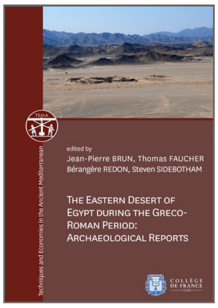


Jean-Pierre Brun, Thomas Faucher, Bérangère Redon and Steven Sidebotham (dir.)

The Eastern Desert of Egypt during the Greco-Roman Period: Archaeological Reports

Collège de France

Fuelwood and Wood Supplies in the Eastern Desert of Egypt during Roman Times

Charlène Bouchaud, Claire Newton, Marijke Van der Veen and Caroline Vermeeren

DOI: 10.4000/books.cdf.5237
Publisher: Collège de France
Place of publication: Paris
Year of publication: 2018
Published on OpenEdition Books: 14 September 2018
Serie: Institut des civilisations
Electronic ISBN: 9782722604889

Electronic reference
BOUCHAUD, Charlène ; et al. *Fuelwood and Wood Supplies in the Eastern Desert of Egypt during Roman Times* In: *The Eastern Desert of Egypt during the Greco-Roman Period: Archaeological Reports* [online]. Paris: Collège de France, 2018 (generated 22 octobre 2018). Available on the Internet: <http://books.openedition.org/cdf/5237>. ISBN: 9782722604889. DOI: 10.4000/books.cdf.5237.

Fuelwood and Wood Supplies in the Eastern Desert of Egypt during Roman Times

Charlène Bouchaud, Claire Newton, Marijke Van der Veen and Caroline Vermeeren

Introduction

1 Due to the scarcity of resources, fuel and wood supply was a major issue in the Eastern Desert of Egypt. This scarcity is caused by the hyperarid conditions that started some 6000 years ago, as indicated by paleo-climatic studies, carried out locally in the mountains of the Red Sea (Butzer 1999; Moeyersons *et al.* 1999) and west of the Nile (Bubenzer, Riemer 2007), as well as in the wider region (Hoelzmann *et al.* 2004; Kuper, Kröpelin 2006). The woody vegetation of this desert is concentrated mainly along ephemeral streams, wâdis, or in upland areas. Elsewhere, in the sandy and rocky plains, we find mostly shrubs rather than trees. Cooking, heating, lighting, reducing and melting ores, making doors, building roofs, firing bricks, carving tools were daily activities or at least regularly carried out by the occupants of the desert at different times, resulting in frequent use of woody resources, either present in the desert or imported. This was particularly the case in Roman times, during which the Eastern Desert experienced a peak of exploitation of local resources of minerals, precious stones and building stones, as well as the development of trade routes between the Nile valley and the Red Sea. Excavations on various Roman sites in this region, mainly occupied between the 1st and the 3rd centuries AD, have provided a substantial corpus of wood and charcoal found in both domestic and craft contexts. These elements provide a unique opportunity to study the wide variety of uses of woody materials and the role of economic and environmental factors in their use and distribution.

The data

Study of wood and charcoal

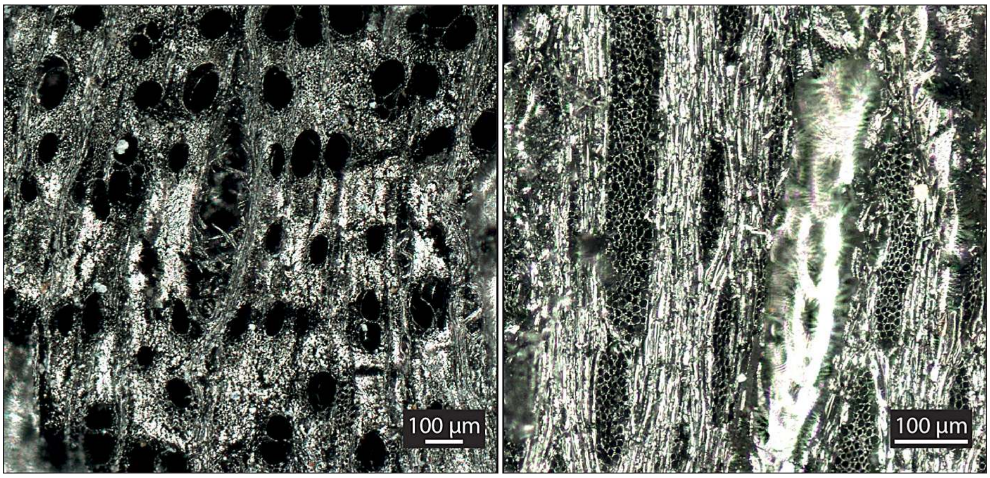
2 The present work is based on the analysis of raw archaeobotanical data, that is the remains of charcoal and wood found in a variety of archaeological contexts at a range of sites. In French, such studies are usually called “anthracologie” and “xylologie”,[1] corresponding to the English words “anthracology” and “xylology”, though the terms “charcoal analysis” and “wood studies” are more commonly used in English.

3 In the Eastern Desert, as in many other regions, charcoal is among the most frequently found items on archaeological sites when the sediments from domestic levels, craft structures or fire layers are finely sieved.[2] The hyperaridity of the region has also allowed the remarkable conservation of wooden elements, which are organic materials generally more vulnerable to insects and biological decomposition. Preservation of the wood varies across sites and contexts, dependent of local levels of humidity. Generally, humidity levels are very low and preservation good.

4 The joint study of wood and charcoal answers various questions illustrating the diversity of the relationships between man and tree. The first aspect is of a utilitarian nature and makes it possible to understand how these remains were used. The study of wood includes an important technical dimension related to the manufacture of the objects and their use (see the studies of C. Vermeeren at Berenike and J. Whitewright at Myos Hormos, references below). Charcoal is mainly used to understand the management of fuel in domestic and artisanal contexts (Théry-Parisot *et al.*, 2010). Identifying the botanical taxon of each item allows us to study the origin and supply of these woody resources.

5 The identification is carried out by microscopic examination of the fragments in reflected light for charcoal and certain woods, and in transmitted light for thin-section wood samples. The anatomy (the number and distribution of vessels, the width of the rays, the types of intervascular structures, etc.) is observed on three planes (cross-section, tangential and radial, Fig. 1) and is compared with descriptions from atlases (Fahn *et al.*, 1986; Neumann 1989; Schweingruber 1990; Neumann *et al.*, 2001) and modern reference collections, such as those of research centres in particular the IFAO (Institut français d'archéologie orientale) Archeometry Laboratory.[3] The proposed identification is made according to different taxonomic ranks[4] depending on the preservation and the size of the observed fragment and the diagnostic value of these anatomical features. Thus, the least identifiable elements are simply classified, as either angiosperms (flowering plants) or gymnosperms (including conifers). Some can only be grouped under a family name. For example the family of Chenopodiaceae[5] includes several shrub species which are difficult to separate from the observed anatomical criteria alone. Many taxa can, fortunately, be identified to genus level, such as acacias (*Acacia* spp.)[6] or some pines (*Pinus* sp.). A few taxa can be identified down to species level, such as wild caper (*Capparis spinosa*), or group of species, such as a group of acacias characteristic of desert areas, *Acacia tortilis / etbaica.*

Fig. 1



Examples of anatomical sections of acacia charcoal from Xeron Pelagos, Roman period (1st-3rd c. AD). Left: cross-section, right: longitudinal tangential section. Anatomical observation of these allows us to identify a group of Acacia species, including: *Acacia tortilis*, *A. ehrenbergiana*, *A. etbaica*.

6 We deduce the provenance of the pieces from the ecological growth requirements of the plant (or plants) and from the historical data associated with their diffusion. Different floras are thus used, such as Egyptian (Boulos 1999, 2000, 2002, 2005), but also Middle-Eastern / Mediterranean (Zohary 1966, 1972; Feinbrun-Dothan 1978, 1986) and European (Ellenberg 1988).

State of the art in the Eastern Desert of Egypt

7 Wood and charcoal studies of Roman sites in the Egyptian Eastern Desert are less numerous than those conducted on seed and fruit remains (see Van der Veen *et al.* 2018). This is partly due to technical contingencies, linked to the obligation to study this material during the archaeological excavations or later at a location where the material has been stored. Unlike seed and fruit studies carried out using a stereomicroscope, the microscopic observation equipment used for analysing wood and charcoal is heavier, expensive and fragile, which implies more complicated logistics, difficult to implement on an excavation site or in an archaeological storeroom. Some laboratories in Cairo, in particular that of the IFAO, are equipped with transmitted and reflected light microscopes. When the samples can be exported to Cairo, post-excavation studies are possible.

8 Despite these practical difficulties, wood and/or charcoal samples from eleven excavation projects have been studied (Table 1, Fig. 2). Their chronological distribution naturally reflects that of the excavated sites. The Roman period (late 1st century BC- 3rd century AD) is the best represented. These sites include the two main ports of the Red Sea, Berenike (Vermeeren 1998, 1999a, 1999b, 2000a, 2000b) and Myos Hormos (Thomas, Whitewright 2001; Whitewright 2007; Blue *et al.* 2011), the quarries of Kainè Latomia (originally called Domitianè, but renamed Kainè Latomia after the death of Domitian, now called Umm Balad) (Newton unpublished), of Mons Claudianus (Van der Veen 2001) and of Mons Porphyrites (Van der Veen, Tabinor 2007), and three way-stations, Badia (Van der Veen,

Tabinor 2007), Didymoi (Tengberg 2011) and Xeron Pelagos (Bouchaud, Redon 2017; Bouchaud unpublished). Only the site of Samut offer data from the Ptolemaic period (Bouchaud forthcoming). Some samples of wood and charcoal dated to Late Antiquity (4^{th} -7^{th} century) have been collected in the worker's village of Lykabettus near the site of Porphyrites (Van der Veen, Tabinor 2007) and in the coastal site of Abu Sha'ar (Fadl 2013). Finally, wood and charcoal from the Islamic layers (11^{th}-15^{th} century) at the old Roman port Myos Hormos, which was re-occupied under the name Kusayr, were also studied (Hiebert 1991; Thomas, Whitewright 2001, Whitewright 2007; Blue *et al.* 2011; Van der Veen *et al.* 2011; Whitewright 2011). As the data for the Ptolemaic, Byzantine and Islamic periods are scarce, we concentrate here on the Roman period. Note that some wood and charcoal materials from Berenike could actually belong to earlier (3^{rd}-2^{nd} century BC) or later (4^{th}-5^{th} century AD) layers (pers. comm., Steve Sidebotham): the information available from published studies (Vermeeren, 1998, 1999a, 1999b, 2000a, 2000b) does not accurately separate earlier and later material from the Roman samples (1^{st}-3^{rd} century AD). Thus the Berenike data presented here combines all periods.

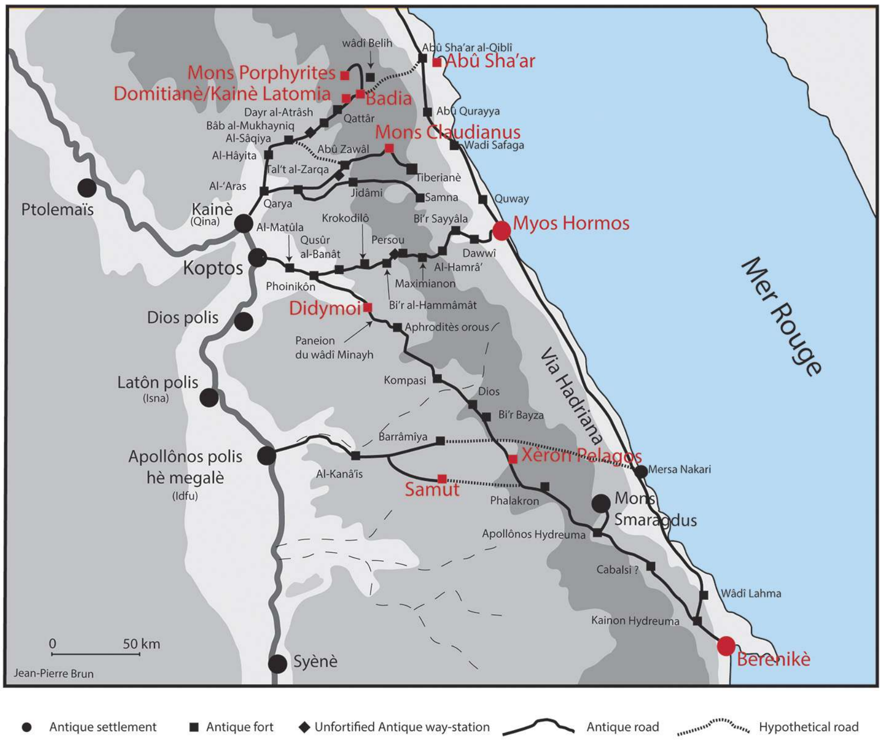
Table 1

SITE	PERIOD	FUNCTION	BIBLIOGRAPHY	MATERIALS
Myos Hormos / Kusayr Qusayr al-Qadim	Rom-Islam	Port	Van der Veen *et al.* 2011	Wood Charcoal
	Rom-Islam	Port	Blue *et al.* 2011 ; Hiebert 1991; Thomas 2011; Thomas & Whitewright 2001; Whitewright 2007, 2011	Wood
Berenike (+Kalalat +Shenshef)	Rom	Port	Vermeeren 1998, 1999a, 1999b, 2000a, 2000b	Wood Charcoal
Abu Sha'ar	Byz	Port	Fadl 2013	Wood Charcoal
Mons Claudianus (+ Barud I + Hydreuma)	Rom	Quarry and way-stations	Van der Veen 2001; Van der Veen & Tabinor 2007	Charcoal
			Hamilton-Dyer & Goddard 2001	Wood
Mons Porphyrites + Badia (+ Lykabettus)	Rom-Byz	Quarry and satellite forts	Van der Veen & Tabinor 2007	Charcoal
Domitianè / Kainè Latomia	Rom	Quarry	Newton unpublished	Charcoal
Didymoi	Rom	Way-station	Tengberg 2011	Wood

Samut (Bi'r Samut + Samut North)	Ptol-Rom	Gold mine and fort	Bouchaud forthcoming	Wood Charcoal
Xeron Pelagos	Rom	Way-station	Bouchaud unpublished; Bouchaud & Redon 2017	Wood Charcoal

Wood (uncharred) and charcoal (charred wood) identifications from the Egyptian Eastern Desert on samples from the Ptolemaic period (Ptol: 4th-1st century. BC), the Roman period (Rom: end 1st century BC – 3rd century AD), the Byzantine period, or Late Antiquity (Byz: 4th-5th century AD) and the Islamic period (Islam: 11th-15th century AD).

