.e. silver fir (*Abies alba* Mill.) and Scots pine (*Pinus sylvestris* L.), both of which grow in the northern Apennines and could have been transported into Etruria via rivers such as the Serchio or Arno. If this was the case, then it implies the existence of adjacent industries related to the construction of ships, such as lumberjacks and river drivers. Whether the ship was constructed in Etruria or further north along the French or Iberian coastlines requires more investigation, but the Giglio wreck highlights the complexity of acquisition of raw materials for ship construction and the importance of a multi-faceted approach to understanding the history of a ship.

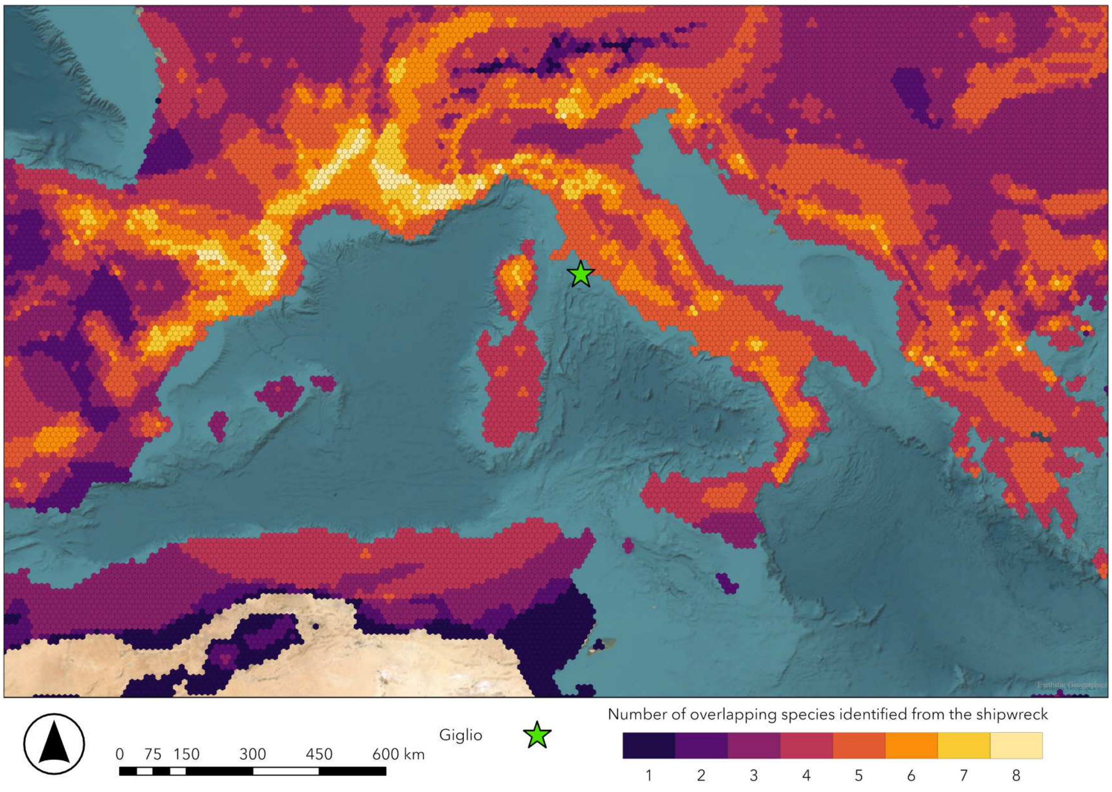

Figure 11. Distribution of overlapping tree species from the Giglio wreck. M. MacDonald © Practical Mariner Project.

Cala Sant Vicenç

The wreck discovered at Cala Sant Vicenç on the northern coast of Mallorca in the Balearic Isles, Spain (Figure 12) probably sank at some point in the final two decades of the 6th century BC. Its planks were lashed together in the sewn boat tradition and featured tetrahedral recesses carved into the wood where the cordage would sew the planks together, a construction method considered to belong to the 'original phase' of the 'Greek' boatbuilding tradition that includes Bon Porté, Jules-Verne 9, Giglio, and Pabuç Burnu (Boetto & Pomey, 2019, pp. 27–28; Nieto & Santos, 2010, p. 47; Pomey, 2009). There is no suggestion from the excavators that Mallorca – or anywhere in the Balearic Islands – was the place where the ship was constructed, and indeed the islands are particularly ill suited to provide the requisite species for its construction, as only one species – holm oak (*Quercus ilex* L.) – out of the seven identified from the wreck grows on the islands. However, the excavators have suggested that the entire keel was replaced at some point, and that a false keel was added to provide it with extra support (Nieto & Santos, 2010, pp. 48–9); both parts were made of holm oak.

