



Why  
Leather?

The material and cultural  
dimensions of leather

edited by

Susanna Harris

& André J. Veldmeijer



*This is a digital offprint from:*

Harris, S. & A.J. Veldmeijer (eds) 2014: *Why Leather? The Material and Cultural Dimensions of Leather*. Leiden: Sidestone Press.



# Sidestone Press

*A new generation of Publishing*

**This is a free offprint, read the entire book at the Sidestone e-library!**

You can find the full version of this book at the Sidestone e-library. Here most of our publications are fully accessible for free. For access to more free books visit:

[www.sidestone.com/library](http://www.sidestone.com/library)

## **Download Full PDF**

Visit the Sidestone e-library to download most of our e-books for only € 4,50. For this minimal fee you will receive a fully functional PDF and by doing so, you help to keep our library running.

[www.sidestone.com/library](http://www.sidestone.com/library)



# Contents

<b>Preface</b>	<b>3</b>
<b>About the Authors</b>	<b>5</b>
<b>Introduction. Leather in archaeology: between material properties, materiality and technological choices</b> Susanna Harris	<b>9</b>
<b>Skin deep: an outline of the structure of different skins and how it influences behaviour in use. A practitioner's guide</b> Amanda Michel	<b>23</b>
<b><i>Cuir bouilli</i> armour</b> Eddie Cheshire	<b>41</b>
<b>Bespoke vellum: some unusual requests</b> Laura Youngson Coll	<b>77</b>
<b>Leather in the textile industry. A memoir</b> Alan S. Raistrick	<b>95</b>
<b>Why Leather in ancient Egyptian chariots?</b> André J. Veldmeijer & Salima Ikram	<b>115</b>
<b>Why wineskins? The exploration of a relationship between wine and skin containers</b> Barbara Wills & Amanda Watts	<b>123</b>

# Introduction

## Leather in archaeology: between material properties, materiality and technological choices

*Susanna Harris*

### **Why leather?**

The study of leather is a specialist field in archaeology, yet focuses on one of the major materials in the past, the use of which continues into the present. The common occurrence of these animal skin products through time, whether tanned leather, parchment, vellum, oil or fat cured skins or rawhide attest to the enduring utility and desirability of animal skins as a material. Traditionally, these products have all been grouped together as leather (Hodges 1995, 151), although their fundamental differences are increasingly recognised and published in the archaeological literature (Thomson 2006a, 1-3). For those without a specialist interest in leather it is easy to overlook the variability of products among this group of materials and to lose sight of the specific reasons behind the choice of leather in particular situations and according to different cultural and temporal contexts. In this volume, the authors address the question ‘Why leather?’ through investigating the nature of animal skins, the behaviour of skins and leather in use and the network of decisions made by the makers, designers and users in bringing raw materials to a finished object and its place in the social fabric of life. The authors also address why leather works in certain situations, and indeed sometimes why other materials were and are chosen in preference to leather. The response to such questions is not only addressed through the properties of materials, but also how leather, like all materials, is viewed with the dimensions of culture and beliefs which surround it. The aim of this introduction is to place the conference theme and chapters herein within the field of leather in archaeology and current issues surrounding the study of materials in the past. This volume benefits from the insights of archaeologists and authors from other professions, whose specialist knowledge provides the archaeologists with a new perspective of seeing their topic.

## Skins to leather

An animal skin, left without treatment for several days, will quickly decay. A simple intervention of removing the subcutaneous fatty layer and drying will reduce the action of harmful bacterial and slow down the rate of decay. It is only through a more lengthy process that animal skins are cured, tanned or dressed to create a stable product (see Hodges 1995, 148-52; Reed 1972, 46-86; Sharpshouse 1983). These processes lead to different products. In English the word 'leather' is used to refer to a wide range of animal skins products, indeed it is used in this manner in the question 'Why leather?'. Technically, however, leather should only refer to animal skins which have been "rendered non-putrescible under warm moist conditions" (Thomson 2006a, 3). Parchment and vellum<sup>1</sup>, for example, are stretched and dried skins which are unstable under warm, moist conditions. Buckskin refers to fat cured skins of variable stability, while true leather processed by vegetable, chrome or other tanning techniques is what we are most familiar with in our shoes and handbags (for details see Thomson 2006a, 2). Such classification and English language terminology reflects differences in raw material, process and product; no doubt all leather producing peoples had their own language to distinguish different animal skin products.