Fig. 2



LOCATION OF SITES (IN RED) FOR WHICH WOOD AND/OR CHARCOAL IDENTIFICATIONS ARE AVAILABLE IN THE EASTERN DESERT. SEE TABLE 1 FOR DETAILS. BACKGROUND MAP: JEAN-PIERRE BRUN.

Selection and quantification of samples

9 This synthesis is based on a selection of materials studied and presented in various publications and in unpublished works (Tables 2 and 3). Specimens poorly dated (except those from Berenike, see above), indeterminate fragments and imprecise determinations (e.g. angiosperms, gymnosperms, monocotyledons) have been ignored. Unclear identifications –at the family level or indicated by the addition of "cf." before the scientific name (Tables 2 and 3)– were retained to illustrate the potential diversity of these taxa.[7] Finally, among the wood specimens, only the worked elements were studied.

Table 2

					MH	BE	DI	XE
				Nb samples	112	252	33	11
				Nb items	113	295	33	11
				Nb taxa	26	20	5	5
TAXON			CODE	ORIGINE				
Abies sp.	Fir	Sapin	ABIE	MEDEUR		1	1	
Acacia tortilis/ etbaica type	Desert acacia	Acacia du désert	ACTO	LOC		75	6	7
Acacia sp. + cf. *Acacia* sp.	Acacia tree	Acacia	ACAC	LOC	9			
Alnus sp.	Alder	Aulne	ALNU	MEDEUR	1			
Avicennia sp. + cf. *Avicennia* sp.	Grey mangrove	Palétuvier gris	AVIC	LOC		13		
Baikiaea/Pterocarpus			BAIPTE	TROP		3		
Bambusa sp.	Bamboo	Bambou	BAMB	TROP		3		
Buxus sp. + cf.*Buxus* sp.	Boxwood	Buis	BUXU	MEDEUR	9			
Cordia sp.	Sebesten	Sébestier	CORD	LOC		1		
Dalbergia sp. + cf. *Dalbergia* sp.	African ebony, African blackwood	Ébène du Mozambique	DALB	TROP	17			
Diospyros sp.	Ebony	Ébène	DIOS	TROP	1			
Fagus sylvatica	Beech	Hêtre	FAGSYL	MEDEUR		1		
Ficus sp. + cf. *Ficus* sp.	Fig tree	Figuier	FICU	LOC	3			
Fraxinus sp. + cf. *Fraxinus* sp.	Ash	Frêne	FRAX	MEDEUR	2	1		
Juglans regia + cf. *Juglans regia*	Walnut tree	Noyer	JUGREG	MEDEUR	1			1

Juniperus / Cupressus			JUNCUP	MEDEUR	1			1
Larix/Picea + cf. *Larix/Picea*	Larche/ spruce	Mélèze/épicéa	LARPIC	MEDEUR	1			
Leptadenia pyrotechica + *Leptadenia* sp.			LEPPYR	LOC			22	1
cf. Maloideae			MALO	NIL	1			
cf. Moraceae			MORA	LOC	2			
cf. *Olea* sp.	Olive tree	Olivier	OLEA	NIL	1			
Palmae + cf. Palmae	Palm tree	Palmier	PALM	LOC		6	1	
Pinus sp.	Pine	Pin	PINU	MEDEUR	1	3		
Pinus pinea/pinaster	Stone/ maritime pine	Pin parasol/ maritime	PIPIPIN	MEDEUR	1	26		
Pinus sylvestris/nigra	Scots/black pine	Pin sylvestre/ noir	PISYNI	MEDEUR	9			
Quercus sp.	Deciduous oak	Chêne à f. caduc	QUEDEC	MEDEUR	6	3		
Quercus sp.	Evergreen oak	Chêne à f. sempervirent	QUEEVE	MEDEUR	8			
Quercus suber	Cork oak	Chêne liège	QUESUB	MEDEUR		1		
Rhamnus/Phyllirea			RHAM	MEDEUR	2			
Rhizophora type + cf.*Rhizophora* sp.	True mangrove	Palétuvier rouge	RHIZ	LOC	1	3		
cf. *Saccharum* sp.			SACC	TROP		1		
Salix sp.	Willow	Saule	SALI	NIL	1	2		
Tamarix sp. + cf. *Tamarix* sp.	Tamarisk	Tamaris	TAMA	LOC	18	4	3	1
Tectona grandis + cf. *Tectona grandis*	Teak	Teck	TECGRA	TROP	12	145		
Ulmus sp.	Elm	Orme	ULMU	MEDEUR	4	2		
Viburnum sp.		Viorne	VIBU	MEDEUR		1		

cf. *Wrightia* sp.			WRIG	TROP	1			
cf. *Ziziphus* sp.		Jujubier	ZIZI	LOC	1			

Results from the identification of wooden artefacts. Presentation of the selected samples and list of identified taxa on the Roman sites of the Egyptian Eastern Desert. For each taxon, the scientific and vernacular names, code and assumed geographic origin used in the figures are detailed. The numbers in the table describe the number of samples in which the taxon was identified. MH= Myos Hormos (Van der Veen *et al.* 2011); BE= Berenike (Vermeeren 1998; 1999a; 1999b; 2000a; 2000b); DI= Didymoi (Tengberg 2011); XE= Xeron Pelagos (Bouchaud unpublished, Bouchaud & Redon 2017; LOC= local; NIL= Nile valley and Western oasis; MEDEUR= Mediterranean and European/continental regions; TROP= Tropical India and/or Africa.

Table 3

					MH	BE	MC	MP	KL	BA	XE
				N samples	34	20	18	10	4	3	6
				N fragments	625	?	194	270	1117	104	338
				N taxa	29	10	14	19	13	7	14
TAXON			CODE	ORIGINE							
Acacia sp. + cf. *Acacia* sp.	Acacia	Acacia tree	ACAC	LOC	9	15	1		4		2
Acacia albida (*Fadherbia albida*)	Faidher bier	White acacia	ACAL	NIL			1			1	
Acacia nilotica	Acacia du Nil	Nile acacia tree	ACNI	NIL	1		14	9		2	
Acacia tortilis / *etbaica* type	Acacia du désert	Desert acacia	ACTO	LOC	8	3	6	7		3	
cf. *Aerva* sp.			AERV	LOC			2				
Arundo / *Phragmites*	Roseau	Reed	ARPHR	NIL							1
Artemisia sp.	Armoise	Mugwort	ART	LOC							1
Avicennia sp. + cf. *Avicennia* sp.	Palétuvier gris	Grey mangrove	AVIC	LOC	29	17					
Boscia sp.			BOSC	LOC			2				
Brassicaceae			BRASS	LOC	1			2	1		

Calligonum comosum + cf. *Calligonum* sp.			CALL	LOC			3			2	
cf. *Calotropis procera*	Pommier de Sodome	Sodom apple	CALPROC	LOC			1				
Capparis decidua + cf. *Capparis decidua*	Câprier	Caperbush	CAPDEC	LOC			2	2			
Capparis sp. + cf. Capparaceae	Câprier	Caperbush	CAPP	LOC	1				1		
Capparis spinosa + cf. *Capparis spinosa*	Câprier	Caperbush	CAPSPI	LOC							1
Chenopodiaceae			CHENO	LOC	5						4
Chrozophora sp.			CHROZO	LOC							1
Cornulaca type			CORN	LOC							1
Cupressus sp. + cf. *Cupressus* sp.	Cyprès	Cypress	CUPR	MEDEUR				1	1		1
Dalbergia sp. + cf. *Dalbergia* sp.	Ebène du Mozam-bique	African ebony, African blackwood	DALB	TROP	1						
Diplotaxis harra			DIPHAR	LOC				1			
cf. *Dipterocarpaceae*			DIPTE	TROP	2						
Fabaceae			FABA	LOC	1		2	1	3		
Ficus sp. + cf. *Ficus* sp.	Figuier	Fig tree	FICU	LOC	1						1
Frankenia sp.			FRAN	LOC				1			
Fraxinus sp. + cf. *Fraxinus* sp.	Frêne	Ash	FRAX	MEDEUR	1						
Grewia sp.			GREW	LOC				1			
Juncus sp.	Jonc	Rush	JUNC	NIL							1

Juniperus / Cupressus			JUNCUP	MEDEUR							1
Juniperus sp.	Genévrier	Juniper	JUNI	MEDEUR	1						
Larix / Picea + cf. *Larix / Picea*	Mélèze/ épicéa	Larche/ spruce	LARPIC	MEDEUR	2						
Leptadenia pyrotechnica + *Leptadenia* sp.			LEPPYR	LOC	4		6	7	1	1	1
Lycium shawii		Desert thorn	LYCSHA	LOC					1		
Maerua sp. + cf. *Maerua* sp.			MAECRA	LOC				2			
Mimusops sp.	Perséa	Persea	MIMU	NIL				1			
cf. Moraceae			MORA	LOC	1						
Moringa peregrina	Arbre à huile de Ben	Bentree	MORPER	LOC	1		3	7	2	1	
Palmae+cf. *Palmae*	Palmier	Palm tree	PALM	LOC	3	3					
cf. *Periploca*			PERIP	LOC					1		
Pinus pinea / pinaster	Pin parasol/ maritime	Stone/ maritime pine	PIPIPIN	MEDEUR	16	11					
Pinus sylvestris / nigra	Pin sylvestre/ noir	Scots/ black pine	PISYNI	MEDEUR	13			1			
Pinus sp.	Pin	Pine	PINU	MEDEUR	8						
cf. *Prosopis* sp.			PROS	NIL				3		1	
Quercus sp.	Chêne à f. caduc	Deciduous oak	QUEDEC	MEDEUR	5		1	2			
Quercus sp.	Chêne à f. semper-virent	Evergreen oak	QUEEVE	MEDEUR	2						
Rhizophora type + cf. *Rhizophora*	Palétuvier rouge	True mangrove	RHIZ	LOC	4	7					

Salvadora persica		Toothbrush tree	SALPER	LOC				1	3		
Salsola / *Suaeda*	Soude	Saltwort/ sea blite	SALSUA	LOC	10	10			1		
cf. *Senna italica*	Senné	Senna	SENITA	LOC					2		
Tamarix sp. + cf. *Tamarix* sp.	Tamaris	Tamarisk	TAMA	LOC	23	5	1		1		3
Tectona grandis + cf. *Tectona grandis*	Teck	Teak	TECGRA	TROP	11	12					
Ulmus sp.	Orme	Elm	ULMU	MEDEUR	13	3					
cf. *Zilla spinosa*			ZILSPI	LOC				1			
Ziziphus sp. + cf. *Ziziphus* sp.	Jujubier	Jujube tree	ZIZI	LOC	6			1			1

Results from the identification of charcoal. Presentation of selected samples and list of taxa identified on Roman sites in the Egyptian Eastern Desert. For each taxon, the scientific and vernacular names, code and assumed geographic origin used in the figures are detailed. The numbers in the table describe the number of samples in which the taxon was identified. MH= Myos Hormos (Van der Veen *et al.* 2011); BE= Berenike (Vermeeren 1998; 1999a; 1999b; 2000a; 2000b); MC= Mons Claudianus (Van der Veen 2001; Van der Veen & Tabinor 2007); MP= Mons Porphyrites (Van der Veen & Tabinor 2007); KL= Domitianè/Kainè Latomia (Newton unpublished); BA= Badia (Van der Veen & Tabinor 2007); XE= Xeron Pelagos (Bouchaud unpublished, Bouchaud & Redon 2017); LOC= local; NIL= Nile valley and Western oasis; MEDEUR= Mediterranean and European/continental regions; TROP= Tropical India and/or Africa.

10 The corpus of wooden artefacts is based on the study of four sites –Berenike, Myos Hormos, Didymoi and Xeron Pelagos. The largest assemblages come from the two ports of the Red Sea. The woods of Didymoi are presented but not discussed, their function being, for the most part, unknown (Tengberg 2011). The wooden elements found at Xeron Pelagos are few, partly due to local, slightly damp, conditions. Wood elements, complete or fragmented, are recorded by number of samples. Generally a wood sample correspond to one artefact, but in some cases (especially at Berenike), one sample corresponds to several artefacts grouped together. Note that the Mons Claudianus quarry site also presents a corpus of everyday wooden objects, but the wood taxa of these objects have not been identified (Hamilton-Dyer, Goddard 2001).

11 Charcoal was studied from seven Roman sites.[8] The samples were obtained from hand-picked or sediment sampling (sieving), though the volume sieved is not always known. Most of the time, a sample corresponds to a stratigraphic unit and contains a heterogeneous number of charcoal fragments. In Berenike, the only archaeological level recorded is that of the structure, and the number of fragments is only estimated.

12 A total of 408 samples of wood, comprising 452 artefacts (Table 2), and 95 samples of charcoal, representing at least 2,648 fragments (Table 3),[9] are considered for this study. This selection corresponds to 71 taxa identified at the level of family, genus or species.

Forty taxa are preserved in desiccated form. Fifty-four taxa are represented as charcoal. Of these, 23 taxa are found both in the form of desiccated wood and charcoal. Each taxon is associated with a geographical origin according to four regions of provenance. Local (LOC) taxa are those that can grow in the desert –including the mountainous area of Gebel Elba– and the Red Sea coastline. The Nilotic and oasis group (NIL) refers to plants from the Nile valley and/or from the oases of the Western Desert. Mediterranean and European/continental taxa are referred to under the same name (MEDEUR). Tropical and sub-tropical plants (TROP), most of which can grow in Asia and Africa, form the fourth group. When a taxon falls into two categories –such as reed *(Arundo / Phragmites)* and tamarisk, which may belong to the group of local (coast of the Red Sea) or Nilotic plants, the closest geographically group has been chosen. These decisions, while aiming to simplify the reading and processing of the data, distort a reality which is probably more complex than that illustrated by the descriptions which follow.