Speculation about the origins of the Cala Sant Vicenç ship have mainly centred around its cargo, and especially the tableware and other objects suspected to have been part of the crew's personal effects. These included lamps from the Greek cities of southern Italy, but particularly ceramic utensils and tableware from *Massalia* and *Emporion*. The ship's sewn construction and similarities to other western Mediterranean vessels from this same time period also led the excavators to suggest that the ship was of either Massaliote or Emporitan origin, travelling on a western trade circuit that included the coasts of Italy, France, and Spain as well as the Balearic Islands (Nieto & Santos, 2010, pp. 53–54; Santos & Nieto, 2009, pp. 326–329).

Our map of the tree species from the Cala Sant Vicenç shipwreck reinforces the excavators' suggestion that the ship likely originated in the Greek colonies at *Massalia* or *Emporion*. In no other cumulative map are the results so stark as with the Cala Sant Vicenç wreck. The only parts of the Mediterranean coast with nearly all of the wood found on the wreck occur in the hinterlands of both *Massalia* and *Emporion*. The only exception is some samples of planks made from cedar (*Cedrus* sp.) – potentially Atlas cedar (*Cedrus atlantica* (Endl.) Manetti ex Carrière) – which were situated near the ship's frames; these fragments potentially represent the interior decking of the ship's hold (Piqué i Huerta, 2009, p. 332). Atlas cedar is native to the mountains of Morocco and Algeria, and its presence on board the Cala Sant Vicenç ship demonstrates the inclusion of wood for ship construction in the networks of interaction and trade between the Greek and Phoenician colonies, as well as the indigenous communities, of the western Mediterranean (see Broodbank, 2013, pp. 546–548; Hodos, 2020, pp. 114–115; Malkin, 2011; Treumann, 2009).