The enduring presence of leather may be attributed to its properties as a strong, flexible, sheet material and its ready availability in cultures where animals are slaughtered for meat. Yet, the finished product depends greatly on the nature of the raw material and the way it is processed. Leather can be soft and supple like a textile, firm and rigid like a basket, or hard and watertight like a pot or gourd. The varied properties of leather are in part due to the chemical and physical composition of animal skins (Haines 2006a), the species or breed from which it originates (Haines 2006b, 12-19), and the method with which it was treated (Covington 2006; Thomson 2006a). For the tanner, an understanding of the way animal skins transform during processing allows them to create a particular material. For the craftsperson, an understanding of leather as a material allows them to create and innovate according to the desires of the designer and consumer. To the consumer, a particular material may be desirable due to its practicality, aesthetic, novelty or availability.

Yet, a utilitarian or functional approach to material properties requires careful questioning; in a world of technological and material choices, archaeological theorists recognise that people appropriate materials according to their suitability on many levels (Sillar & Tite 2000, 3-9). The separation of materials into functional or symbolic is criticised as a simplistic and unhelpful dichotomy (Meskell 2005, 2). In recent years, it has been proposed that mind, agency and matter are co-dependent and come together in the object (Knappett 2005, 85). Accordingly, we should no more prioritise the empirical analysis of material properties, than the meaning of leather as the essence of creativity and human agency, but see these as integrated aspects surrounding the very actions and choices of making and using materials in daily life.

---

1 Parchment is made from sheep or goat skin, whereas vellum is made from calf.

In this volume the chapters follow a range of perspectives within this sphere; however, the extremes of either approach are tempered by the recognition of the relationship between the material and cultural dimensions of leather. The authors show why some leathers work and are perceived to work in certain situations, and why these materials are chosen over other materials, or other types of leather. In several chapters the approach is very much centred on the internal dynamic of the material. Amanda Michel demonstrates how the structure of skins, as viewed microscopically, influences the behaviour of skins and certain species of skins in use, while Alan Raistrick provides an account of the leathers with specific performance characteristics (thickness, smoothness, grip, strength) for use in nineteenth and twentieth-century textile machinery. Here, it was not only species (cow, goat) that mattered, but also the age, breed, climate and way the animals were cared for.

Yet even among such materials based selection, the authors recognise a more holistic approach to leather. Michel has to understand the consumer's perception of the final product, while Raistrick notes what he calls a 'Samson Complex', as the customer believed (wrongly, in Raistrick's opinion) that hair-on leather bands were stronger. Similarly, there were requests for coloured leathers in textile machinery, which again in Raistrick's opinion were more to do with a memory of the efficacy of former coloured leather, than actual performance. By contrast, leather craft practitioner Laura Youngson Coll points out the discrepancy between design brief and materials, where specialist leathers are proposed and used for purposes that are not necessarily suitable for those materials: leather floors in stores where women wear stiletto heels or leather covered plant pots. Here, factors other than utilitarian properties are leading the selection of material. These points show the complex relationship between mind, agency and matter which is found in the selection of materials and not readily explained by a strict empirical approach.

## **Leather in archaeology**

In archaeology, the answer to the question 'Why leather?' is complicated by the poor survival of leather and other skin based products and the difficulty of identifying their origin and the way they were processed. When leather is preserved, its contact with the preservation environment often means it has undergone chemical and physical transformations. These changes may hinder the identification of the animal species from which skins originate, and make it difficult to determine the method by which the animal skin was processed. Species identification by microscopic techniques depends on the preservation of morphological features of the skin or hair, which may be seriously degraded (Appleyard 1978; Leather Conservation Centre 1981; Teerink 1991; Wildman 1954). When preservation of sufficient molecular structure allows, DNA or protein mass spectrometry techniques (also referred to as ZooMS, collagen or peptide fingerprint, protein sequencing) offer new means of species identification (Collins *et al.* 2010; Hollemeyer *et al.* 2012; Schlumbaum *et al.* 2010). In terms of archaeological evidence, leather processing may be detected through the preservation of associated tools (for example, Thomson & Mould 2011; Mould *et al.* 2003; Ottaway & Morris 2003; Raedler



2007; Schwarz 2002), evidence of the substances applied to skins (Rifkin 2011), and chemical or biological analysis of organic residues remaining within the leather itself (Driel-Murray 2002; Falcão & Araújo 2011; Groenman-Van Waateringe *et al.* 1999, 886-890; Thomson 2006b, 58-59). Archaeologists must draw on as many lines of evidence as possible to build up an understanding of leather in the past.

