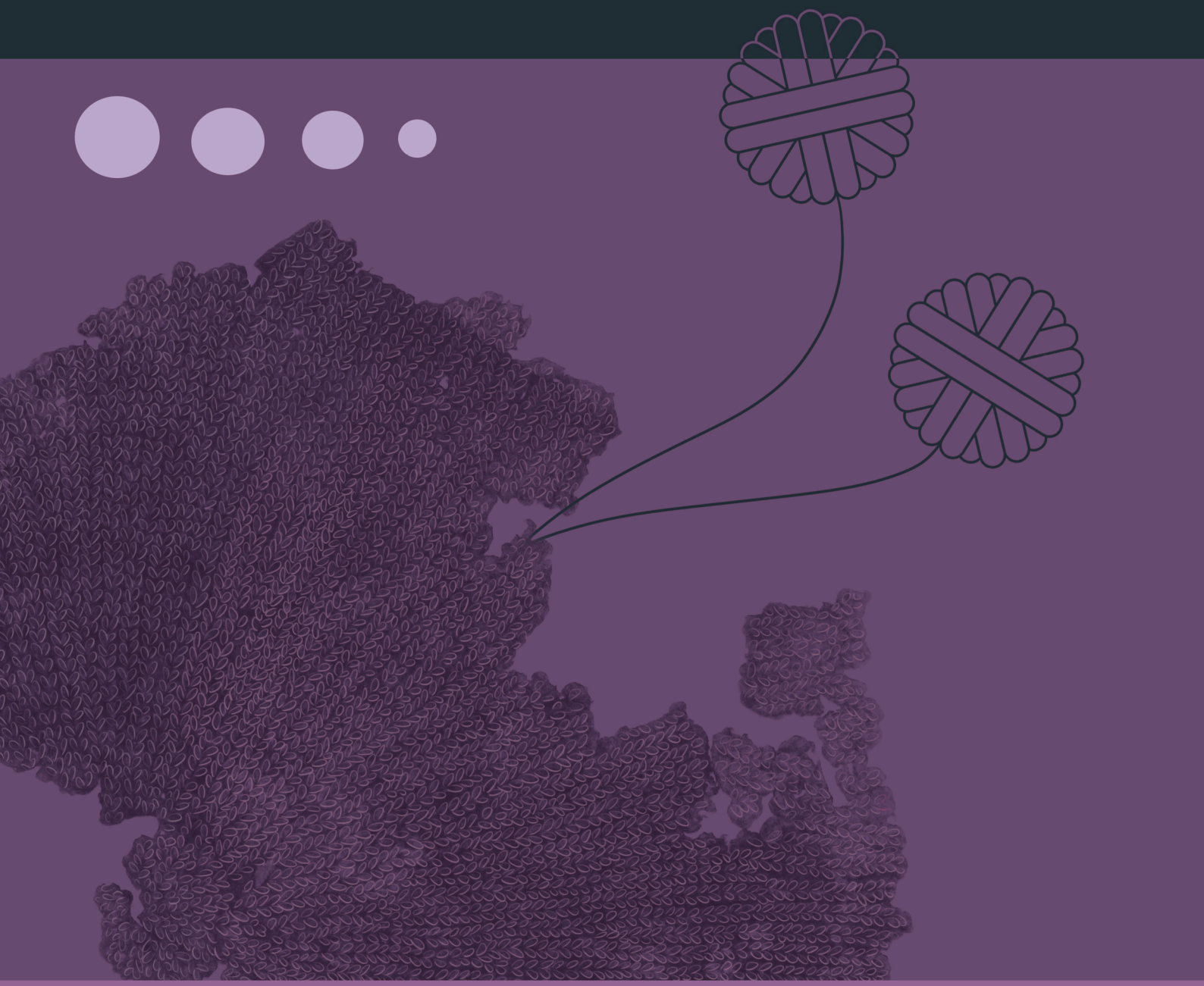
Nº 60

ARCHAEOLOGICAL TEXTILES REVIEW



2018 issue

Archaeological Textiles Review

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Editorial

Welcome to the diamond issue of the *Archaeological Textiles Review* 2018. It is an achievement worthy of celebration to have kept an independently-funded peer-reviewed journal up and running for 60 issues. We endeavour to strike a tone which embraces both scholarly articles and current affairs in textile-related matters. We are pleased to report that we are still going strong thanks to the staunch support of the Friends of ATR, which we very much value. Many thanks to you all!

For the ATR team, 2018 has been a turbulent year. Ulla Mannering has been on a long-term sick leave, but is now fully recovered and back on track. This is also why there has been no Annual General Meeting of the Friends of Archaeological Textiles Newsletter this year. We will provide more information about the next AGM on our homepage www.atnfriends.com at the beginning of 2019. Further, Ursula Rothe has left the editorial board and suggestions for a new, preferably native English speaking, editor are welcomed, and can be emailed to evaandersson@hum.ku.dk.

This year's issue is primarily dedicated to the study of knitwork with articles on protocol and terminology, and evidence for the craft's origins and development. The nine joint articles by Jane Malcolm-Davies, Ruth Gilbert, Susanne Lervad, Helena Lundin, Lesley O'Connell Edwards, Annemarieke Willemsen, Maj Ringgaard, Sylvie Odstrčilová and Rosalind Mearns are important contributions to the formation of a more standardised way of addressing and describing knitted items in an archaeological and historical context. We hope that readers will appreciate this initiative and continue the scholarly development of our scientific languages, which are imperative for modern textile research.

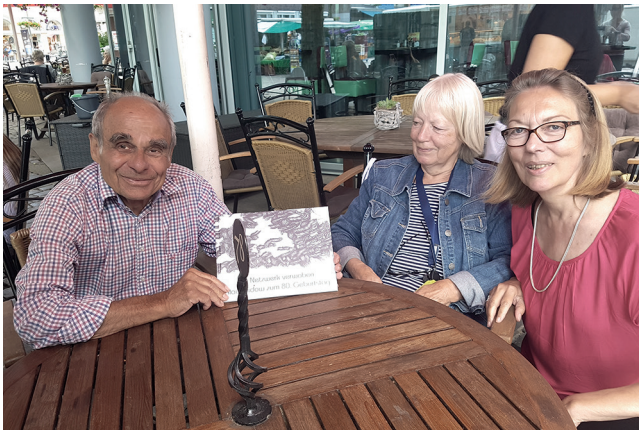
While this issue concentrates on knitwork, the editors would like to bring needle binding into better focus. We encourage our readers to submit articles about this technique for future issues. This issue presents five project descriptions about on-going and up-coming textile research projects. It is inspirational to see how textile research and the many excellent researchers working within this field are capable of creating new and innovative projects that successfully generate large sums of external funding.

We welcome new contributions to forthcoming issues and encourage you to send them to us as they are ready, so that we may spread the editing work over the year and have time for the peer review process. The deadline for contributions is **1 May** each year. Please also remember to send us news of projects, PhDs, publications and conferences, so that we can continue to be a hub for the archaeological textile community.

The Editors

Klaus Tidow celebrates his 80th birthday

Beautiful summer weather provided a wonderful backdrop for the handing over of a photo album to celebrate Klaus Tidow's 80th birthday on 15 July 2018 in Neumünster. Fit and joyful, Klaus and his wife Dörte arrived by bike. It was a great pleasure to see Klaus at all the symposia, meetings and workshops that have been documented in this photo album that also impressively demonstrates Klaus' long working life.



It is clear that NESAT would take up a lot of space in the photo album. After Susan Möller Wiering had recited a multi-verse poem about Klaus, an ice cream was needed to cool the emotions. Thanks to Annette Siegmüller and Christina Peek from the The Lower Saxony Institute for Coastal Research in Wilhelmshaven, who all helped with the compilation of the photo album and to all colleagues who contributed photographs. Klaus is still actively involved in textile archeology. Nevertheless, it is good to know that he has deposited his most important works and records in digital format with me for safe keeping. We all hope that on his 90th birthday we will be invited back for more ice cream!

Johanna Banck-Burgess

Jane Malcolm-Davies

Sticks, stones, fingers and bones: Nurturing knitting and the other neglected non-wovens

Abstract
Textile analysis is dominated by woven fabrics across all time periods. A variety of other textile production methods are attested by the archaeological and historical evidence, including knotting, lacemaking and sprang, and all are worthy of serious study. It is surprising to find knitted artefacts among these under-investigated textiles. The serious scientific study of evidence for early knitting is long overdue. Few knitted artefacts have been comprehensively reported leaving a large gap in the recorded history of textiles. This article sets out the argument for a new protocol to study knitted fabric and an agreed terminology for debating it.

Keywords: Textile, knit, analysis, terminology, protocol

Knitting is one of the many poor cousins of textile history. To date, textile analysis has largely concentrated on the evidence for weaving even though there is copious archaeological and historical evidence for many other techniques – from knotting to bark beating. Perhaps this neglect can be excused because their results are not easily recorded using conventional textile definitions and descriptions. Nevertheless, the lack of attention to knitting in particular was recognised in 1993 with the formation of the Early Knitting History Group (EKHG) in the United Kingdom with the hope that work on "the origins and history of knitting in western Europe" would be encouraged (Staniland 1997, 247). At an EKHG meeting in Manchester (United Kingdom) in March 1996, there was evidence of international collaboration with contributions from specialists from Denmark (Karen Finch and Lise Warburg), Spain (Eulalia Morral and Silvia Carbonnell) and Switzerland (Noemi Speiser). Richard Rutt suggested "strategies for setting up a database of early knitting" and, at the same meeting, Montse Stanley recognised that there was much confusion in the vocabulary of knitting history. The meeting concluded with a discussion chaired by Joan Thirsk on "clarity in terminology" (Knitting History Forum 2017). The EKHG later amalgamated with the Medieval Dress and Textile Society (MEDATS) but re-emerged as the Knitting History Forum (KHF) in 2006.

Despite these laudable initiatives, the scholarly study of knitted items has been slow to evolve – not from a lack of enthusiasm or interest in the development of the craft and industry – but because of a disjointed and diverse approach to the evidence available. There has been a regrettable lack of collaboration between practitioners of the craft and keepers of the material evidence – not due to any resistance on either side but rather because of a lack of opportunity and resources.

It is the purpose of the following articles to press on with the EKHG's aims of collecting the evidence for early knitting and developing the tools to discuss it. Malcolm-Davies et al. (2018, 10-24, in this issue) propose a terminology for the scholarly study of knitted items in order to contribute to the debate about the craft's origins and development, which are surprisingly mysterious given its relatively

late appearance in the history of textile production processes (Desrosiers 2013, 36). Most discussions of early knitting point to the High Middle Ages for its arrival in continental Europe but as yet there is no systematic scholarly analysis of the evidence which corroborates this. A recent article in the *Oxford Journal of Archaeology* demonstrates the continued lack of precision with which non-woven textile structures are discussed. The identification of textile imprints in clay as evidence for "two-needle knitting" dating to Early Bronze Age Anatolia is not supported by clear definitions or logical arguments (Sagona 2018).

Attempts at defining knitting are many and varied. Most have merit but none capture all the necessary characteristics which would permit them to be used as diagnostic tools. Several rely on definition by comparison with looping techniques which look similar to knitting (Emery 1994, 30-33; Phipps 2011, 50). Examples of looping are so-called coptic "knitting" or single-needle "knitting", and warp "knitting" – neither of which are true knitting (Kruseman 2015). Some works accurately describe looping and differentiate it from knitting (Burnham 1972; Claßen-Büttner 2015) but sometimes in corrected later editions of previously erroneous work which is still in general circulation and use (for example, d'Harcourt 1987). Others, including very recent contributions, inadequately distinguish between "looping" and "knitting" thereby continuing to confound rational debate (Warburg 2018, 426-435; Meakes 2018). There is as yet no published and tested method for differentiating the concept of looping (also known as nålebinding, knotless netting and other similar ill-defined names) from knitting, although an excellent discussion of "structures readily confused with knitting" is available (Rutt 1987, 8-11).

One limiting characteristic (Dury & Lervad 2016, 2) which might distinguish knitting from other similar techniques is the use of a single continuous yarn which runs through the fabric from beginning to end (Emery 1994, 39; Gagneux-Granade 2016, 47 & 85). The end of this theoretically continuous element is never put through a loop, however complex the loops. The multitude of possible structures embraced by the term "knitted" (and its sibling "crocheted") share just one characteristic – that the loops are only penetrated by other loops of the theoretically endless yarn. Simple knit "is commonly understood to be the creation of a fabric from a single thread, formed with horizontal rows of individual loops that intermesh with each successive row of loops" (Black 2012, 7). However, the thread or yarn is not necessarily continuous because separate yarns may be used for different sections of the fabric (Rutt 1987, 7) – as happens, for example, when one ball of yarn ends and a new one is introduced or a new colour is added. True knitting, whether made with two or more needles, a spool or a machine, produces a "looped construction formed in rows of open loops-into-loops" (Phipps 2011, 44) in which the alignment of loops and their interconnection is vertical (Emery 1994, 40). It is worth noting that it is possible to mimic some knitted loops by sewing – as in, for example, the grafted join (Hemmons Hiatt 2012, 641; Stanley 2001, 241) and the embroidered Ceylon stitch (Eaton 1989, 113 & 131).

Fig. 1: Eleonora of Toledo's stockings on display at the Palazzo Pitti, Florence, Italy (Image: Gabinetto Fotografico delle Gallerie degli Uffizi)

The state of the art

Well researched works document contemporary knitting techniques (for example, Hemmons Hiatt 2012; Stanley 2001). There are a few general histories which draw together some of the evidence (Nargi 2011; Rutt 1987; Thirsk 2003; Turnau 1991) and a welcome recent contribution adds details of previously obscure but relevant artefacts in France (Gagneux-Granade 2016). Each has its limitations – superficiality, a narrow cultural or geographical

focus, or a lack of footnotes. None achieves a thorough account of the present knowledge of the archaeological and historical record.

There has been no systematic or scientific review of the archaeological and historical evidence for knitting, although preliminary catalogues have been published (for example, Kruseman 2015). Such useful research tools are hard to compile owing to many knitted items going unrecognised as such in museum collections. Curators in the past may have lacked the knowledge to identify this method of construction or simply failed to record that items were knitted because it was obvious to them. Today, curators in many museums (even those with relevant specialist knowledge) lack the resources to investigate collections for such overlooked evidence.

A few studies describe the context of a specific item in detail (for example, Buckland 1979 on the Monmouth cap), survey examples of similar items (Ringgaard 2014 on silk waistcoats) or record a diverse collection such as that at the Victoria & Albert Museum in London (Levey 1982; Black 2012). Very rare are accurate academic articles describing individual items or disciplined systematic surveys (Gilbert 2012 on cotton waistcoats), which not only make evidence available to a wide audience but contribute to the clear definition and diagnosis of knitting as a method of textile production. Archaeological fragments of knitted fabrics have been recorded but not always to the exacting standard of woven items from the same excavation and sometimes omitting key characteristics (for example, Henshall 1951, 36, 21-28; Walton 1981, 1983; Walton Rogers 1999, 2012, 2013). Often, the best contributions to this debate explain items made with techniques mistaken for, but which are not, knitting because of the need to distinguish clearly between the results (Burnham 1972).

Scientific studies of the fibres and dyes used for knitted goods are even more scarce. Notable recent exceptions are details about an 18th century stocking found on the *Sankt Michel* in Finland (Vajanto 2014, 122-123) and older studies of similarly shipwrecked items from the 17th century *Vasa* and 16th century *Mary Rose* warships (Ryder 1983 & 1984). Fibre diameters are discussed for two knitted fragments from Black Gate, Newcastle (United Kingdom) (Walton 1981, table 1). More recent isotopic analysis of one of these knitted fragments of an unidentified item dated to the first half of the 15th century (T13) has produced more questions than answers in terms of trade in raw materials and finished goods (Von Holstein et al. 2016).

There is a dearth of knitted items on display in museums – especially the older, fragmentary examples which help demonstrate the evolution of the craft. They lack glamour and are largely incomprehensible without considerable interpretation. Notable exceptions are: two 13th century silk cushions at Las Huelgas, Burgos in Spain; at the Museum of London (United Kingdom) a 16th century child's petticoat (or waistcoat), mitten and cap; a collection of 17th century gloves, mittens and headwear at the National Museum of Denmark, Copenhagen; and the Early Modern multicoloured whalers' caps at the Rijksmuseum, Amsterdam (Netherlands). The disadvantage of permanent display is that these items have been unavailable for close study for decades. They also tend to take on a significance beyond their representativeness because they are more accessible than those in storage, especially with the advent of Pintrest and other online platforms which increase their global visibility.

Even those on display can remain a mystery. Among the most iconic of Early Modern knitwork is a pair of stockings recovered from the grave of Eleonora of Toledo, who died in 1562. Their construction remains a source of much speculation since they have never been reported in detail by their first-hand observers, who state only that "different stitches were used to create vertical designs on the legs, with open-work effects in the upper section which just covered the knee. They were worked starting from the top, and then joined with a seam under the foot" (Landini & Bruni 2007, 146). The relevant footnote (28) cites Westerman Bulgarella (1993, 86-87). However, neither source gives evidence for the knitting being from the top down or toe up, worked round or back and forth, nor is there any information about the shaping or materials. A more thorough description based on photographic examination suggests they were knitted round not back and forth and that they present "the earliest verifiable purled stitches" (Rutt 1987, 24, 71-72, figs 63 & 64). A set of pre- and post-conservation photographs are available online but these are not of sufficient quality or comprehensive enough to allow hard and fast conclusions to be drawn (Digital Archive 2008).

Eleonora of Toledo's stockings are currently on display behind glass at the Palazzo Pitti in Florence (Italy). They are flattened (that is, not displayed on mounts to give them a three-dimensional shape) and folded to show the sections covering the tops of the feet but not the soles or the centre backs of each leg. One stocking was inside out on Eleonora's body (Westerman Bulgarella 1993, 86-87) but they are both displayed the right way out thereby hiding the insides from view. The interpretive panel in English states they "were knitted using straight needles starting at the top and working

down dropping stitches until the toe" which implies that it is evidence of decreasing which suggests the working direction; it also says: "The closure seam is at the centre back" which suggests they were knitted back and forth and sewn together (Palazzo Pitti 2018). In Italian, the wording may be interpreted differently: "*Le calze di seta indossate da Eleonora erano lavorate dall'alto su ferri diritti scandalo I punti fino alla punta del piede, quindi cucite nel mezzo dietro*" (Palazzo Pitti 2018). In the light of these imprecise and conflicting accounts, it is not possible to know how they were made, and into this void have fallen many assertions about them. To date, Eleonora's stockings stand as mute reminders of the dangers of making assumptions about knitwork without supporting evidence. A thorough examination according to a protocol which addresses all the evidence available is long overdue.

