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Waterproofing material from a 2nd century AD barge from Lyon: looking for the roman know-how to caulk with pitched textiles

Laure Meunier, Marc Guyon

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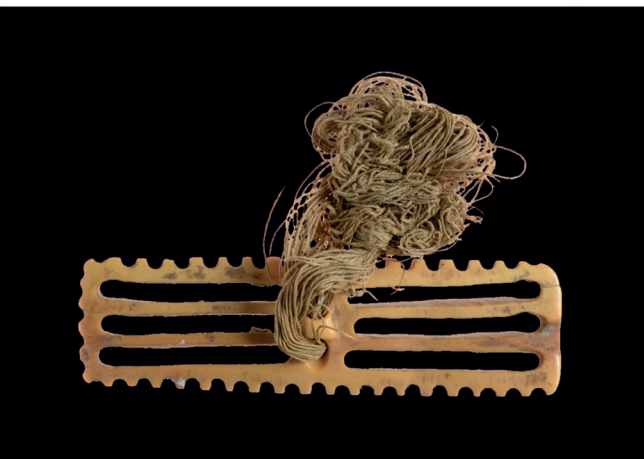
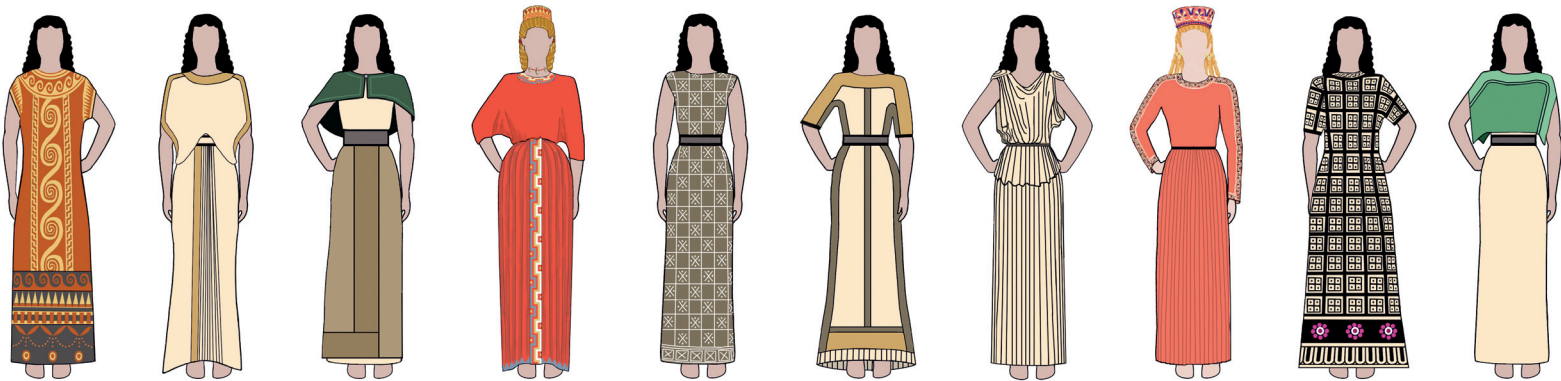


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REDEFINING ANCIENT TEXTILE HANDCRAFT STRUCTURES, TOOLS AND PRODUCTION PROCESSES

Macarena Bustamante-Álvarez, Elena H. Sánchez López, Javier Jiménez Ávila (eds.)



PURPUREAE VESTES VII
Textiles and Dyes in Antiquity

Redefining Ancient Textile Handcraft
Structures, Tools and Production Processes

**Proceedings of the VIIth International Symposium
on Textiles and Dyes in the Ancient Mediterranean World
(Granada, Spain 2-4 October 2019)**

Macarena Bustamante-Álvarez, Elena H. Sánchez López, Javier Jiménez Ávila (eds.)

GRANADA 2020

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Los trabajos de edición de este libro coincidieron con los peores momentos de la crisis sanitaria provocada por la COVID-19 que golpeó duramente en muchos de los territorios que en él están representados. Por ello queremos dedicarlo a la memoria de los/las colegas y amigos que perdieron sus vidas y a todos cuantos padecieron las graves consecuencias de tan terrible pandemia en todo el Mundo.

Macarena, Elena y Javier

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PURPUREAE VESTES VII

Redefining Textile Handcraft. Structures, Tools and Production Processes (Granada, 2019)

The International Symposium Purpureae Vestes VII “Redefining textile handcraft. Structures, tools and production processes” took place at the University of Granada (Spain) over the 2-4 October 2019. Almost 120 specialists on ancient textiles coming from different scientific institutions in 20 countries presented the results of their recent investigations through 50 communications and 35 posters. There were interesting discussions in the eight sessions in which the Congress was divided and on the last day participants could visit the wonderful archaeological and monumental ensemble of “La Alhambra de Granada”, World Heritage.

The Symposium had the financial support from the University of Granada (Departamento de Prehistoria y Arqueología, Grupo de Investigación GAECATAO/HUM 296) and the Campus de Excelencia Internacional del Mar (CEIMAR), in the framework of the Plan de Excelencia, Consolidación y Apoyo a las Universidades Andaluzas. PECA 2018, it also had the logistical support from the universities of Valencia (Spain) and Salento (Italy).