13 Despite the heterogeneity of data from one site to another, a first synthesis can be carried out by using a semi-quantitative presentation of the results.

Uses

14 The presence of worked wood and charcoal on archaeological sites evokes various sectors of activity. Desiccated (uncharred) wooden artefacts include everyday objects, architectural timbers, maritime equipment (shipbuilding and objects connected with ships or fishing) and waste from cutting or shaping. Charcoal has been found in domestic (fireplaces, hearth refuse, ovens, domestic refuse deposits) and artisanal contexts, mainly related to metallurgical activities. Charring of wood thus results, *a priori*, from its use as fuel.

Woodworking

15 Uncharred worked wood elements found at Myos Hormos, Berenike and Xeron Pelagos can be separated into various major functional categories[10] (Table 4, Fig. 3-5).

Table 4

Category	Identified items	Eléments identifiés	MH	BE	XE
Domestic objects	Firelighter	Allume-feu			LEPYR 1
	Tool indet.	Outil indet.			ACTO 1
	Tube	Tube		ACTO 1	
	Handle	Manche	FRAX 1 ZIZI 1	ACTO 1 VIBU 1	
	Brush	Brosse		ACTO 1	
	Needle	Aiguille		PIPIPIN 1	

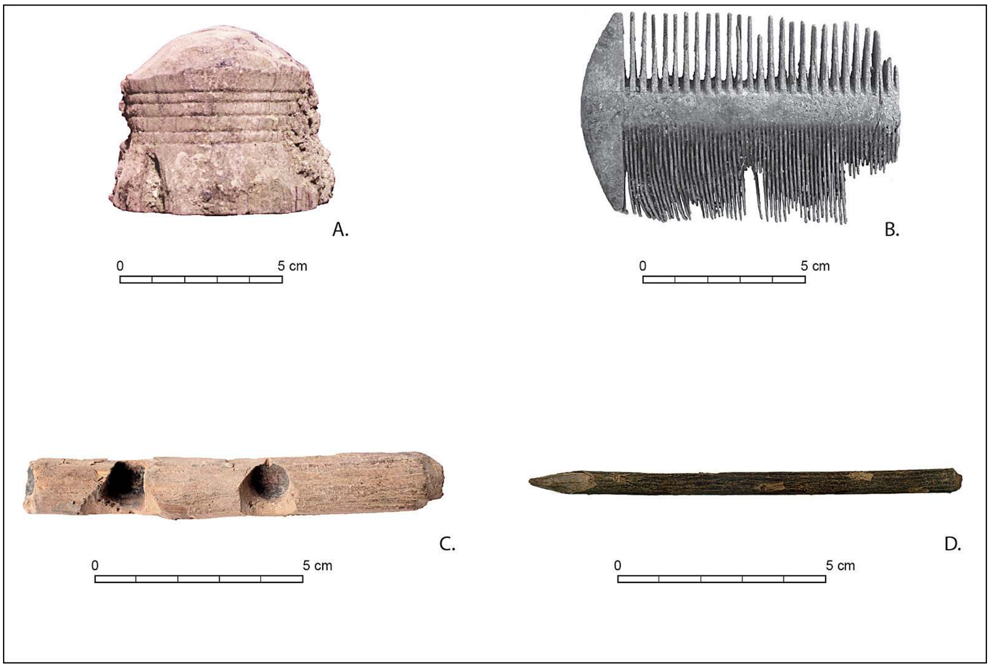
Basket	Panier	LARPIC 1 RHIZ 1		
Bowl	Bol	DALB 1 FRAX 1 TAMA 2	ACTO 1 TECGRA 1 QUEDUC 1	
Cup	Coupe		ACTO 1	
Bung / lid / amphora stopper	Bonde / couvercle / bouchon d'amphore	ACAC 2 FICU 2 MORA 1 PISYNI 1 QUEDEC 1 QUEEVE 1 SALI 1 TAMA 3 TECGRA 1	ACTO 6 AVIC 2 BAIPTE 2 RHIZ 1 QUESUB 1 TECGRA 2	
Knob	Bouton		ACTO 2	
Box	Boite		TECGRA 1	
Gorges	Hameçon	JUNCUP 1 TAMA 1 TECGRA 1		
Key	Clé	QUEDUC 1		
Pen	Stylet		ACTO 2	ACTO 1
Stick	Bâton		ACTO 1	
Spatula	Spatule	DALB 1 PISYNI 3 TECGRA 1 ULMU 2	TAMA 1	
Spoon	Cuillère	FICU 1 PISYNI 1		
Vessel	Vaisselle	BUXU 1 TAMA 3		
Ring	Bague		TECGRA 3	
Ornament indet.	Ornement indet		ACTO 1 BAIPTE 1	

	Bracelet	Bracelet		ACTO 1	
	Comb	Peigne	BUXU 8 DIOS 1 RHAM 2		
Architecture	Wedge	Coin		TECGRA 1	
	Plank, board	Planche		ACTO 3 FRAX 1 PINU 3 PIPIPIN 16 QUEDEC 1 TECGRA 32	ACTO 3 JUGREG 1 JUNI 1 TAMA 1
	Pole, beam	Poteau, poutre		BAMB 1 PIPIPIN 4 TECGRA 6	ACTO 2
	Pin, peg	Tenon	ACAC 2 DALB 1 QUEDEC 2 TAMA 2 TECGRA 7	ABIE 1 ACTO 7 CORD 1 PALM 3 PIPIPIN 2 RHIZ 1 TECGRA 14	
Maritime	Brail ring	Anneau de cargue	DALB 11 OLEA 1 MALO 1 TAMA 1 WRIG 1	TECGRA 3	
	Deadeye	Cap de mouton	DALB 1		
	Tapered hole	Mortaise biseautée		TECGRA 1	
	Pulley	Poulie	TECGRA 1		
	Sheave	Réa	ALNU 1 DALB 2 TECGRA 1		
	Cleat	Taquet	QUEDUC 1		

Wood shavings	Wood chips / shavings	Fragment de débitage / copeau	ACAC 5 JUGREG 1 MORA 1 PINU 1 PIPIPIN 1 PISYNI 4 QUEEVE 7 TAMA 2 ULMU 2	ACTO 31 AVIC 6 BAMB 2 PIPIPIN 1 QUEDEC 1 RHIZ 1 TECRA 48 ULMU 2	
Other	Worked wood	Elément travaillé	TAMA 1	ACTO 14 AVIC 5 PALM 2 PIPIPIN 2 SACC 1 TAMA 2 TECGRA 33	
	Disc	Disque		TECGRA 2	

Functional category of wooden artefacts found in Myos Hormos (MH), Berenike (BE) and Xeron Pelagos (XE) (1st-3rd c. AD). The identified items are presented using the names used in the original publications (in French or in English). For each functional type, the last three columns indicate for each site the types of wood used followed by the corresponding number of artefacts.

Fig. 3



Examples of domestic wooden objects from the Roman period. A. Amphora stopper, Rhodesian teak/*pterocarpus* type (*Baikiaea/Pterocarpus*), Berenike (BE98-21 PB 045, after Fig. 7 in Vermeeren 2000a, © Sidebotham & Wendrich 2000, photograph: Z. Kosc); B. Boxwood comb (*Buxus* sp.), Myos Hormos (W284, after Fig. 5.6 in Van der Veen 2011, p. 216, © Van der Veen 2011, photograph: W. van Rengen); C. Firelighter, *Leptadenia pyrotechnica*, Xeron Pelagos, (US 40510/Po220, © A. Bülow-Jacobsen, French mission in the Eastern Desert); D. Pen, acacia (*Acacia* sp.), Xeron Pelagos (US 40520/n°IFAO 5154, © G. Pollin, French mission in the Eastern Desert /IFAO).

Fig. 4

A.

B.

Architectural wooden elements from the Roman period. A. Teakwood (*Tectona grandis*) board with iron nail (left), cross lath (hole on the right) and layer of pitch or tar, also seen as re-used maritime element Berenike (after Fig. 14 in Vermeeren 2000a, photograph: C. Vermeeren, © Vermeeren 2000); B. Juniper (*Juniperus* sp.) plank, Xeron Pelagos (US 60608/Po2015 B, © A. Bülow-Jacobsen, French mission in the Eastern Desert).

Fig. 5

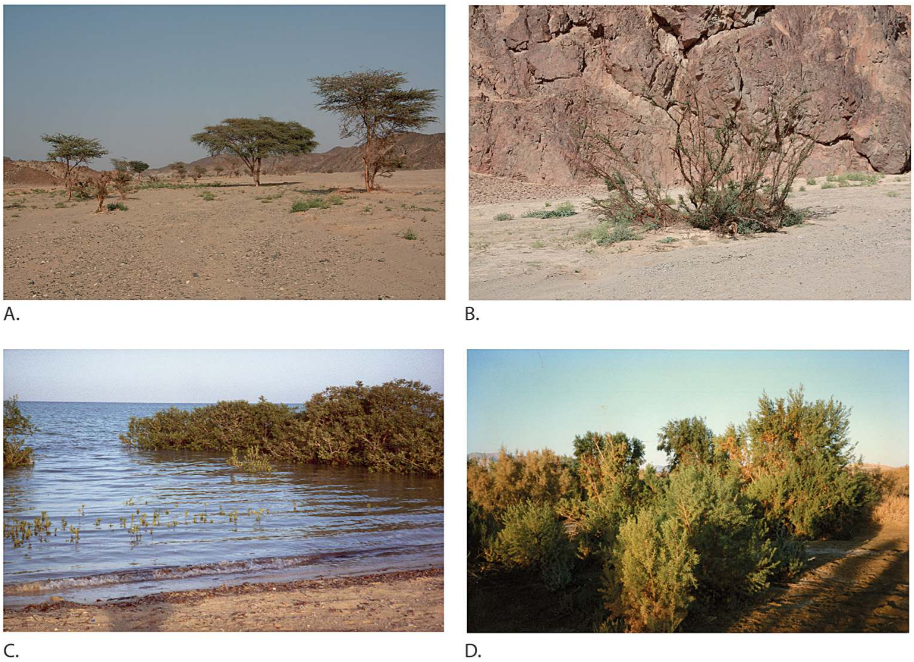
Roman maritime artefacts: A. Roughly cut ring made of teakwood (*Tectona grandis*), possibly a brail ring, Berenike (BE98-21.032 PB 042, after Fig. 9 in Vermeeren 2000a, © Sidebotham & Wendrich 2000, photograph: Z. Kosc); B. Teak (*Tectona grandis*) object with tapered hole, used to block a rope, Berenike (BE98-21.027 PB 033, after Fig. 8a in Vermeeren 2000a, © Sidebotham & Wendrich 2000, photographie: Z. Kosc); C. Brail ring made of African ebony (*Dalbergia* sp.), Myos Hormos (W072, after Fig. 5.1 in Van der Veen 2011, p. 208, © Van der Veen 2011, photograph: W. van Rengen); D. Dead-eye made of African ebony (*Dalbergia* sp.), Myos Hormos (W294, after Fig. 5.1 in Van der Veen 2011, p. 208, © Van der Veen 2011, photograph: W. van Rengen).

© Z. KOSC, W. VAN RENGEN

Everyday objects

16 Everyday objects comprise the first, very heterogeneous, group of wooden artefacts (Fig. 3). Their numbers vary from one site to another. Three objects have been found in Xeron Pelagos, while Myos Hormos and Berenike have respectively 39 and 49 artefacts, representing a total of 27 types of objects whose function is more or less well recognized. There are fragments of tableware (bowl, spoon, spatula), tools (firelight, hook, handle), elements associated with storage and transport (stopper and lid, box), ornaments and hair accessories (bracelet, comb, ring), keys, styli, etc. The heterogeneity of these objects corresponds to analogous heterogeneity of the wood taxa. The large sample of wood used for amphora stoppers found at Berenike (N=14) and Myos Hormos (N=13) includes a first group of woods characteristic of the desert regions, which can grow locally or in the Nile valley, acacia, tamarisk and mangrove. Acacias (ACTO, ACTA)[11] can include several species with anatomical features too similar to be distinguished by microscopic observations. The most common acacias of the Eastern Desert are trees up to several metres high, *Acacia tortilis* subsp. *raddiana (sayyal)* and *Acacia tortilis* subsp. *tortilis (samur),* and shrubs, *Acacia ehrenbergiana (salam)* and *Acacia etbaica* (*'arad)* (Mahmoud 2010, pp. 27-30) (Fig. 6).

Fig. 6



A. Forest gallery of acacia trees (*Acacia tortilis* subsp. *raddiana*) along the wâdi Abu wasil (Photograph: C. Bouchaud). B. *Acacia ehrenbergiana* near Xeron Pelagos (al-Jirf) (Photograph: C. Bouchaud). C. Mangrove (*Avicennia marina*) growing on the Red Sea coast, south of Qusayr al-Qadim (after Fig. 5.15 in Van der Veen 2011, p. 222, © Van der Veen 2011, photograph: M. van der Veen). D. Sea-blite (*Suaeda monoica*), near Berenike (Photograph: C. Vermeeren).

17 The genus *Tamarix* sp. (TAMA) comprises six species that can grow in Egypt in form of trees or shrubs, the two most common are *Tamarix aphylla (itl)* and *Tamarix nilotica (turfa).* Both grow either in the desert, on the edge of wâdis, in the sandy plains and saline soils, or in the Nile Valley (Boulos 2000, pp. 126-129). The grey mangrove *Avicennia marina* (AVIC *shura manjaruf)* and the red mangrove, *Rhizophora mucronata* (RHIZ) are typical of mangrove formations (Fig. 6) growing on the shores of the Red Sea (Boulos 2000, pp. 148-149, 2002, pp. 5-6, Schneider 2011). Some amphora stoppers are made of Mediterranean wood such as bark from cork oak, *Quercus suber* (QUESUB) and other deciduous (QUEDUC) and evergreen (QUEEVE) oaks. Finally more exotic taxa were also identified, including teak from India, *Tectona grandis* (TECGRA), known as hard, durable wood, and *Baikiaea* / *Pterocarpus* (BAIPTE) indicating an African or Indian origin (Vermeeren 1998 2000b; Van der Veen *et al.*, 2011, p. 207).