Recent temporary exhibitions such as those in Leeuwarden, Netherlands (*Breien!*) and Nürnberg, Germany (*In Mode*) have confirmed the existence of lesser known early knitted items and put them more firmly in the public domain. Illustrated online museum catalogues also reveal knitted items to a wider audience, even if examination is not possible. Other important evidence is unavailable because museum storage and inventories need updating: for example, the whereabouts of archaeological knitting needles in Nîmes (France) are currently unknown (Gagneux-Grenade 2016, 90).

Scientific reporting of knitted items

There are three main avenues of research: craftwork, general history, and material evidence. All three draw on similar concepts and vocabulary but do not agree on definitions. This uncertainty is compounded in an international context and is even problematic in English because UK-English and North American-English diverge on key points. There is a geographical specificity to the language used to discuss knitting which sometimes contradicts its current location – for example, immigrants brought the traditions of their homelands to new countries, and marriages across different communities then reinforced or rejected them. This has resulted in the same words meaning different things, and different words meaning the same thing across international, national, regional and local boundaries (Hemmons Hiatt 2012, xiii). It should be noted that, despite the challenges it presents, this linguistic variety has great cultural value.

Not everyone who has the responsibility or opportunity to examine archaeological or historical evidence is a knitter or expert in identifying knitting techniques. Nevertheless, they may be called upon to catalogue what they see. It is desirable that this be achieved in as reliable a way as possible. The lack of a conventional system for describing what may be observed in knitted items makes it difficult to produce a report that is immediately comprehensible to others. A recording protocol is required to provide reliable descriptive detail for people who may not be able to view the item for themselves and offer a sound foundation upon which later observers can build with further insights.

Another difficulty is the extent to which authors assume their readers' knowledge of knitting techniques. Specialist audiences for textile history are not necessarily knitters and it should not be necessary to be so to understand the evidence for the development of the activity or what it produces. Knitters who are not textile historians/archaeologists should likewise be able to access information about objects from which they may gain technical insights or artistic inspiration. Finding an approach and a language which engages and satisfies all is a challenge.

The geographical spread of the evidence, the lack of a detailed inventory for it, and its relative invisibility have all contributed to the absence of a comprehensive scientific overview of the development of knitting and a practical guide to identifying and studying it. Comparative analysis of the evidence is also hampered by the lack of an established terminology and protocol which facilitates an exchange between and among practitioners, academics and other interested parties (Gilbert 2012, 105, n3).

There have been attempts to make sense of the many diverse terms used in knitting. Hemmons Hiatt explained her method of naming techniques as follows: "Identical techniques were often referred to by different names or symbols in different books. In some cases, I have simply abandoned all of them and settled on a term that conveys a sense of the operation performed or the resulting appearance" (Hemmons Hiatt 2012, xiii).

The priority for the study of archaeological and historical knitted items is to describe the resulting appearance accurately by separating the objective examination from the interpretation (Prown 1982, 7-10). Knitting may be performed in different ways which result in the same structure and it is safest not to speculate on the performance but to concentrate on the appearance of the evidence, which is all that can be recorded with certainty. The adoption of a standard for recording knitted items will also facilitate communication and dialogue about it. This themed 60th issue of the *Archaeological Textiles Review* (ATR)

Fig 2: An early prototype for a three–dimensional representation of a knitted cap at Platt Hall, Manchester, Inventory number 1952.3413, created by Theis Jensen (University of York) using Agisoft Photoscan Pro (Visit https://sketchfab.com/models/ef2b60d5cfbb4e-67a1c78e5a77cbfa0c to see the animation)

demonstrates a proposed protocol and terminology in action by revising reports of knitted items which deserve more thorough description and providing previously unpublished evidence for Early Modern knitting. It also reports a test of citizen science in an experimental archaeology project investigating fleece and finishing. It is hoped that the articles offer a helpful road map. It represents a first step on a new path towards a rigorous approach to the scientific study of non-woven textile artefacts. Anticipated future improvements will embrace other European languages, diagrammatic representations of the knitwork, and specially-commissioned, good quality, high-resolution digital photographs, including three-dimensional images (fig. 2) to capture the constructional details and surface textures.

There has been far-reaching and friendly collaboration on the journey thus far thanks to the networks of scholars and craftspeople who share expertise via the Knitting History Forum (KHF), the North European Symposium on Archaeological Textiles (NESAT), and the *Knitting in Early Modern Europe* (KEME) project. The next step on the road is rigorous application and testing of the protocol and terminology followed by constructive suggestions as to how it can adapt and expand to embrace all the evidence for knitwork – not only for the High Middle Ages but from the earliest evidence up to the present day.

The focus on knitwork here is intended to lead the way for renewed study of other textiles such as those looped with a single needle, on a bobbin, or a hook. It is time for the many poor cousins of textile history to rediscover their rich legacies.

Acknowledgements

Thanks are due to a wide and generous family of scholars who have contributed to these knitted articles. The editorial board took a leap of faith in agreeing to devote the 60th anniversary issue to knitted textiles. The authors of the articles that follow were patient and generous with their time and expertise as they wrote and rewrote their articles as the terminology and protocol evolved. The many equally generous contributors, collaborators and reviewers are acknowledged for each article. In particular, Ruth Gilbert is to be applauded for her patient support with technical details and Lesley O'Connell Edwards likewise for her bibliographical corrections. Stefania

Montemezzo kindly helped with image research for this article. The *Knitting in Early Modern Europe* project (see kemeresearch.com) and the editorial work on this volume was funded in part by a Marie Skłodowska Curie Research Fellowship (grant agreement 656748) courtesy of the European Commission.

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Jane Malcolm-Davies, Ruth Gilbert & Susanne Lervad

Unravelling the confusions:
Defining concepts to record archaeological and historical evidence for knitting

Abstract
Evidence for the development of knitting as a craft and industry is not as readily available as it is for weaving. The reasons for this include the relative scarcity of the archaeological and historical material, its inaccessibility due to incomplete or inaccurate cataloguing, and the lack of agreed terminology for a scholarly discussion. This paper proposes a vocabulary based on English terminology used in textile analysis, in craftwork and in the mechanised knitting industry today. A recording protocol is required to provide reliable descriptive detail for those who cannot view the items for themselves and to offer a sound foundation upon which later observers can build with further insights. This paper aims at a protocol for recording knitted items which may be used as a guideline by experts and non-experts in textile analysis of knitwork. It cautions against deductions as to methods of construction without credible evidence and calls for more discussion of appropriate terms in English and other languages.

Keywords: Textile, knit, terminology, protocol, dossier, analysis

Introduction
Good practice in terminological work is based on an analysis of the relevant concepts, the identification of appropriate terms to assign to these concepts, and the development of definitions. There may be a need for the creation of new terms and for translation into other languages (Dury & Lervad 2016, 1). A variety of terms representing the concepts may be synonymous (Dury & Lervad 2016, 3). It is not always necessary to have prescriptive terminology or to outlaw previously used terms which convey meanings for specific concepts in other contexts. Published knitting instructions, for example, serve a different purpose to museum catalogues. Conventions used in instructions rely on a cultural understanding of the practice of knitting and, aside from the language in which the instructions are written, require translation from word to action. Knitters learn that words may need interpretation across geographical and cultural conventions. Their priority is finding the appropriate actions to create/recreate a knitted item. A new scholarly language for recording the evidence of knitting should be authoritative but need not become the standard in other contexts. The requirement in an academic context is to describe the items accurately in a way that may be understood by scholars. There is no need for words to translate into actions. Indeed, the difference between description and prescription is key. The language used cannot therefore rely on the practical expertise of an experienced knitter or the understanding that words may mean one thing in one place and another elsewhere.

The search for terminology
Best practice in the definition of textile terminology has been established in several projects (notably in Scandinavia) which take an inclusive approach to identifying concepts, terms and meanings. This provides a broad base from which to select the most helpful terms. In contrast to words (or "general language"), an agreed terminology is a "special" or subject-specific language, which aids clear communication (Humbley 1997, 14). Some of these web-based resources include international and literary

references, which shed light on the origin, etymology and use of terms, facilitating cross-cultural analysis of textiles (see, for example, textilnet.dk). Thus far, none of these resources has tackled archaeological or historical knitting terms with the rigour required for academic application.

Textilnet.dk identifies the key concepts to define as: the tools; the materials; the techniques used to construct and decorate the fabric; and the product of those techniques with all its features. There are many useful sources in English to draw upon (Thomas 1943; Emery 1994; Phipps 2011) in addition to the international standard which defines some basic knitting concepts (ISO 4921:2000).

Knitting may be performed by hand or by machine – the pulling of a new loop through a previous loop is common to both. In contrast to the succession of loops worked from one needle to the other in handknitting, a knitting machine has one needle for the top loop of each **wale** (the vertical column of loops), which increases the speed at which the fabric is formed (Black 2012, 62). The international standard for knitted fabric was developed primarily for the modern mechanised knitting industry (ISO 8388:1998). Although this proposal is primarily concerned with handknitting, it is desirable that the terminology be, as far as possible, applicable to machine-knitted items too. Knitting machines, including William Lee's 16th century frame, employed the same fundamental action as handknitting – termed weft knitting in industry because the yarn is fed horizontally to form rows of loops (Miller 1992, 12). The structure of handknitted and weft machine-knitted fabric is the same. Warp knitting, patented in 1775 (Spencer 2001, 9-12), may only be achieved by machine and has no equivalent in handknitting. It employs multiple continuous yarns which are interlinked laterally, which distinguishes it from true knitting (Miller 1992, 100). A photographic method for "differentiating between handknitting, frame knitting, v-bed knitting and Cotton's patent knitting" has been published and tested (Cooke & Tavman-Yilmaz 1999).

Much of the terminology proposed here has been developed in collaboration with scholars, knitters, textile technologists and terminologists working in several languages. It has also been discussed as part of the *Knitting in Early Modern Europe* (KEME) citizen science project. The terms shown in **bold** are those currently proposed but it is anticipated that further collaboration will permit these to be refined. The aim is for it to serve a similar purpose to Linnaean classification of the natural world; the Latin names are not used in common parlance but ensure a reliable basis for communicating exact information among specialists.

Proposed terminology and its use

The hand tools for knitting are usually referred to as **needles,** sticks, wires or pins (see tables 1 and 2 for all terms shown in bold). An inclusive definition of knitting needles covers a range of variants. It is helpful to note that without the needles being recovered with or within a knitted item, it is usually impossible to state with certainty how many needles were used (for a rare exception, see Gilbert 2012, 95) or what form they took, although there must be more than one for back and forth knitting and more than two for round knitting (see below). This discussion of tools illustrates one of the requirements of terminological work: the need to categorise. If the tools may be defined as needles, the recognition that there are various types of needles allows for further definitions to be added and permits variants to be incorporated, if necessary.

The **material** used, known as **yarn,** is "any assemblage of fibres or filaments which has been put together in

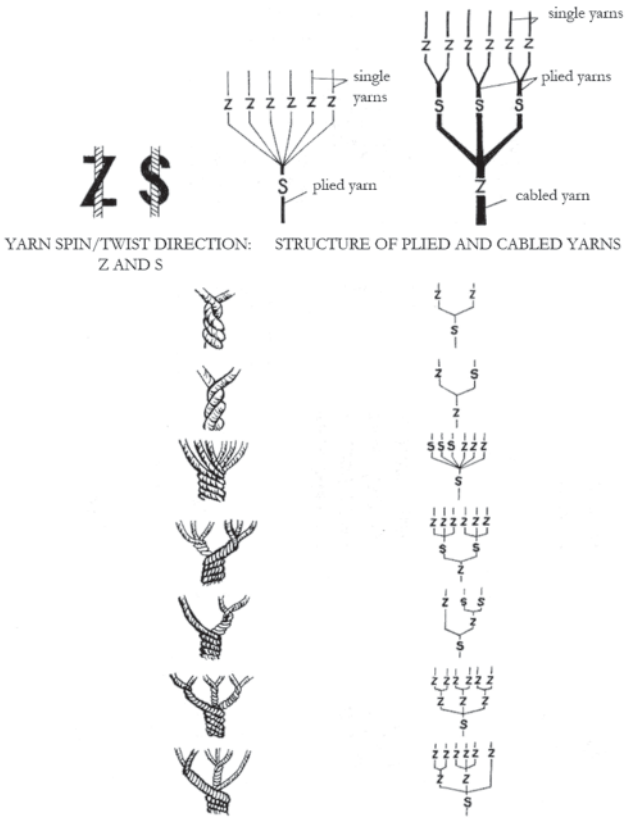

Fig. 1: The structure of yarns (Image: after Michałowska 2006; with thanks to Malgorzata Siennicka & Sidsel Frisch)

Table 1: Summary of proposed key terms for basic description of knitwork. This terminology will expand to cover more complex structures in the future.

Concept		Discussion points, variables, references	PROPOSED TERM - English
Tool	Needles (two or more than two)	Sticks, pricks, wires, pins	NEEDLES (plural)
		Double-pointed	
		Single-pointed	
Material	Yarn	Applies to all fibres (Emery 1994, 10)	YARN
	Fibre	Animal, plant, mineral or synthetic (Emery 1994, 4-5)	FIBRE
	Fibre or yarn as structural element	Element (Emery 1994, 8)	ELEMENT
Element structure	Single (spun or not spun)	(Emery 1994, 8)	SINGLE
	More than one (spun or not spun) combined or plied	(Emery 1994, 8)	COMPOUND
	Compound (spun or not spun) but not twisted together	(Emery 1994, 8)	COMBINED (I)
	Compound and twisted together	(Emery 1994, 10)	PLIED (S, Z)
	Ply	(Emery 1994, 10)	PLY ANGLE
	Number of single yarns	(Emery 1994, 11)	2-PLY, 3-PLY etc
	Additional twist	Re-plied (Emery)/cabled (Eastwood & Walton 1998, fig 3, 12)	CABLED
	Spin/twist angle	(Emery 1994, 11)	SPIN (S, Z) for single yarn; TWIST for plied
	Spin/twist angle	(Emery 1994, 11)	SPIN ANGLE for single yarn; TWIST ANGLE for plied
Method of working	In a continuous spiral	Knitted in rounds	ROUND
	Back and forth in the same plane - including turned/not turned	Straight rows (Phipps 2011, 50)	BACK AND FORTH
Form	Form	Tubular, conical, discoid, "square, rectangular, or otherwise shaped" (Emery 1994, 30)	As appropriate
Orientation	Top/bottom		TOP/BOTTOM
Fabric features	Starting edge	Casting on or binding on (Hemmons Hiatt 2012, 656)	CAST-ON EDGE
	Finishing (locking) edge	Casting off or binding off (Hemmons Hiatt 2012, 656)	CAST-OFF EDGE
	Unfinished edge	Cut/torn/decayed	EDGE
	Turning edge	Secure edge (ISO 4921:2000: 3.3.2)	SELVEDGE
	Loop	Stitch	LOOP
	Column/s of vertically aligned loops		WALE/S
	Course/s of element through horizontally aligned loops		COURSE/S

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Concept		Discussion points, variables, references	PROPOSED TERM - English
Fabric features	Gauge (US)/Tension (UK)	Wales x courses per 10 cm square or inch square	GAUGE (LOOP DENSITY)
		(W per cm x YD) + (C per cm x YD) minus (W per cm x YD) x (C per cm x YD), where W is wales, C is courses and YD is yarn diameter in cm	COVER FACTOR
	Surface of fabric	Right/wrong sides	RECTO/VERSO
	Surface of item	Inside/outside	INSIDE/OUTSIDE
	Flat side or worked loop	Right/knit/plain stitch in fabric	FACE LOOP
	Ridge side or worked loop	Left/purl stitch in fabric	REVERSE LOOP
	Shaping	Addition of wale/s	INCREASE (noun)
		Removal of wale/s	DECREASE (noun)
	Start/finish of round	Step/jog (Hemmons Hiatt 2012, 32; Stanley 2001, 31)	JOG
	Decoration worked as part of fabric structure, whether loop formation or colour changes	"Stitch patterns" (Stanley 2001, 19); "decorative stitch technique" (Hemmons Hiatt 2012, 660)	STITCH/COLOUR PATTERN
	Decoration applied to the fabric	Ornamentation	EMBELLISHMENT
Fabric structure	One surface of face and the other of reverse loops	Plain/Stockinet[te]/Jersey	SIMPLE KNIT FABRIC
(as observed)	Two surfaces each of alternate courses of face and reverse loops	Garter stitch	SINGLE RIDGE FABRIC
	Enumerated courses of face/reverse loops		RIDGE FABRIC
	Two surfaces of alternate wales of face and reverse loops	Single rib	SINGLE RIB FABRIC
	Enumerated wales of face/reverse loops		RIB FABRIC
	Fabric made with two elements of the same yarn in various configurations, one working and one carried across either surface of fabric		TWINED KNIT
Finish			MATTED
			FULLED
			NAPPED
			SHORN
Colour			PIGMENTED
			DYED
Process/action	Construction of fabric	Knit	WORK
Descriptor			KNITTED
Product		Under construction/finished	KNITWORK

Table 2: *Dossier de recensement* or protocol for recording early knitwork based on Centre International d'Etude des Textiles Anciens (CIETA)'s textile analysis system

1	**Item identification**	
	Location where the item is currently held	
	Inventory/accession number	
	Object name (in official record)	
	Source/find location (if known)	
	Provenance (if known)	
2	**Item material & yarn structure**	
	Details of each yarn, including those in fabric structure and sewing or embellishment, as follows:	
	Fibre: animal, plant, mineral, synthetic (wool, silk, linen, cotton, metal, acrylic etc)	
	Fibre diameter (in microns based on 100 measurements, if possible)	
	Yarn diameter based on at least 10 measures with range stated	
	Yarn analysis, as follows:	
	Single or compound elements	
	If compound, combined, plied or cabled	
	If compound, number of single component yarns	
	For each yarn:	
	Single yarn diameter/s based on at least 10 measures with range stated	
	Single yarn spin direction (Z, S, I) "I" indicates no visible spin	
	Single yarn spin angle/s (0-45 degrees) based on at least 10 measures with range stated	
	Plied yarn diameter/s based on at least 10 measures with range stated	
	Ply twist/s direction (Z, S, I)	
	Ply angle/s (0-45 degrees) based on at least 10 measures with range stated	
	If cabled, number of plied yarns, twist & twist angle based on at least 10 measures with range stated	
3	**Fabric structure**	
	One yarn:	
	Simple knit (yes/no)	
	Single ridge (yes/no)	
	Ridge fabric (with enumerated courses of face/reverse loops)	
	Single rib (yes/no)	
	Rib fabric (with enumerated wales of face/reverse loops)	
	Other combination of face and reverse loops (with chart/diagram, as necessary)	
	More complex structures (with chart/diagram, as necessary)	
	More than one yarn:	
	Twined knit (yes/no)	
4	**Fabric features**	
	Surface designated recto with reason (with chart/diagram as necessary)	
	Surface designated verso with reason (with chart/diagram as necessary)	
	Designated working direction with reason	
	Loop height (average based on a minimum of 10 loops)	
	Loop width (average based on a minimum of 10 loops)	
	Gauge: count wales and courses, as follows:	
	Wales (count horizontally) per 10 cm or inch	
	Courses (count vertically) per 10 cm or inch	
	Course to wale ratio = course count divided by wale count expressed as n:1	
	Loop density (gauge) = wales x courses per 10 cm square or inch square	
	Cover factor = (W per cm x YD) + (C per cm x YD) minus (W per cm x YD) x (C per cm x YD) W refers to wales, C to courses and YD to yarn diameter in cm. Use the same units of measurement for W, C and YD (cm, mm or inches).	