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Participants of the *VII Purpureae Vestes International Symposium on Textiles and Dyes in the Ancient Mediterranean World*
Granada, Spain 2-4 October 2019

WATERPROOFING MATERIAL FROM A 2nd CENTURY AD BARGUE FROM LYON: LOOKING FOR THE ROMAN KNOW-HOW TO CAULK WITH PITCHED TEXTILES

Laure Meunier *, *Marc Guyon* **

Abstract: Thanks to the complete dismantling of this 2nd century AD wrecked ship found in Lyon in order to conserve her, 26 linear metres of waterproofing material made of pitched textiles were removed from the seals between the planks. A new unfolding protocol led to the recovery of larger pieces than in the past, while information on the Roman caulker was made available by looking at the way the material was folded during use. By comparing material from a variety of locations, it was possible to see if a choice had been made to match the textiles and the space.

Keywords: Lyon, Gallo-Roman, Shipwreck, Textiles, Pitch, Caulking.

Resumé : Grâce au démantèlement complet opéré pour la restauration du chaland Lyon Saint-Georges 4, daté de la fin du deuxième siècle après J.-C., 26 mètres linéaires de matériau d'étanchéité composé de tissus poissés ont pu être prélevés dans les joints du bateau. Un nouveau protocole de déploiement a permis de mettre au jour des pièces significativement plus grandes que lors des expériences précédentes, et des informations sur le calfateur romain ont pu être collectées en examinant la façon dont les matériaux avaient été pliés lors de leur utilisation. En comparant les tissus de plusieurs localisations, il a été possible de voir qu'un choix avait été fait pour accorder les tissus avec l'espace disponible.

Mots-clés : Lyon, Gallo-romain, Épave, Textiles, Poix, Calfatage.

Introduction

When excavations on the level of the fossil right bank of the river Saône took place in Lyon (France) between October 2002 and June 2004, 16 wrecks dated between the 1st century AD and the 18th century (Fig. 1) were found. It was the Institute of Preventive Archaeological Research (Inrap) who carried out the excavation of this harbour site, located on the future Parc Saint Georges' car park, at the request of the Ministry of Culture. Grégoire Ayala was the manager of this huge archaeological operation and Marc Guyon

was responsible for the wrecks' excavation. It took place in a cofferdam according to the traditional methods of terrestrial archaeology on an area of approximately 4000 square meters and a height of 10 meters.¹

Lyon Saint-Georges 4 (LSG4) belongs to a larger set of six Gallo-Roman boats discovered in 2004 (Figs. 1 and 2). Their complete architectural study has been done and published in 2010.² But the lack of time and the impossibility of dismantling *in situ* prevented an intensive survey. The three most complete wrecks were removed and stored in a lake near Lyon, awaiting funding

* IFIRES, Grenoble (France).

** Institut National de Recherche Archéologique Préventive (Inrap) Auvergne Rhône-Alpes; UMR 7299 Centre Camille Jullian (CNRS), Aix-en-Provence (France).

¹ AYALA *et al.* 2005, 89-94.

² GUYON 2010; RIETH 2010a; 2010b.

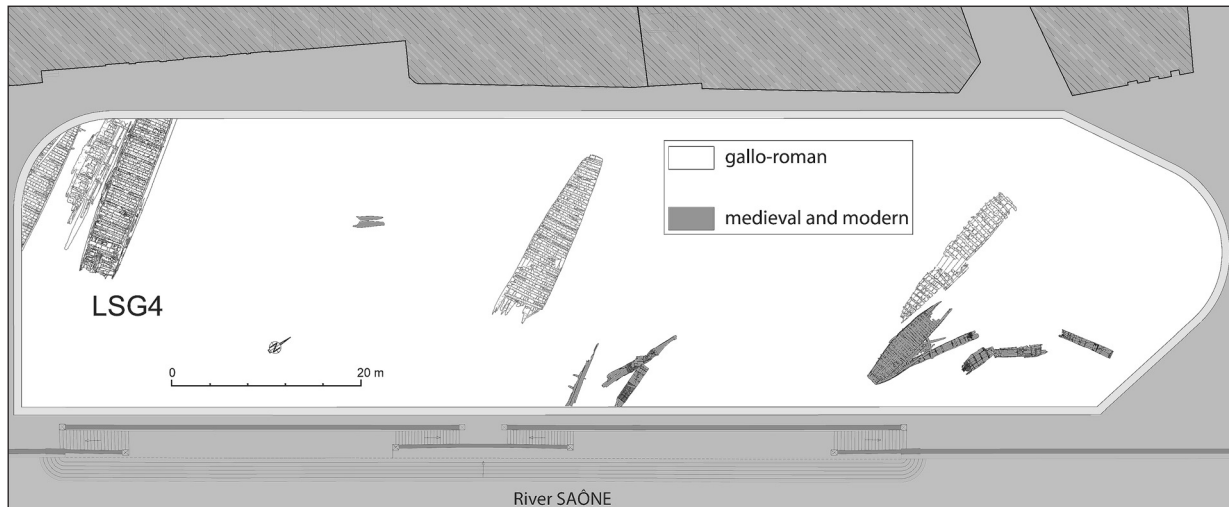


Fig. 1. Localization of the wrecks in excavation of Parc Saint-Georges in Lyon (W. Widlak, Inrap).



Fig. 2. LSG 4 in her metallic frame (M. Guyon, Inrap).

for further study. This transpired in 2013, signalling the launch of the LSG4 project which lasted several years and involved consolidation of the waterlogged wood, its restoration and preparation for display in the *Lugdunum* museum in Lyon for 2024. Since then, further analysis of the various materials took place and data recovered and leading to the provision of new archaeological information.