Poor preservation contrasts with the notion that leather is thought to have been a common material in the past. Since humans migrated to the northern hemisphere, it has been assumed they wore skins to protect themselves from the cold, an assumption supported by the ubiquity of stone scrapers, cut marks on animal bones associated with skinning in the Palaeolithic (Charles 1997) and the early presence of lice whose habitat is clothing worn by humans (Toups *et al.* 2011). In Europe and the Mediterranean it is only from the Roman period onwards that leather becomes more common in archaeological excavations, most likely due to the method of processing leather by vegetable tanning (Driel-Murray 2000, 305; Groenman-Van Waateringe *et al.* 1999, 885-886, 889-890). In some Medieval and Post-Medieval urban centres with waterlogged deposits, leather finds are sufficiently common that all but the most exceptional leather small finds are classified as a bulk (Grey 2006, 28). In this volume André Veldmeijer and Salima Ikram present the remarkable remains of the only known complete example of the leather casing, harnessing and related leather equipment of a New Kingdom Egyptian chariot, preserved for over 3000 years in the dry environment of Egypt. Through comparison with surviving wooden chariots, they are able to draw conclusions about physical and aesthetic properties of the chariot materials, for chariots that were used either in lavish processions or in the fast paced heat of battle. Where leather is not preserved, archaeologists work with other sources of evidence. Using written, pictorial and artefactual sources, Barbara Wills and Amanda Watts investigate early evidence for wineskins in the Mediterranean and consider this in relation to historical knowledge of wine transported in wineskins via mule trains. From this evidence they are able to build up a vivid picture of the qualities of the wineskins, the taste the skins imparted to the wine, the riotous feasting and drinking, along with godly behaviour that was related to wineskins. In these chapters the authors addresses the question ‘Why leather?’ from the perspective of materials integrated into daily life with its varied complexity.

## **Assessing materials**

There are several routes available to the archaeologist to understand how materials, such as leather, may have performed in use. One route is the chemical and physical testing of raw materials (animal skins) or its processed form (leather and other skin products); these methods are based in the natural sciences. The other route is the comparison of contemporary or historically known leather types and leather objects with those under investigation, on the assumption that past materials performed in similar ways. The comparative approach uses sources from experiment and design,



ethnography and history. The natural sciences and comparative approaches may be used singularly or in combination, and these different methods can be directed towards understanding diverse aspects of leather.

As introduced above, Michel uses her extensive knowledge of the microscopy of animal skins gained through working in the leather industry to evaluate how the structure of animal skins influences the behaviour of leather in use. She demonstrates the complex interplay between the role of collagen fibre bundles (animal proteins), the structure of the skin according to the area of the hide, and the influence of species. Taking the butt area of the animal, for example, we learn that its compact structure means it is one of the strongest areas of a hide, in comparison to the belly which is stretchy, or the neck area, which is thick but wrinkly. If we then take into consideration species, we are able to understand that wool sheepskins are prone to splitting due to the presence of a layer of fat cells, unlike goat and cattle skins.

Eddie Cheshire uses quantitative tests to assess the efficacy of different recipes for *cuir bouilli* against arrow penetration. According to medieval literature, this form of leather was used to make armour. By their nature, such tests isolate specific features – in this case the extent to which an arrow can penetrate through the armour into the wearer’s flesh beneath. As ancient leather is rarely preserved and, when it is, the leather is degraded, fragile and no-longer retains its original qualities, the tests are carried out on modern leather. In this case, the leather was made according to recipes and techniques Cheshire deemed likely for the period. The tests presented are useful in that they provide quantitative results, and hence allow the comparison of specific performance characteristics across different materials or versions of similar materials. Cheshire tests a range of possible recipes by which *cuir bouilli* may have been prepared for use in armour. His results suggest that the *cuir bouilli* was most likely not boiled leather, as previously believed, but boiled rawhide, which was potentially improved by the addition of an applied, hard surface.