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	Cast-on edges (yes/no & description)	
	Cast-off edges (yes/no & description)	
	Selvedges (yes/no & description)	
	Cut edges (yes/no & description)	
	Torn edges (yes/no & description)	
	Decayed edges (yes/no & description)	
	Shaping: number of increases (locations & type/s - cite evidence in full)	
	Shaping: number of decreases (locations & type/s - cite evidence in full)	
	Embellishment	
5	**Item form & construction**	
	Form/s: Tube - (two edges, two surfaces) or plane (one edge, two surfaces) Shape/s (disc, square, rectangle, triangle, otherwise etc) with diagram, as necessary	
	Designated top/bottom with reason	
	Dimensions of item (with diagram, as necessary), as follows:	
	Length (maximum/minimum, if appropriate)	
	Width (maximum/minimum, if appropriate)	
	Depth (maximum/minimum, if appropriate)	
	Designated inside	
	Designated outside	
	Weight (grams or ounces)	
6	**General overview**	
	Finish: Matted (yes/no)	
	Finish: Evidence of fulling, napping, shearing (yes/no & description of evidence)	
	Colour/s: Archaeological brown - yes/no (light, dark, further details)	
	Colour/s: Munsell, CIELAB or a similar colour recording system definition	
	Natural pigmentation (yes/no & description)	
	Dyed (yes/no & description)	
	Sewn seams, fastenings, evidence of wear or use, damage, repairs, mistakes/anomalies, marking, additions, writing, evidence of conservation work	
	Further observations (including number of parts, pattern sections, shaping, seams, hems, gussets, neckband, finishes)	
	Drawing/s completed (yes/no)	
	Photographs taken (yes/no)	
7	**Interpretation**	
	Deductions as to the technique/s used to make the fabric with appropriate evidence, as follows:	
	Hand/machine/indeterminate	
	Round	
	Back and forth (turned/unturned)	
	Working direction (with evidence from cast on, cast off, increases, decreases)	
	Fleece characteristics: modern fine fleece is usually interpreted as less than 20.6 µ, medium from 22 to 29.3 µ, coarse from 31 to 34.4 µ and very coarse more than 36 µ	
8	**Further information**	
	Object description (in official record): take photocopy, photograph or pdf, if possible	
	Comparable items (locations and accession numbers)	
	Relevant literature (full references)	
9	**Examination record**	
	Name of examiner (first name & surname, affiliation with contact details)	
	Place of examination	
	Date of report	

a continuous strand suitable for weaving, knitting, and other fabric construction" (Emery 1994, 10). This material may be identified as animal, plant, mineral or synthetic (Emery 1994, 4-5) or more precisely as **fibre**, such as wool, silk, cotton, metal or acrylic.

The **structure** of yarn for knitting may be **single** or **compound**, **combined** (two or more **elements** used as a unit but not twisted together), **plied** (two or more single elements twisted together to form a two-ply, three-ply etc yarn – Phipps 2011, 59) and/or re-plied (two or more plied elements twisted together – Emery 1994, 10) also known as **cabled** (Walton & Eastwood 1988, 12) and for each **spin or twist** its S or Z direction may be discernible (Emery 1994, 10). Conventional methods of indicating the hierarchy of the spin and ply may be incorporated in this system as in, for example, an uppercase S or Z for the final twist (Splitstoser 2012, 9) or represented diagramatically (fig. 1). "No high degree of accuracy is possible in the measurement of yarns in a fabric … [nevertheless] even such approximate measurements as are possible can be extremely valuable and are, in fact, necessary for full description and comparison" (Emery 1994, 10). Both the yarn and its component elements may be measured to provide their diameters and **spin or twist angles:** the spin angle of single and the twist angle of plied yarns. The diameter is measured perpendicular to the length of the yarn and the angle likewise (Emery 1994, 11-12). A loose spin/twist is up to 10 degrees, medium from 10 to 25 degrees and tight 25 to 45 degrees (Emery 1994, 12). Both these dimensions are best calculated as the average of at least ten measurements with the range of values stated.

While the above terms are helpful for discussing characteristics of the material which are visible to the naked eye, there are further features at the micro level which offer valuable data too. Conventionally, the diameter of the fibres or filaments which compose the yarn is recorded as an average of 100 fibre diameters (Ryder 1983 & 1984; Gleba 2012; Rast-Eicher & Jørgensen 2013). Such measurements may permit conclusions to be drawn about the source material – for example, wool fibre diameter is an indication of the quality of fleece used (which may be sorted and/or mixed), although there is still much debate about how wool types may be categorised accurately (Rast-Eicher & Jørgensen 2013, 1; Christiansen 2004). In industrial contexts today, fine fleece is usually interpreted as less than 20.6 μ, medium between 22 and 29.3 μ, coarse from 31 to 34.4 μ and very coarse more than 36 μ (Kott 1993, table 1), although in archaelogical interpretation, the distribution of fibre diameters in a histogram is used (for example, Bender Jørgensen & Walton 1986).

There are several ways of working a knitted fabric – **round** as a continuous spiral or **back and forth** in the same plane. In the latter case, the work may be turned (usual in handknitting) or the same surface kept towards the knitter throughout (usual in machine knitting). In contemporary craftwork, working round is termed circular knitting and working back and forth is termed flat knitting (Black 2012, 7) or straight knitting (Phipps 2011, 50). These terms distinguish the method of construction not the resulting object (Stanley 2001, 29-33). The direction in which the fabric is constructed, the working direction (known in industry as "technical upright"), is important and may indicate the method of constructing the item.

In describing a knitted item, its **form** is an important characteristic. In this context, flat is a problematic term because, strictly speaking, all finished knitted fabric is flat. An item may be three-dimensionally tubular, conical, discoid, "square, rectangular, or otherwise shaped" (Emery 1994, 30). The surfaces and edges are also important features (see below). A disc or "otherwise shaped" object has two surfaces and one edge (the circumference or perimeter), while a tube has two surfaces and two edges.

It is helpful to orientate the item by designating the top

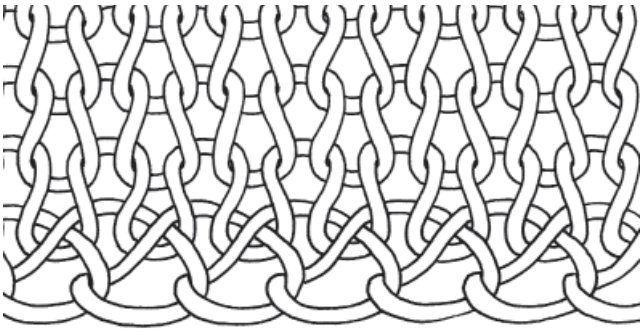

Fig. 2: An example of a starting edge: a one-strand knit on cast on (Image: Sarah Thursfield)

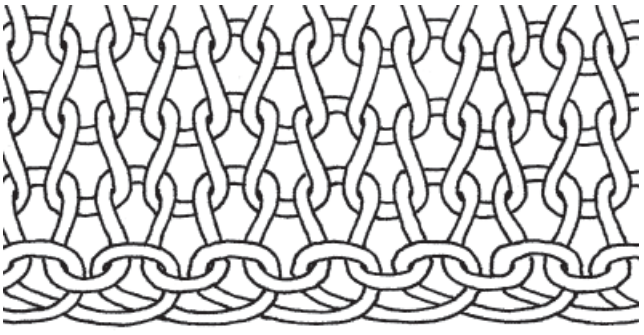

Fig. 3: An example of a starting edge: a two-strand "thumb" cast on (Image: Sarah Thursfield)

and bottom. If enough remains for a clear orientation to be determined, the evidence may be stated. Cast-on and cast-off edges (Rutt 1987, 13; Stanley 2001, 71) are often the distinguishing features or means of designating the top and bottom of an item (figs 2, 3 & 4). "A surprising number of techniques can be used for casting or binding on. Each produces an edge with unique characteristics" (Hemmons Hiatt 2012, 37). All interlooped structures require a row of securing loops to prevent unravelling, unlike linked and most looped structures in which each loop is secured as it is made (Emery 1994, 39). Casting off is the process by which loops are taken off the knitting needles securely to prevent them from unravelling, for which the historical term in English was bind off (Rutt 1987, 14). There are a number of ways of doing this using two needles (or a hook) all of which are based on the basic techniques for making loops (Stanley 2001, 82-91 & 72). The result is usually a chain, where each loop is pulled over another until the final loop has the broken end of the yarn drawn through it (Hemmons Hiat 2012, 80). There are other less conventional ways of casting off, which use a single sewing needle (that is, with an eye), whereby the yarn is drawn through all the loops to secure them (Hemmons Hiatt 2012, 80). The top and bottom may be identified through the evidence of the edges or shaping (see below). If there is no evidence for the top and bottom, an expedient decision is advisable since it makes further discussion of the item easier. A description of the top and bottom edges – for example, **cast-on**, **cast-off**, **cut, torn, decayed** – is necessary. Note that the orientation based on identification of a cast-on edge, which establishes the working direction or technical upright, may not be the same as the direction of the fabric in wear or use. The sides may also consist of cut, torn or decayed edges (for examples, see Black 2012, 20 & 14, fig. 5) and/or **selvedges** (Hemmons Hiatt 2012, 72; Stanley 2001, 62), which are the "secure edge[s] of a knitted fabric" (ISO 4921:2000: 3.3.2). Some fragments of

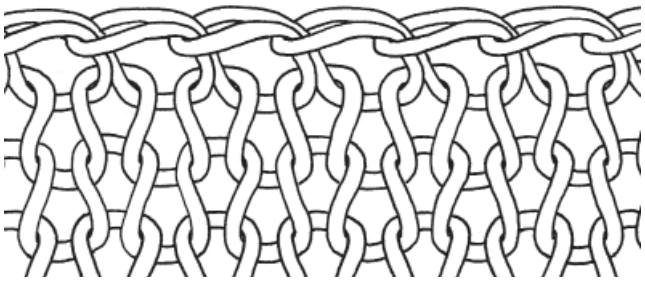

Fig. 4: An example of a finishing edge: a chain cast-off (Image: Sarah Thursfield)

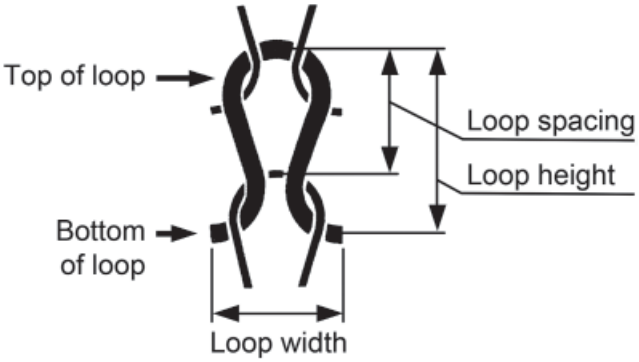

Fig. 5: Measurement of a knitted loop (Image: after Rikstermbanken, Swedish Centre for Terminology; with thanks to Hanna Bäckström & Sidsel Frisch)

archaeological and historical knitted material have edges which are all cut, torn or decayed. These may have been deliberately cut (as a decorative feature, for expediency in manufacture or to recycle all or part of the item) or accidentally torn in wear, storage, disposal or when excavated. It is useful to record these edges and to describe any evidence of finishing which has prevented the loops from unravelling.

The action of knitting creates loops, which are conventionally called stitches in knitting instructions. The term stitch more properly describes the action which creates the loop. This confusion is a particular difficulty of English. The word for stitch in other languages (for example, maske in Danish and Masche in German) refers only to the loop made in knitting. It is not used for the action of making a loop nor for a sewn stitch. The knitted loops can be measured as rectangles – often wider than they are tall (Eltahan et al. 2016). The length can be expressed either as the full height of the loop from top to bottom or the height of the interlinked part of the loop (fig. 5). The latter is proposed here as the more useful. These measurements are best recorded based on an average of at least ten loops (depending on the fineness of the knitted fabric) at different positions in the knitted item, and are essential details to note. These average measurements may be necessary in several sections of the knitted item if the loops are different sizes in different parts of an artefact or the fabric structure.

The continuous yarn forms vertical and horizontal lines of loops in the fabric. These can be represented in a similar way to vertical and horizontal elements in woven fabrics and provide the means to describe the fabric in detail using the equivalent of thread counts. The vertical columns of loops (fig. 6) are referred to as wales (ISO 4921:2000: 3.3.1). The wales may also be

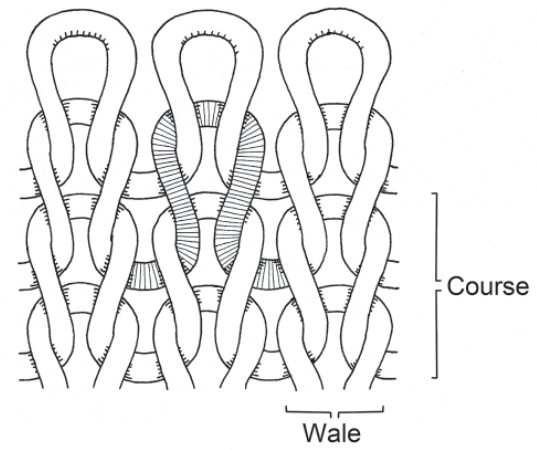

Fig. 6: Wales and courses in knitted fabric (Image: Sarah Thursfield)

expressed as a number per unit of measurement with the ruler placed perpendicular to them. The number of wales per 10 centimetres or per inch is a crucial descriptive detail for understanding a knitted item.

In back and forth knitting, the horizontal lines of loops in the fabric are conventionally known as rows whereas in round knitting they are named rounds. In other languages, a single word helpfully means both row and round (*rang* in French and *rij* in Dutch, for example). As it is very difficult to tell how archaeological fragments have been knitted, it is necessary to have a term which embraces the concept of the horizontal loops however they were made. In the knitting industry, these are known as **courses (**fig. 6; ISO 14921:2000: 3.3.3). It is also helpful to count the courses against a ruler placed perpendicular to the horizontal line of loops.

Counting wales and courses per 10 centimetres or per inch provides several helpful descriptors enabling comparison with similar items. Measurement over 10 cm is an ideal, but smaller measurements can be taken in several places and a calculated figure given, although this should always be stated. Achieving the appropriate number of loops per unit of measurement in the horizontal and vertical directions when knitting is a target known as the gauge (United States) or tension (United Kingdom). **Gauge** is the better term since tension more properly describes how tightly the knitter pulls on the yarn (Hemmons Hiatt 2012, 456). Multiplying the wales and course counts in a given square unit in this way provides the "stitch **[loop] density**" of a knitted fabric (Miller 1992, 94). Dividing them gives the relationship of the height to the width of the loops, which may be of use in technical analysis. This **course to wale ratio** is calculated by dividing the course count by the wale count. These calculations provide useful evidence for identifying fragments which come from the same item, assist in the identification of techniques and provide parameters for comparisons between knitted fabrics.

A further useful parameter for comparing fabrics is the **cover factor**, which has been long used in industrial contexts (Russell 1965). It has also been proposed in the archaeological analysis of woven fabrics as "the ratio of the area covered by the yarn, to the total area covered by the fabric" (Hammarlund 2005, 115). By substituting the loop counts in the wales and courses for the warp and weft thread counts, it is possible to calculate a cover factor for a knitted fabric: (W per cm × YD) + (C per cm × YD) minus (W per cm × YD) × (C per cm × YD), where W refers to wales, C to courses and YD to yarn diameter in cm. The number so produced is the relationship between the fabric elements and the space between them. The higher the number, the closer the fabric, with a maximum of 1 for the complete cover provided by heavily finished fabrics. It is noteworthy that yarn diameter is often an approximation and that this calculation may exaggerate the inaccuracy. It is therefore advisable to record whether it is an estimate or a precise measurement.

Naming the **surfaces** in knitted fabric is a challenge. Some fragments make it obvious which surface was intended to be seen – for example, if a decorative design is more clearly visible on one side than the other (Rutt 1987, 38). However, without knowing which way a knitted item was worn or used, it is sometimes not possible to discern which is the "right" surface (the technical face) – that is, the one intended to be seen. In knitting instructions and in several languages, the difference between right/left and right/wrong is confusing (Hemmons Hiatt 2012, xiii). **Recto** and **verso** are clearer terms for this purpose. However, it is necessary to state which surface has been interpreted as one or the other with any evidence supporting this decision, if available. An item may have other features (for example, shaping, seams, remnants of a lining or fastenings) showing which surface was on-the **outside** as opposed to hidden on the **inside** but fragments often lack these clues and it may be helpful for descriptive purposes to name the surfaces A and B or similar. The item may now be inside out, which makes the need for clarity even more important.

It is also not possible to say with any certainty which surface of a fabric was facing the knitter when it was under production or which way the knitter was working – from left to right or right to left (Thomas 1943, 53). In several languages, the loops are referred to as right/left loops and in English as knit/purl. "The terms purl and purling are essentially terms of

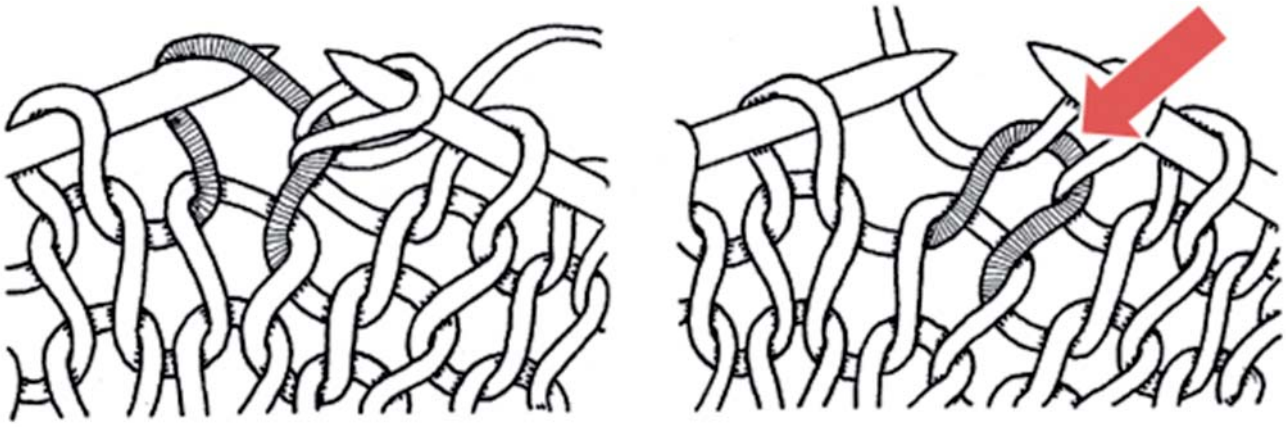

Fig. 7: Working a face loop on the recto of simple knit fabric – commonly called knit stitch (Image: Sarah Thursfield)

construction. They indicate the way the loop is made in relation to the implements being used. They do not describe anything about the actual structure of the fabric" (Emery 1994, 41). A right/knit stitch and a left/purl stitch produce exactly the same result – what differs is the loop's relationship to the face of the fabric. Therefore, the terms right/knit and left/purl belong to descriptions of the process not descriptions of the fabric. They are not helpful in the reportage of a knitted item because they simply guess at how it was made.