18 The taxa used for tableware –bowls, spatulas, spoons, undetermined containers– especially present at Myos Hormos, also show this great diversity. The wood of tamarisk and fig tree, *Ficus* sp. (FICU), suggests manufacturing locally or in the Nile valley. Fig wood has been arbitrarily classified in the local taxa group because wild fig, *Ficus palmata (hummat, tin barri)* can grow on rocky slopes and along the wâdis of the desert. However, the genus *Ficus* sp. can also refer to the common fig tree, *Ficus carica,* growing in the Nile valley and having a similar anatomy. The identification of sycamore fig, *Ficus sycomorus* can be excluded because it has other distinctive anatomic features. The tableware also includes several objects made of wood that cannot grow in Egypt, and, thus, were

imported from Mediterranean regions and/or continental Europe, such as Scots/black pine group, *Pinus sylvestris/nigra* (PISYNI), ash, *Fraxinus* sp. (FRAXI) or elm, *Ulmus* sp. (ULMU) –or the Indian subcontinent, such as teak.

Domestic architecture

19 Domestic building elements, boards, poles, wedges, tenons have also been identified from Myos Hormos, Berenike and Xeron Pelagos (Fig. 4). Most were found in destruction or rubbish levels, thus limiting our understanding of their function. The absence of technical study prevents us to know the exact nature and shape of these building elements, or to restore their exact place within the architecture. Nevertheless, some indirect evidence, such as door lintels, sockets and empty spaces, nevertheless suggests the almost systematic presence of wooden doors and roofing (see, for example, the architectural descriptions of the forts in Cuvigny 2003). Once again, the main taxa used show a large diversity dominated by local wood, especially acacia, Mediterranean wood, such as pine or juniper, *Juniperus* sp. (JUNI), which can come from the Sinai Peninsula (Boulos 1999, Zahran, Willis 2009) and Indian woods, especially teak. A pin fragment found at Berenike corresponds to one of the two occurrences of fir, *Abies* spp. (ABIE), the second comes from an unknown object found at Didymoi (Table 2). Fir, although growing in high-altitude areas of some Mediterranean regions, may also be imported from farther afield, from temperate Eurasian regions or Anatolia. At Berenike, several fragments of teak planks have a curved shape as well as iron nails, cross lathes and layer of pitch or tar that do not find any logical architectural explanation. These have been interpreted as reused boat hull planks (Vermeeren 2000b, pp. 340-341). It is, therefore, probable that all the teak fragments, such as the tenons found at Myos Hormos, correspond to material originally used in maritime equipment contexts.

Maritime equipment

20 These latter elements in teak can possibly be integrated into the third category of wooden artefacts which groups objects whose maritime function is clearly identified. They are only found on the two ports of Myos Hormos and Berenike. Multiple examples of brail-rings (Fig. 5) have been identified on both sites (16 at Myos Hormos, 2 at Berenike),[12] including one from Myos Hormos found with a fragment of sail still attached to it. On this site, pulley wheels or sheaves, deadeye (Fig. 5) and cleats were also identified (Vermeeren 2000b, p. 332; Whitewright 2007; Van der Veen *et al.*, 2011, p. 206.). This sailing equipment is mostly made of teak wood, tamarisk, and possibly African ebony, *Dalbergia melanoxylon*. Indeed, the structure and the very dark colour of objects made of *Dalbergia* sp. (DALB) found at Myos Hormos could indicate that they were made of African ebony, which is distinct from the more commonly known black ebony, *Diospyros ebenum,* native to India. African ebony, a native of sub-Saharan dry savannah is attested in Egypt from the Middle Kingdom onwards (Delange 1987, p. 129) and regularly used during the New Kingdom for making furniture and sculpture (Gale *et al.* 2000, pp. 339-340). These wooden elements, together with the actual remains of sails, linen and cotton, found in abundance on both sites (Wild, Wild 2001; Handley 2004; Wild, Wild 2014) attest the presence of merchant ships, which crossed the Red Sea and the Indian Ocean (Whitewright 2007; Blue *et al.*, 2011). The origin of these ships, either Mediterranean, local or Indian, is an issue still widely debated (see below).

Wood shavings and chips

21 A final group includes shavings and chips. These remains found at Myos Hormos (N=24) and Berenike (N=55) include a large number of taxa at both sites. The acacia, the evergreen oak, and the Scots/black pine group dominate at Myos Hormos (Van der Veen 2011, p. 207) while acacia and teak are the best represented taxa in Berenike (Vermeeren 1998, 1999b, 2000b). Among them, the local wood fragments (acacia, tamarisk, mangrove) probably illustrate the shaping of wooden trunks and branches available nearby, while the abundant presence of teak wood wastes indicates, like the boards mentioned above, probable re-use and cuttings of pieces of boats and furniture made of Indian wood (Vermeeren 2000b, p. 335).

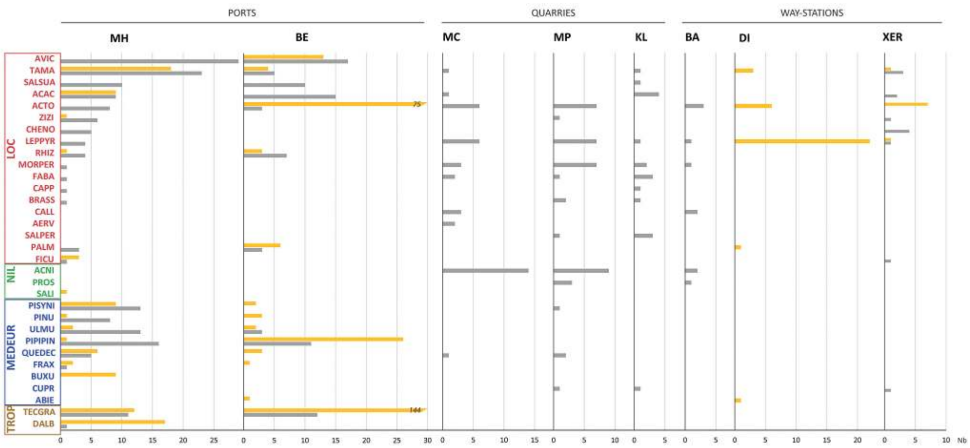
Fuel

22 The presence of charcoal in the soil layers and dumping areas shows its use as fuel in domestic activities for heating, cooking, lighting, etc. Some specific contexts also attest the use of fuel for metalworking and pottery firing (see below). These charcoal assemblages come mainly from secondary deposits (waste from the fireplace, dumps, etc.) and can result from one or more combustion events occurring over time, which are not necessarily of the same nature. Alongside these fuel remains, the presence of accidentally burnt timber (fire) cannot be ruled out. Nevertheless, no clear context of burnt structures has been the subject of an anthracological study to date.

Local gathering

23 The vast majority of the fuel, all contexts and sites combined (7 sites), corresponds to taxa that can grow in the immediate vicinity of the sites (Table 3, Fig. 7). Acacia charcoal is identified at all sites, highlighting the major economic role of acacia trees as timber (see above) and fuel (Fagg, Stewart 1994; Le Floc'h, Grouzis 2003). Several desert taxa are present on at least three of the seven sites: the tamarisk, which can correspond to several tree and shrub species (see above); the Chenopodiaceae (CHENO containing the genus, *Salsola* and *Suaeda*, SALSUA), which includes a large number of tree and shrub species, growing along wâdis, sandy and rocky plains or on saline soils (Mahmoud 2010) including sea-blite (Fig. 6); and the bentree, *Moringa peregrina* (MORPER, *maya)*, whose current distribution is reduced to areas above 700 meters (Mahmoud 2010: 99). The shrubs *Leptadenia pyrotechnica* (LEPPYR, *markh)* and *Ziziphus* sp. (ZIZI) –which probably correspond to the Christ' thorn tree, *Ziziphus spina-christi (nabq, sidr)*[13]– also are part of the major taxa. Mangrove taxa, in particular grey mangrove, are only present on coastal sites, where they represent a significant proportion of the charcoal remains.

Fig. 7



Occurrence of the most common woody taxa at each site, wood in yellow, charcoal in grey, grouped by site and geographical affinity, following the data presented in tables 2 and 3. Each bar represents the number of samples in which a taxon has been identified. Only taxa attested on at least two sites or in at least five samples, as either charred or uncharred wood, are represented. Bevelled bars indicate that the taxon is present in more that 30 samples (actual number given in italics). See tables 2 and 3 for abbreviations of site names, plant names as well as qualitative and quantitative details.

24 The twenty-nine remaining taxa are in the minority and correspond mostly to bushes and shrubs (Table 3). They illustrate both the diversity and amplitude of desert wood resources used by the inhabitants. These floristic spectra offer *a priori* a non exhaustive picture of the woody vegetation growing around archaeological sites. For example, mangrove wood is used as fuel on coastal sites where mangrove formations are present, and the bentree is mostly attested on the quarry sites, Mons Claudianus, Mons Porphyrites, Badia and Kainè Latomia (Fig. 7), all located in high altitude areas where this tree grows naturally. Beyond these qualitative observations, the number of samples and fragments of charcoal studied is not sufficient to detect possible differences in plant diversity from one site to another.

25 It is worth noting that *Zilla spinosa* (ZILSPI, *shuk),* which is a fuel commonly used alongside acacia, is almost absent and only represented here in small quantities at Mons Porphyrites, and perhaps among the undetermined fragments from the Brassicaceae family at Myos Hormos and Kainè Latomia. Its scarcity is probably due to the fact that the light twigs of this bush are generally used to start a fire and are, therefore, less likely to be preserved among the ashes and charcoal of the fireplaces. However, the presence of charred fruits of this shrub on the sites (see for example the botanical results from Mons Claudianus in Van der Veen 2001, those from Mons Porphyrites in Van der Veen, Tabinor 2007 as well as the unpublished data of Xeron Pelagos), attests its presence and use as fuel. Other taxa identified within charcoal assemblages such as *Cornulaca* (CORN), *Lycium shawii* (LYCSHA), etc., also show the repeated use of twigs and small fire wood.

26 In addition to wood resources, other flammable materials have been used as fuel, but do not appear in charcoal assemblages. These include cereal by-products, chaff and straw (see below), palm leaves and animal droppings (camel and sheep/goat), which were widely available at these sites. The use of dung, sometimes mixed with cereal by-products is widely documented archaeologically and ethnographically in domestic contexts. It is demonstrated at Badia (Van der Veen, Tabinor 2007, pp. 106-107) and at Kainè Latomia (unpublished Newton). At Xeron Pelagos, the presence of camel dung with acacia and

tamarisk charcoal highlights the effectiveness of this type of fuel to provide sufficient and durable heat for heating the baths (Bouchaud, Redon 2017).

Fuel imports from the Nile Valley

27 Alongside the extensive exploitation of fuel resources from the desert, there are at least two indications for the importation of fuel from the Nile Valley. The first is the identification of the Nile acacia, *Acacia nilotica* (ACNI, *sunt*) found at Myos Hormos, Mons Claudianus and Mons Porphyrites. This tree has distinctive anatomical features that help to differentiate it from the other acacias. Nile acacia hardly grow in the desert and its charcoal is regularly found in artisanal contexts, suggesting the importation of fuel from the Nile Valley (Van der Veen, Tabinor 2007, p. 107; see also discussion below). Of the three sites, the relative proportions of Nile acacia even exceed those of other types of acacia. Moreover, it is possible that the group of undifferentiated acacias (ACTA) on these sites and elsewhere include acacia from the Nile valley.[14]

28 Secondly, there is the substantial presence among botanical assemblages of cereal by-products, such as chaff of durum wheat and, to a lesser extent, chaff of hulled barley. These remains are present in quantity in the communal kitchen at Mons Claudianus, possibly to fuel the bread ovens (Van der Veen, 2001, p. 216, Fig. 8.9) and in the dumps of Xeron Pelagos, here constituting probable waste from domestic households (see the contribution of Van der Veen *et al.* 2018). Botanical analysis of animal dung shows the import of cereal by-products from the Nile valley to provide feed and litter at the Eastern Desert sites (see the contribution of Van der Veen *et al.* 2018 and more generally Van der Veen 1999, 2007). It is reasonable to think that a part could be used in parallel as fuel.

Recycling timber

29 At least ten tree taxa that could not grow in Egypt are present within the charcoal assemblages (Table 3, Fig. 7). They include taxa growing in high altitude areas of the Mediterranean or in Eurasian temperate regions –such as the group of Scots/black pine, deciduous oak (QUEDEC), elm, *Ulmus* sp. (ULMU)– as well as Mediterranean taxa such as stone/maritime pine, *Pinus pinea/pinaster* (PIPIPIN) and cypress, *Cupressus sempervirens* (CUPR) and tropical wood such as ebony (probably African ebony) and teak. They are mainly present at Myos Hormos and Berenike. Some rare occurrences have been recorded on other sites. It may seem surprising to find such exotic taxa among charcoal assemblages, since one can hardly consider that these woods originating from the Mediterranean regions of continental Europe, tropical Africa and India were specifically imported for feeding a kitchen fire. There is little doubt that they represent the reuse of end-of-life wooden objects as fuel. All these taxa are also represented among the uncharred wood elements. The practice of reusing timber as well as the use of diverse local trees and shrubs, animal waste, cereal chaff and straw and fuels imported from the Nile valley show the large spectrum of flammable materials.

Economic and environmental dynamics

30 Here we look in more detail at how the study of wooden objects and charcoal can help us trace economic and environmental factors that may have influenced wood use from one site to another and across Egypt in the Roman period.

Species selection

The worked wood

31 Taxonomic identification of wooden artefacts, mostly from the ports of Myos Hormos and Berenike, and to a lesser extent from the fort of Xeron Pelagos, shows that certain categories of objects, such as the amphora corks or dishes were made from a wide variety of woods including Egyptian, tropical and Mediterranean woods (see above and Table 4). Other artefacts seem, instead, largely dependent on the choice of a taxon or a group (s). Thus, if we take into account the five best represented taxa (Fig. 7), namely the acacia (ACTO + ACTA), tamarisk, pine (PINU+PIPIPIN+PISYNI), African ebony and teak (Fig. 8), we note, first, that everyday objects are made with local wood (acacia and tamarisk); secondly, that the building elements are represented by local wood, pine (at Berenike) and teak (at Myos Hormos);[15] thirdly, that the maritime objects are mainly made of African ebony and teak wood.