Leather is not only renowned for its physical and chemical properties, it also has aesthetic appeal. Recently archaeologists have been increasingly interested in the aesthetic or visual qualities of materials, situated more widely in a full sensory engagement. This sensory approach to materials recognises that people engage with materials primarily through their bodily senses such as touch, sight, sound, taste and smell (for example Delong *et al.* 2012; Edwards *et al.* 2006). A sensory approach to materials has a small but growing appreciation in archaeology (Hurcombe 2007; MacGregor 1999), including experiments on leathers and furs (Harris 2014). In this volume, Youngson Coll shows the attention that craft workers pay to the sensory nature of leather. For example, as a wall-covering material vellum is appreciated for its smoothness to the touch, while visually it is appreciated for its translucency and texture created by the pattern of hair follicles. The skin of the stingray, referred to as ‘shagreen’, is appreciated for the opulent, glossy surface created by the polished, calcified papillae within the structure of the leather, which can be dyed any colour according to the demands of fashion.

Historical, ethnographic and experimental accounts of leather craft and industry provide a rich resource for archaeologists to investigate the varied ways skins are or were processed, and how the qualities of such materials can be understood through their application and use (some of many sources: Angus 2002; Douglas 1956; Kellogg 1984; Klokkernes 2007; Mason 1891; Oakes & Riewe 1996; Paine 1994, 19-20, 30-41; Rahme & Hartman 2001; Richards 2004; Wilder 1976). Such accounts also provide examples of the way materials and objects are integrated into society, through the organisation of production, the relationship between humans and animals, variations in process and the way the resulting materials are used in specific circumstances. There is much to learn, for example, from accounts of the north European skin working traditions, where women selected the area of hide in combination with the processing method to make shoes that protect feet from either the wet of autumn or the cold of winter (Brandon-Cox 1969, 124) and which were also a source of pride to their wearers. In this volume, Wills and Watts use historical observations of the transportation of wine in pitch-lined goatskins from nineteenth-century Cyprus to understand how the flavour of wine was tainted through this means of transport. Although an exact comparison cannot be made, it does provide information that would be unlikely to be considered without reference to such sources.

## **Materials and materiality**

Materials have long been the focus of archaeologists' theories of the past. However, whereas Thomsen's Three Age System (Stone Age, Bronze Age, Iron Age) was developed to classify artefact collections, and empirical approaches attempt to attach fixed lists of properties to materials, current theories seek to understand the complex interplay between artefacts and the human agent. A recent approach has been to consider objects and materials from the perspective of materiality. Dictionary definitions of materiality focus on the physical qualities or characteristics of the material. This is the way it tends to be used by artists and craftspeople, as for example Youngson Coll who refers to the materiality of leather in terms of her understanding of the way it can be worked. However, the discussion of materiality in archaeology focuses on the relationship between people and things (DeMarrais *et al.* 2004, 2; Meskell 2005, 2, 4). Materiality, as such, emphasises the importance of the relationship between people, objects and materials.

Materiality has proved rather a nebulous concept. To some, it is explained as "how the very material character of the world around us is appropriated by humanity", whereby material culture shapes human lives and relationships (Graves-Brown 2000, 1). To others, this process is expressed as a mutual relationship; materials are shaped by humans, humans are shaped by materials and hence are part of a material world which cannot be separated from social practices, as both bring each other into existence (Jones 2004, 330). From another perspective materiality encompasses the ideas embedded in an object in specific contexts. Here materiality is to materials what gender is to sex; in other words a social construct grounded in a body or object (Hurcombe 2007, 537). Although there are many

approaches to materiality in archaeology, the broad underlying theme is the desire to address the interrelationship between the physical materials (their qualities and properties), the perception, use and appropriation of materials, and how these are part of historically situated human lives. These approaches specifically seek to reject what is seen as a false dichotomy between objects as either highly symbolic or purely functional (Meskell 2005, 2). For some scholars, materiality stands in contrast to a materialist approach which places more emphasis on the significance of material properties and material attributes. However, this is distinct from a strictly empirical approach, as materialist approaches recognise that material properties are not fixed so much as relational and processual, as materials are embedded within histories and the 'currents of the lifeworld' and therefore vary according to situation (Ingold 2007, 1-3, 9) (for position papers see Ingold 2007; 2012; Jones 2004; Tilley 2007).