The distinguishing feature between the surfaces is the shape of the face and reverse of the loop in the knitted fabric (Rutt 1987, 12). These are described in several languages as smooth versus ridged or raised. The origin of the term purl in English reflects this defining feature, as it derives from its purled appearance, that is, rippling or uneven (*Oxford English Dictionary*). A surface with the smooth V shapes is usually interpreted as the face of the fabric. The other side of these loops, the bars making a ridged surface, are usually interpreted as the reverse of the fabric. The industry terms are therefore **face and reverse loops** (ISO 4921:2000: 3.1.2). It is possible for an item to have been worn or used with the reverse loops on the recto, the surface intended to be seen. Despite this potential confusion, face and reverse loops are adequate terms for describing the appearance of loops in a knitted item (figs 7 & 8). The production of face/reverse loops and the resulting recto/verso surfaces cause confusion for knitters when describing an item. This is because the effect of turning the work between courses when knitting back and forth alters the effect of working a knit or a purl stitch in relation to the fabric surfaces - and this is easily overlooked.

Most **shaping** in knitting is achieved by altering the number of wales (columns of loops) either by **increasing** or **decreasing**. It is not always easy to see in which direction the work was done (particularly with fragments and sometimes with entire garments)

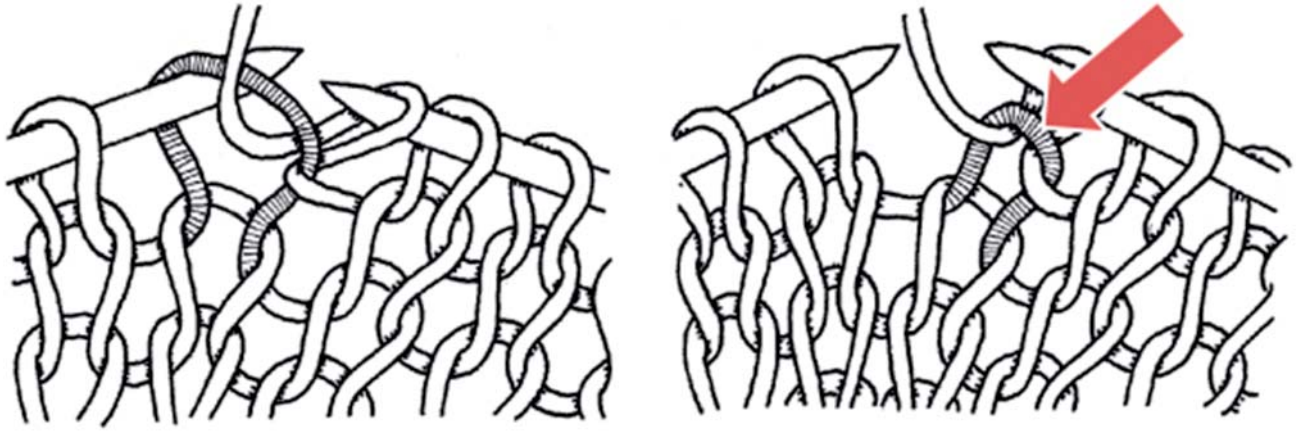

Fig. 8: Working a reverse loop on the recto of simple knit fabric – commonly called purl stitch (Image: Sarah Thursfield)

and this makes the distinction between an increase and a decrease hard to deduce. There are at least five methods of increasing the number of wales, which leave evidence in the finished item such as a small hole, the elongation and/or twisting of a loop (Rutt 1987, 14-15). Decreasing can be achieved by knitting through more than one loop at once (Rutt 1987, 15). This leaves evidence such as a loop leaning to the right or left or a hole where a loop has been slipped rather than knitted as part of the decrease (Stanley 2001, 117; Hemmons Hiatt 2012, 216-221). A guide to identifying increases and decreases in knitted fabric states (Ringgaard 2018, 35, in this issue) "A knitted loop has a head and two legs … When a new wale of loops is added by increasing, the loop head will be at the upper end of the first loop in this wale. If the number of wales is reduced by decreasing, the loop heads will be towards the point where the wale ends (Ringgaard 2018, 36, fig. 3, in this issue).

These features are hard to identify in worn fragments and it is often impossible to positively identify working direction from shaping. Often, these clues are not clearly visible because of deterioration, wear and tear in use, or the finishing process (see fig. 9 top left). Stress generated by distortion is often the cause of damage to archaeological textiles and this is evident in breakage at points where increases or decreases have been made. However, it is helpful to record the presence of increases/decreases if possible, with their locations in the knitted item.

An irregularity called a **jog** may be visible at the start/finish of the courses (Hemmons Hiatt 2012, 32; Stanley 2001, 31). As the yarn passes from the last loop at the end of a course to the first loop at the beginning of the next, it "creates a step at the intersection, which makes its first appearance at the cast-on edge and continues the entire length of the fabric" (Hemmons Hiatt 2012, 32). It is most noticeable if there are horizontal stripes, although there are techniques which can disguise this (Hemmons Hiatt 2012, 33). In addition, finishing processes can obscure the tell-tale irregularity. Close examination of a medieval Egyptian fragment (Victoria & Albert Museum T.201-1929) showed that, even though it is now a two-dimensional, irregular form, it was knitted round. Its construction is evident from "the typical mismatch of knitting courses that occurs when this technique is employed" (Black 2012, 11 & plate 4).

It is also necessary to describe the arrangement of loops in the knitted item, which define the structure of the fabric. This is often referred to as the pattern or "stitch technique" (Hemmons Hiatt 2012, 660) but the term pattern is also used for a complete set of instructions for making an item (Black 2012, 124). **Pattern** may be used for a decorative elaboration of the fabric structure, as distinct from **embellishment** (such as lace or embroidery) applied after the fabric is complete.

A knitted fabric with one surface composed entirely of face loops has the other surface composed entirely of reverse loops. If the recto is a mix of face and reverse loops in a sequence along each course, such as: three face loops, three reverse loops, then the other surface shows the same sequence reversed. A knitted item made up of several different arrangements of loops may be divided into sections (indicated by a stated number of wales and courses) and each described separately. All the above may be represented as charts, on grids or in diagrams and there is a growing consensus on a system of symbols for contemporary stitch and colour patterns in craft work, which it may be helpful to adopt for describing archaeological and historical knitwork (Thomas 1943, 17; Stanley 2001, 296-300; Frederiksen 1982; Hemmon Hiatt 2012, 391-426).

Words are also required for the fabrics produced by knitting. The fabric known as stocking stitch, stockinet, stockinette and jersey has one surface of face loops and the other of reverse loops. It may be made by round knitting (although using purl alone gives the same end result) or working alternate rows of knit and of purl stitches. **Simple knit fabric** is the proposed term here because "plain knitting", which has been used as an equivalent to "plain weave" (Emery 1994, 40-41; Seiler-Baldinger, 1994, 24-25) already has different meanings in different contexts. Likewise, the French term *jersey* has a host of other meanings. Terms which carry implications of left/right (such as *glatt rechts stricken* in German) are also problematic. "Garter stitch" refers to fabric with identical faces consisting of alternate courses of face and reverse loops. This is made by knitting (or purling) back and forth throughout, or by knitting and purling alternate rounds. The proposed term for this is **single ridge fabric**. For fabrics featuring more courses of one or the other, these may be enumerated and the result referred to as **ridge fabric**. This equivalent for vertical patterns is **single rib** which refers to alternate wales of face and reverse loops. For fabrics featuring more wales in the ribbed pattern, these may be enumerated and the result referred to as **rib fabric**.

International equivalents for simple knit, single ridge and single rib are required (*Nordiska Textillärarförbundet* 1979). Simple knit is known as *Glattgestrick*t (German), *Glatstrikning* (Danish), *Jersey* (French), *Tricot* or *Tricotsteek* (Dutch). Single ridge is known as *Kraus*

Fig. 9: A split-brimmed discoid now brown wool cap (Victoria & Albert Museum, inventory number 1562-1901) in simple knit with double-layered brims (crown diameter 25.4 cm; head circumference 54.61 cm; brim widths 6.35 cm & 5.08 cm) and a separate lining found in Worship Street, London (UK) features in the online database at www.kemeresearch.com with details for both objects recorded according to the draft protocol for reporting evidence for Early Modern knitting. There are 36 wales & 52 courses per 10 cm in the crown and 32 wales & 56 courses per 10 cm in the brims. Clockwise from top left - detail of the remaining silky nap at × 25 magnification on the recto showing how it prevents accurate measurement of the yarn, although it appears to be approximately 1.25 mm in diameter, Z spun and composed of two separate yarns (0.63 mm) which are not plied together; measuring the fibre diameters (average 22.7 µ based on 100 fibres); the cap as it is now displayed with the facing turned inside the brim; the cap as it used to be displayed with the facing outside the brim before comparative analysis with other similar caps suggested the arrangement shown is more appropriate; inside the cap showing the cut edge of the facing (shown vertically), the ridge at the brim/crown edge (shown horizontally) and the now red lining. (Images: © Jane Malcolm-Davies, except bottom right © Victoria & Albert Museum, London)

gestrickt (German), *Retstrikning* (Danish), *Point Mousse* (French), *Ribbels* or *Ribbelsteek* (Dutch). It is important to note, when describing a knitted fabric in an historical or archaeological context, that the fabric does not necessarily show how the work was done.

More terms will be required as the protocol grows to accommodate knitted fabrics with more complex patterns of loops – for example, fabrics made with two elements of the same yarn in various configurations, one working and one carried across either surface of fabric, which is designated **twined knit** here.

Fabric finishing or fulling is often called felting because these are erroneously assumed to be the same processes and to create the same effects (Phipps 2011, 33; Hemmons Hiatt 2012, 361). Felting coheres and combines dissociated fibres which have not been previously interworked to create fabric. Subjecting woven or knitted fabrics to finishing is more properly called fulling (Emery 1994, 20 & 22), which "aims at changing the touch (hand) and the appearance of textiles" (Desrosiers 2013, 33 & 39). The visible effect of fulling is the nap and this appearance is described as **matted**, although sometimes the word felted is used (for example, Crowfoot et al. 2001, 35). It is also possible that this matted appearance is the result of wear and/or long burial rather than deliberate **fulling**.

It can produce a surface entirely obscuring the knitted loops or woven threads, which may be raised to a **nap** and **shorn** (Emery 1994, 173). Fulling may also shrink the fabric (Emery 1994, 22) and reduce its elasticity (Hemmons Hiatt 2012, 362).

A note as to the current appearance to the naked eye and under magnification (if possible) is desirable. "Archaeological brown" may be all that can be documented about the **colour** without further analysis (Ringgaard & Bruselius Scharff 2010, 221). Reference to appropriate standards such as the Munsell or CIELAB colour system is helpful. Natural (undyed) colours are usually confined to those of sheep's fleece for wool: grey, black, white. Further evidence for **natural pigmentation** may be viewed using transmission electron microscopy (Bruselius Scharff 2017). It is useful to note if there is a suggestion that the fabric has been dyed.

The word knitting in English is used for both the verb (the process) and the noun (the fabric) (Emery 1994, 41). It also refers to the manner of making a face loop on the recto the fabric which in other languages is designated a "right" loop (as opposed to left): for example, *rechts stricken/arbeiten* (German), *endroit* (French) – that is, not purling. These three different meanings make knit a potentially confusing term. In other languages, the distinctions are better made (although there are variations to these terms in current use): *Strikning/Strik* (Danish), *Stricken/Strickarbeit* (German), and *Tricoter/Tricot* (French). Simply using the verb **work** for the making of loops in whatever manner is proposed here.

In Swedish, there is no single term for a finished **knitted** item. The adjective *stickad/stickat* is required. The term knitware has been coined in a discussion of the development of knitting (Thirsk 2003), although it has the disadvantage of sounding the same as "knitwear" (which implies clothing). Another potential term is **knitwork**, which is a helpful direct translation from other languages. In Danish and Swedish, the equivalent term refers to knitting which is being created (*Strikketøj/Stickning*). This would only apply to an unfinished knitted item, which is a rare archaeological or historical find.

Interpretation of the evidence

All the data collected must be treated with caution given that items which were subjected to finishing processes, wear and tear, and/or distortion by burial or storage may not now have the same dimensions or characteristics as when new. Knitted fabrics should not be diagnosed as the product of round knitting or back and forth in the same plane without clear and incontrovertible evidence. A knitted item with evidence of a sewn seam parallel to the wales suggests it was knitted back and forth and the selvedges joined to create a tube or cone. The distinguishing feature of round knitting is the lack of any seam, although there may be a jog (see above), and an item knitted round may be cut and sewn. It has been suggested that a number of fragments of medieval and earlier knitting "that are now flat can be shown to be the remains of round knitting" (Rutt 1987, 24). Without the fragments being identified or the clues provided, such an assertion cannot be corroborated. Only under very specific circumstances is it possible to state that an item was knitted round or back and forth. Fragments usually lack the clues which allow this to be stated with certainty. They key to the continued scientific study of early knitting is the presentation of evidence for all assertions stated in agreed terminology.

Conclusion

Specialised communication relies on consistency. This paper has argued a rationale for a systematic approach to the evidence for the development of knitting as a craft and an industry. It proposes a terminology for the discussion of knitwork with the aim of encouraging a scientific approach to describing the evidence whether the examination is undertaken by a textile analyst, a non-knitter or a non-expert volunteer. The proposed terminology for identifying, describing and analysing archaeological and historical knitwork appears in table 1 and a protocol for recording the observations in table 2. There are many more features and characteristics of knitted fabric needing unambiguous description which have not been discussed here. More work is required to capture accurately the full sophistication of knitted items.

In the following artices the authors have applied the terminology to a range of knitted items from museum and archaeological collections. These represent a first step towards developing a more sophisticated approach for describing knitwork and a diagnostic tool. Comment on the scope and usefulness of these materials to the study of the early evidence of knitting is welcomed and it is hoped that they "have not added to the confusion".

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Do you read my signal?

An attempt at the application of clear terminology in recording archaeological knitwork

Abstract
The lack of a conventional approach to the analysis of knitted fabrics has led to limited information being available for the study of early knitting. This paper discusses some reports of finds of knitwork and applies a newly developed terminology and a proposed protocol for reporting archaeological and historical knitted textiles to four previously published artefacts to demonstrate their clarity in use. It points out the pitfalls of assuming how items were knitted without appropriate evidence. It also proposes that some characteristics of knitted fabric such as gauge and yarn diameter are essential for the comprehensive understanding and comparability of early evidence for knitting as a technique.

Keywords: Archaeological, historical, textiles, knit, terminology

Introduction
Woven textiles are usually described and recorded accurately in archaeological reports but the same is not true for knitted fabrics. Handknitting itself lacks a precise vocabulary and the concern of this article is the description of knitted artefacts with clarity, using a consistent vocabulary that neither makes assumptions about methods of work nor depends on colloquial terms. The terms used here are those proposed after much discussion under the auspices of the *Knitting in Early Modern Europe* (KEME) project.
The structure of **knitted artefacts** or **knitted fabrics** or **knitwork** is what needs to be described, not 'knitting', which is the process. This article reviews some published examples and attempts a comprehensive description of the fabrics using the new protocol for describing knitwork proposed elsewhere in this issue (Malcolm-Davies et al. 2018).
In the following text, where preferred terms from the terminology, table 1 (Malcolm-Davies et al. 12-13, in this issue) or from the recording protocol, table 2 (Malcolm-Davies et al. 14-15, in this issue) are introduced, they are in **bold.** Most of these words are already used by hand knitters, by machine knitters or in industry and together they enable accurate and unambiguous description of knitted fabrics.
Woven textiles are usually recorded using a clear and agreed system but knitted fabrics are referred to by obscure or ambiguous terms such as "garter stitch" and "brocade patterns" (Thomas 1945, 16 & 49). While these may be suitable for colloquial use, for technical recording it is necessary to describe what can be seen, not how the observer thinks the structure was produced. This is challenging for knitters who are accustomed to thinking in terms of instruction rather than description. One fundamental issue is the use of the word "stitch" for the action of making a new loop, for the loop thus formed, and for the configuration of loops within the fabric. It is proposed that the word "stitch" be reserved for the action, and that the fabric is described in terms of face and reverse loops. A **knit stitch** worked on the surface presumed to be the "right side" or technical face, the **recto,** of the fabric and a **purl stitch** worked on the other surface, the **verso,** produce the same result: a new loop that shows on the recto as a **face loop**, which appears as a flat "v", and on the verso as a **reverse loop**, which appears as a horizontal bar. They are not two different things but the two surfaces of the same thing (see figs 8 and 9 on page 19,

in this issue). Fabric structures can also be represented as charts for added clarity. The use of charts is not new, having been a feature of *Mary Thomas's Book of Knitting Patterns* first published in 1943, and there is increasing consensus on a system of symbols for more complex fabrics (Chartgen; Thomas 1945, 6 & 56). The deduction of **orientation** and of **working direction**, sometimes known as technical upright, requires care and may not be possible because some common structures are reversible (table 2).

An apparent lack of understanding of the potential variety of knitted fabric structures is almost universal in archaeological and historical reports, and indeed elsewhere. Simple knit is the commonest fabric structure found and frequently the only one in an archaeological assemblage but the same can be said for the common weave structures, for which diagrams are usually given, and it would be pleasing to see knit fabrics treated with the same consideration. Diagrams or charts of structures may be given to avoid ambiguity, but more importantly shaping should be illustrated either with diagrams or photographs. Some previous reports of knitwork come closer than others to providing adequate information even where ambiguous terms are used. The problem may be illustrated with reference to published descriptions of artefacts.