Caulking

The waterproofing of the boat was made with textiles impregnated with pitch. During the manufacture of the flat bottom planks, carpenters gave a particular shape to the profile of the edge. This profile, once the two planks had been positioned against each other, formed an inverted “Y” with a slight projection downwards to keep the caulking material in place without any other

means to secure it (Fig. 3). The initial profile of the edge was axe-cut. When replacing the waterproofing, the projection disappeared, because to remove it, a gouge had to be used to get access to the pitched cloth. Using this tool eliminated the projection of the edge as a result, which allowed a precise record of where the tightness has been replaced.

During the dismantling of the barge, 26 m of caulking material was removed for further study. It mainly came from the spaces between the bilge and the side (Fig. 4).

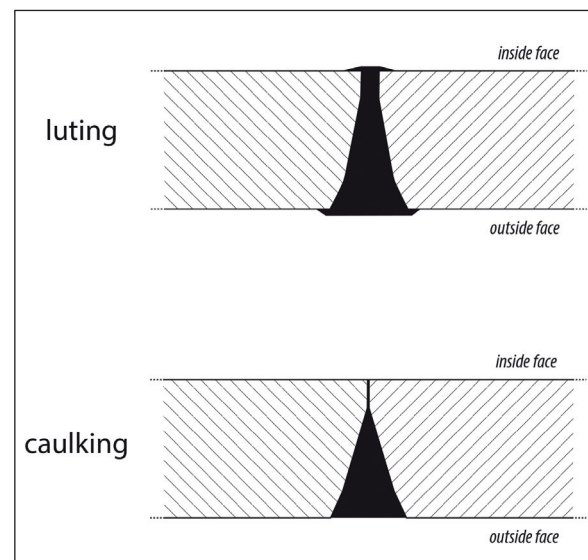


Fig. 3. The difference between luting and caulking: luting is placed while building the boat along a plank, then the following one is put aside and nailed. This can be seen because waterproofing material surrounds both seals. For caulking, assemblage is done and then waterproofing material is forced in the seal. No waterproofing material can be observed inside the boat (M. Guyon, Inrap).

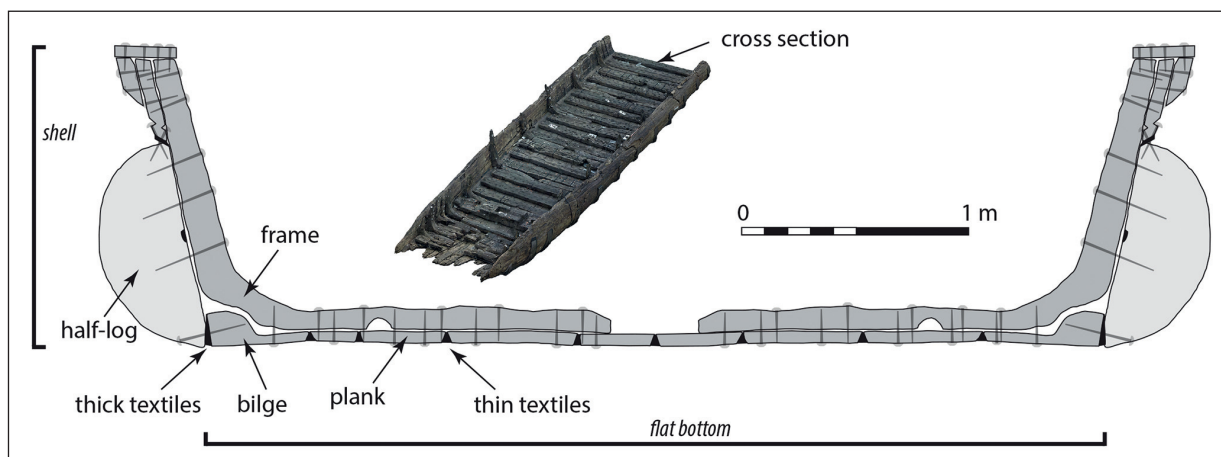


Fig. 4. Cutaway view of the barge with location of the different kind of waterproofing, because the space available is different from a location to another (M. Guyon, Inrap).

First, the fragments looked like pieces of wood but after a more detailed examination, textiles appeared. A new challenge arose regarding an appropriate unfolding technique: how can we answer historical questions with this new data?

Roman nautical textiles are quite rare artefacts and the previous studies were focused on the textile characteristics.³ Our aim is to link these textiles with the barge, to understand how the caulker did his job, and which techniques were employed.

Until now, caulking textiles were chemically unfolded by removing the pitch, to be handed over in a clean and flat state for archaeological study. Trials to follow the previous procedure led to the destruction of the samples because of the very dominant role of the pitch, which completely impregnated the textile. This unsatisfactory state led us to develop a new protocol which had to address first the connection between the material and the barge and, second how to record the unfolding operations, because each stage between start and completion is temporary and without any possible return. The functional specifications for this new protocol needed to be efficient and fast in order to limit the waste, the costs and the toxicity for the operator but also to respect the textile. Organic solvents damage fibers, which become more fragile once treated this way, resulting in tearing on the folds. The new protocol uses hot water for the pitch to become sufficiently plastic to allow the unfolding of the textile. With this technique, larger pieces of textile can be recovered and it demonstrates that previously the multiplication of fragments was certainly the result of the unfolding

technique. Observation of impregnated textiles is more difficult because pitch is not removed using the new method but this technique allows recording different type of information.