This makes generalisations about material problematic. On the one hand, archaeologists seek to identify materials, such as leather, and processes, such as tanning, in a highly empirical manner to allow them to draw generalisations about material properties and use. On the other hand, the common occurrence of leather or a certain type of leather, does not mean that it fulfilled the same role, was associated with the same ideas, or shared all perceived qualities in all times and places, by all people. Indeed, the rejection of leather and furs by certain sectors of the population over the last few decades attests to the complex interplay of motivations and emotions surrounding materials (for example, Harper 2008). Youngson Coll addresses leather from several of these perspectives. In the world of interior design there are discernible fashions in materials; the showy opulence of vellum and shagreen is highly desirable to some clients at the time of writing. Such issues are complicated by concern for animal welfare and environmental issues: the sudden demand for shagreen skins means that many skins come from fish of unknown origin, causing concern as to whether they have been farmed from sustainable sources, or if the product's sudden popularity risks decimating stingray populations. Far from being peripheral to the archaeologist's understanding of materials, such emotive debates highlight the complexity of the way people appropriate materials. This may be particularly true of leather, which often retains such a visual reminder of its animal origins.

## **Technological choices**

As the modern materials science and engineering industry has often found to its cost, it is not enough to produce innovative materials with superlative properties and performance and expect them to be adopted for use; people are surprisingly dismissive of unfamiliar materials (National Research Council (US) 1999, ix-x). The means by which people accept and use materials is a complex and multifaceted web of properties, values, aesthetics and emotions. The appropriation of materials in a particular time and place is not only a matter of assessing the finished product, but also the technology of sourcing raw materials and techniques of production. This contextual interplay between production, properties, performance,



distribution, appropriation and use is encapsulated in the theory of ‘technological choices’ (Lemonnier 1993; Sillar & Tite 2000, 6, fig.1). This approach recognises technology as a social construct, which is embedded in the perceptions and beliefs of local populations. It centres round the observation that there are many ways to achieve a technological goal, whether to spin thread, build a chariot or cover a table. The way which it is done, is a means by which archaeologists can understand that society.

An investigation of technological choices, achieved through the method of identifying the *chaîne opératoire* (operational sequence) is a way to question why certain technologies become the accepted approach. At first glance these may appear determined by material constraints while technical processes may be primarily seen as manipulating the material, but if one investigates a little deeper, material constraints emerge as just one aspect of the many contributing factors to how and why people go about producing and using whatever they do (Sillar & Tite 2000, 3). From this stance, we are encouraged to question the choices made at each stage of the *chaîne opératoire* in the production of an object. We may question; why this raw material, these tools, in this place, this crafts person, these techniques or this sequence of actions (Sillar & Tite 2000, 4)? Through being encouraged to answer these questions we can recognise the multiple influences on the maker and recognise not only a process of material transformation from skins to leather and leather to object, but that the maker is informed in these choices through his or her wider cultural beliefs and expectations. From Raistrick’s leather sourced from the well cared-for Swiss cattle used to make textile machinery to spin thread for cloth, to Youngson Coll’s opulent shagreen table top, to the leather chariot that drove a pharaoh into battle as described by Veldmeijer and Ikram, we see that the use of leather is deeply embedded not only in the capability of leather to perform these tasks, but also in the complex wants, ambitions and desires of people past and present and their ability to achieve them.

## **The authors and chapters**

The authors in this volume address the question ‘Why leather?’ from their own specialist perspective. In the first two chapters, Amanda Michel and Eddie Cheshire present different approaches to identifying the material properties of specific leathers. In Michel’s case, she uses her experience of microscopy in the contemporary leather industry to show how goat, sheep and cattle skins can be examined to predict how they behave in use. Cheshire uses his skills in mechanical and production engineering examining composite materials to test various methods of processing leather against the impact of ballistics. Through their different approaches these authors provide an understanding of the material properties of the raw materials for leather, then highlight the significance of processing skins into leather to create very different finished leathers. The next two authors, Laura Youngson Coll and Alan Raistrick are both directly involved with using leather to make products. Youngson Coll is a fine artist who is skilled in the traditional craft practice of bookbinding and leatherwork. Her chapter shows how a crafts person

approaches leather commissions in a practical sense, as part of a collaborative design and craft team and then reflects on the role of such objects in contemporary society both in terms of ethics and status. Raistrick's chemistry background and family heritage in tanning, making leathers for the machinery used in the textile industry, show the great specificity and control over the tanning process and selection of raw materials that was required to gain exactly the right performance characteristics for each of the leather components.