In 1950, a major review of known prehistoric textiles in Britain was published (Henshall 1950). This was influential in establishing, for example, the use of S and Z to indicate spin direction, although since most of the information came from previous publications some of the descriptions are partial. Charts are given of most weaves mentioned (Henshall 1950, fig. 1) and diagrams of the more complex structures (Henshall 1950, fig. 2). There are no looped or knitted items in this report, but the following year *Early Textiles Found in Scotland* described items in the National Museum's collection "from the Roman period to the 17th century" (Henshall 1952, 1). Thanks to to a collaboration with spinner and weaver Morfudd Roberts, the weave charts and terminology are more professional although some of the entries are extremely brief. The descriptions of knitted items is for its time exemplary, although they lack illustration. Assumptions have been made about production, as in "stocking stitch and four pins have been used" (Henshall 1952, 24), but this is also the case with the woven examples. The same year the Gunnister finds were published (Henshall & Maxwell 1952), which included a number of knitted items. These are described in sufficient detail for a knitter to reproduce, but without any form of chart or diagram of the fabrics for the benefit of non-knitters. Photographs of the items are given, but they are not adequate to see detail. There are no diagrams of weave structures either, except an explanatory one of a warp-faced band (Henshall & Maxwell 1952, 35). No attempt was made to give yarn diameters, and the descriptions are subjective, but for its time Henshall's work was a beacon of good practice.

A commendable report (Walton 1981) details characteristics of 15 knitted textiles excavated at Black Gate, Newcastle (United Kingdom). Two assemblages of these fragments (T47 to T50 and T51 to T55) are the remains of knitted caps. Each fragment's dimensions, gauge per 5 cm, yarn spin, ply and twist, and colour are given (Walton 1981, catalogue II). No yarn diameters are provided but fibre diameters (range, mode and mean) and fleece types for two fragments are stated: T13 (early 15th century) is "true fine" and T47, which is part of a cap (early 16th century) is "shortwool" (Walton 1981, table 1). The finish of the fabric is also recorded with one of the caps described as "more felted than the other, perhaps from fulling; [on] the second … there is no attempt to mat the surface" (Walton 1981, 200). All the fragments are said to be "worked in stocking stitch" which is problematic in that it is a description not of the fabric but of a presumed process. The caps are said to have been knitted "from the centre … and at least one of them was worked on only two needles" but no evidence is cited for either of these assertions (Walton 1981, 200).

The following analyses and critiques are not intended to devalue the achievements of previous publications, but to demonstrate the application of the proposed terminology and protocol to improve the clarity of data presentation. The terminological shortcomings of publications will be briefly laid out followed by a section describing the same items using the proposed vocabulary from table 1 (Malcolm-Davies et al. 2018, 12-13, in this issue). These items have not been examined, and the new descriptions mostly rely on the information contained in the publication or more recent photographs of the artefacts reviewed.

Example 1: Published report (2001) on 14th century fragments of knitted fabric from London, UK (inventory numbers 316, 317 and 429)

Crowfoot, Pritchard and Staniland's exemplary catalogue of textile finds from medieval London includes descriptions of knitted fabric fragments (Crowfoot et al. 2001, 72-75). While the recording is good, the terminology relies to a considerable extent on familiarity with the technique, and with then current colloquial handknitting usage. The section is entitled

"knitting", a verbal form, in contrast to other headings such as "three-shed twills" and "hairnets" which are descriptive of the artefacts (Crowfoot et al. 2001, 72, 27 & 145). Four finds are listed and photographs of three are given. Two groups of fragments (316 and 317) and one separate piece (inventory number 429) are described, the fourth (inventory number 438) is neither described nor illustrated, although a **gauge**, the count of loops in a given distance both horizontally and vertically, is provided. The total number of fragments is not stated.

The **yarn structure** (table 2, 1) is given, but no measurement of **yarn diameters**, which would permit the calculation of the **cover factors** (Malcolm-Davies et al. 2018, 18, in this issue). The importance of this information is for accurate comparison, as subjective assessments can be misleading if used without supporting detail. The authors suggest, presumably by analogy with other surviving pieces, that the work was probably done **round** on all pieces. However the gauges refer to "rows" where **courses** would be unambiguous and the fabric is described as "stocking stitch", which, however familiar, is a purely colloquial term and not universal even among Anglophone readers. The photographs are clear and include an indication of scale, but no measurements are given.

There is no diagram to show the fabric structure or the placing of the features mentioned, the orientations of the fabrics are unclear and the presumed working directions are not indicated. The irregular decreases are described by means of a line of code of the kind used in published knitting instructions: "k8 (or more),

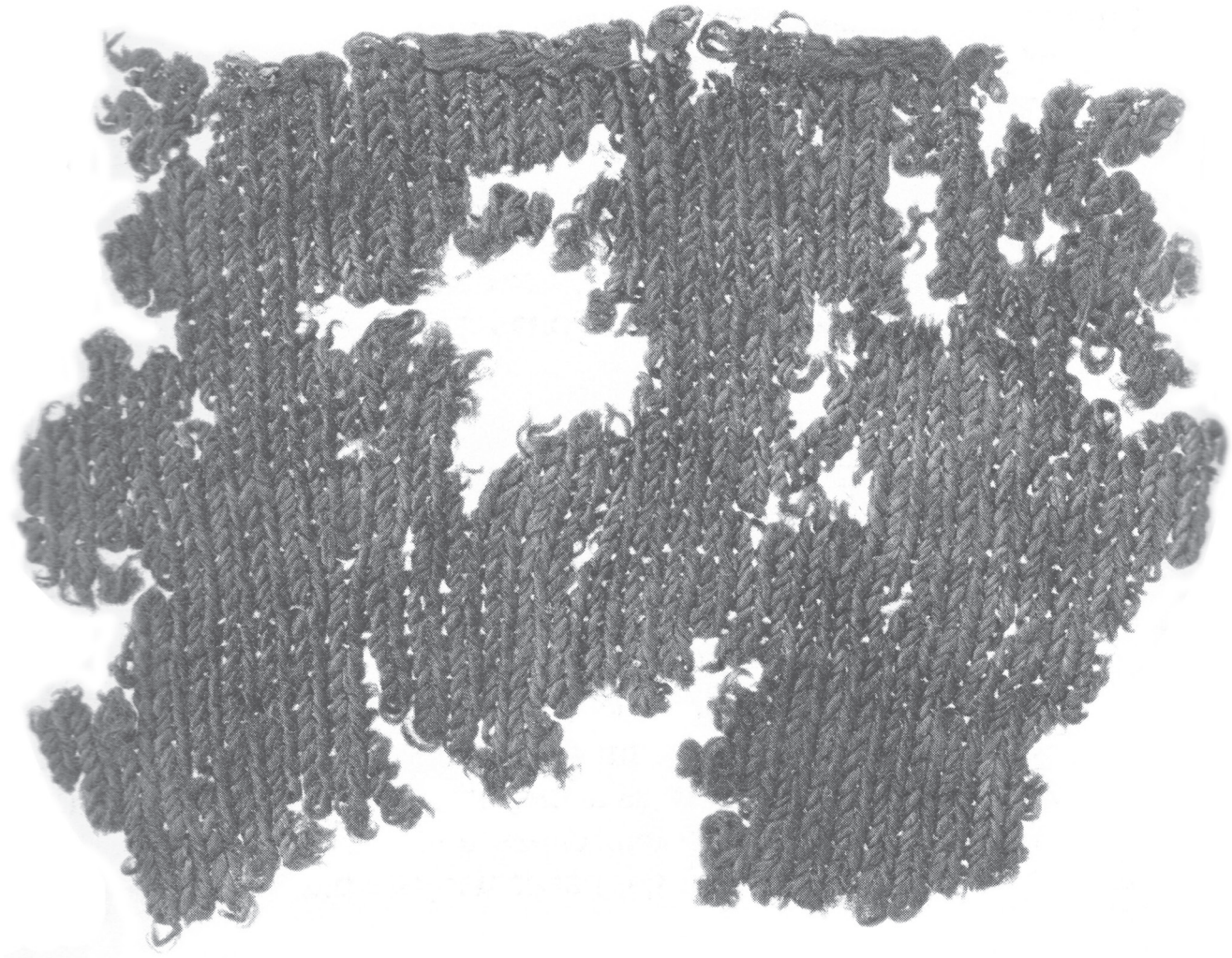

Fig. 1: Fragment of knitwork (inventory number 429) from a 14th century deposit. Scale 3:4 (Crowfoot et al. 2001, fig. 49, 74) (Image: Museum of London)

k2 tog, k2, k2 tog, k5, k2 tog, k3, k2 tog, k8, k2 tog, k2 (and probably more)". This is not explained for non-knitters. On the following page, a mention is made of a "decrease ... accomplished by knitting two stitches together" but no evidence to explain how this has been deduced is given. Edges are described as **cast on** and **cast off** without clarification as to why they can be so designated. Two red fragments of the same fabric (inventory number 316) are stated to have been dyed with madder, although no evidence is cited (Crowfoot et al. 2001, 72).

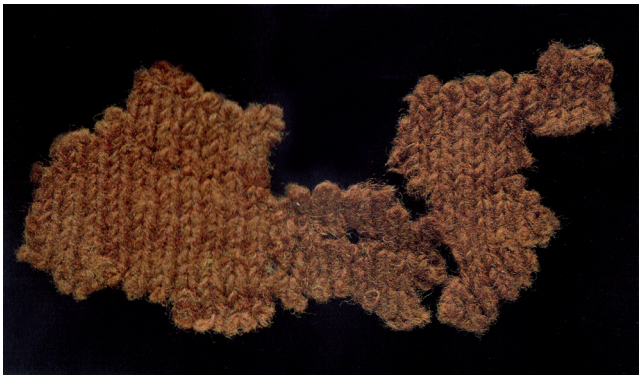

Fig. 2: Fragment of knitwork (inventory number 316) from a 14th century deposit worked in a two-ply yarn with a maximum width of 110 mm (Crowfoot et al. 2001, plate 13A, between 174 & 175) (Image: Museum of London)

Example 1: Proposed report on 14th century fragments of knitted fabric from London, UK (inventory numbers 316, 317 and 429)

The finds of knitted fabric consist of fragmentary pieces from 14th century contexts on the Thames embankment in London. The total number of fragments is not stated in the original report. The pieces are all **planes** (that is, pieces with one continuous edge and two distinct faces) made from wool yarn, Z plied from two S spun components, which can be abbreviated to S2Z (tables 1 and 2). Both **yarn diameter** and **spin angle** can be estimated from the photographs, but this is not really satisfactory. The fabrics are all **simple knit fabric**, often called "stocking stitch", "stockinet[te]", "plain" or "jersey"; that is, one surface consists entirely of face loops and consequently the other surface of reverse loops (it is essential to remember that a face loop on the recto appears as a reverse loop on the verso). There is no way of determining the recto or the method of working, but all could have been made by knitting round without the use of purl stitches, or by knitting alternate courses back and forth of knit stitches and purl stitches, turning the work. None of these fragments have a matted surface. The pieces are small, none apparently much over 10 cm in any direction, so the measurement of gauges can only be approximate (Malcolm-Davies et al. 2018, 18, in this issue).

No information is given about the single piece (inventory number 438, not illustrated) except the gauge of 20 **wales** (columns of loops) and 30 **courses** (rows or rounds of loops) per 10 cm, giving a **density** of 600 loops per 10 cm^2 and a **course-to-wale ratio** of 1.33:1. These data, the density (calculated by multiplying the wale and course counts) and the ratio (calculated by dividing the course count by the wale count), can be useful in matching pieces of the same fabric and may help to identify particular techniques.

The gauge of the other single piece (inventory number 429; fig. 1) is given as 50 × 40 per 10 cm (the first figure is the wale count and the second the course, following the convention for woven fabrics of warp × weft) but measurement of the illustration gives 30 × 50, or 22.5 × 37.5 per 10 cm when adjusted for the stated 3:4 scale of the photograph. Certainly, the given proportion is wrong. Using the figures from the photograph, the density is 844 per 10 cm^2 and the ratio is 1.66:1. This piece has several **shapings** and an edge that appears to be cast off, a simple chain of laterally interlinked loops. If this is the case, then the shapings must be **increases** to be consistent with the working direction. However, this edge structure can be produced by some methods of casting on (Stanley 2001, 74 & 75) in which case the appearance of the shapings is consistent with decreasing by working two loops together. Although the authors state that neither dye nor natural pigment was found in the analysis of this piece, one course is darker than the rest.

Two fragments of the same red fabric (inventory number 316 – one shown in colour in plate 13A; fig. 2) are in simple knit**,** the gauge stated as 20 wales and 40 courses per 10 cm, giving a density of 800 per 10 cm^2 and a ratio of 2:1. The illustrated piece has no surviving edges or shaping and looks looser and fluffier than the others illustrated. Two of the unspecified number of fragments inventory number 317 (figs 3A and 3B) appear denser than the others. They are also in simple knit and the gauge is stated to be 30-40 × 40-50 per 10 cm. Using the median for the calculations gives a density of 1575 per 10 cm^2 and a ratio of approximately 1.3:1. The density, almost twice that of the red pieces described above, is consistent with the appearance of solidity. One fragment has a finished edge described as cast-on and the other illustrated piece has a number of shapings that appear to include increases and decreases. The shapings are not in any discernible pattern. The results of the dye analysis are not given

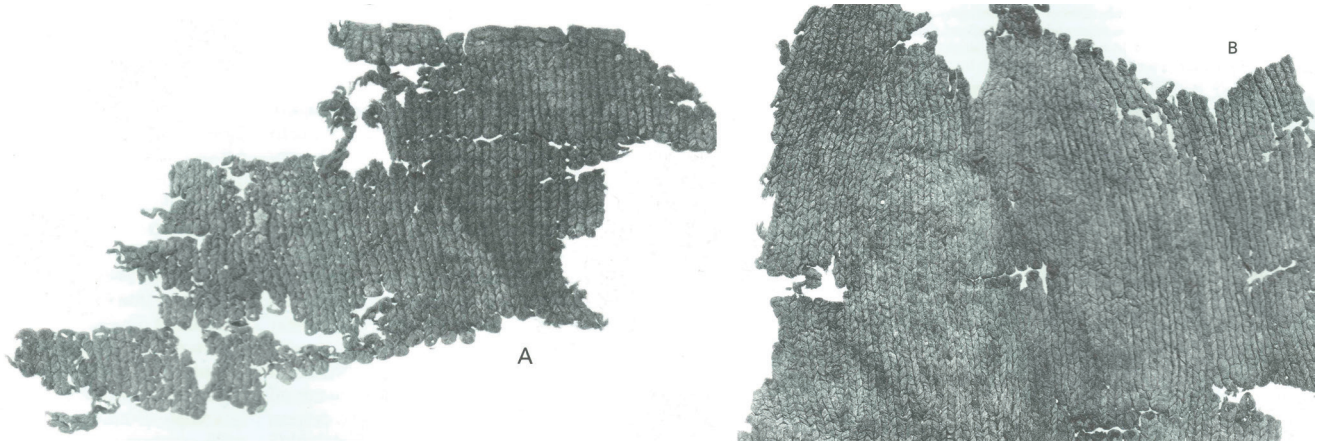

Fig. 3: Fragments of knitwork (inventory number 317) from a 14th century deposit. A is labelled "cast-on edge", scale 3:4 and B "detail of shaping", scale 1:1 (Crowfoot et al. 2001, fig. 47, 73) (Image: Museum of London)

but the colour is said to be "almost black" (Crowfoot et al. 2001, 73).

Example 2: Published reports (1987 and 2005) on a knitted tube from the *Mary Rose*, Portsmouth, UK (inventory number 981A1936)

There are two published descriptions of a knitted artefact from the *Mary Rose* shipwreck, a tube of simple knit fabric (981A1936). This is unusual in being reliably dated, as the ship sank in 1545 and the clothing aboard was presumably in use at the time. Richard Rutt's *History of Hand Knitting* includes a photograph and gives dimensions and gauge (Rutt 1987, 63-65) but no detail of yarn twist or diameter. His explanation of how the tube is constructed is clear to anyone familiar with the process of knitting a sock: "it has fairly regular decreases made by knitting two stitches together at the ends of three needles in a single round, the decrease rounds being set at regular intervals down the tube" (Rutt 1987, 63). The need here is for a diagram, for the benefit of those who do not knit.

The same artefact is published in *Before the Mast* (Richards & Green 2005, 58-59) with a drawing including scale (fig. 5), but this does not indicate the working direction or the positions of the shapings. The yarn is described and gauge given, but a method

Fig. 4: Knitted tube (inventory number 81A1936) from the *Mary Rose,* which sank in 1545 (Richards & Green 2005, fig. 2.31, 58) (Image: © The Mary Rose Trust)

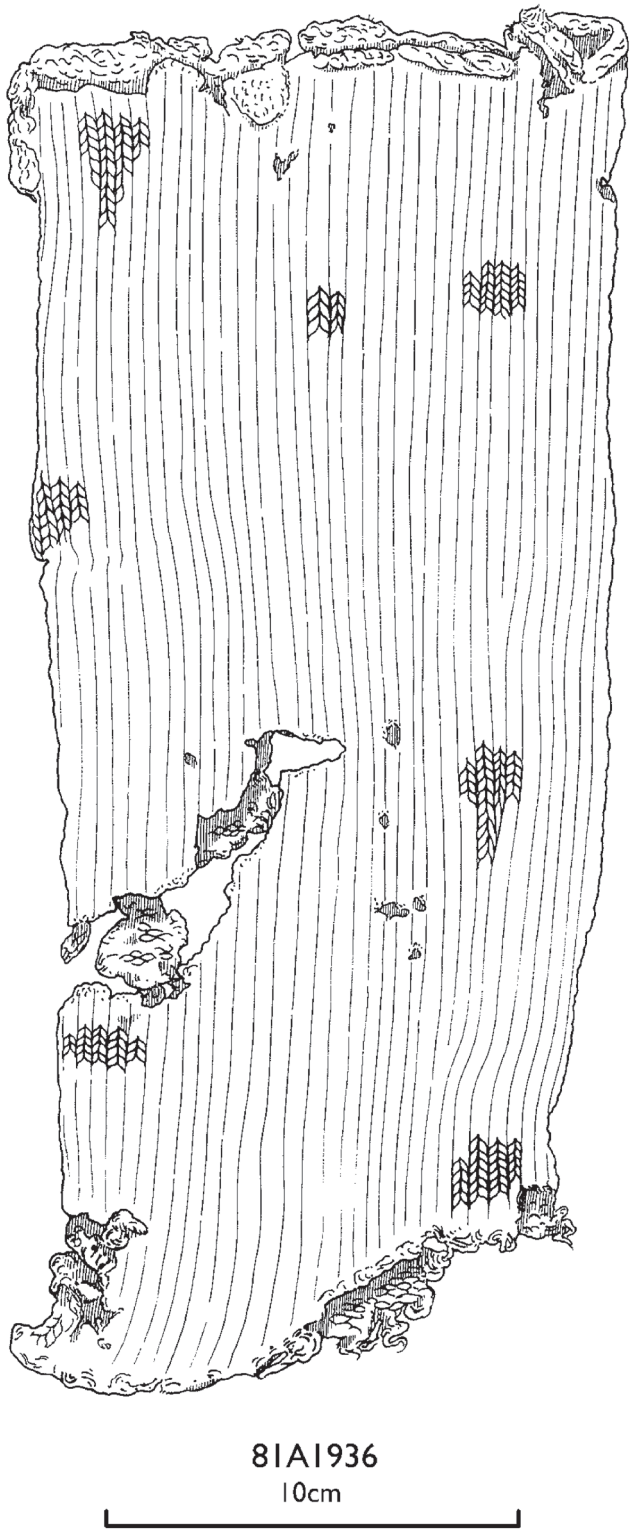

Fig. 5: Knitted tube (inventory number 81A1936) from the *Mary Rose,* which sank in 1545 (Image: © The Mary Rose Trust)

of casting on is stated that cannot be deduced from the object. After a description of the presumed decreases it is stated that "some garter stitch can be seen". Since the piece is described as a tube worked round, the term "garter stitch" is anomalous, referring to a method of working in rows.