Fig. 8

Distribution of wooden artefacts made of acacia, tamarisk, pine, African ebony and teak, according to their supposed function. See table 2 for abbreviations of site names as well as quantitative and qualitative details. Note that the boards made of teak from Berenike, which are probably boat parts reused in domestic architecture, are counted as maritime artefacts. Pegs from Myos Hormos are considered here as being building materials but they could also be maritime elements.

32 The presence of tropical maritime woods including rigging and hull equipment at Berenike and Myos Hormos and the presence of linen and cotton sails (Wild, Wild, 2001, 2014) raise questions about how the ships were built and repaired. Indeed, it is been proposed that the technical construction was similar to that known in the Mediterranean world. It has also been suggested, from the study of epigraphic sources, that a “forest” of acacia could have been maintained and operated from Pharaonic times until the medieval period for ship building at Coptos, the parts being transported to the ports and reassembled on site (Gabolde 2002). This proposal is similar to that made in the late 19th

century by W. Golenischeff who, crossing the desert to Berenike, suggested that the acacias near the ports were used to build boats (Golenischeff 1890, pp. 89-90). However, the raw materials (wood and textiles) clearly identified as belonging to old ships from the Roman period are neither of Egyptian nor of Mediterranean origin. Exceptions are the few objects made of tamarisk wood, potentially of olive tree, *Olea europaea* (OLEA) and of a taxon of the subfamily Maloideae (MALO), which includes fruit trees such as apple and pear whose cultivation is known at this time in the Nile valley (Barakat, Baum 1992). Flax sails probably came from the Nile valley too (Wild, Wild 2001). The objects made of African ebony reasonably indicate a tropical African origin while teak objects (Van der Veen *et al.* 2011, p. 207) and the weaving techniques for cotton sails (Wild, Wild 2001; Handley 2004; Wild, Wild 2014) clearly show an Indian origin. On this basis, we could have, on the one hand, Roman ships, made on Mediterranean models, built with Mediterranean and/or Egyptian woods, and on the other hand, boats built in India, whose manufacturing process is still poorly understood (Whitewright 2007; Blue *et al.* 2011). Some teak elements (wood chips and boards) and the cotton sails from the ports of Myos Hormos and Berenike may come from ships built in India, but reused for repairing locally built Roman ships, in such a way that it is not possible to recognize the wood species originally used to build the Roman ships.

33 Less common wood taxa were also chosen for specific objects / categories. For example, combs are mostly made of boxwood, *Buxus sempervirens* (BUXU) and are amongst the everyday most frequently identified items at Myos Hormos (Van der Veen *et al.* 2011, p. 216). The boxwood grows in Europe, the Levant, North Africa, Central and East Asia (Gale Cutler 2000); it is, thus, impossible to pinpoint the place of origin / manufacture of these items. However, the frequency of boxwood combs on other contemporary sites in the Middle East and around the Mediterranean suggests that these objects travelled regularly along Roman trade routes, likely indicating a circum-Mediterranean origin (Bouchaud *et al.* 2011; Derks, Vos 2010).

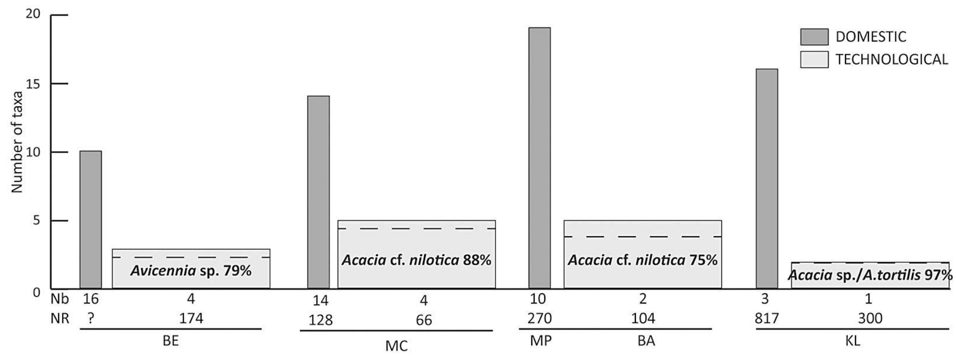
Fuel in an artisanal context and charcoal making

34 The plant list obtained by the analysis of charcoal from the seven Roman sites shows the widespread use of fuel resources for which geographical proximity seems to be a determining factor. These resources were supplemented by fuel imports from the Nile Valley and recycled timber reaching the end of its life (see above). Several ostraka –or potsherds bearing texts, here in Greek– show that soldiers of the Roman army collected wood in the immediate vicinity of the military forts.[16] Plant diversity expressed within charcoal spectra echoes modern Bedouin practices gathering a wide range of wood resources available in the area. Bedouin people used to collect dead wood and fresh cut wood, limiting their cutting to the branches rather than the entire trunk (Hobbs 1989, p. 53; Christensen 2001). Some of them have other criteria of selection, which are more subjective and difficult to identify in the archaeological context, preferring acacia for long lasting fires, sea blite (SALSUA) for cooking and the species *Lycium shawii* (LYCSHA) when the fire has to be started in the rain (Hobbs 1989; Vermeeren 2000b).

35 The majority of charcoal come from waste contexts considered "domestic".[17] Several charcoal assemblages also clearly correspond to artisanal contexts, such as from the forge at Kainè Latomia (Newton unpublished), charcoal waste probably corresponding to craft or 'industrial' activities in the satellite fort of Badia and, at Mons Claudianus (sector "Well

sebakh") (Van der Veen, Tabinor 2007, pp. 107, 137), and in a probable brick-making workshop at Berenike (Vermeeren 1998). Comparison of these different types of charcoal assemblages shows the same trend from one site to another: the number of taxa present in domestic contexts is higher than the number of taxa found in craft/industrial contexts (Fig. 9). Of course, the larger number of domestic samples can naturally explain more plant diversity. However, taxa found in craft contexts correspond mostly to charcoal from acacias: Nile acacia (*Acacia nilotica*), a local type of acacia (*Acacia tortilis*) or undifferentiated acacias at Mons Claudianus (88%), Badia (more than 90% of the total number of fragments) and Kainè Latomia (100%). Mangrove charcoal dominates at Berenike (79%). The small number of specific contexts and the low number of charcoal fragments studied ask for caution, but, nevertheless, it looks very likely that specific fuel selection was practiced for 'industrial' activities such as metalworking (acacia) and brick making (It should also be considered that a clearing of the harbour area of mangrove would have provided a large availability), both activities that require control over the intensity and duration of the combustion.

Fig. 9



Charcoal analysis. Comparison of the number of taxa represented in supposedly domestic contexts and in some contexts with technological function requiring high burning temperatures. For the latter, the dominant taxon is given, expressed as the relative proportion of the total number of fragments (%). Nb: number of samples, NR: number of fragments. See table 2 for abbreviations of site names.

36 The use of charcoal from charcoal making, was essential for some of these 'industrial' activities. Charcoal can also be used for routine activities such as for making coffee today by the Bedouins of the Beja tribe in the mountains of the Red Sea (Christensen 2001). Several ostraka from Mons Claudianus mention the use and transport of charcoal from the Nile Valley to the sites of the imperial quarries of Mons Claudianus and Porphyrites (including Badia) (*O.Claud.* I 21; *O.Claud.* IV 697; *O.Claud.* IV 742; *O.Claud.* IV 826; *O.Claud.* IV 850). Three ostraka found at Kainè Latomia also mention the import of charcoal from the Nile Valley for workshops repairing metal tools (*O.Kala* inv. 596; *O.Kala* inv. 63; *O.Kala* inv. 507; A. Bülow-Jacobsen, pers. comm.). A major obstacle hindering the research on this topic is our present inability to differentiate, using anatomical observation, charcoal obtained from charcoal making from fresh or dried firewood. The presence of intentionally produced charcoal in charcoal assemblages has been demonstrated indirectly. The studies conducted at Mons Claudianus, Porphyrites and Badia relied on four indices: taxonomic identification, fragment size, the presence or absence of twigs and charcoal hardness. Charcoal of *Acacia nilotica* and *Acacia tortilis* had, in general, a greater proportion of large fragments (≥30 mm), more hard fragments (difficult to break),

as well as fewer twigs than the two other main taxa in the charcoal corpus, namely *Leptadenia pyrotechnica* and *Moringa* sp. Both types of acacia are also proportionally more abundant in archaeological areas connected to metallurgical activities (as at Badia and in the Well *sebakh* sector of Mons Claudianus: Van der Veen, Tabinor 2007).

37 Other studies assume that the observation of puffing effect (bubbles) and radial cracks indicate charcoal making from green wood (Vermeeren 1998, p. 346; Krzywinski 2001, p. 137). However, the size, the hardness of charcoal (from soft to hard) and the puffing effect are not criteria currently used by the specialists of charcoal making, and no methodological study has yet been conducted to demonstrate a correlation between these proxies and the degree of combustion. Furthermore, it has been shown that the observation of radial cracks in cross-section is not a relevant criterion to demonstrate the combustion of green woods (Thery-Parisot, Henry 2012). On the contrary, the reflectance measurement does appear to be an effective tool to estimate the temperature of combustion and thus intentional charcoal production. To date, this method has not (or little) been tested on archaeological material (Braadbaart Poole 2008).

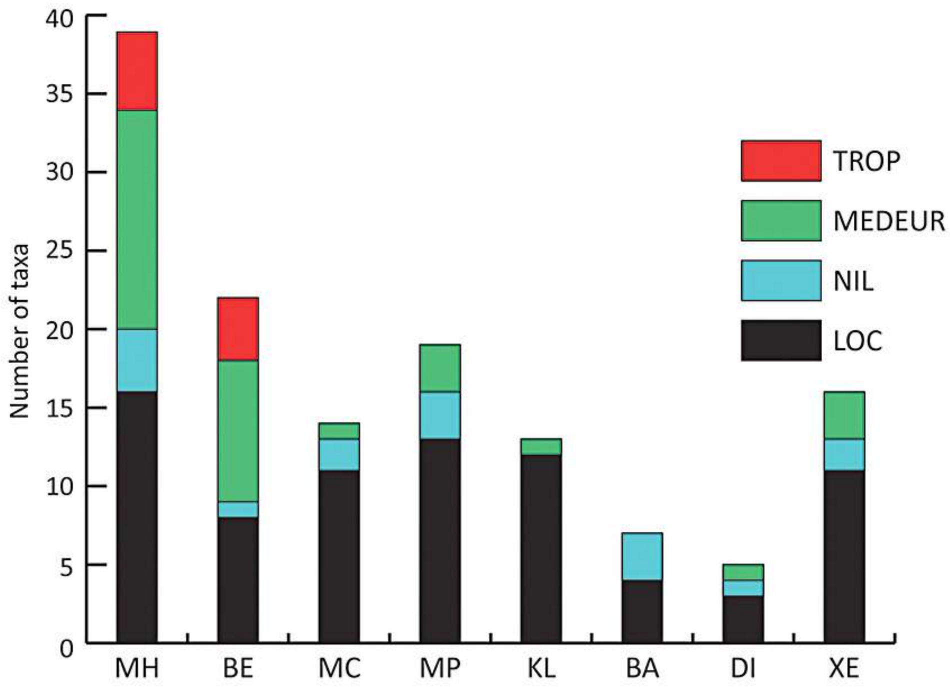
38 In addition to the written sources mentioning the importations of charcoal from the Nile Valley, the strongest argument in favour of this practice is the abundance of Nile acacia charcoal in non-domestic contexts. Its recurring presence in those specific contexts and its absence in the desiccated wood corpus[18] suggests that at least some acacia wood was brought from the Nile Valley as charcoal, reducing the weight and volume for transportation while meeting the important fuel needs at different sites. The convergence of papyrological sources and the charcoal results (Fig. 7) indicate that these imports were particularly aimed at quarry sites. On the other hand, the hypothesis of locally made charcoal on these sites or elsewhere, using desert acacia, such as *Acacia tortilis* subsp. *raddiana* whose calorific value is recognized (Le Floc'h Grouzis 2003, p. 46) or mangrove wood, remains largely untested. This practice has been suggested for the exploitation of desert gold resources during Pharaonic times (Gale *et al.* 2000, pp. 353-354) and during the Ptolemaic period (Bouchaud forthcoming). It was still common until recently among Bedouin populations (Hobbs 1989; Belal *et al.* 2009; Andersen 2012).

Comparisons between sites: site functions and the regional economy

39 The wood diversity differs from site to site, in both the number of taxa identified and their geographical origin. These differences partly depends on the amount of archaeobotanical samples as well as the state of preservation. For example, the small number of charcoal samples and the absence of desiccated wood identified at Badia, as well as the absence of charcoal studies at Didymoi certainly explain the low number of taxa identified on these sites. Similarly, the larger number of samples from Myos Hormos and Berenike produces a richer taxonomic list. In addition, other types of explanation can explain taxonomic differences between sites.

40 The classification of taxa by provenance, combining the results of the analysis of uncharred and charred wood of each site (Fig. 10) provides an initial qualitative comparison.

Fig. 10



Number of taxa identified per site, including results of both wood and charcoal identifications, grouped according to their most likely provenance. See table 2 for abbreviations of site names, provenances as well as quantitative and qualitative details.