Recording of the different steps

In order to record the different steps of the protocol, several complementary techniques have been used. First, photogrammetry of the caulking material was carried out in order to keep a 3D record of how it was found originally, and to provide documentation for recording (Fig. 5). Then, a GoPro® film was made during unfolding, and a map of the different pieces of textiles was drawn. This was a transitional state where observations could be made.

This stage was also recorded, and a relief map was made, to understand how the textile was folded to be put between the planks (Fig. 6). The folds were still visible, and could be read by transferring the relief map into a monochrome picture. Using this technique, we compared the way the textiles from different spots were folded. We wanted to know if it was always made in the same way or not and, to understand the gestures of doing this task. Textiles used between the side and the flat bottom were often thicker, and their preparation looked rougher; the pieces used were less regular for this purpose than those between the flat bottom planks, where the border was torn. These little pieces presented reduced dimensions, to fit the space to be filled, in contrast to the space between the flat bottom and the side which is wider.

³ MÉDARD 2010; 2014.



Fig. 5. A 3D model is made from photogrammetry before beginning the unfolding operations (M. Guyon, Inrap).

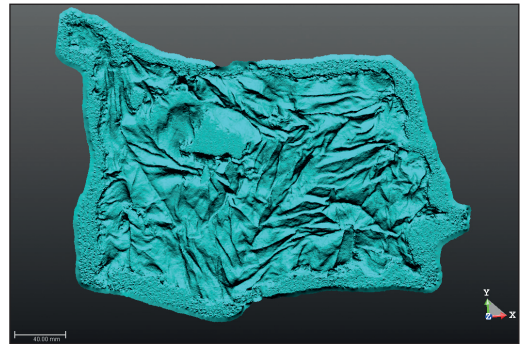


Fig. 6. Based on an ortho-projection, an image can be transferred into a soft allowing a monochrome view with a possibility to orientate the light in order to ease the reading of the folds (M. Guyon, Inrap).

All these textiles could give an exceptional amount of information on Roman techniques of caulking of course, but also on textiles in themselves. The way the caulker operated seemed to have been to make some strips by folding textiles, because we regularly found parallel longitudinal folds, and then spaced perpendicular marks. It looks like a caulking iron has been used, the way it is still used nowadays in traditional caulking, by forming a loop while inserting caulking material, the rest of it pushed inside afterwards to fill the remaining space. We already have more than three square meters of textile unfolded, coming from nearly six linear meters of material, and there are still 23 m waiting for to be investigated. There is a great potential here to make a reference set of Roman textiles. This is what is planned to be done shortly.

New finds for archaeology

Waterproofing technique

During the unfolding of the textiles, a clue appeared to identify the waterproofing technique used on the Lyon Saint-Georges 4 shipwreck. Usually, on the Rhône-Saône axis, luting is used between the 1st to the 3rd century AD. This technique applies the waterproofing material in the course of boat construction, before the addition of the next timber (Fig. 3). A very good example of this technique used with pitched textiles, as in Lyon Saint-Georges 4, was recorded on the Arles Rhône 3 shipwreck.⁴ According to Marlier, very important parts of the waterproofing material project inside the barge, mainly between the flat-bottom planks reaching 6.5 cm over the seal between the bilge and the

side. However, excess waterproofing material can regularly be observed inside the boat. A lining was put over which avoided the necessity to intervene with it. In Arles Rhône 3, the form of the seal was an inverted V with no projection, going from one side to the other on the edge. This can be explained by the luting technique used. Pitched textile was nailed during the construction, helping to keep it in place.

Arles Rhône 3 shipwreck can be compared to Lyon Saint-Georges 4 due to her characteristics, date (1st century AD) and location, where no excess of waterproofing material has been observed inside the shipwreck. The profile of the seals between the planks, in inverted Y, stops before reaching the over side. This means that waterproofing material cannot physically override the seal, because there is no possibility. Moreover, while unfolding pitched textiles, no lack of textile has been observed in the pieces located in the upper part of the seal, meaning that nothing was cut because it projected. Additionally, the projection at the bottom of the edge helps to keep the waterproofing material in place. All this led to the hypothesis of caulking instead of luting for this barge. This hypothesis was confirmed when we found an example from the space between the bilge and the side, a nail imprisoned in the pitched textile (another one has also been found, showing this was not a unique example), but did not get through (Fig. 7). The textile is wrapped around it, and the fact that textile is not pinned by the nail indicates that the waterproofing material was put down after the nailing. The textile does not reach the end of the gap, it was possible to observe it while dismantling, meaning that it has been put in position after assembly, and to complete it by making up for the lack of material was impossible. This shows that the

⁴ MARLIER 2014, 114.

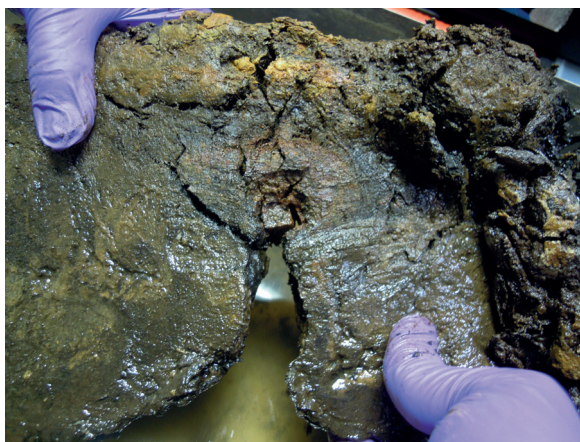


Fig. 7. Waterproofing material surrounds the nail (M. Guyon, Inrap).

waterproofing was done after the construction of the boat has been completed, and this is known as caulking.