These descriptions lack detail and neither states their presumed direction of work. Both give subjective assessments of the fabric, "heavy, black" (Rutt 1987, 63) and "coarse black woollen" (Richards & Green 2005, 58) but there is no indication of whether the colour is "archaeological brown" due to burial, naturally pigmented wool or dye colour.

Example 2: Proposed report on a knitted tube from the *Mary Rose*, Portsmouth, UK (inventory number 981A1936)

The photograph supplied by the museum (fig. 5) may be referred to here, although it appears in neither of the published accounts. This is a tube, the maximum length 34.5 cm and the width decreasing from 14 to 12 cm across, i.e. 28 to 24 cm round. It is of coarse wool yarn, S2Z, with no yarn diameter given. It is largely of simple knit fabric, the gauge stated as 24 wales × 38 courses per 10 cm, so the density is 912 per 10 cm^2 and the course-to-wale ratio is 1.58:1. These measurements are consistent with the majority of surviving stockings and sleeves of similar date in the Museum of London (for example, stockings inventory numbers A26851 and 39.188.5 and sleeve inventory number 22449). The number of wales is decreased from 72 to 56, all the decreases made by knitting two loops together if the working direction is as presumed, from the top down. The decreases are spaced at three points around the tube, suggesting the use of four needles, three holding the loops and one working. There are some reverse loops at the narrower end, just visible on the left in the photograph (fig. 4) that may be the remains of heel shaping similar to that of coarse stockings in the Museum of London that are presumed to be of a similar date. Some of these have heels turned with flaps made by knitting back and forth to form **single**

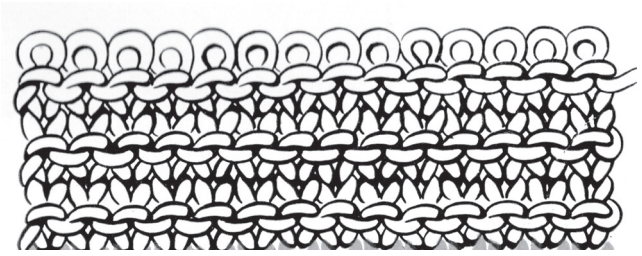

Fig. 6: Structure diagram of single ridge fabric (Image: No current copyright holder identified)

ridge fabric (fig. 6)**,** a ridged fabric with the same recto and verso appearance commonly known as "garter stitch". (Hemmons Hiatt 2012, 103; Thomas 1938, 217-221). Some images, detail and discussion of the London stockings have been published (Staniland 1997, 246 -247) and now further information is available (O'Connell Edwards 2018, 42-50, in this issue). There is no nap or matting visible on the Mary Rose fabric and although the colour is described as "black" (Rutt 1987, 63; Richards & Green 2005, 58) it might be better understood as the discolouration referred to as "archaeological brown".

Example 3: Published report (2007) on a fragment of knitted fabric from a 17th century latrine in Lüneburg, Germany (no inventory number)
This brief report is not really about the knitted piece so much as about the crystalline deposit on it but it does give some information (fig. 7). The article is in German and the translations have been made for this article. The yarn is inadequately described, no gauge is given and the explanation of the technique is not enlightening: "*Gestrickte rechte Maschen, auch glatte Maschen genannt. … Die Kehrseite zeigt das entsprechende rückseitige Maschenbild*". "Knitted in knit stitches, called stocking stitch … The other side shows the corresponding appearance of the reverse loops." Both the photographs show the fragment with the wales aligned horizontally.

Example 3: Proposed report on a fragment of knitted fabric from a 17th century latrine in Lüneburg, Germany (no inventory number)
One of an unspecified number of fragments of knitted fabric is described in some detail. They were excavated in October 2006 from a location recorded as

Fig. 7: Fragment of knitwork measuring 11.5 cm × 8 cm from a 17th century latrine in Lüneburg, Germany (Haase & Weißgraf 2007, 76) (Image: Lüneburger Stadtarchäologie)

Fig. 8: The recto and verso of a piece of knitwork measuring 19.5 cm long, 2 cm wide in the narrower part, and 2.5 cm in the wider part (Image: Museum of London, inventory number NN18752)

Baumstraße, Kloake 1, in Lüneburg, Germany, and are dated to the first half of the 17th century. The piece described is stated to be 8 cm wide and 11.5 cm long. It is of wool yarn described as "lightly Z twisted", which appears from the photograph to be made of two elements. The fabric is simple knit and the gauge estimated from the photograph is approximately 26 wales × 40 courses to 10 cm, giving a density of 1040

per 10 cm² and ratio of 1.54:1. It has no undamaged edges. There may be one or two shapings, apparently decreases, but the size of the scrap does not allow any interpretation. The surface shows no nap or matting. The wool fibres are described as brown and black, which could be natural pigmentation or staining from burial.

Example 4: Published description (1997) of a knitted strip in the Museum of London (inventory number NN18752)

Kay Staniland included some of the knitted items in the Museum of London's collection in an article largely devoted to changes in tailoring practice. One of these is an odd fragment described as a garter from imprecisely dated deposits said to be circa 1540 to 1560 (Staniland 1997, 247-248). The article includes a poor photograph (fig. 16.6, 248) with no scale and no description other than "This is a knitted garter … This must be the origin of the term 'garter stitch' , the most basic knitting stitch" (Staniland 1997, 247). The piece has been more recently examined in detail and the unpublished description made available for this article (O'Connell Edwards 2018) along with close scrutiny of new photographs (Malcolm-Davies 2018).

Example 4: Proposed description of a knitted strip in the Museum of London (inventory number NN18752)

This fragment comes from the same 16th century deposits as caps, stockings and other knitwork. It is 19.5 cm long, 2 cm wide in the narrower part, and 2.5 cm in the wider part. It is unclear from the photograph whether the ends are complete or damaged, and further examination of the artefact is needed to settle this. It is worked back and forth, as indicated by the selvedge on both sides, and, at the narrow end, there are seven wales. Every course was worked the same, either knit or purl, to produce single ridge fabric until the point where the strip widens. Here, there are three courses with the loops facing the same way, implying one course was worked differently (the same effect could be achieved by working in the same way and in the same direction with a second yarn, but there is no suggestion of yarn ends). At this point, a wale is added to one edge, another being added to the same edge on the next course. The measurement of the nine-wale section is 2.5 cm, giving a wale count of 28 per 10 cm. The course count is 54 per 10 cm, making the course-to-wale ratio 1.93, showing the contraction of ridge fabric. The yarn appears to be consistent throughout and its colour is "archaeological brown". As it stands, this fragment is clearly not a garter, being nowhere near long enough but it could be part of one if one or other end is incomplete.

Conclusion

Archaeological finds of non-woven fabrics have usually been assumed to be of interest only to specialists and have consequently tended to be marginalised. Assuming that those interested in knitting are knitters themselves is not helpful. Good practice in analysing and describing fabrics makes them more accessible, as has been demonstrated by the recording of woven fabrics. It is to be hoped that agreement on terminology and necessary information for reporting knitwork finds can help to create records of similar quality that are clear and comparable so as to be of real value to researchers.

Acknowledgements

I am grateful to all of those who have shared the unravelling of the mysteries of knitting, including Lesley O'Connell Edwards, and the nit-picking of words and things, including Sandy Black, Geeske Kruseman, Susanne Lervad, and Jane Malcolm-Davies. Thanks are due to Dorothée Wortelboer, who translated the German text.

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Maj Ringgaard

The church cap and the crypt cap:

Early modern knitted fragments found in Denmark

Abstract
Two Early Modern knitted caps are compared in terms of the quality of the fabric and way they were constructed. One is a flat cap which was probably knitted in the round on more than two needles. It was found in 2014 amongst rubbish on the site of a naval shipyard under a building dating to 1562. This suggests it is the oldest knitted fabric in Denmark known to date. The other cap is a brimless, head-hugging style which lay unnoticed in the National Museum of Denmark's collection for almost a century. The dating is uncertain but it is likely to be 17th century. This was probably not knitted in the round but worked back and forth with two needles or on a knitting frame.

Keywords: Cap, knit, grave find, early knitwork in Denmark, increase, decrease, knitted back and forth

Introduction
Evidence for early knitwear in Denmark includes an assortment of stockings, gloves, mittens and several caps and hats now on display at the National Museum in Copenhagen. There are also a number of stockings, some mittens, and nine examples of the so-called "sugar loaf" hats from excavation of layers dated to the 17th century in Copenhagen (Ringgaard 2017). Several fragments of 17th century *nattrøjer*, also known as waistcoats or petticoats, are held in a range of collections too (Ringgaard 2014). Two previously unpublished knitted caps from different locations in Denmark provide further evidence of knitwear in the Early Modern era and one dating to the 16th century may be the earliest known example of knitting in Denmark.
This article employs a proposed protocol and terminology for knitted items developed as part of the *Knitting in Early Modern Europe* project (see Malcolm-Davies et al. 2018, 10-24, in this issue).

The Holmens Church cap: description
One of the knitted caps currently housed in the National Museum of Denmark (inventory number X715 K387) was found near Holmens Church in Copenhagen. The church is situated on what was a small islet called Bremerholm next to the island Slotsholmen on which Copenhagen Castle (Københavns slot) stands. The naval shipyard was located at Bremerholm from around 1500. In 1562, an anchor smithy was built on the islet by the king's master builder, Peter de Dunker. This building was converted to a church in 1617 and further altered to create the present Holmens Church in 1641.
The knitted cap was found amongst other rubbish under the remains of the part of the building dating to 1562, together with at least another 18 textile fragments, including scraps of silk, a gathered strip of wool cloth, and shaped pieces of a coarse 2/2 twill textile of a type often seen in medieval finds (*vadmal*). These demonstrate evidence of tailoring. All appear to be discarded oddments from repairs or reuse of old clothing.
After the excavation in 2014, the cap and some of the other textile finds were moved to the conservation department at the National Museum of Denmark and freeze dried in order to stabilise them.
What remains of the cap is irregular in shape. It measures approximately 470 mm × 330 mm with a large hole near the crown centre, which is 60 mm × 90 mm at its

Fig. 1: The Holmens Church cap, inventory number X715 K387. Its find context makes it the oldest known knitted fabric in Denmark to date. What remains of the double edge is pictured at the left (Image: National Museum of Denmark)

maximum (fig. 1). As part of the edge is also preserved, it is possible to measure the crown depth (from the crown centre to the bottom edge) as 255 mm. The cap is single-layered apart from a 40 mm section at the bottom edge which is double-layered. One small section of the finished edge (80 mm in length) and the crown centre are intact whereas the outer edges of the cap are torn. The bottom of the cap is finished with a 16-course double-layered section finished with either a cast-off edge or a row of reverse loops.

It is not possible to know for certain which of the surfaces was worn towards the wearer's head but convention dictates that the reverse loops would be on the inside of the cap. The surface designated the recto for the purposes of clarity (and therefore the outside of the cap) is entirely composed of face loops, while the verso comprises the corresponding reverse loops.

A knitted loop has a head and two legs (fig. 2). When a new wale of loops is added by increasing, the loop head will be at the upper end of the first loop in this wale. If the number of wales is reduced by decreasing, the loop heads will be towards the point where the

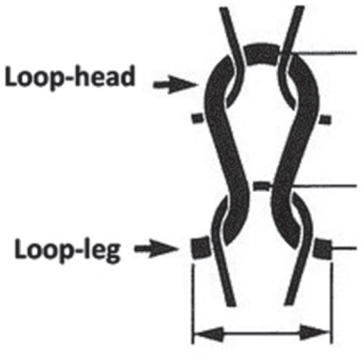

Fig. 2: A representation of a knitted loop showing the head and legs from Rikstermbanken, Swedish Centre for Terminology (available at http://www.rikstermbanken.se/rtb/visaIllustration.html?id=1929&termpostId=53059, last accessed 4 July 2017)

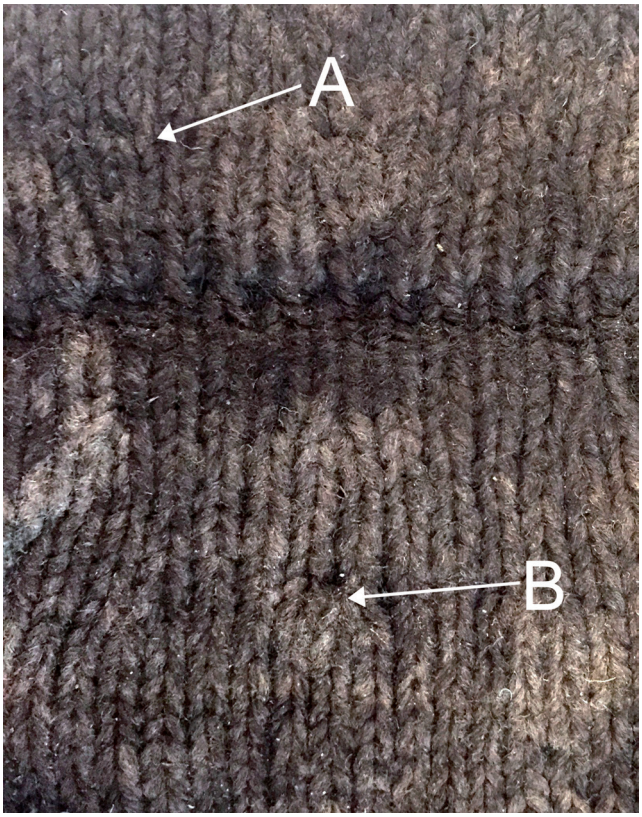

Fig. 3: The evidence indicating increases and decreases in the number of wales in the knitted fabric of the Holmens cap (inventory number X715 K387). Arrow A points to an increase and arrow B to a decrease (Image: Maj Ringgaard)

wale ends (fig. 3). Using these features, it is possible to note the location of irregularly placed increases and decreases in the number of wales observable in the knitted fabric. The irregular placement of increases and decreases means there are no lines on the top of the cap.

The knitted loops are on average 2.5 mm high and 4 mm wide. The gauge of the knitted fabric is different in the main part of the cap from the double-layered edge section. The number of wales in the former is 24 per 10 cm and the number of courses is 44 per 10 cm, while in the double-layered section the number is 28 wales and 48 courses per 10 cm. This indicates the edge section is knitted using finer needles than those used for the rest of the cap. (The course to wale ratio for the main part of the cap is therefore 2:1. The loop density of the fabric is 1056 per 100 mm^2).

Microscope analysis confirms that the fibre is wool, which is 28.03 microns in diameter (average of 100 counts). This indicates the fleece is medium grade (Kott 1993, table 1). The z-spun yarn is 2.07 mm in diameter (average of 10 counts) and constructed of two elements plied together. The spin angle of the yarn elements could not be determined.

There is some nap remaining on parts of the cap, which is darker in colour than the visible knitted loops of the ground fabric. This could be due to a different reflection of the light in the raised nap than in the smooth loops. The cap is now in various shades of "archaeological brown" the colour provided by the long sojourn in soil. The brownish colour is even and there are no obvious signs of pigmented fibres. As no dye analyses have been made it is not possible to say if the yarn was dyed (Ringgaard & Bruselius Scharff 2010, 221).

The Holmens Church cap: interpretation

Using the evidence for increases and decreases in the knitted fabric, it is possible to deduce that the cap was started at the crown centre.

Increases were made at every third loop in every three courses over 15 courses. Then, five courses were knitted without increases. After this, increases were made at every third loop in a single course. Then, seven courses were knitted without increases. After this, increases were made at every fourth loop in a single course followed by nine courses which were knitted without increases. After this, increases were made at every fourth loop in a single course. Then, 12 courses were knitted without increases. Decreases were then made by knitting every fourth and fifth loop together in a single course, followed by three courses which were knitted without increases or decreases. After this, decreases were made by knitting every fourth and fifth loop together in a single course.

The cap is finished with a 16-course double-layered edge. It is unclear if this was made as a separate knitted strip, where the face loops are on the verso, or if, after a course of reverse loops, another 16 courses were knitted and then turned back over the previous 16 courses and stitched in place. If the latter method was used, this resulted in a course of reverse loops finishing the bottom edge of the cap. But this cannot be seen because of the preservation condition. There are no visible sewing stitches at the top end of the strip, so the loops could have been picked up at the verso and cast off at the bottom edge.

The remaining nap on parts of the cap suggests that it was fulled, napped and sheared to create a raised surface, which originally obscured the knitted loops.

The Grindsted Crypt Cap: description

This fragmentary cap, which is currently in store at the National Museum of Denmark (inventory number

D10318), was found in Grindsted Church in southern Jutland in a crypt belonging to the manor Urup near Grindsted. The crypt was established at the beginning of 17th century and remained in use until the second half of the 18th century.

The cap was sent to the National Museum of Denmark together with a silk cap by a school teacher named Nielsen, who found them in the crypt when the church was rebuilt 1921. It is noted in the museum archives that the cap was found on the head of a man and was placed on the forehead and over the neck. Even though it was found on the head of a man, with some of the wearer's hair and skin still remaining inside, it is not now known to which body the cap belonged.

The wales radiate out from a central point. The number of and distance between the increases show that this was most likely originally a brimless, head-hugging style of cap (Malcolm-Davies & Davidson 2015, 226). This style, though frequently seen in artworks of the period – for example, Pieter Breugel (1565) *Die Jäger im Schnee* (Kunsthistorisches Museum, Vienna) – is the least numerous in the archaeological record (Malcolm-Davies & Davidson 2015, 228) making this a significant find. Comparable caps are at the Museum of London, United Kingdom (inventory number 13049) and Memorial University of Newfoundland, St John's, Canada (inventory number 29631c). The former is double-layered throughout and the latter has an extant separate lining. Another similar cap dated to the 18th century has recently been found at Gårdby Church on Öland in Sweden but details of it are not yet available (Ahlström Arcini, pers. comm.).

The cap comprises a single layer of irregularly shaped knitted fabric. The partial remains of the cap are very damaged with pieces missing, torn or rotten edges, and broken yarns. Although the crown centre is intact, it is not possible to measure the crown depth

Fig. 4. The Grindsted crypt cap, inventory number D10318. (Image: National Museum of Denmark.)