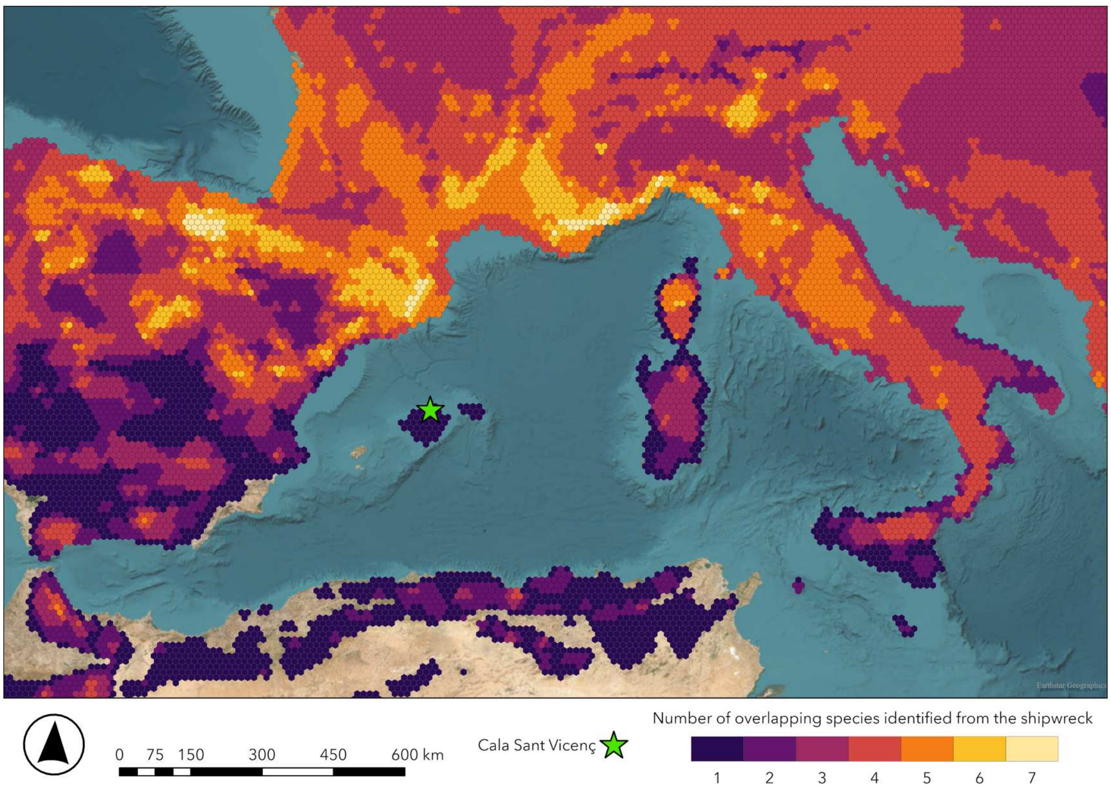

Figure 12. Distribution of overlapping tree species from the Cala Sant Vicenç wreck. M. MacDonald © Practical Mariner Project.

The ship's ligatures – the cordage used to sew the hull planking together – were found to be made from esparto grass, which grows natively in Spain. These ligatures would have had to be periodically replaced over the course of the ship's life, so they may represent maintenance undertaken at an Iberian port. On the other hand, the cordage might also have been traded to and acquired from other Greek cities along the ship's route. It is interesting to note that the Mazarrón and Cala Sant Vicenç ships are the only three pre-Classical sewn boats to have used esparto grass as the sewing material. The identified sewing fibres from the Jules-Verne 9 wreck were made of flax (Pomey & Poveda, 2018, p. 46). This, together with all of the species present in the city's hinterlands suggest that the Cala Sant Vicenç ship could plausibly have been sourced and constructed from the trees around *Emporion*, along with cedar wood, imported or acquired later from North Africa or the eastern Mediterranean.

Conclusions

'The complexity of ships offers one of the best ways to access the past' (Adams, 2001, p. 304).

This paper has updated the list of known wrecks from 1500–500 BC, and of particular importance for this study, the number of wrecks with wooden remains up to 20. Using modern chorological datasets produced by the European Commission Joint Research Centre (JRC), it is now possible to create cumulative maps overlaying all of the known wood types found on a shipwreck to narrow down and identify potential places where that ship might have been constructed or where its wood might have been sourced from. However, beyond the origins of the ship itself, it is clear that understanding the natural landscapes and ecologies of the Mediterranean coast was an essential part of ancient seafaring. Shipbuilding, maintenance, and repair all require knowledge not only of carpentry, but also of trees and wood characteristics. When sailing on a long-distance voyage, ships such as the Cape Gelidonya or Uluburun wrecks would take their sailors away from familiar forests, forcing them to repair and replace ship parts with potentially unfamiliar tree species. Knowledge of wood characteristics was clearly one of the most important aspects of ship construction and maintenance in the ancient world.

The case studies of the wrecks presented here have both added evidence for the origin and construction of ships and have challenged or revised the current understanding. The Uluburun and Cape Gelidonya ships operated within the eastern Mediterranean trading system, with their materials, such as cedar of Lebanon (*Cedrus libani* A.Rich), selected as much for its cultural significance as its seafaring properties. The Zambratija, Jules-Verne 7, Jules-Verne 9, and Pabuç Burnu ships were all sourced locally, agreeing with their original interpretations: regional woods for regional ships. For the Cala Sant Vicenç ship, it was possible to support the original interpretation of the ship as coming from one of the Greek colonies in the western Mediterranean, as the only two areas with all of the ship's requisite species (save for the *Cedrus* sp.) happened to occur in the hinterlands of *Massalia* and *Emporion*; the use of esparto grass for the ship's sewing might further suggest *Emporion* as a potential construction site. The Mazarrón boats initially were both considered to be of Phoenician origin, but further study seemed to indicate that they actually belonged to an indigenous Iberian boat building tradition. While the Mazarrón 2 wreck seems to conform to this picture – a boat constructed along the Iberian coast and meant to operate along it – the Mazarrón 1's cypress (*Cupressus sempervirens* L.) keel suggests divergent histories for the two ships, perhaps even evidence for the recycling of an older Punic/Phoenician vessel. Finally, the woods from the Giglio wreck are surprising, they either suggest that the ship was built along the northern coast of the western Mediterranean, perhaps even in *Massalia* or somewhere close by, or they may hint at a larger regional organisation of Etruscan boat building, sourcing coniferous wood from the mountains around Etruria and sending them down river.