Textiles discovered

Through a careful unfolding of the textiles, new perspectives and new data emerged. With nearly 3 m² of Roman textiles, the Lyon Saint-Georges 4 assemblage is currently one of the most numerous in Europe. Some vegetal fiber textiles are part of this material (linen has been identified through cross-section observation with an optical microscope on a sample of Calfat 54-7), but they represent a very small proportion of the discoveries, which are mainly of animal fiber (essentially sheep or goat, as it is very difficult to differentiate them without analysis). Among the vegetal fiber fragments, only two types of weave are present, tabby and twill, without any special weaving motives. The latter has been identified as a technical textile known in the third century AD as the foundation to which metal scales forming Roman armour were sewn (pers. comm. J.-P. Wild, about finds from Vindolanda). Our textiles are of course reused, and we tried to find some clue about their previous utilization or to understand if they were specifically chosen for this task.

The first step is the comparison between textiles recovered from different locations in the barge (Fig. 4). We have mainly material from the space between the bilge and the side, but also from between the planks, in

the crack due to the heart of the tree in the internal face of the sides, and from around the nails. First evidence is the match between the space and the thickness and the size of the textiles: the more space there is, the larger the textiles are. The thickest ones (3 threads/cm) are from the space near the bilge. Less coarse textiles are present throughout. The examination of the textiles from these different locations shows also that for the fissures between plank edges (due to the wood of the heart of the tree), both little pieces of textile in good condition and rags were used, certainly, because there was no direct contact with water.

Other textiles found in roman shiprecks

Nautical textiles from ancient shipwrecks have been found before. First, the textiles which coated hulls of shipwrecks at La Madrague de Giens from the first century BC⁵ and the boats of Nemi, from the first century AD,⁶ were both of wool, and for those from Nemi of a very high quality. Four samples were analyzed, and three of them showed selected constituting fibers, samples I and II between 20 and 24 microns, sample IV very regular with 16 microns, despite sample III, even with an average of 24 microns, shows a range from 16 to 60 microns. The three finest samples of Nemi (Technical data) showed a very high number of thread in weft, using a double-thread. For sample IV the thread count is 21/2x35 thread/cm (warp/weft). No thread diameter has been recorded in Nemi's articles, but looking in the textiles found in the Lyon Saint-Georges group and in Arles Rhône 3 allowed to recover one very similar: AR3 2011 #8 tissu 2 with 20/2x32 thread/cm (warp/weft) with thread diameter 0.2/0.2 mm (warp/weft).⁷ The threads from the six samples analyzed for Comacchio's wreck from the first century AD cannot be compared because they are too coarse and none of them presents a double weft-thread with high number.⁸ The finest one, sample 277 shows a thread count of 13/13 thread/cm (warp/weft) and thread diameter of 0.3/0.5 mm (warp/weft). The finest textiles are clearly standing out from the average for Nemi, Lyon Saint-Georges and Arles-Rhône 3, both through thread count and thread diameter. They represent nearly 20% from the whole collection of Lyon Saint-Georges first analysis on the six roman shipwrecks⁹, but also in the studied textiles from Arles-Rhône 3.¹⁰ These textiles are very rare for

⁵ TCHERNIA *et al.* 1978, 85. Unfortunately, no report of textile analysis is available nor samples any more, despite exchanges with archaeologists.

⁶ LEVI 1932; 1934.

⁷ MÉDARD 2014, 125.

⁸ CASTELLETTI *et al.* 1990.

⁹ MÉDARD 2009.

¹⁰ MÉDARD 2014, 125.

example in those found in Vindolanda, reserved for the garrison commandant and his family as luxury textile imported from Mediterranean area (pers. comm. J.-P. Wild). This cannot be a coincidence. Analysis are still on going and further results would be available while a PhD will connect all this. The Nemi fabrics were half-basket weave and were used between the planks of the hull and an external protective cladding of lead sheets. Their characteristics indicate a specific production and a very controlled quality. The question is to understand how high-quality textiles could have arrived there.

What textiles were present on board?

First is to assess the various textiles present on board: sails and tarpaulin were known, even if ancient texts are scarce about them, and they can be identified through iconography. In Maria C. Shaw and Anne P. Chapin article,¹¹ a catalogue of the various elements available, with sources and materials has been done. Time is earlier than roman era, but they link elements by comparison until nowadays because navigation is very conservative and most of the elements are still in use. They list cordage, essentially made from various vegetal fibers, sails that might have been reinforced to avoid tearing while using. Finally, they say “Cross-cultural comparison with reinforced woolen sails preserved in Scandinavian archaeological context suggests further that the cross-hatching on Aegean glyptic imagery may refer to woolen sails, which are more elastic than those made of linen.”¹² Other textiles were awnings/sunshades to protect high-ranking passengers from the sun. “Later in the Classical era, side screen made of linen and hair were standard issue on Athenian triremes in the 4th century BC, as evidenced by their being listed in naval inventory inscriptions”.¹³ Then it could have been possible between Aegean era and Viking time that some wool sails have been used, because cross-hatching is still visible on sails representations. At least Nemi and the Madrague de Giens prove wool textiles utilization in boat building. The belonging of these textiles to the nautical area can be understood through the excavations conducted by the Southampton University in the roman port of Quseir-Myos Hormos (Egypt),¹⁴ For Quseir, the amount of material (2.455 Roman textiles) and the location based on usage encouraged Handley to propose that textiles

were remaining in the place they were first used until eventual deposition, and that in a boat repair yard the cloth would come from a torn sail.¹⁵ From this observation, we can hypothesize that the textiles reused to waterproof the French roman barges of Lyon Saint-Georges, Arles-Rhône, Tolozan and Chalon-sur-Saône belong to the nautical field.