Fig. 5: The crown centre of the Grindsted cap with the two-stranded yarns from what may have been the sewn stitches at the sides of the cap, which was probably knitted back and forth near the centre. Also pictured is one of the much finer single yarns in a different colour from the cap (Image: Jane Malcolm-Davies)

or estimate the original head circumference as too little of the bottom edge of the cap remains (fig. 4).

The fragment is 425 mm wide at its maximum. This may represent approximately three-quarters of the original cap. Likewise, the crown depth is incomplete at 180 mm. There are long, loosely twisted strands of yarn along one side edge which appear to have been sewn stitches at one time. There are no cut yarns on the edge of this part of the knitted fabric. There is also evidence of the crown centre having been drawn together with a single thread to tighten it. The loose sewing strands have a larger diameter than the knitted yarn. The structure of both the knitted yarn and the loose sewing yarn is Z2s (two s-spun yarns Z-twisted), but the knitted stitches have a matted appearance, whereas the sewing strands do not (fig. 5).

As there are still remains of skin and hair, it is possible to determine that the surface with reverse loops was worn towards the wearer's head. The surface designated the recto (the outside of the cap intended to be seen) is composed entirely of face loops, while the verso comprises the corresponding reverse loops. There are irregularly placed increases in the number of wales which shaped the cap to fit the head. All the increases are in the upper 50 mm. The knitted loops are on average 2.5 mm high and 2.5 mm wide. The gauge of the knitted fabric is consistent throughout the fragment. The number of wales per 10 cm is approximately 40 and the number of courses per 10 cm is 48. The course to wale ratio is therefore 6:5. The loop density of the fabric is 1,920 per 100 mm^2.

Microscope analysis confirms that the fibre is wool, which is 19.5 microns in diameter (average of 100 counts). This indicates the fleece is fine grade wool (Kott 1993, table 1). The yarn diameter is 0.81 mm (average of 22 counts). The twist degree of the two yarn elements is not possible to determine.

There are at least nine short (up to 25 mm) lengths of separate, very thin worsted yarns, of a much darker colour than the knitted fabric lying on top on one side of the fragment and a few elsewhere. These yarns have some crinkles in them indicating they were stitched

into something at one time. These may have come from another textile worn by the deceased or a pillow under his head.
There are traces of nap on the cap, which are a darker colour than the ground fabric where the knitted loops are exposed. The current colour of the cap is a light yellowish "archaeological brown" (Ringgaard & Scharff 2010, 221). It appears to be produced of white or almost white wool and was probably not dyed.

The Grindsted Crypt Cap: interpretation
The placement of the increases suggest that the cap was knitted starting from the crown centre, and their concentration in the upper part of the fragment indicates that it did not have a long pointed top but a more rounded shape. It was probably knitted from the crown centre to the bottom edge and then sewn up to create a tube. This cap was probably knitted back and forth as suggested by the evidence of what may be a sewn edge, where there are broken yarns and stitch marks. The cap could have been knitted on two needles or on a knitting frame. The earliest knitting frames produced only flat items and the fabric could be as coarse as this cap is. The consistency of the gauge throughout the cap also suggests a frame-knitted garment (Rapley 1975).

Discussion of the Holmen and Grindsted caps
As Holmen housed the naval dockyards, it is tempting to interpret the cap found there as a mariner's cap or as belonging to one of the workers in the shipyard. It could have been discarded well before the building was raised in 1562. Too little is known to support these suggestions. It is likely that it was knitted in the round on more than two needles as there is no evidence of a seam, which would indicate working back and forth with two needles. It may have been knitted from the crown centre to the brim. The shaping achieved

Fig. 6: The Danish King Christian II wearing a fashionable knitted cap in a somewhat more elaborate style than the find from Holmens Church; from an altarpiece dated 1520, *Helligåndshuset*, Nykøbing Falster, Denmark (Image: National Museum of Denmark)

by the arrangement of the increases and decreases indicates the cap had a flat crown. This is the most numerous Early Modern style of knitted cap found in the archaeological record (Malcolm-Davies & Davidson 2015). It was in fashion all over Europe in the 16th century and was therefore likely to be so in Denmark. It is not possible to be sure if caps depicted in artworks are knitted but there are some indications such as shapes not easily achieved with cut and sewn fabric. The cap worn by the King Christian II on the altarpiece from *Helligåndshuset* Nykøbing Falster is one example (fig. 6). Looking for these caps in probate records or inventory lists is problematic as it is not certain what they were called at the time. Examination of Danish probate records from the period 1550 to 1650 revealed very few caps, and knitted caps are not specifically mentioned. This could be because it was obvious at that time that a cap called a *hue*, *lue* or *møsse* was a knitted item.

The lack of detail about the discovery and the context in which the Grindsted crypt cap was found yields little evidence of the wearer. It is most likely the style of headwear called a *nathue* (nightcap) in Danish. It was often worn by sailors in 17th century and is found in some whalers' graves at Spitzbergen (Ringgaard 2010; Jensen 1990). During the 18th and into the 19th centuries, it became the typical headwear of Danish peasants. It is somewhat puzzling that this knitted cap was found in a noble family's crypt. In the 17th to 18th centuries, the deceased often wore a nightcap when laid in the grave (for his final long rest). Evidence for this comes from many crypt finds but these caps are mostly of fabric – velvet or satin in four or six triangular pieces decorated with gold ribbons covering the seams (Mikkelsen et al. 2015). The knitted type is not known in any graves belonging to the nobility.

An unusual thing about this Grindsted cap is that it appears to be knitted back and forth and not knitted in the round as most other caps are. Most knitted items from this period seem to be knitted in the round, and there is no obvious reason for a cap like this to be knitted back and forth. However, it is possible that it is a frame-knitted item. Maybe this is the reason why a knitted cap was in this noble family's crypt – it was made using the new frame-knitting technique? There is no certain evidence for the use of knitting frames in Denmark before permission to start a 'factory' was given by the king in 1680. Before this there were frames only in the duchies of Schleswig and Holstein (Ringgaard 2017, 310). Grindsted is situated in the part of Denmark near to these duchies and goods produced there would have been accessible for this noble family.

The 18th century cap found in at Gårdby Church on Öland, Sweden, is of similar type. It was placed on the head of a person buried in a prominent position in the church (Ahlström Arcini, pers. comm.). This cap matches the Grindsted cap in style and colour, but whether this cap corresponds in yarn type and gauge or if it is knitted back and forth is still unknown.

Conclusion

The context of discovery for the cap found near Holmens Church makes it the oldest known knitted fabric in Denmark to date. The knitted nightcap from the Grindsted crypt is unusual in this burial context. The Holmens Church cap and the Grindsted crypt cap provide little evidence of who wore them or how they were worn. The latter retains particles of flesh and hair which may yield new knowledge if they are analysed using techniques for identifying DNA. The yarns too may be more forthcoming with the application of isotope analysis to investigate their place of origin and carbon 14 dating might pinpoint their period of manufacture with greater accuracy.

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Knitted wool stockings in the Museum of London:

A study of 16th century construction

Abstract
This paper presents the results of a study of the construction of 13 wool stockings dated to the 16th century, which are held by the Museum of London. Although knitted garments, especially stockings, became very common in later 16th century England, there has been little study of their construction in this period. Each of the stockings was examined in detail, including wale and course counts, leg shaping and heel and toe construction. Other knitted items from the same period in the collection were also examined to compare construction details. The light that these examinations shed on the construction of knitted stockings is discussed in detail, including leg shaping, toe shaping, and an unusual method of heel construction. The paper will also discuss the insights this study provides on knitted stocking construction in this period, including support for archival evidence.

Key words: Knit, stocking, wool, early modern, 16th century

Introduction
Knitted garments became very common in later 16th century England, especially stockings or hose, which were worn by virtually everyone by the end of the century. Thirsk (1973) calculated that most people would need at least two pairs annually; later research in the Netherlands (Decaleur 2001) suggests people might have needed at least three pairs. Knitting was a by-employment, not a structured industry, but was nevertheless effectively an "industrial" process – knitters knitted their items and sold them to merchants, or to others, for selling on. There are records of stockings being lengthened (Arnold 1988, 209), so it is likely that knitters made standard sizes; how many were made to fit, possibly by private commission, is unknown. Inventories of merchants and other documents often list pairs of stockings by the dozen or other multiples (for examples, see O'Connell Edwards 2007-8).
Very little is known about how knitted garments from this period were constructed. Some research has been done on the knitted fabric of caps (for example, Malcolm-Davies 2017). Civic authorities set up schemes in the later part of the sixteenth century to teach knitting because it was seen as a way to provide the poor with an income, especially stocking knitting. These sometimes provided buildings, yarn and tools. A few records of knitting teachers and knitting schools from the sixteenth century have survived (O'Connell Edwards 2013), but none provide details of the actual practicalities of how people learned to knit, nor how they created and shaped garments, including stockings. The first knitting pattern, which was for a stocking, was published in 1655 in *Naturata Exenterata* (Rutt 1987, 239-241). To understand the construction of knitted items, therefore, we need to look at surviving archaeological finds from the period.

The 16th century stockings in the Museum of London
The Museum of London has a collection of 13 wool stockings and part stockings which are dated to the 16th century. This is the largest known collection in the United Kingdom, and was found in a relatively small area of the City of London, at Finsbury and Moorfields, which is part of the modern London Borough of Islington, whose total area is less than

Museum of London Accession number	Notes
Stocking (or sock – terminology varies in the catalogue entry)	
39.188/4a	
39.188/4b	
39.188/5	
22399	(leg only)
22400	(foot only)
22401	
22402	
22403	
A26602.b	(foot only)
A26851	
A26852	
A26875	(child's stocking – in very poor condition)
A26876	(described as baby's stocking)
Other items, examined for comparative purposes	
Child's mitten A1989	
Silk stocking A13833	(foot only)
Sleeve 22448	
Sleeve 22449	
Sleeve 22450	

Table 1: List of items examined.

15 km^2. The museum's collection also holds three wool sleeves, a child's wool mitten and a silk stocking foot, dated to the 16th century, which were also studied to compare their methods of construction with that of the stockings. Table 1 lists the items examined.

Examination methods

The terminology used to describe the stockings is that suggested by Malcolm-Davies et al. (2018). Each item was measured and examined in detail, for wale and course counts, shaping and any other construction detail. The individual loops were examined under a hand magnifying glass; a USB microscope did not improve the clarity. Points of decrease and increase were identified by the formation of the wales. Decreases make a smooth line, and one loop appears to be absorbed by the other. Increases could be identified by a small hole below the point where one stitch becomes two. Yarn diameter was measured from micrographs.

Findings on materials, construction and finishing

All the stockings still retain at least some of their original tubular form, and are simple knit fabric, with face loops on the outside (recto), created by knitting in the round, aside from the heels which were created by knitting back and forth. They show many similarities but are not identical. The stockings examined were previously identified by the Museum of London as being created from wool yarn, and this examination did not provide any evidence to challenge this, although its primary purpose was to look at how knitting created the finished items. The museum provides data on the yarn construction for four items, which are recorded as "2 ply, S spun". Most of the loops are clearly visible, although some are less distinct, covered by a nap, possibly fulled, probably as a result of wear or laundering. The other items used for comparative purposes are all identified by the museum as made from wool yarn, aside from A13833, which is identified as silk.

Wale and course counts, gauge and yarn diameter

The number of wales per 10 cm on the adult stockings are all within the range 27 to 33, and the course count per 10 cm varied from 40 to 55. The two small children's stockings (A26875 and A26876) have a higher count – averaging 45 wales and 60 courses per 10 cm.

Yarn diameters were measured for eight stockings. Individual diameters were quite variable, which reflects the hand-created nature of the yarn, but there were two distinct groups. The average yarn diameter of five of the stockings (39.188.4a, 39.188.4b, 39.188.5, 22401 and 22402) was in the range 1.24 mm to 1.56 mm (total range 0.92 mm to 1.99 mm). The yarn diameters of the other three (22400, 22403 and 26876) were narrower, with an average ranging from 0.92 mm to 0.98 mm (total range 0.65 mm to 1.38 mm).

Leg construction

Only six of the stocking legs have their top edge preserved, which means the original leg length is unknown on the others. The child's stocking A26875 also shows a finished edge at the top, but it is too badly damaged to measure the length of the leg accurately. The construction of the stockings was from the top down, confirmed by the fact that the decreases towards the heel are clearly visible. Four of the cast-on edges have the appearance of a "cable" cast-on in which each loop is created by drawing the yarn between the last

Fig. 1: Example of short-row single ridge heel construction on a stocking (inventory number A22402) (Image © Museum of London)

Fig. 2: A variant heel (inventory number 26851) with a single ridge short-row heel knitted back and forth with loops picked up along the side. It then reverts to be being knitted round (Image © Museum of London)

two loops on the needle (Stanley 1982, 15). Those of items 22403 and 39.188/4a are different from the other items in having obvious horizontal 'V's, and there is also a small chain of a few loops joined to the top edge (fig. 8). The length from the top of the leg where there is a finished edge to the start of the heel on four adult stockings (39.188/4a, 39.188/4b, 26851, 26852) varies from 30 cm to 33 cm but item 39.188/5 measures 38 cm between those points, and item 22403 only 22 cm. The width at the top on the longer legs varies from 21 cm to 27 cm and the width at the heel is generally 18 cm; on items 39.188/4a and 39.188/5 the wale count is coarser at the top of the leg than lower down, 28 per 10 cm rather than circa 32 per 10 cm.

Wales were counted and measurements taken at various points down the length of the legs. The counts varied from leg to leg, depending on its finished appearance. All the stocking legs are tapered, but there is no set pattern for this. Decreasing is not done at set intervals nor is it is it usually done above a previous decrease. Item 22401 is an exception, with a vertical line of decreases at the front which results in a diagonal slant on the leg, with four decreased in six courses, then six or seven courses without decreases followed by another three decrease courses, each separated by two or three courses without decreases. Most of the stocking legs have a flow of decreases - but two (items 39.188/4b and 22402) have more decreases only around the ankle area, whilst item 26851 has a few decreases on the upper leg, and the majority in the ankle area. The wale count on item 26852 remains the same all down the leg, though the width reduces. The sleeves were examined for comparison, and showed a similar tapering shape, although one may have been increased up from the wrist.

Item A26851 shows a clear colour demarcation line at 9 cm above the start of the heel; item 22401 shows a similar demarcation at 10 cm above the start of the heel. On item 39.188/4b the yarn appears to be thicker on the leg from 7 cm above the top of the heel section. Only the foot of item 26602b exists; its heel edge is a straight line, suggesting it may have been cut.

Only the silk stocking has a marker rib (a so-called false seam). None of the wool stockings has this feature.

Heel and foot construction

Nine of the stockings show a similar heel construction, with every row knitted back and forth rather than round, resulting in ridges. Experimental reconstruction has shown that this is single ridge fabric, as the ridges caused by the alternating direction of working, resulting in alternating courses of face and reverse loops on each side, are more distinct that they would be in the verso of simple knit, in which every row consists of reverse loops. The heel section is worked with only some of the loops, using a "short-row" construction, as the knitting is turned before the course has been completed, and knitted back across the work in the previous row (Righetti 1986, 114-117). On some courses another loop is incorporated at the end of the ridge. This extra loop increases the width of the heel (fig. 1): the relative position of the extra wales and ridges is different on each stocking. The number of wales added vary on each side, and their positions are not mirrored. Usually, fewer than half the total leg wales are used in the heel. The stocking then continues to be worked round, and the foot is usually worked straight to the toe section.ridgeThere are two exceptions to this single ridge short row construction. The heel of item A26851 (fig. 2) is created by knitting back and forth across the width of the heel flap and then picking up loops along the side of the heel flap, at an average of one loop per two ridges (i.e. every fourth course), knitting into both ridges, although two loops link to only one ridge. The stocking then reverts to being knitted round. One decrease was noted on the underside of the foot, about 2.5 cm away from the heel. Seven decreases were observed in the instep side of the foot in the area from 2.5 cm above it to the start of the heel, which cancel out some of the extras picked up from the heel – the foot is not noticeably wider than the leg at the ankle. Further decreases occur on the foot, 7 cm after the heel.

The heel of item 22401 (fig. 3) is also created by knitting straight on all the heel wales, and then picking up loops from the end of the ridges. The rate of pick-up is generally one per ridge (i.e. per two courses), and wales are then decreased along a gusset line, which is created by all the decreases being knitted to the side of one specific wale, which is differently situated on each side of the foot. On one side, the line starts near the bottom of the foot, and points diagonally down towards the underside of the foot. Five wales are decreased over 25 courses, finishing about 5 cm from the pick-up line. The other decrease line is straight, and the decreases are on the top of the foot, so the picked up wales are all straight – 10 wales are decreased over 7 cm.

Item 39.188/5 has what seems to be an extra, now golden brown, strand in a rectangular area above the back of the heel 15 courses high and 25 to 26 wales wide. The demarcation between the two vertical zones is very clear.

Fig. 3: A variant heel (inventory number 22401), with a single ridge short-row heel knitted back and forth with loops picked up along the edges and surplus wales being decreased along a gusset (Image © Museum of London)

Toe construction

A total of seven stockings have either complete or partial toes. Aside from item 22401, the construction is similar and very basic. The width of the foot is reduced close to the toe, by several rounds of decreasing by knitting two loops together repeatedley within 3 cm of the end of the foot. The number of wales decreased in a course varies – on item 22403 the number of wales is halved, whilst on others, such as item 39.188/4b, only some are decreased. Item 22402 (fig. 4) shows that the decreasing was done in segments. Some stockings have at least some of the decreases separated by a course without decreases. On some feet (items 22400, 22403, 26602b and A26851), there are a few decreases before the main block of decreases for the toe, 5 cm or less from the toe. Item 22401 is an exception to this. It has a line of

Fig. 4: The toe of stocking inventory number 22402 with decreases in segments (Image © Museum of London)

Fig. 5: The decrease lines on the toe of stocking inventory number 22401 (Image © Museum of London)

decreases towards the toe, starting at 7 cm away from the toe, on both sides of the foot, with several courses without decreases between each decrease. On the top of the foot there is a pronounced inverted "V" of decreases at the point of the toe, creating a triangular shape (fig. 5).

Interpretation

Wale and course counts and yarn diameter

The wale and course counts on the adults' stockings were all within a small range, suggesting that similar yarn and needles were used. There was no automatic correlation with wale/course count and yarn diameter. A22400 and A22403 had the smallest yarn diameter, and a high wale/course count (33 wales and 50 to 55 courses per 10 cm); but although the yarn diameter of 39.188/5 and A22401 was larger, they had a similar wale count, though with only 40 courses per 10 cm; whilst 39.188/4b had a lower wale count, but a closer course count (49 per 10 cm). The variation may be due to individual knitters' styles, knitting more tightly or loosely, but the effect of washing and wearing, and the effect of being in the ground for more than 300 years must also to be considered. Sleeve 22450 had a similar wale count, but a course count of 53 per 10 cm. The wale/course count for the silk stocking foot was much finer – c. 72 wales and 120 courses per 10 cm, and the yarn diameter much narrower, with an average of 0.53 mm (range 0.48 mm to 0.58 mm).