Wood is, of course, only one resource required for the construction, maintenance, and repair of ancient ships: metal fastenings and brailing rings, stone anchors, cloth for sails and wadding, pitch and beeswax for waterproofing, and leather for oar-straps and fastenings were all required for the functioning of what Muckelroy (1978, p. 3) called the ancient world's most complex machines. However, the results of this study demonstrate the value of provenancing the wood *taxa* from shipwrecks, and, in particular, in studying their distribution together, rather than individually. This paper offers precision precisely because it stresses the mutual availability and co-location of tree species, and the results can both confirm and add nuance to the picture derived from other lines of evidence. Understanding the ecological origins of ancient ships offers new and evocative narratives of ancient seafaring and ship construction. The knowledge of trees and wood was vital for sailing the Mediterranean and this study has demonstrated the different ways in which this information can be gleaned from the – often limited – archaeological record.

Acknowledgements

We would like to thank the members of the Practical Mariner's advisory board for their insightful suggestions; Karl Smith for his support with the GIS; the two anonymous reviewers for their helpful comments; and Harry Tzalas, Pierre Poveda, Tom Maltas, and Deborah Cvikel for their helpful responses to our questions. We would also like to acknowledge Iro' B. Camici and Peter MacDonald for their suggestions and edits on earlier versions of this paper and Guido Camici and Anthoula Makri for their help with the abstract translations.

Disclosure Statement

The authors know of no competing interests to declare.

Funding

This research was funded by Augmentum (www.augmentum.ch) as part of the Practical Mariner Project at the University of Oxford.

Author Contribution

MM: Writing – original draft, visualisation, methodology, investigation, conceptualisation.

LH: Conceptualisation, supervision, validation, writing – review & editing.

Endnotes

1. This figure may not translate exactly to the ancient world however, since in areas where forests were habitually harvested for ship construction trees may have been intentionally shaped to fit the specifications of ships reducing the total trees required (for the use of a tree's morphology in wood selection for ship building see Rival, 1991, pp. 113–121, pls. 109–112; for an example of forest management for shipbuilding in northern Sweden see Westerdahl, 2009).
2. The full database will be made available in due course, but an abridged version can be found on the project's website: https://practicalmariner.site.ox.ac.uk. It is our aim to have the database remain open access even after the close of the project.
3. Some of Parker's wrecks were omitted from the study for a number of reasons: they were not from verifiable sources, they consisted of one or two amphorae only, or they were placed within a very wide date range that extended far outside the timeframe of the Practical Mariner. The omitted wrecks included Parker Numbers: **418**, **113**, **508**, **718**, **432**, **742**, **1042**, and **1209**.
4. For *Ficus carica* L., which was introduced into the Mediterranean by humans well before the LBA, we follow Zohary et al. (2012, pp. 126–130).
5. Though see Kilani (2016) who suggests that juniper may have been the intended species.
6. Pomey (1998, p. 150, n. 3) claims that stone pine (*Pinus pinea* L.) was also used for the ship's planking, but this is not mentioned again in later publications, nor was it incorporated into the *Gyptis* replica.
7. While the expansive collection of prestige items on board the ship reflects the goods mentioned in these exchanges, the contents of the Uluburun ship itself need not necessarily represent this kind of exchange, and the consignment of goods on the ship could just as easily be part of a commercial or private enterprise (see for example: Bachhuber, 2006; Manning & Hulin, 2005; Monroe, 2010; Zangani, 2016).
8. The Point Iria wreck produced a small piece of wood with a potential mortise, but the wood has never been identified (Vichos, 1999, pp. 78–79).
9. There is a great deal of confusion about wood in the publications of the wreck. Miñano (2014, p. 9) claims that the frames are made of juniper, but Negueruela (2014, p. 244) claims that they are fig branches. The frames of Mazarrón 1 have also been reported to be made of fig (Negueruela, 2004, pp. 236–237; 2006, p. 25) and Miñano repeatedly asserts that identification of wood on Mazarrón 2 is equivalent to Mazarrón 1: '*Los análisis de especie realizados de la quilla corresponden al Barco 1, que se han equiparado para ambas embarcaciones*' (2014, n. 1, 2), but no formal list of Mazarrón 2's species has been published. Cabrera Tejedor (2022, p. 87) also notes that the Mazarrón 1's cypress keel has been incorrectly referred to as cedar on several occasions.

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