41 Thirty-five taxa are shrubs and trees growing in the desert. These local taxa, dominated by desert acacia (*Acacia tortilis* type) are attested everywhere. The cultivated or naturally growing plants coming from the Nile or the Western Desert oases are represented by nine taxa. The most ubiquitous taxon, Nile acacia, especially present at the quarry sites (Mons Claudianus and Porphyrites) is probably related to the import of charcoal. The remaining eight taxa are only represented sporadically, such as possible olive wood and Maloideae at Myos Hormos, the persea,[19] *Mimusops laurifolia* (MIMU) at Porphyrites –a fruit tree protected by the state during the Ptolemaic and Roman periods (Manniche 1989, p. 121)–, or the reed (ARPHR) at Xeron Pelagos. Nineteen taxa are typical of the Mediterranean region and/or more northern areas of Europe or the Middle East. Most of the imported taxa can grow in any part of the Mediterranean (maritime/stone pine, boxwood, evergreen oak, cypress, etc.), including the Sinai (juniper). Others, like the group of Scots/black pine, elm, fir, although growing in high altitude areas of certain Mediterranean regions, may also attest long distance imports from temperate regions of Eurasia or Anatolia. Among those, pine and elm are the most frequently identified taxa, but attested only at Myos Hormos and at Berenike. Finally, eight taxa only found on the two port sites are exotic woods characteristic of tropical and sub-tropical India (teak, bamboo, *Bambusa* sp., BAMB) or Africa (African ebony).

42 These observations highlight the difference between the supply of port sites and that of forts and quarries located further inland. This is due, on the one hand, to the use of wood and, on the other hand, to the economic and social status of the sites. As previously shown, the exotic tropical taxa are related to shipbuilding; logically, they are more present in ports than inland sites. Moreover, the two harbours provided numerous

wooden objects, including personal items such as combs, and architectural elements, such as planks, made of wood from the Mediterranean/European mainland. These ports saw a multiplicity of human activity, with traders, officials of the Roman army, soldiers and civilians passing through or settling, each requiring different materials, including wood. The recycling of these pieces of wood as fuel (see above) resulted in the diversity observed in the charcoal assemblage. Conversely, the forts, way-stations and quarry sites are areas of residence and movement less directly related to long-distance trade: this situation is reflected by the types of wood. They represent a smaller geographic diversity, especially focusing on local taxa and to a lesser extent on Nilotic wood (for charcoal, see above) and on wood from the Mediterranean. As well as the study of seeds and fruits, faunal remains, textiles, pottery (see the various contributions in this volume of Bender *et al.* 2018, Leguilloux 2018, Tomber 2018, Van der Veen *et al.* 2018), the wood and charcoal remains help us to figure out the economic system of the Eastern Desert during the Roman period and highlight supply differences between the Red Sea ports and the inland sites.

Chronological dynamics

The exploitation of wood resources in the *longue durée* and the uniqueness of the Roman period

43 The wood studies from earlier periods, from the Old Kingdom to the Late Period, generally derive from funerary contexts, often of important figures (see for example for the New Kingdom: Waly 1996; Newton 2002, 2009; and for the Third Intermediate Period: Asensi Amorós 2017). They correspond to Egyptian wood, such as acacia, tamarisk and sycamore fig and imported wood, predominantly from Levant and Mediterranean regions, such as cedar (*Cedrus* sp.) (see also Asensi Amorós 2003, 2016; De Vartavan, Asensi Amorós 2010). The cedar and acacia woods are resistant to wood-boring insects; they can be over-represented as they preserve particularly well, but their well-known resistance could also have influenced their choice as a material for funerary furniture (Newton 2009). However, the sycamore fig, which is less durable and of poor quality, is particularly well attested, probably because of its availability (Asensi Amorós 2008, p. 30). One domestic context from Upper Egypt provides data for the Pharaonic period (Middle Kingdom and Late Period): desert acacia and tamarisk are used for headrests and rods (Waly 1999). Pharaonic boat timbers were found at Mersa Gawasis (Gerisch 2007; Bard, Fattovitch 2008; Ward, Zazzaro 2010; Ward 2012) and at Ayn Soukna (Newton unpublished data). Once again, the identified woods correspond to Egyptian supplies (acacia, fig) and to imports from the Levant (cedar and deciduous oak). While the data from the Roman period do not allow us to identify the woods originally used for Mediterranean shipbuilding (see above), these Pharaonic elements support the hypothesis developed by Golenischeff (1890) and Gabolde (2002) assuming the use of acacia "forests" for the building and repair of ships.

44 Charcoal studies of periods preceding the Graeco-Roman show local fuel supplies (e.g. for the Pre-dynastic: Newton Midant-Reynes 2007; Gatto *et al.* 2009; for the Persian period: Newton *et al.* 2013). Acacia charcoal is dominant on urban sites or sites linked to religious institutions in the Nile Valley, for instance at Amarna (Gerisch 2004), Giza (Murray 2005) and Karnak during the Late Period (26th Dynasty) (Newton *et al.* forthcoming). At Karnak,

charcoal data and textual sources indicate a possible management of acacia plantations for charcoal making (Newton *et al.* forthcoming).

45 For the periods covered by this paper, desiccated wood and charcoal found on Egyptian sites outside of the Eastern Desert are generally dated vaguely to the Graeco-Roman period (Marchand in press; Waly 2003 Vermeeren 2016), and datasets clearly dated to the Ptolemaic period, such as Tebtynis in the Fayoum (Marchand 2015), or to the Roman period (Bouchaud, Redon 2017; Asensi Amorós 2008) are too small to understand global diachronic dynamics (Asensi Amorós 2003). The use of the published or unpublished papyri from these periods would bring important information, but this would exceed the limited scope of this paper. For both Greek and Roman periods, the available studies highlight local fuel supplies, dominated by the acacia, tamarisk trees and fruit trees (date palm, olive tree and vine) (Bouchaud, Redon 2017; Vermeeren 2016). The same woods as well as imported wood from the Mediterranean/European regions –boxwood, fir, cypress, ash, beech, lime– were used as building materials or for specific objects.

46 The charcoal and wood corpus of the Eastern Desert stands out from those of sites in the Nile Valley and the Western Desert oases, firstly because of the number of samples analysed (limited, but bigger than in other Egyptian regions) and secondly because it reflects the economic dynamism of the Roman period, involving the transport and use of wood at local, medium and long distances. While most identified taxa are similar to those found in the Nile Valley or Fayoum sites, the Eastern Desert assemblages are distinct in some aspects. For example, pines from the Mediterranean, already present in small quantities in earlier times and occasionally identified on the contemporary sites of Fayoum (Marchand in press; Vermeeren 2016), seem to have been widely used at Myos Hormos and at Berenike (see above). Teak is identified for the first time at both these sites (Asensi Amorós 2003). Its absence on inland desert sites or in the Nile Valley and in the Western Desert oases indicates that this wood was preferentially linked to maritime activity, for Indian ships, and that it was not (or was little) traded in the Egyptian territory under Roman rule.

The use of cedar in Roman times

47 Cedar, *Cedrus* sp., a prized wood regularly identified for making funerary furniture, buildings and boats from the pre-dynastic period onwards (Gale *et al.* 2000, p. 349; Newton 2002; Asensi Amorós 2003; Newton 2009) is absent from the Roman corpus of the Eastern Desert despite an impressive taxonomic list. This may be related to functional and contextual aspects, this wood being used for buildings or objects not used in the Eastern Desert. Nevertheless cedar has not been identified on other contemporary Egyptian sites, with the exception of two supports for painted portraits (Asensi Amorós 2008). Although an *argumentum ex silentio* should be used cautiously, it seems that cedar originated from Syrian-Lebanese regions (*Cedrus libani*) or, less likely, North Africa (*Cedrus atlantica*), but was not a main resource during the Greco-Roman period. Furthermore, the identification of cedar wood in written sources is rather confused. Indeed, the same popular name may be given to different botanical taxa as vernacular classification of plants does not necessarily coincide with the Linnaean classification. This is as true today as in the past, especially in the classical literature, suggesting that some Lebanese cedar identifications proposed in museum catalogues or archaeological reports might be incorrect, because a single term was used for both cedar and other conifers. Anatomically identified cedar is recognized for the Pharaonic period and perhaps for late Antiquity, as suggested by the

fragments found at Abu Sha'ar (Fadl 2013), but its availability in Egypt during Greek and Roman times appears to have been significantly reduced. However, the reasons for these changes, potentially involving other products, such as sycamore fig, are not yet fully understand (changes in habits and/or practices of trade relations, or even decline of these resources are some of the many hypotheses that might be explored).

A scarcity of resources?

48 The working hypothesis that comes to mind given the numerous activities involving the use of wood and charcoal on the "longue durée" is that these activities significantly affected timber resources available in the desert, in the Nile Valley or even, if we take the case of cedar, in other Mediterranean regions, leading to their scarcity. Current Bedouin populations perceive the Roman era as the first period of overexploitation of wood resources, partly because of large-scale charcoal making (Hobbs 1989, pp. 98-100). This hypothesis, if it is relevant (Krzywinski, Pierce 2001), is difficult to confirm. At present, the data prevent us to describe the qualitative and quantitative evolution of wood resources in the aforementioned regions. In the Eastern Desert, datasets are still too limited and suffer from excessive methodological bias (limited number of remains, narrow sampling) to describe the dynamics of biodiversity.

49 The only available data are for mangrove wood. The two main types, *Avicennia* and *Rhizophora*, probably corresponding to the grey mangrove, *Avicennia marina*, and red mangrove, *Rhizophora mucronata*, were recognized in the Eastern Desert datasets. Their presence, linked to coastal environments, is only recorded at Berenike and at Myos Hormos, suggesting both wide local use at these ports and low utility value elsewhere (Schneider 2006, 2011, 2017). The red mangrove is, for example, a timber known for its rot-proof qualities, making it popular for ship building and port architecture, but of little use at sites deprived of water. Currently, mangrove formations are extremely scarce, or even absent, around Berenike, and red mangrove has disappeared locally (Vermeeren 1998, p. 347, Schneider 2011, pp. 396-397). The study of wood and charcoal from medieval Kusayr offers the unique opportunity to compare these results with those of the Roman port of Myos Hormos and to follow the evolution of the corpus. This comparison highlights a net change between the two periods, marked in particular by a drop off of grey mangrove[20] (Van der Veen 2011, p. 226). These few clues are the only relevant arguments demonstrating the impact of Human activities on the local vegetation. The chronological evolution of acacia population cannot be measured at present because of the lack of data. However, modern testimonies indicate that potential Roman over-exploitation did not cause irreversible consequences. At the beginning of the 19th century, Linant Bellefond described wâdis filled with acacias (Linant Bellefonds in 1831). E.A. Floyer made the same observation and observed, in the 1880s, acacia trees, some up to 10 metres high, exploited by the Bedouin for charcoal production (Floyer 1887, p. 670; quoted in Hobbs 1989). The scarcity of the wood resources of the desert[21] observed nowadays seems to be the result of very recent developments during the last 50 years, marked among other things by the gold rush and increase of charcoal making, leading as well to the destruction of archaeological heritage and increasing desertification (Hobbs 1989, p. 100; Andersen, Krzywinski 2007; Redon 2017).

Summary and conclusion

50 This first synthesis of wood and charcoal studies conducted on eight Roman sites in the Eastern Desert offers a regional overview of the uses and supply of wood resources. The arid conditions have allowed the preservation of wooden objects that are not generally found in archaeological contexts. These findings show the use of a wide spectrum of wooden artefacts and timber (domestic and maritime). Their presence underlines the important place of wooden furniture and objects in ancient societies and, indirectly, their under-representation on sites where the organic material is not preserved. The taxa list demonstrates the complex routes of supply which combine local exploitation of desert resources (acacia, tamarisk, bentree, mangroves, etc.), especially to satisfy fuel requirements, and acquisitions from the Nile valley (acacia) or Sinai (juniper), and imports from more distant Mediterranean regions (pine, oak), continental Europe (elm tree, fir) or tropical African regions (African ebony). The re-use of wood, such as teak from Indian boats, for building or as fuel also seems to be a common practice.

51 Despite the heterogeneity of the studies between sites and the small amount of data in some cases, the results highlight both the diversity of resources and the selection practices. Special attention was paid to choose specific woods for buildings, for shipbuilding, for everyday objects and for heating. Thus, while the use of wood for making some objects (amphora corks, dishes) or for fuel might be described as opportunistic, some selection have been made for maritime objects and building material (tropical timber and pine) at the ports and for smithing activities in the quarries (acacia wood, some of which were being imported from the Nile Valley as charcoal) in order to benefit from the specific properties of the wood. Comparisons between sites show significant differences between the coastal sites (Myos Hormos and Berenike) and the inland sites. Like the studies of other materials presented in this volume, the study of wood resources identifies ports as the main hubs for the transfer and use of many products used in the Eastern Desert.

52 Results from the Eastern Desert also provide unique data for Roman period in Egypt. The comparison with other contemporary sites in the Nile Valley and the Western Desert oases highlights the similarities, but also the emergence of new species such as teak, and the scarcity of cedar. The available corpus, however, remains too small to address some issues, such as the hypothetical local making charcoal and the impact of human activities on biodiversity dynamics. Ongoing archaeobotanical analysis and the examination of papyrological evidence are two paths that will be explored in the coming years in order to complete this first synthesis.

Aknowledgements

53 Charlène Bouchaud and Marijke van der Veen wish to thank Jean-Pierre Brun and the College de France for the invitation to the conference of Paris 2016, where this study was presented by the first author. Charlène Bouchaud and Claire Newton thank Hélène Cuvigny for the invitation to participate in the French archeological mission of the Egyptian Eastern Desert, while Marijke van der Veen thanks Valerie Maxfield and David Peacock for inviting her to join their projects in the Eastern Desert, and Caroline Vermeeren thanks Steve Sidebotham and Willeke Wendrich for the invitation to join

their excavations at Berenike. Also thanks to Hélène Cuvigny and Adam Bülow-Jacobsen for information about unpublished ostraka and Valerie Schram and Victoria Asensi Amorós for their comments on the previous versions of this article. Finally, we would like to thank Steve Sidebotham for this English translation of the French text.

BIBLIOGRAPHY

Andersen G.L. 2012. "Vegetation and Management Regime Continuity in the Cultural Landscape of the Eastern Desert". In *The History of the Peoples of the Eastern Desert*. H. Barnard, K. Duistermaat (ed.), Los Angeles: Cotsen Institute of Archaeology Press, pp. 127-139.

Andersen G.L. and Krzywinski K. 2007. "Mortality, Recruitment and Change of Desert Tree Populations in a Hyper-Arid Environment", *PLoS ONE*, 2, 2: e208.