Textiles observation

Previous surveys by Médard on behalf of the Lyon Saint-Georges textiles¹⁶ provided valuable information on the technical part of the textiles used and their production, but made no real link with the nautical world. Médard’s knowledge of skills in garments and domestic fabrics allowed her to distinguish sewing remains of that type, but she could find none in the textiles of Arles-Rhône 3 or in the Lyon Saint-Georges’ group.

Another detail to be noticed is the impregnation of 45 textiles with ochre¹⁷ that cannot be dissolved with water or organic solvents (cleaning is still on-going, giving textiles in a soft way after pitch removal, and allowing to observe this particularity. After this operation, most of the textiles present this appearance, also visible in Fig. 8). This cannot be due to burial matrix, because the soil was sandy or from the storage lake, and because all the textiles would have been impregnated, and some of them are not. The presence of ochre could be interpreted in the light of nautical practices as a well-known technique recorded since antiquity: sails used to be



Fig. 8. Warp-faced tabby from Lyon Saint-Georges 4, comparable to the Nemi’s finest textile (L. Meunier, IFIRES).

¹¹ SHAW and CHAPIN 2016.

¹² *IBID.*, 153.

¹³ *IBID.*, 154.

¹⁴ HANDLEY 2011.

¹⁵ *IBID.*, 323.

¹⁶ MÉDARD 2010 ; 2014.

¹⁷ Ochre hasn’t been scientifically identified yet, but analysis are still on-going.

tanned to improve their technical performance and avoid rotting. This technique has been used successfully on the wool sails of the Skuldelev ships replicas,¹⁸ called “smörning”.¹⁹ The textile is put in a heated solution of seawater, grease and ochre, then rinsed in the sea and air-dried. Similar appearance can be observed in the Arles Rhône 3 collection. Further analysis to identify ochre and fat will allow to confirm this hypothesis.

Conclusions

This work showed how conservator’s know-how can shed new lights on material and complement knowledge of artifacts. Ancient repairs are small, but can provide a lot of information on a ship’s maintenance during her employment. For textiles, the conservation process is facilitating the recovery of information about textiles used to waterproof barges on the Rhône. They surely come from a shipyard context even if additional research still has to be conducted. Textiles belong to the technical part of the boat building, and they provide important information about their use in this task, but they were also part of the nautical world, and this aspect is still to be explored.

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Bibliography

AYALA *et al.* (2005): G. Ayala, M. Guyon and F. Laurent, “Lyon Saint-Georges (France): la fouille d’une berge de Saône”, in H. Stoepker (ed.), *Archaeological Heritage Management in riverine landscapes* (Rapportage Archeologische Monumentenzorg 126), Amersfoort, 89-94.

CASTELLETTI *et al.* (1990): L. Castelletti, A. Maspero, S. Motella and M. Rottoli, “Analisi tecnologiche dei tessuti”, in F.

Bert (ed.), *Fortuna Maris, la nave romana di Commachio*, Bologna, 157-160.

COOKE *et al.* (2002): B. Cooke, C. Christiansen and L. Hammarlund, “Viking woolen square-sails and fabric cover factor”, *IJNA* 31.2, 202-210.

GUYON (2010): M. Guyon, “Les épaves”, in E. Rieth (dir.), *Les épaves de Saint-Georges. Lyon. I^{er} – XVIII^e siècles* (Archaeonautica 16), Paris, 48-96.

HANDLEY (2011): F.J.L. Handley, “Textiles: a preliminary report”, in D. Peacock and L. Blue (eds.), *Myos Hormos – Quseir-al-Qadim, Roman and Islamic Ports on the Red Sea, vol. 2: Finds from the excavations 1999-2003*, Southampton, 321-334.

LEVI (1932): C. Levi, “I tessuti recuperati sulle navi di Nemi”, *Bollettino della laniera* 46.3, 156-158.

LEVI (1934): C. Levi, “Tessuti di rivestimento della seconda nave di Nemi”, *Bollettino tecnico della Regia Stazione Sperimentale per l’Industria della Carta e delle Fibre Tessili Vegetali*, aprile 1934, 242-243.

MARLIER (2014): S. Marlier, *Arles-Rhône 3, un chaland gallo-romain du I^{er} siècle après Jésus-Christ* (Archaeonautica 18), Paris.

MÉDARD (2009): F. Médard, *Les tissus du Parc Saint-Georges (Lyon, 5^e arrondissement) I-III^e siècles de notre ère* (Unpublished report), Lyon.

MÉDARD (2010): F. Médard, “Les tissus associés à la construction des chalands gallo-romains du Parc Saint-Georges (Lyon), I^{er} – III^e siècles ap. J.-C”, in E. Rieth (dir.), *Les épaves de Saint-Georges. Lyon – I^{er}-XVIII^e siècles* (Archaeonautica 16), Paris, 136-146.

MÉDARD (2014): F. Médard, “Les tissus associés à la construction du chaland Arles-Rhône 3: qualité et gestion de la matière première”, in S. Marlier (dir.), *Arles-Rhône 3, un chaland gallo-romain du I^{er} siècle après Jésus-Christ* (Archaeonautica 18), Paris, 116-125.