The final two chapters by Barbara Wills working with Amanda Watts, and André Veldmeijer writing with Salima Ikram, provide the archaeological view. In these, the authors are working with archaeological evidence of leather objects, and building a comprehension of leather materials as a means to understand the role of leather in the societies under investigation. Wills and Watts are working predominantly with written and pictorial sources of wineskins in the Mediterranean, which are further elucidated using historical knowledge of the wineskin trade and the science of the contemporary wine industry. Veldmeijer and Ikram investigate the remarkably preserved leather remains of an ancient Egyptian chariot, and compare the dynamics of such a model with wooden examples as a way to understand the relationship of technique, materials and use. The eight authors possess a remarkable range of skills and perspectives, which together provide an innovative answer to the research question set for the conference. These feed into a wider current interest in archaeology to understand materials such as leather in the past.

## Acknowledgements

With thanks to Roy Thomson and Ruth Whitehouse for their advice on an earlier draft of the introduction. Their knowledgeable comments sharpened the text, for which I am very grateful. I am indebted to the British Academy for providing financial support in the way of a Post-Doctoral Fellowship, for the project 'Cloth Cultures in Prehistoric Europe' held at the Institute of Archaeology, University College London. This project provided the time and intellectual foundation to develop this collaborative volume.

## References

- Angus, A. (2002). An introduction to the types of tannages use on ethnographic leather. In: Wright, M.M. (ed.). *The conservation of fur, feather and skin. Seminar organised by the conservators of ethnographic artefacts at the Museum of London on 11th December 2000*. London: Archetype Publications. 1-6.
- Appleyard, H.M. (1978). *Guide to the identification of animal fibres*. Leeds: Wira.
- Brandon-Cox, H. (1969). *The trail of the Arctic Nomads*. London: Kimber.
- Charles, R. (1997). The exploitation of carnivores and other fur-bearing mammals during the North-Western European late Upper Palaeolithic and Mesolithic. *Oxford Journal of Archaeology*, **16**, (3). 253-277.

- Collins, M., Buckley, M., Grundy, H.H., Thomas-Oates, J., Wilson, J., & Van Doorn, N. (2010). ZooMS: the collagen barcode and fingerprints. *Spectroscopy Europe*, **22**, (10) 6-10, available from: [http://212-113-150-109.static.directrouter.co.uk/images/stories/ArticlePDFs/MS\\_22\\_2.pdf](http://212-113-150-109.static.directrouter.co.uk/images/stories/ArticlePDFs/MS_22_2.pdf)
- Covington, A.D. (2006). The chemistry of tanning materials. In: Kite, M. & Thomson, R., (eds.). *Conservation of leather and related materials*. Oxford: Butterworth-Heinemann. 22-35.
- Delong, M., Wu, J., & Park, J. (2012). Tactile response and shifting touch preference. *Textile: The Journal of Cloth & Culture*, **10**, (1). 44-59.
- DeMarrais, E., Gosden, C., & Renfrew, C. (2004). Introduction. In: DeMarrais, E., Gosden, C. & Renfrew, C., (eds.) *Rethinking materiality: the engagement of mind with the material world*. Cambridge: McDonald Institute for Archaeological Research. 1-7.
- Douglas, G.W. (1956). *Survey of the production of hides, skins and rough-tanned leathers in India, Pakistan, Ceylon and Africa*. Egham, Surrey: British Leather Manufacturers' Research Association.
- Driel-Murray, C. van (2000). Leatherwork and skin products. In: Nicholson, P.T. & Shaw, I., (eds.). *Ancient Egyptian materials and technology*, Cambridge: Cambridge University Press. 299-319.
- Driel-Murray, C. van (2002) Practical evaluation of a field test for the identification of ancient vegetable tanned leathers. *Journal of Archaeological Science*, **29**. 17-21.
- Edwards, E., Gosden, C., & Phillips, R.B. (2006). Introduction. In: Edwards, E., Gosden, C. & Phillips, R.B., (eds.). *Sensible objects: colonialism, museums, and material culture*. Oxford: Berg. 1-31.
- Falcão, L. & Araújo, M.E.M. (2011). Tannins characterisation in new and historic vegetable tanned leathers fibres by spot tests. *Journal of Cultural Heritage*, **12**, (2). 149-156
- Graves-Brown, P. (2000). Introduction. In: Graves-Brown, P., (ed.). *Matter, materiality and modern culture*, London and New York: Routledge. 1-9.
- Grey, T. (2006). *Archaeological Finds Procedures Manual*. With contributions by: Barham, L., Egan, G., Goodburn, D., Groves, J., Keys, L., MacConnoran, P., Maloney, C., Pearce, J., Smith, T. & Wardle, A., <http://www.animalbones.org/Warwick%20teaching%20files/postex/MoLAArcFindsProcedures.pdf>. MOLA, Museum of London. Museum of London Specialist Services. [Accessed: 08/03/2014.]
- Groenman-Van Waateringe, W., Kilian, M., & Londen, H. van (1999). The curing of hides and skins in European prehistory. *Antiquity*, **73**. 884-890.