Asensi Amorós V. 2003. "L'étude du bois et de son commerce en Égypte: lacunes des connaissances actuelles et perspectives pour l'analyse xylologique". In *Food, Fuel and Fields: progress in African Archaeobotany.* K. Neumann, A. Butler, S. Kahlheber (ed.), Köln: Heinrich-Barth-Institut, coll. Africa Praehistorica, 15, pp. 177-186.

Asensi Amorós V. 2008. "Les bois utilisés pour les portraits peints en Égypte à l'époque romaine". In *Portraits funéraires de l'Égypte romaine. Cartonnages, linceuls et bois.* M.-F. Aubert, R. Cortopassi, G. Nachtergael, V. Asensi Amorós, P. Détienne, S. Pagès-Camagna, A.-S. Le Hô (ed.), Paris: Éditions Kheops, Musée du Louvre éditions, pp. 29-40.

Asensi Amorós V. 2016. "The history of conifers in Egypt, part I: Mediterranean cypress (*Cupressus sempervirens* L., Cupressaceae)". In *News from the past: Progress in African archaeobotany. Proceedings of the 7th International Workshop on African Archaeobotany in Vienna, 2-5 July 2012.* U. Thanheiser (ed.), Groningen: Barkhuis, coll. Advances in Archaeobotany, 3, pp. 3-11.

Asensi Amorós V. 2017. "The wood of the Third Intermediate period coffins: the evidence of analysis for the *Vatican Coffin Project*". In *Proceedings of the First Vatican coffin conference, 19-22 June 2013. Volume 1.* A. Amenta, H. Guichard, Vatican: Edizioni Musei Vaticani, pp. 45-50.

Barakat H., Baum N. 1992. *La végétation antique de Douch (oasis de Kharga), une approche macrobotanique*, Cairo: Institut français d'archéologie orientale, coll. DFIFAO, 27.

Bard K.A., Fattovich R. 2008. "Harbour of Paraohs to the land of Punt (Marsa/Wâdi Gawasis report 2007-2008)", *Newsletter Archeologia (CISA)*, pp. 22-38.

Belal A., Briggs J., Sharp J., Springuel I. 2009. *Bedouins by the lake: environment, change, and sustainability in southern Egypt*, Cairo: American University in Cairo Press.

Bender L. 2018. "Textiles from Mons Claudianus, 'Abu Sha'ar and other Roman Sites in the Eastern Desert". In *The Eastern Desert of Egypt during the Greco-Roman Period: Archaeological Reports.* J.-P. Brun, T. Faucher, B. Redon and S. Sidebotham (ed.). On line: https://books.openedition.org/cdf/5234.

Blue L., Whitewright J., Thomas R.I. 2011. “Ships and ships’ fittings”. In *Myos Hormos-Quseir al-Qadim: Roman and Islamic ports on the Red Sea. Volume 2: The finds from the 1999-2003 excavations.* D.P. Peacock, L. Blue (ed.), Oxford: Archaeopress, pp. 179-209.

Bouchaud C. Forthcoming. “Les données archéobotaniques”. In *L'exploitation de l'or dans le district de Samut (désert Oriental). La mine ptolémaïque et les villages de mineurs du Nouvel Empire et de l'époque médiévale*. B. Redon, Th. Faucher (ed.), Cairo: Institut français d'archéologie orientale, coll. FIFAO.

Bouchaud C., Redon B. 2017. “Heating the Greek and Roman baths in Egypt. Papyrological and Archeobotanical data”. In *Collective baths in Egypt 2. New discoveries and perspectives.* B. Redon (ed.), Cairo: Institut français d'archéologie orientale, coll. EtudUrb 10, pp. 323-349.

Bouchaud C., Sachet I., Delhopital N. 2011. “Les bois et les fruits des tombeaux nabatéens de Madâ’in Sâlih/Hégra (Arabie Saoudite) : les provenances des végétaux et leur utilisation en contexte funéraire”. In *Actes du colloque “Des hommes et des plantes. Exploitation et gestion des ressources végétales de la Préhistoire à nos jours”.* Session Usages et symboliques des plantes XXX[e] Rencontres internationales d’archéologie et d’histoire d’Antibes. 22-24 octobre 2009. Antibes. C. Delhon, I. Théry-Parisot, S. Thiébault (ed.), *Anthropobotanica 01.*

Boulos L. 1999. *Flora of Egypt. Volume 1 (Azollaceae–Oxalidaceae)*, Cairo: Al Hadara, 1999.

Boulos L. 2000. *Flora of Egypt. Volume 2 (Geraniaceae-Boraginaceae)*, Cairo: Al Hadara, 2000.

Boulos L. 2002. *Flora of Egypt. Volume 3 (Verbinaceae-Compositae)*, Cairo: Al Hadara, 2002.

Boulos L. 2005. *Flora of Egypt. Volume 4. Monocotyledons (Alismataceae-Orchidaceae*, Cairo: Al Hadara, 2005.

Braadbaart F., Poole I. 2008. “Morphological, chemical and physical changes during charcoalification of wood and its relevance to archaeological contexts”. *Journal of Archaeological Science*, 35, 9, pp. 2434-2445.

Bubenzer O., Riemer H. 2007. “Holocene climatic change and human settlement between the central Sahara and the Nile Valley: archaeological and geomorphological results”. *Geoarchaeology*, 22, 6, pp. 607–620.

Butzer K. 1999. “Climatic history”. In *Encyclopedia of the Archaeology of Egypt.* Bard K. (ed.), London: Routledge, pp. 195-198.

Christensen A. 2001. “Charcoal and coffee”. In *Deserting the desert a threatened cultural landscape between the Nile and the sea.* K. Krzywinski, R.H. Pierce (ed.), Bergen: Alvheim og Eide Akademisk Forlag, pp. 109-132.

Cuvigny H. (ed.). 2003. *La route de Myos Hormos. L’armée romaine dans le désert Oriental d’Égypte. Praesidia du désert de Bérénice I*, 2, Cairo: Institut français d’archéologie orientale, coll. FIFAO, 48.

Derks T., Vos W. 2010. “Wooden combs from the Roman fort at Vechten: the bodily appearance of soldiers”,. *Journal of Archaeology in the Low Countries* 2-2, pp. 53–77.

de Vartavan C., Asensi Amorós V. 2010. *Codex of ancient Egyptian plant remains*, London: SAIS.

Delange E. 1987. *Catalogue des statues égyptiennes du Moyen Empire*, Paris: Louvre éditions.

Ellenberg H. 1988. *Vegetation ecology of central Europe*, Cambridge: Cambridge University Press.

Fadl M.A. 2013. “Comparison between archaeobotany of inland and coastal sites in the Eastern Desert of Egypt in 300 B.C.-700 A.D.”. *International Research Journal of Plant Science*, 4, 5, pp. 117-132.

Fagg C., Stewart J. 1994. “The value of *Acacia* and *Prosopis* in arid and semi-arid environments”. *Journal of Arid Environments*, 27, 1, pp. 3-25.

Fahn A., Werker E., Baas P. 1986. *Wood anatomy and identification of trees and shrubs from Israel and adjacent regions*, Jerusalem: the Israel academy of Sciences and Humanities.

Feinbrun-Dothan N. 1978. *Flora Palaestina. Part three: Ericaceae to Compositae*, Jerusalem: Israel Academy of Sciences and Humanities.

Feinbrun-Dothan N. 1986. *Flora Palaestina. Part four: Alismataceae to Orchidaceae*, Jerusalem: Israel Academy of Sciences and Humanities.

Floyer E.A. 1887. “Notes on a sketch map of two routes in the Eastern Desert of Egypt”. *Proceedings of the Royal Geographical Society of London*, 9, pp. 659-681.

Gabolde M. 2002. “Les forêts de Coptos”. In *Autour de Coptos - Actes du colloque organisé au Musée des Beaux-arts de Lyon (17-18 mars 2000).* M.-F. Boussac, M. Gabolde, G. Galliano (ed.), Lyon: Maison de l’Orient et de la Méditerranée, coll. Topoi Orient Occident, suppl 3, pp. 137-145.

Gale R., Gasson P., Hepper N., Killen G. 2000. “Wood”. In *Ancient Egyptian materials and technology.* P. Nicholson, I. Shaw (ed.), Cambridge: Cambridge University Press, pp. 268-298.

Gale R., Cutler D. 2000. *Plants in Archaeology, Identification Manual of Vegetative Plant Materials Used in Europe and South Mediterranean to c. 1500*, Otley: Westbury and Royal Botanic Gardens (Kew).

Gatto M.C., De Dapper M., Gerisch R., Hart E., Hendrickx S., Herbich T., Joris H., Nordström H.-A Pitre M., Roma S., Âwi’Ch D., Usai D. 2009. “Predynastic settlement and cemeteries at Nag el-Qarmila, Kubbaniya”. *Archéo-Nil*, 19, pp. 186–206.

Gerisch R. 2004. *Holzkohleuntersuchungen an pharaonischem und byzantinischem Material aus Amarna und Umgebung*, Mainz: Verlag Phillip von Zabern.

Gerisch R. 2007. “Identification of wood and charcoal”. In *Harbor of the Pharaohs to the Land of Punt*. K.A. Bard, R. Fattovich (ed.), Naples: Università degli studi di Napoli l’Orientale, pp. 170-188.

Golénischeff W. 1890. “Une excursion à Bérénice”. *Recueil de Travaux relatifs à la Philologie et à l'Archéologie égyptienne et assyrienne*, 13, pp. 75-96.

Hamilton-Dyer S., Goddard S. 2001. “Wooden objects”. In *Survey and excavation: Mons Claudianus, 1987-1993. The Excavations: Part 1.* V.A. Maxfield, D.P. Peacock (ed.), vol. 2, Cairo: Institut français d’archéologie orientale, coll. DFIFAO, 43.

Handley F.J.L. 2004. “Quseir al-Qadim 2003: The textiles”. *Textiles Newsletter*, 38, pp. 27-30.

Hiebert F.T. 1991. “Commercial organization of the Egyptian port of Quseir al-Qadim: evidence from the analyis of the wooden objects”. *Archéologie islamique*, 2, pp. 127-159.

Hobbs J.J. 1989. *Bedouin Life in the Egyptian Wilderness*, Austin: University of Texas Press.

Hoelzmann P., Gasse F., Dupont L.M., Salzmann U., Staubwasser M., Leuschner D.C., Sirocko F. 2004. “Palaeoenvironmental changes in the arid and sub arid belt (Sahara-Sahel-Arabian Peninsula) from 150 kyr to present”. In *Past Climate Variability through Europe and Africa.* R.W. Battarbee, F. Gasse, C.E. Stickley (ed.), Dordrecht: Springer, coll. Developments in Paleoenvironmental Research, 6, pp. 219-256.

Krzywinski K. 2001. “Charcoal in the Eastern Desert in Roman and Byzantine times”. In *Deserting the desert a threatened cultural landscape between the Nile and the sea.* K. Krzywinski, R.H. Pierce (ed.), Bergen: Alvheim og Eide Akademisk Forlag, pp. 133-142.

Krzywinski K., Pierce R.H. 2001. *Deserting the desert. A threatened cultural landscape between the Nile and the sea*, Bergen: Alvheim og Eide Akademisk Forlag.

Kuper R., Kröpelin S. 2006. "Climate-Controlled Holocene Occupation in the Sahara: Motor of Africa's Evolution". *Science*, 5788, p. 803.

Le Floc'h E., Grouzis M. 2003. "*Acacia raddiana*, un arbre des zones arides à usages multiples". In *Un arbre au désert :* Acacia raddiana*.* M. Grouzis, E. Le Floc'h (ed.), Paris: IRD éditions, pp. 21-58.

Leguilloux M. 2018. "The Exploitation of Animals in the Roman *Praesidia* on the Routes to Myos Hormos and to Berenike: on Food, Transport and Craftsmanship". In *The Eastern Desert of Egypt during the Greco-Roman Period: Archaeological Reports.* J.-P. Brun, T. Faucher, B. Redon and S. Sidebotham (ed.). On line: https://books.openedition.org/cdf/5245.

Linant de Bellefonds L.M.A. 1831. *Voyage aux mines d'or du pharaon*, Tourcoing: Fata Morgana.

Mahmoud T. 2010. *Desert Plants of Egypt's Wâdi El Gemal National Park*, Cairo, New York: American University in Cairo Press.

Manniche L. 1989. *An ancient Egyptian herbal*, Austin: University of Texas Press.

Marchand S. Forthcoming. "Petits vases à parfum en boi de Tebtynis (Fayoum). Epoques ptolémaïque et romaine". In *Hommages Capasso*.

Marchand S. 2015. "Bols en bois peint d'Egypte d'époque ptolémaïque, IIe-Ier s. av. J.-C.". *Instrumentum. Bulletin du Groupe de travail européen sur l'artisanat et les productions manufacturées de l'Antiquité à l'époque moderne*, 42, pp. 27-30.

Marichal R. 1992. "Les ostraca de Bu Njem". *Libya Antiqua*, suppl. 7.

Moeyersons J., Vermeersch P.M., Beeckman H., Van Peer P. 1999. "Holocene environmental changes in the Gebel Umm Hammad, Eastern Desert, Egypt". *Geomorphology*, 26, 4, pp. 297-312.

Neumann K. 1989. "Vegetationsgeschichte der Ostsahara im Holozän Holzkohlen aus prähistorischen Fundstellen". In *Forschungen zur Umweltgeschichte der Ostsahara.* R. Kuper (ed.), Köln: Heinrich-Barth-Institut, coll. Africa Praehistorica, 2, pp. 13-181.

Neumann K., Schoch W., Détienne P., Schweingruber F.H. 2001. *Woods of the Sahara and the Sahel: an anatomical atlas*, Bern: Paul Haupt.

Newton C. 2002. *Environnement végétal et économie en Haute-Égypte à Adaïma au Prédynastique ; Approches archéobotaniques comparatives de la Deuxième dynastie à l'Époque romaine*, Thèse de doctorat, Montpellier: Université de Montpellier II.

Newton C. 2009. "Mobilier en bois et offrandes végétales de la tombe BE 18, Elkab (Nouvel Empire, début de la 18e dynastie)". In *Elkab and Beyond: Studies in Honour of Luc Limme.* H. De Meulenaere, W. Claes, S. Hendrickx (ed.), Louvain, Paris: Peeters Publishers, coll. OLA, 191, pp. 119-129.