RIETH (2010a): E. Rieth, “Archéologie de la batellerie gallo-romaine et architecture ‘sur sole’”, in E. Rieth (dir.), *Les épaves de Saint-Georges. Lyon. I^{er} – XVIII^e siècles* (Archaeonautica 16), Paris, 35-47.

RIETH (2010b): E. Rieth, “Les épaves du Parc Saint-Georges : une variante régionale de l’architecture ‘sur sole’”, in E. Rieth (dir.), *Les épaves de Saint-Georges. Lyon. I^{er} – XVIII^e siècles* (Archaeonautica 16), Paris, 98-103.

SHAW and CHAPIN (2016): M.C. Shaw and A.P. Chapin, “Sailing the Shining Sea: Maritime Textiles of the Bronze Age Aegean”, *Woven threads, Patterned Textiles of the Aegean Bronze Age*, Oxford, 149-181.

TCHERNIA *et al.* (1978): A. Tchernia, P. Pomey and A. Hesnard, *L’épave romaine de la Madrague de Giens (Var). Fouilles de l’Institut d’archéologie méditerranéenne* (Supplément à Gallia 34), Paris.

¹⁸ COOKE *et al.* 2002.

¹⁹ IBID., 208-209.

Table 1. Technical data of textiles coming from different ships: Arles-Rhône 3 shipwreck (AR3) (1st century AD) data come from MÉDARD 2014, 124-125; Comacchio (1st century BC) data come from CASTELLETTI *et al.* 1990, 160; Lyon Saint-Georges 2 (LSG2) (3rd century AD), Lyon Saint-Georges 3 (LSG3) (2nd century AD), Lyon Saint-Georges 4 (LSG4) (2nd century AD) excluding LSG4 Calfat 10, Lyon Saint-Georges 7 (LSG7) (3rd century AD) and Lyon Saint-Georges 8 (LSG8) (1st century AD) data come from MÉDARD 2009, 44-45; LSG4 Calfat 10 come from a survey conducted by F. Médard in 2017, unpublished; Nemi (1st century AD) data come from LEVI 1934, 243.

Name	Thread count warp/cm	Thread count double warp/cm	Thread count weft/cm	Thread count double weft/cm	Thread count triple weft/cm	Diameter warp thread (mm)	Diameter weft thread (mm)	Warp spin	Weft spin	Pattern
AR3 2001 #8 tissu 3	12		24			0,2	0,5	z	z	tabby
AR3 2006 #8 tissu 1	7 to 8		7 to 8			0,7-0,9	0,7-0,9	z	z	tabby
AR3 2006 #8 tissu 10	12		50			0,2-0,3	0,2-0,3	z	z	tabby
AR3 2006 #8 tissu 2	10 to 12		10 to 12			0,5-0,7	0,5-0,7	z	z	tabby
AR3 2006 #8 tissu 3	16		8			0,8	0,5	S2z	z	tabby
AR3 2006 #8 tissu 4	26		14			0,8	0,5	S2z	z	tabby
AR3 2006 #8 tissu 5	30		10			0,5	0,5	z	z	tabby
AR3 2006 #8 tissu 6	10		10			0,6-0,8	0,6-0,8	z	z	twill
AR3 2006 #8 tissu 7	16			65		0,2-0,3	0,2-0,3	z	z	basket weave
AR3 2006 #8 tissu 8		18	10			0,3-0,4	0,3-0,4	z	z	basket weave
AR3 2006 #8 tissu 9	6		6			1	1	z	z	twill
AR3 2007 #14	30		12			0,3-0,4	0,3-0,4	z	z	tabby
AR3 2009 #22 tissu 1	21		10			0,5-0,6	0,5-0,6	z	z	tabby
AR3 2009 #22 tissu 2	10		10			0,5-0,6	0,5-0,6	z	s	tabby
AR3 2011 #12	4 to 6		4 to 6			2	2	z	z	twill
AR3 2011 #22 tissu 1	10		10			0,6-0,7	0,6-0,7	z	z	diamond twill
AR3 2011 #22 tissu 2	8			11		0,2-0,4	0,5	z	z	basket weave
AR3 2011 #6 tissu 1	20-22		10 to 11			0,8-0,9	0,3-0,4	z	z	tabby
AR3 2011 #6 tissu 2	10			24		0,3	0,3			basket weave
AR3 2011 #6 tissu 3	30		30			0,3	0,3	z	z	twill
AR3 2011 #6 tissu 4	22		5			0,8-0,9	0,3-0,4	z	z	tabby
AR3 2011 #6 tissu 5	16			17		0,2	0,4			basket weave
AR3 2011 #6 tissu 6	16		25-26			0,2	0,5	z	z	tabby
AR3 2011 #6 tissu 7	9 to 10			17		0,2	0,2-0,5	z	z	basket weave
AR3 2011 #6 tissu 8	7 to 8		20-22			0,1-0,2	0,5	z	z	tabby
AR3 2011 #7 tissu 1	32		15			0,3	0,3	z	z	tabby
AR3 2011 #7 tissu 2	25		10			0,4-0,5	0,2-0,3	z	z	tabby
AR3 2011 #7 tissu 3	10 to 12		15			0,5-0,7	0,5-0,7	z	z	twill
AR3 2011 #7 tissu 4	8		8			1	1	z	z	twill
AR3 2011 #7 tissu 5	17			15		0,2	0,2			basket weave
AR3 2011 #7 tissu 6	12			30		0,1-0,2	0,1-0,2			basket weave
AR3 2011 #8 tissu 1	12		12			0,8	0,8	z	z	twill
AR3 2011 #8 tissu 2	20			32		0,2	0,2			basket weave
AR3 2011 #8 tissu 4	18		10			0,4-0,5	0,3 et 0,6	z	z	tabby
AR3 2011 #8 tissu 5	10		34			0,3	0,4	z	z	tabby
AR3 2011 #8 tissu 6	18			10		0,2	0,2-0,3	z	z	twill
AR3 2011 #8 tissu 7	10		27-28			0,8 and 0,5	0,2	z and S2z	z	twill
Comacchio 274	6		8			1	1	z	z	tabby
Comacchio 276	12		12			0,5	0,5	z	z	tabby
Comacchio 277	13		13			0,3	0,5	z	z	tabby
Comacchio ALS	6		6			0,5-1,8	0,5-1,8	z	z	tabby
LSG2 tissu 25	6		6			1	1	z	z	twill
LSG2 tissu 26	23			20		0,3	0,4	z	z	basket weave