- Haines, B.M. (2006a). Collagen: the leathermaking protein. In: Kite, M. & Thomson, R., (eds.). *Conservation of leather and related materials*. Oxford: Butterworth-Heinemann. 4-10.
- Haines, B.M. (2006b). The fibre structure of leather. In: Kite, M. & Thomson, R., (eds.) *Conservation of leather and related materials*. Oxford: Butterworth-Heinemann. 11-21.
- Harper, C. (2008). I found myself inside her fur... *Textile: The Journal of Cloth & Culture*, **6**, (3). 300-313.
- Harris, S. (2014). Sensible dress: the sight, sound, smell and touch of Late Ertebølle Mesolithic cloth types. *Cambridge Archaeological Journal*, **24**, (1). 37-56.
- Hodges, H. (1995). *Artifacts: an introduction to early materials and technology*, 2nd ed. London: Gerald Duckworth and Co.
- Hollemeier, K., Altmeyer, W., Heinzle, E., & Pitra, C. (2012). Matrix-assisted laser desorption/ionization time-of-flight mass spectrometry combined with multidimensional scaling, binary hierarchical cluster tree and selected diagnostic masses improves species identification of Neolithic keratin sequences from furs of the Tyrolean Iceman Oetzi. *Rapid Communications in Mass Spectrometry*, **26**, (16). 1735-1745 available from: DOI: 10.1002/rcm.6277
- Hurcombe, L. (2007). A sense of materials and sensory perception in concepts of materiality. *World Archaeology*, **39**, (4). 532-545.
- Ingold, T. (2007). Materials against materiality. *Archaeological Dialogues*, **4**, (1). 1-16.
- Ingold, T. (2012). Toward an Ecology of Materials. *Annual Review of Anthropology*, **41**, (1). 427.
- Jones, A. (2004). Archaeometry and materiality: materials-based analysis in theory and practice. *Archaeometry*, **46**, (3). 327-338.
- Kellogg, K. (1984). *Home tanning and leathercraft simplified*. Charlotte, Vermont: Williamson Publishing Co.
- Klokkernes, T. (2007). *Skin processing technology in eurasian reindeer cultures. A comparative study in material science of Sami and Evenk methods. Perspectives on deterioration and preservation of museum artefacts. PhD thesis*. Rudkøbing: LMR-Press.
- Knappett, C. (2005). *Thinking through material culture: an interdisciplinary perspective*. Philadelphia: University of Pennsylvania Press.
- Leather Conservation Centre (1981). *The fibre structure of leather*. London: The Leather Conservation Centre.
- Lemonnier, P. (1993). Introduction. In: Lemonnier, P., (ed.). *Technological choices: transformation in material cultures since the Neolithic*. London: Routledge. 1-35.