Newton C., Chaix L., Masson A. Forthcoming. "Les plantes et les animaux". In *Le quartier des prêtres du temple d'Amon à Karnak*. A. Masson (ed.).

Newton C., Midant-Reynes B. 2007. "Environmental change and settlement shifts in Upper Egypt during the Predynastic: charcoal analysis at Adaïma". *The Holocene*, 17, 8, pp. 1109-1118.

Newton C., Whitbread T., Agut-Labordère D., Wuttmann† M. 2013. "L'agriculture oasienne à l'époque perse dans le sud de l'oasis de Kharga (Égypte, Ve-IVe s. AEC)". *Revue d'ethnoécologie (online)* [on line], 4. URL: http://ethnoecologie.revues.org/1294.

Redon B. 2017. "De tristes nouvelles du district de Samut (janvier 2017)", *Désert Oriental* [on line]. URL: http://desorient.hypotheses.org/693.

Schneider P. 2006. "La connaissance des mangroves tropicales dans l'Antiquité". *Topoi*, 14, 1, pp. 207-244.

Schneider P. 2011. "La connaissance des mangroves tropicales dans l'Antiquité (Compléments)". *Topoi*, 17, pp. 353-402.

Schneider P. 2017. "On the Red Sead the trees are of a remarkable nature" (Pliny the Elder): The Red Sea mangroves from the Greco-Roman perspective". In *Human Interaction with the Environment in the Red Sea. Selected Papers of Red Sea Project VI.* D.A. Agius, E. Khalil, E. Scerri, A. Williams (ed.), Leiden, Boston, Brill, pp. 9-29.

Schweingruber F.H. 1990. Anatomy of European wood: an atlas for the identification of European trees, shrubs and dwarf shrubs, Bern, Stuttgart: Paul Haupt.

Sidebotham S., Wendrich W.Z. (ed.), 2000. *Berenike 1998: Report of the 1998 excavation at Berenike and the survey of the Egyptian Eastern Desert, including Excavations in Wâdi Kalalat*, Leiden: CNWS.

Tengberg M. 2011. "L'acquisition et l'utilisation des produits végétaux à Didymoi". In *Didymoi. Une garnison romaine dans le désert Oriental d'Egypte (Praesidia du désert de Bérénice IV). Volume 1. Les fouilles et le matériel.* H. Cuvigny (ed.), Cairo: Institut français d'archéologie orientale, pp. 205-214.

Théry-Parisot I., Chabal L., Chrzavzez J. 2010. "Anthracology and taphonomy, from wood gathering to charcoal analysis. A review of the taphonomic processes modifying charcoal assemblages, in archaeological contexts". *Palaeogeography, Palaeoclimatology, Palaeoecology*, 291, 1, pp. 142–153.

Théry-Parisot I., Henry A. 2012. "Seasoned or green? Radial cracks analysis as a method for identifying the use of green wood as fuel in archaeological charcoal". *Journal of Archaeological Science*, 39, 2, pp. 381-388.

Thomas R. 2011. "Fishing activity". In *Myos Hormos - Quseir al-Qadim. Roman and Islamic ports on the Red Sea 2: Finds from the 1999-2003 excavations*. D.P.S. Peacock, L. Blue (ed.), Oxford: Archaeopress, coll. "BAR International Series", 2286.

Thomas R.I., Whitewright J. 2001. "Roman period maritime artefacts". In *Myos Hormos and Quseir al-Qadim: A Roman and Islamic port on the Red Sea coast of Egypt: Interim report 2001.* D.P.S. Peacock, L. Blue, N. Bradford, S. Moser (ed.), Southampton: Southampton University.

Tomber R. 2018. "Quarries, Ports and *Praesidia*: Supply and Exchange in the Eastern Desert". In *The Eastern Desert of Egypt during the Greco-Roman Period: Archaeological Reports.* J.-P. Brun, T. Faucher, B. Redon and S. Sidebotham (ed.). On line: https://books.openedition.org/cdf/5251.

Van der Veen M. 1999. "The economic value of chaff and straw in arid and temperate zones". *Vegetation History and Archaeobotany*, 8, 3, pp. 211-224.

Van der Veen M. 2001. "The Botanical evidence (Chapter 8)". In *Survey and excavation: Mons Claudianus, 1987-1993. The Excavations: Parti 1, vol. 2.* V.A. Maxfield, D.P. Peacock (ed.), Cairo: Institut français d'archéologie orientale, coll. "DFIFAO", 43, pp. 174-247.

Van der Veen M. 2007. "Formation processes of desiccated and carbonized plant remains - the identification of routine practice". *Journal of Archaeological Science*, 34, 6, pp. 968-990.

Van der Veen M. 2011. *Consumption, Trade and Innovation: Exploring the Botanical remains from the Roman and Islamic Ports at Quseir al-Qadim, Egypt*, Frankfurt: Africa Magna Verlag.

Van der Veen M., Bouchaud C., Cappers R.J.T., Newton C. 2018. "Roman Life in the Eastern Desert of Egypt: Food, Imperial Power and Geopolitics". In *The Eastern Desert of Egypt during the Greco-*

Roman Period: Archaeological Reports. J.-P. Brun (ed.), on line: https://books.openedition.org/cdf/5252.

Van der Veen M., Gale R., Übel D. 2011. "Woodworking and firewood – Resource exploitation". In *Consumption, Trade and Innovation: Exploring the Botanical remains from the Roman and Islamic Ports at Quseir al-Qadim, Egypt*. M. Van der Veen, Frankfurt: Africa Magna Verlag, pp. 205-226.

Van der Veen M., Tabinor H. 2007. "Food, fodder and fuel at Mons Porphyrites: the botanical evidence". In *The Roman imperial quarries. Survey and excavations at Mons Porphyrites 1994-1998. Volume 2 : the excavations.* D.P. Peacock, V.A. Maxfield (ed.), London: Egypt exploration society, pp. 83-142.

Vermeeren C. 1998. "Wood and charcoal". In *Berenike 1996: Report of the 1996 excavation at Berenike (Egyptian Red Sea Coast) and the survey of the Eastern Desert.* S. Sidebotham, W.Z. Wendrich (ed.), Leiden: CNWS, pp. 331-348.

Vermeeren C. 1999a. "The use of imported and local wood species at the Roman port of Berenike, Red Sea coast, Egypt". In *The Exploitation of Plant Resources in Ancient Africa.* M. Van der Veen (ed.), New York: Kluwer/Plenum, pp. 199-204.

Vermeeren C. 1999b. "Wood and charcoal". In *Berenike 1997: Report of the 1997 excavation at Berenike and the survey of the Egyptian Eastern Desert, including excavations at Shenshef Eastern Desert.* S. Sidebotham, W.Z. Wendrich (ed.), Leiden: CNWS, coll. "Special Series 4", pp. 307-429.

Vermeeren C. 2000a. "Boats in the Desert, the desiccated wood and charcoal from Berenike (1998)". *BIAXiaal*, 90, pp. 2-11.

Vermeeren C. 2000b. "Wood and charcoal". In *Berenike 1998: Report of the 1998 excavation at Berenike and the survey of the Egyptian Eastern Desert, including Excavations in Wâdi Kalalat.* S. Sidebotham, W.Z. Wendrich (ed.), Leiden: CNWS, pp. 311-342.

Vermeeren C. 2016. "Wood use in Graeco-Roman Karanis (Fayum, Egypt): Local origin or import? First results". In *News from the past: Progress in African archaeobotany. Proceedings of the 7th International Workshop on African Archaeobotany in Vienna, 2-5 July 2012*. U. Thanheiser (ed.), Groningen: Barkhuis, coll. Advances in Archaeobotany, 3, pp. 127-136

Waly N.M. 1996. "Identified wood specimens from Tutankhamun's funerary furniture". *Taeckholmia*, 16, pp. 65-78.

Waly N.M. 1999. "The selection of plant fibres and wood in the manufacture of organic household items from the El-Gabalein area". In *The exploitation of Plant Resources in Ancient Africa*. M. Van der Veen (ed.), New York: Kluwer/Plenum, pp. 261-272.

Waly N.M. 2003. "Wooden objects from Ptolomaic and Early Coptic Periods, Upper Egypt". In *Food, fuel and fields: progress in African archaeobotany.* K. Neumann, A. Butler, S. Kahlheber (ed.), Cologne: Heinrich-Barth-Institut, coll. "Africa Praehistorica", 15, pp. 187-194.

Ward C. 2012. "Building pharaoh's ships: Cedar, incense and sailing the Great Green". *British Museum studies in Ancient Egypt and Sudan*, 18, pp. 217-232.

Ward C., Zazzaro C. 2010. "Evidence for Pharaonic Seagoing Ships at Mersa/Wâdi Gawasis, Egypt". *International Journal of Nautical Archaeology*, 39, 1, pp. 27-43.

Whitewright J. 2007. "Roman rigging material from the Red Sea port of Myos Hormos". *The International Journal of Nautical Archaeology*, 36, 2, pp. 282-292.

Whitewright J. 2011. "Wooden artefacts and woodworking". In *Myos Hormos-Quseir al-Qadim: Roman and Islamic ports on the Red Sea. Volume 2: The finds from the 1999-2003 excavations.* D.P. Peacock, L. Blue (ed.), Oxford: Archaeopress, pp. 167-178.

Wild F.C., Wild J.P. 2001. “Sails from the Roman port at Berenike, Egypt”. *International Journal of Nautical Archaeology*, 30, 2, pp. 211–220.

Wild J.P., Wild F.C. 2014. “Berenike and textile trade on the Indian ocean”. In *Textile trade and distribution in Antiquity*. K. Droß-Krüpe (ed.), Wiesbaden: Harrassowitz, pp. 91-110.

Zahran M.A., Willis A.J. 2009. *The vegetation of Egypt*, 2, Springer, Dordrecht: Springer e-books.

Zohary M. 1966. *Flora Palaestina. Part one: Equisetaceae to Moringaceae*, Jerusalem: Israel Academy of Sciences and Humanities.

Zohary M. 1972. *Flora Palaestina. Part two: Platanaceae to Umbelliferae*, Jerusalem: Israel Academy of Sciences and Humanities.

NOTES

1. The French sometimes use the term "dendrologie".
2. Depending on the areas and issues arising, the sieve mesh used for an anthracological study varies between 2 and 4 mm (for details on the theoretical and methodological aspects of anthracological studies see Théry-Parisot *et al.*, 2010).
3. This collection consists mainly of material collected by Claire Newton and Hala Barakat in Egypt and the North of Africa, and continues to be enriched. The wood is partly kept unchanged, and partly carbonized in order to facilitate its use for the identification of archaeological charcoal.
4. Taxonomy is the science and the laws of principles of the classification of living organisms. A taxon is an entity comprising living organisms, in this case plants, with common defined diagnostic characteristics and a phylogenetic relationship.
5. The botanical classification of angiosperms APG III (2009) does not recognize them as a family; Chenopodiaceae are now included in the family Amaranthaceae. However, for this paper we use the term traditionally used by the archeobotanical community.
6. The “sp.” suffix indicates that a single species of the mentioned genus is considered but that its identity is not known. The suffix “spp.“ indicates that several species of the same genus may be considered.
7. Only the taxon *Myrtus*/*Santalum* type was not taken into account in the corpus. The identification of these two fragments from Berenike as *Myrtus*/*Santalum* is very uncertain (Vermeeren 2000a, 2000b), and further represents two potentially rare taxa from completely different origins (Mediterranean region for *Myrtus* sp., and India for *Santalum* sp.)
8. The charcoal study of the site of Xeron Pelagos is ongoing.
9. The charcoal from Berenike is not included in this total, since the exact number is not known, with the exception of those studied during the 1996 campaign (Vermeeren 1998). Note, however, that tens of thousands of fragments were observed (Vermeeren 1999b, 2000b).
10. The function of wood pieces from Didymoi is not known; their data are not included in this discussion.
11. Indications in parentheses are the code used to designate the taxa (acronym in uppercase) and/or local Arabic names used by the ‘Ababda where known (from Hobbs 1989; Mahmoud 2010). The vernacular term in English is also stated in the text where applicable.
12. Many brail rings have been found at Berenike, but only two have been studied.
13. Two other jujube species found in Egypt in the Nile Valley, *Ziziphus lotus* and *Ziziphus nummularia* , may also be considered (Boulos 2000, pp. 85-86).
14. Confusion with *Prosopis* is also possible, even if it is not present in Egypt.
15. The architectural elements in question could be included in the category of maritime objects.

16. These military chores are mentioned at Xeron Pelagos (pers. comm. H. Cuvigny) and in other regions controlled by the Roman army, such as Dura-Europos, Syria (*P.Dura* 82, col. 2, l. 9) and Bu Njem, Lybia (R. Marichal 1992, p. 94).
17. As already mentioned, some charcoal contexts potentially result from a mixture of domestic and craft activities. In the absence of any other context index, only the particularity of the taxonomic spectrum (e.g. the over-representation of a taxon, see below) may indicate the existence of non-domestic discharges.
18. Nile acacia is a strong wood, which is difficult to work. It is used in the Nile Valley, especially in architecture, but this is not always the first choice (observation C. Newton)
19. The persea is only present as charcoal at Mons Porphyrites. It could, however, like Scots/black pine wood, match timber recycled into fuel.
20. Red mangrove is virtually absent from the Roman and Islamic corpus.
21. This scarcity is observed in other parts of Egypt. The acacia was a rather normal find in Roman Karanis where it is nowadays not or hardly present anywhere in/around the site (per. obs. Caroline Vermeeren).

AUTHORS

CHARLÈNE BOUCHAUD

Archaeozoology, Archaeobotany: Societies, Practices and Environments (UMR 7209), Sorbonne Universités, Muséum national d’histoire naturelle, CNRS, Paris, France

CLAIRE NEWTON

Laboratory of Archaeology and Patrimony, University of Quebec in Rimouski (Qc), Canada

MARIJKE VAN DER VEEN

School of Archaeology & Ancient History, University of Leicester, Great Britain

CAROLINE VERMEEREN

Biological Archaeology & Environmental Reconstruction (BIAX Consult), Zaandam, The Netherlands