Name	Thread count warp/ cm	Thread count double warp/ cm	Thread count weft/ cm	Thread count double weft/ cm	Thread count triple weft/ cm	Diameter warp thread (mm)	Diameter weft thread (mm)	Warp spin	Weft spin	Pattern
LSG2 tissu 27	24-28		10 to 12			0,6	0,4	z	z	tabby
LSG2 tissu 28	7				16	0,4	0,4	S2z	Z	tabby
LSG2 tissu 29	16			16		0,3	0,4	z	z	basket weave
LSG2 tissu 30	16		90-110			0,2	0,1	z	z	tabby
LSG2 tissu 31	20			60		0,1	0,3	z	z	basket weave
LSG2 tissu 32	12			8		0,5	0,5	z	z	basket weave
LSG2 tissu 33	10			10		0,3	0,4	z	z	basket weave
LSG3 tissu 10	25		8			0,5	0,3	z	z	tabby
LSG3 tissu 11	15			20		0,4	0,2	z	z	basket weave
LSG3 tissu 40	10			24		0,4	0,2	z	z	basket weave
LSG3 tissu 41		13		27		0,2	0,3	z	z	basket weave
LSG3 tissu 42	14		14			0,9	0,9	s	z	twill
LSG4 Calfat 10-1	11 to 12		6			0,8	1-1,2	z	z	tabby
LSG4 Calfat 10-10	10		10			0,8-1	0,8-1	z	z	tabby
LSG4 Calfat 10-2	7		11			0,6-0,8	0,6-0,8	z	s and z	tabby
LSG4 Calfat 10-3	12		6			0,5-0,6	1	z	z	tabby
LSG4 Calfat 10-4	11 to 12		11 to 12			0,8-1	0,8-1	z	s	diamond twill
LSG4 Calfat 10-5		12	30			0,3	0,7-0,8	z	z	basket weave
LSG4 Calfat 10-7	10		10			0,8-1	0,8-1	z	z	twill
LSG4 Calfat 10-8		11	20			0,4	0,8	z	z	basket weave
LSG4 Calfat 10-9	10 to 11		10 to 11			0,8-1	0,8	z	z	tabby
LSG4 Calfat 10-6	12		12			0,5	0,5	z	z	tabby
LSG4 tissu 19	5			5		1	1	S2z	z	basket weave
LSG4 tissu 43	5		5			2	2,1	z	z	twill
LSG4 tissu 44	8			8		0,5	0,3	z	z	basket weave
LSG4 tissu 45	8 to 10			32-36		0,4	0,4	z	z	basket weave
LSG4 tissu 46	11		14			0,6	0,5	z	z	twill
LSG4 tissu 49	10		11			0,7	0,4	z	z	tabby
LSG4 tissu 50	6 to 8		6 to 8			1,3	1,3	z	z	twill
LSG4 tissu 51	10		10			0,6	0,6	z	z	tabby
LSG4 tissu 52	14			17		0,6	0,4	z	z	basket weave
LSG7 tissu 1	16			8		0,4	0,5	z	z	basket weave
LSG7 tissu 2	4		4			2,3	2,3	z	z	twill
LSG7 tissu 3	24		8			0,7	0,5	z	z	tabby
LSG7 tissu 34	6		6			1,5	1,5	z	z	tabby
LSG7 tissu 35	9		14			0,7	0,9	z	z	tabby
LSG7 tissu 36	14		14			0,5	0,5	s	z	twill
LSG8 tissu 12	17		8			0,4	0,4	z	z	tabby
LSG8 tissu 14	12		22			0,4	0,5	z	z	tabby
LSG8 tissu 17	10 to 12		13-16			0,3	0,8	z	z	tabby
LSG8 tissu 23	12		10 to 11			0,6	0,6	z	s	twill
LSG8 tissu 24	14-18		11			1	0,5	z	z	tabby
LSG8 tissu 38	6		6			1,5	1	z	z	twill
LSG8 tissu 4	10		10			0,5	0,5	z	s	tabby
LSG8 tissu 5	24		8			0,5	0,5	z	z	tabby
LSG8 tissu 7	13		13			0,6	0,5	z	s/z	tabby
LSG8 tissu 9	10			16		0,4	0,4	z	z	basket weave
Nemi I	13			15						basket weave
Nemi II	16			25						basket weave
Nemi IV	21			35						basket weave