- MacGregor, G. (1999). Making sense of the past in the present: a sensory analysis of carved stone balls. *World Archaeology*, **31**. 258-272.
- Mason, O.T. (1891). *Aboriginal skin-dressing - a study based on material in the U.S. National Museum*. Washington: Smithsonian Institute.
- Meskel, L. (2005). Introduction: object orientations. In: Meskel, L., (ed.). *Archaeologies of materiality*. Oxford: Blackwell Publishing. 1-17.
- Mould, Q., Carlisle, I., & Cameron, E. (2003). *Craft, industry, and everyday life: leather and leatherworking in Anglo-Scandinavian and Medieval York*. York: Council for British Archaeology.
- National Research Council (US) Committee on Materials Science and Engineering: Forging Stronger Links to Users. (1999). *Materials science and engineering: forging stronger links to users / Committee on Materials Science and Engineering: Forging Stronger Links to Users, National Materials Advisory Board, Commission on Engineering and Technical Systems, National Research Council*. Washington, D.C.: National Academy Press.
- Oakes, J. & Riewe, R. (1996). *Our boots: an Inuit women's art*. London: Thames and Hudson.
- Ottaway, P. & Morris, C.A. (2003). The leatherworking tools recovered. In: Mould, Q., Carlisle, I. & Cameron, E., (eds.). *Craft, industry, and everyday life: leather and leatherworking in Anglo-Scandinavian and Medieval York, vol. 17: The small finds*. York: Council for British Archaeology. 3235-3244.
- Paine, R. (1994). *Herds of the tundra: a portrait of Saami reindeer pastoralism*. Washington: Smithsonian Institution Press.
- Rahme, L. & Hartman, D. (2001). *Leather; preparation and tanning by traditional methods*. Portland, Oregon: The Caber Press.
- Raedler, C. (2007). Geräte aus Keramik in der spätbronzezeitlichen Ramsesstadt. Die Schaber der Werkstätten des Grabungsplatzes Q I. In: Pusch, E.B. & Bietak, M., (eds.). *Forschungen in der Ramses-Stadt. Band 5*. Hildesheim: Verlag Gebrüder Gerstenberg.
- Reed, R. (1972). *Ancient skins, parchments and leathers*. London and New York: Seminar Press.
- Richards, M. (2004). *Deerskins into buckskins: how to tan with brains, soap or eggs*, 2nd ed. Cave Junction, Oregon: Backcountry Publishing.
- Rifkin, R.F. (2011). Assessing the efficacy of red ochre as a prehistoric hide-tanning ingredient. *Journal of African Archaeology*, **9**, (2). 131-158. Available from: [http://www.academia.edu/2009297/Assessing\\_the\\_efficacy\\_of\\_red\\_ochre\\_as\\_a\\_prehistoric\\_hide-tanning\\_ingredient](http://www.academia.edu/2009297/Assessing_the_efficacy_of_red_ochre_as_a_prehistoric_hide-tanning_ingredient).

- Schlumbaum, A., Campos, P.F., Volken, S., Volken, M., Hafner, A., & Schibler, J. (2010). Ancient DNA, a Neolithic legging from the Swiss Alps and the early history of goat. *Journal of Archaeological Science*, **37**, (6). 1247-1251.
- Schwarz, S. (2002). Leathercraft in the mid-18th Dynasty. In: Andoin-Rouzeau, F. & Beyries, S., (eds.). *Le Travail du Cuir de la Préhistoire à Nos Jours. XXII rencontres internationales d'archéologie et d'histoire d'Antibes*. Antibes: Éditions APDCA. 481-493.
- Sharphouse, J.H. (1983). *Leather technician's handbook.*, 23rd. rev. ed. Northampton: Leather Producers' Association.
- Sillar, B. & Tite, M.S. (2000). The challenge of “technological choices” for materials science approaches in archaeology. *Archaeometry*, **42**, (1). 2-20.
- Teerink, B.J. (1991). *Hair of West European mammals: atlas and identification key*. Cambridge: Cambridge University Press.
- Thomson, R. (2006a). The nature and properties of leather. In: Kite, M. & Thomson, R., (eds.). *Conservation of leather and related materials*. Oxford: Butterworth-Heinemann. 1-3.
- Thomson, R. (2006b). Testing leathers and related materials. In: Kite, M. & Thomson, R., (eds.). *Conservation of leather and related materials*. Oxford: Butterworth-Heinemann. 58-65.
- Thomson, R. & Mould, Q., (eds.). (2011). *Leather tanneries: the archaeological evidence*. London: Archetype Press.
- Tilley, C. (2007). Materiality in materials. *Archaeological Dialogues*, **4**, (1). 16-20
- Toups, M.A., Kitchen, A., Light, J.E. & Reed, L. (2011). Origin of clothing lice indicates early clothing use by anatomically modern humans in Africa. *Molecular Biology and Evolution*, **28**, (1). 29-32.
- Wilder, E. (1976). *Secrets of Eskimo skin sewing*. Anchorage, Alaska: Alaska Northwest Publishing Company.
- Wildman, A.B. (1954). *The microscopy of animal textile fibres: including methods for the complete analysis of fibre blends*. Leeds: Wool Industries Research Association.