The wale/course count on the children's stockings was finer than the adult wool ones ranging from 41 to 60 wales and 55 to 66 courses per 10 cm. The yarn diameter measurement for A26876 was the narrowest of those sampled, with an average of 0.92 mm (range 0.65 mm to 1.24 mm). There are two possible reasons for this: either that these items were initially made for a child of the upper classes whose family could afford finer yarn, and passed them on; or that it was common practice to use finer yarn for garments for children. However, the wale/course count for the mitten (A1989) is similar to that for the adult's wool stockings, as is that of the child's mitten held in the Norfolk Museums Service (NWCHM 1961.74.6), suggesting the first possibility is more likely.

Leg construction

An examination suggests that the cast-on edges may have been created using a "cable" cast-on (see above). Tiramani and North suggest a "purl chain cast-on", creating each loop from the last, for their re-creation of a 17th century silk waistcoat (item 807-1914) in the

Victoria & Albert Museum, London (2011, 16). Rutt (1987, 13) considers that the "thumb" method was the most commonly used in this period but cites only secondary sources. However, the cast-on used on items 22403 and 39.188/4a was probably achieved by making a looped chain and knitting into the loops (Ringgaard 2016): the loose loops there being the unused part of the chain.

Women's stockings in the period are occasionally listed as a specific item, particularly in inventories (for example, Raine 1863, 277). The two different leg lengths observed on the adult stockings could suggest that the longer ones were men's and the shorter one a woman's – or an older child's. The wide range of widths at the top of the legs may simply reflect the fact that they were worn by people with different leg sizes, and, in some cases, the coarser wale count suggests the fabric had stretched to accommodate a wider leg. The reduction in width down the leg of item 26852, despite a lack of any wale decreases, is another indication of the elasticity of the knitted fabric, and the effect of wear.

The unusual position of the shaping on the front of item 22401 could suggest that the knitter had seen an ornamental line created by knitting two wales together, possibly like that on the silk stocking foot A13833, and was experimenting to reproduce this. The fact that this stocking has two gussets decreasing the heel wales by knitting two together on the same wale line, albeit at different positions each side of the foot, is further support for this interpretation, but shows that either the knitter did not have an understanding of how to mirror ornamentation, or did not feel the need to do so.

It could be argued that some stockings show evidence of re-footing, with a cut line at the top of a foot, or a straight line across the leg suggesting a yarn change, after a damaged or worn out foot and heel section had been cut off. Evidence for re-footing stockings occurs in literature of the period – see, for example, Historical Manuscripts Commission (1895, 17) and Arnold (1988, 209). However, a linear change could simply indicate that the knitter had started with a new yarn at this point. It is possible that the silk stocking foot, which has some damage, was cut off in order that the leg could be re-footed.

Heel and foot construction

The heel construction on all the stockings except A26851 and 22401 has not been described elsewhere, other than in instructions for a reconstruction of a child's stocking (Huggett & Mikhaila 2013, 147).

Fig. 6: A silk stocking heel (inventory number A13833) showing a fully-fashioned heel shaping, and foot gusset (Image © Museum of London)

Fig. 7: Reproduction of short-row single ridge heel construction (Image: Mike Edwards)

Norfolk Museums Service has a stocking which dates from this period (NWCHM 1961.74.3), with this style of short row single ridge heel construction, at least one of which was found in London. Reconstructions (fig. 7) show that the short-row single ridge construction of the heel on the Museum of London stockings does make a reasonably elastic heel in wear with stretch around the outside of the heel and ensuring a smooth and unwrinkled fit on the front of the foot, and also places the toe finish not at the tip of the toes but in under the gap between the toes and the ball of the foot.

This construction is quite different to the "common heel" (Laning 2011, 29) which is often used in reconstructions (Ravelry 2007) and modern heel construction, which makes a shape specifically for the heel. Both divide the leg into two sections at the heel, and continue using half the wales, until the base of the heel is reached. The flap of a "common heel" is folded in half and joined into a seam, and the stocking continues by picking up loops along the side of the heel flap, and reverts to being knitted in the round, usually decreasing the number of wales.

A modern heel uses variations of short-row shaping for the section under the heel, before picking up loops along the sides of the flap, and reverting to knitting in the round, with excess wales being decreased along a "gusset line" at the top of the heel angling down towards the foot. The two exceptions in the Museum of London use parts of these two methods. On item A26851 wales are decreased just above the heel, then picked up along the side of the foot, and then wales are decreased circa 7 cm away from the heel. On item 22401 loops are picked up along the side of the heel and decreased along a gusset line on both sides of the foot. Neither use short-row shaping under the heel.

The silk stocking foot, A13833, (fig. 6) is fully shaped along its length. The leg has been divided, and the heel continued to the base of the foot only on the loops at the back of the leg, decreasing both edges of the flap thus made. More loops have been picked up from the edge of this, at 90 degrees to the continuation of the heel. These are then decreased away, in a fashion similar to a modern heel. "Gusset" lines of decreases run steadily down from the top of the heel along the length of the foot, on both sides, each taking away more than 50 wales. Underneath the foot are two lines of reverse loops on the recto, with increases beside each line, resulting in the underside of the foot steadily widening as it gets nearer the toe, partially compensating for the gusset decreases. The silk funeral stocking of Johan III of Sweden, dated to 1592, shows a similar mode of construction (Ekstrand 1982, 166-168).

The extra strand above the heel of item 39.188/5 is unlikely to have been knitted in because knitting in the round requires it to have been carried as a loose strand for the remainder of the circumference of the stocking, or broken and reattached on every course. It was not possible to examine the inside of the heel.

Toe construction

Some of the toes, such as 39.188/4b, show evidence of the decreases being made in segments. It could be argued that this was a design feature – but it may simply be how the knitter found it easiest to decrease for the toe. Item 22401 has clear lines on its toe, suggesting these could be intended for ornamentation.

The end of a stocking foot created with the heel shaping used on the majority of these stockings finishes slightly under the toes, on the underside of the foot, with the final part of the toe decreases fitting in the gap between the ends of the toes and the ball of the foot. The "knit two together at very frequent intervals" method might be expected to create an uncomfortable lump of fabric under the foot in wear. However, a reconstruction knitted in this way showed it does not form a large lump.

The toe of the silk stocking (A13833) is very different. It is foot shaped, with decreasing only at the sides of the foot, and the remaining loops in the centre of the foot, on the top and the underside, appear to be cast off

and joined together, looking rather like a fish's mouth. It is possible that the knitter of item 22401 was trying to mimic what they could remember of the shaping on a similar stocking to A13833.

Conclusion and further research

The uniformity of construction of many of these stockings suggests a standard method, but it is dangerous to extrapolate from a negligible percentage of all stockings created in the period. It is possible that the majority were the work of one person, or of a collection of people in the area, who may possibly have been trained by one person; or that these stockings were created to suit the demands of one merchant. It could be argued that a localised construction method existed in the area; but the variations shown, especially in the heels and feet of 22401 and 26851, suggest that knitters were aware of other construction methods. Their awareness might well have been through seeing other stockings, including finer, silk ones, such as A13833, and adapting what they could remember of these for coarser wool ones.

It would be instructive to make a detailed examination of the construction of other stockings from the period in similar detail from different geographical areas, to identify further points of comparison and contrast.

Fig. 8: Stocking inventory number 22403 showing cast-on edge probably created by knitting into a looped chain showing the chain of loose loops (Image © Museum of London)

Acknowledgements

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Early modern stockings in museums in the Czech Republic

Abstract
Knitted stockings from six burials dating from 1576 to 1626 and three without clear dating were examined. All the stockings have fully shaped legs and triangular gussets bordered on all three sides with patterns of reverse loops, along which the foot was shaped by both decreases and increases. Right-leaning decreases were used mostly; left-leaning decreases were used only in some stockings, exclusively in the upper part of the gusset on the proper left side of the stocking. For increasing, only raised (row below lifted) increases were used. Their asymmetric position in several stockings shows that some of the early knitters understood an increase to be two loops knitted from one parent loop, and for some it was only an added loop. Instead of the usual method of picking up new loops for gussets, the heel flap selvedges were probably whipstitched in several stockings, and these sewn stitches were then used as the base for knitting the gussets. A comparison of the stockings from the Czech Republic to the stockings from the same period found in other European countries suggests the possibility of using a range of construction types for determining their provenance.

Keywords: Knit, stockings, silk, 16th century, 17th century, shaping

Introduction

Until recently, little attention has been paid to archaeological knitwork in the Czech Republic. Reports that did note it usually mentioned only the dimensions of the objects, and that they were of simple knit fabric, sometimes with patterns of reverse loops (although not always in such unambiguous terms). Some handknitted stockings were considered to be frame-knitted due to the fine gauge of the fabrics, and a wale of reverse loops along the back of the leg (a marker rib) was often mistaken for a real seam. The main aim of this paper is to describe in detail the knitted stockings briefly introduced at NESAT XIII (Odstrčilová 2017), using the newly proposed terminology and protocol for recording knitwork (see Malcolm-Davies et al. 2018, 10-24, in this issue). However, the research also revealed evidence that some working methods used by 16th and 17th century knitters differed from those of modern knitters, which suggests ways in which the proposed terminology may expand in the future.

Methodology and terminology

The research presented here concentrates on collecting evidence for how the stockings were knitted. Information on the materials, yarn characteristics and dimensions of the stockings were mostly copied from previous reports by textile historians and conservators. Terminology for the parts of the stockings (fig. 2) was taken from modern instructions for knitting socks (for example, Bush 2011), with two exceptions. In modern knitting instructions, foot often refers only to the part of the sock knitted after the heel is finished or its tubular part after the gussets are finished, and sole refers to the bottom half of the foot. The term foot in this paper corresponds with its anatomical meaning, referring to the whole bottom part of the stocking below the ankle, and sole refers to the triangular or trapezoid area delimited by two patterned lines (sometimes known as false seams but more accurately called marker ribs).

Overview of the stockings

Most of the stockings reported here were made from silk. The stocking from Opava was not analysed to identify the fibre, and there is conflicting information about the stockings of Tycho Brahe. The gauge varied from 50 to 100 wales and from 65 to 130 courses per 10 cm (see table 1).

Owner of the stockings	Burial date	Current location	Inventory/ accession number	Previous publications [or unpublished reports]	Dimensions: length, length of foot, width of top edge (if given)	Yarn dia-meter	Yarn single/plied/ cabled/ combined	Yarn twist	Gauge (wales x courses per 10 cm)	Current colour
Emperor Maxmillian II.	1576	Prague Castle	HS 13746 PHA 26/08	Bravermanová, Kobrlová and Samohýlová 1995; Bravermanová 1997	81 cm, 27 cm *	NR	several 2-plied threads combined	I (ply: S)	60 x 65 (leg), 50 x 75 (gusset)	brown (goldish)
Tycho Brahe (stocking A)	1601	City of Prague Museum	86 565	[Pirník 1971]; [Vorlová 1974]; Bravermanová 1997	64 cm, 23 cm, 19 cm *	NR	several 2-plied threads combined	I (ply: Z)	90 x 80 *	beige
Tycho Brahe (stocking B)		Prague Archbishopric	31-105327/3	[Knejflová 2017]	63 cm, 22 cm, 17 cm *				70 x 100	brown
Emperor Rudolf II.	1612	Prague Castle	HS 13757 PHA 27/04	Bravermanová and Čierna 1997; Bravermanová 1997	76 cm, 26 cm (76.5 cm, 27 cm) *	NR	plied	S *	100 x 100	brown (goldish)
Jan Diviš ze Žerotína	1616	Museum of the Brno Region in Ivančice	10/93	[Otavská 2010]	62 cm, 21 cm (deformed, originally longer), 19 cm *	NR	2-plied *	2z/S *	70 x 120 *	brown (dark)
Markéta Františka Lobkowitz, née Dietrichstein	1617	Regional Museum in Mikulov	T 835	[Otavská 2006]; Pietsch 2008	52 cm, 17.5 cm, 15.5 cm *	NR	2-plied *	2z/S *	70 x 90 *	brown (reddish), with ornaments in metallic yarn
Václav Vilém Popel Lobkowitz	1626	Regional Museum in Mikulov	T 1125	[Otavská 2009]	57 cm, 27 cm *	NR	3-plied *	3z/S *	70 x 120 *	brown (greyish)
A member of the Mošovský family	1599-1652	Silesian Museum in Opava	1981/5		57 cm, c. 28 cm	NR	2-plied ? combined	I or slight S	70 x 100	brown (dark)
unknown	NA	South-Moravian Museum in Znojmo	A31457/28	[Komendová 2008]	NR	NR	3? 2-plied threads combined or cabled	I or slight S (ply: S)	90 x 150; 80 x 130; 60 x 90 (in different fragments)	brown (one foot knitted in three different shades)
unknown	NA	Brno City Museum	A32/2011 1166/1	[Šulcová 2012]	19 x 14 cm *	0.508 mm	single ?	I or slight S *	55 x 100	brown (dark)

Table 1: General data on the stockings, yarn, gauge and colour - * indicates information taken from previous publications or reports. Notes: NA = not available; NR = not recorded

Fig. 1: One of the stockings and the garter which belonged to Markéta Františka Lobkowitz, née Dietrichstein (Image: V. Otavská, © Regional Museum in Mikulov)

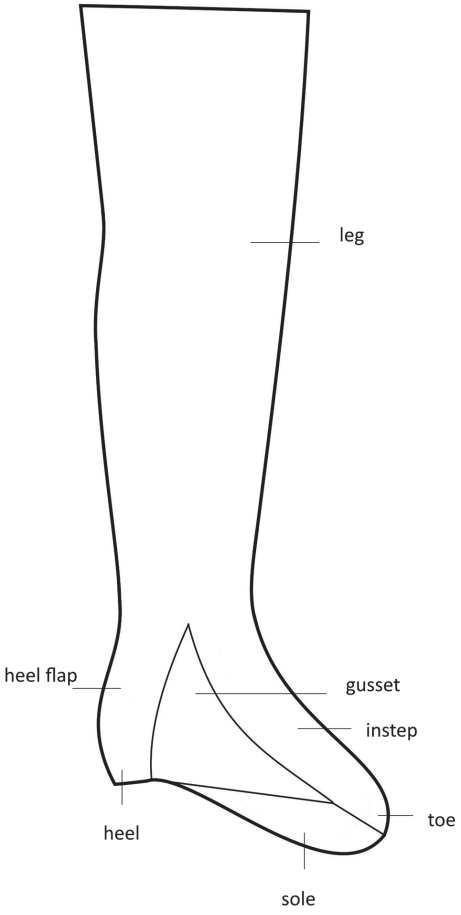

Fig. 2: Terminology for parts of a stocking. See fig. 1 for application to an example of an extant artefact (Image: S. Odstrčilová).

The orientation of well-preserved stockings in wear (thigh to toe) is clear but this should not be confused with the orientation of the knitwork. Even though the cast-on edge was clearly visible in only one stocking (in others it was either obscured by a curled edge or by a sewing thread which attached a lining fabric), the orientation of the knitwork was recognised by the direction of the V shapes of the face loops next to reverse loops or loops in a different colour. This orientation of the loops helps to identify the shaping by distinguishing the decreases from the increases (fig. 3).

All examined stockings had a marker rib running along the back of the leg, formed by alternating face and reverse loops placed one above another (a single ridge pattern in a single wale). This marker rib was a central line along which the leg was shaped: narrowed by decreases in the thigh, then slightly widened by several increases under the knee, and narrowed by decreases in the calf. This shaping was similar for all the stockings, but the distances between shaping loops in the vertical and horizontal directions varied.

In several cases, the decreases along the central line ran all the way to the tip of the heel. If they stopped in the ankle area, the heel flap was shaped by decreases along its sides. None of the stockings had an unshaped rectangular heel flap, as is usual in later stockings and modern socks. All the heels were knitted from selvedge to selvedge, without using short rows for turning the heel (see Bush 2011, 51 or Hemmons Hiatt 2012, 103 for an explanation of this technique) and they were finished by the seam at the bottom. Among the preserved heels, the type known as a shaped common heel (Bush 2011, 57) prevailed. While one loop from every other course of the heel flap selvedge is usually

Owner/location		Leg			Heel			
		Frequency of decs in thigh	Frequency of incs under knee	Frequency of decs in calf	Position of heel flap decs	Frequency of heel flap decs	Decs in tip of heel	Under-heel seam
Emperor Maxmillian II		NA	NA	4	lateral	4-8 (irregularly)	NA	NA
Tycho Brahe	**A**	NA, 10	6 (5x)	8	lateral	8	8x?	<->
	B	10					9x	recto: <-> ; verso: chain of cast-off loops
Emperor Rudolf II	**A**	12 (12 cm), 8 (13 cm), 4 (8 cm)	8 (5x)	6 (mostly)	central	6-8	5x	<->
	B	7 cm without decs, 12 (4 cm), 8 (8 cm), 10 (8 cm), 4 (5 cm)		6			6x	
Jan Diviš ze Žerotína		1/4 of thigh length without decs, 14 (2x), 8 (1x), 10 (1x), 8 (c. 4x), 6 (c. 15x)	8-10 (7x)	6-8 (mostly)	central	6 (mostly)	NA	NR
Markéta Františka Lobkowitz, née Dietrichstein		ornamental band without decs, 8	8 (3x)	8	lateral	10 (10x)	9x	<->
Václav Vilém Popel Lobkowitz		8-18 (almost from the top)	4-10 (7x)	4-10 (mostly 6)	central	6 (mostly)	NR (covered)	<->
Opava		16 (8x; almost from the top)	10 (6x)	6	lateral	6	5x2 (Balbriggan type)	NA
Znojmo		NA	NA	> 30 cs between decs	central	NA	NA	NR
Brno		NA	NA	10 (unknown part of leg)	NA	NA	NA	recto: <-> ; verso: chain of cast-off loops

Table 2a: Shaping of the stockings. Frequency indicates decreases/increases in every *n*th course, number following in brackets gives number of repeats or the length of this section. Decreases in the tip of the heel always occurred in alternate courses, therefore only their number is given. Abbreviations: dec(s) = decrease(s), inc(s) = increase(s), c(s) = course(s), R = right (leaning) decrease/increase, L = left (leaning) decrease/increase, <-> indicates two loops orientated in the opposite direction joined by a single section of yarn (see *Under-heel seam* section)

Owner/location		Gusset			Sole	Toe			Type(s) of decs	Type of incs
		Ratio of heel flap welts and gusset loops	Method of making more gusset loops	Frequency of decs	Frequency of incs	Shaping	Frequency of decs	Toe seam		
Emperor Maxmillian II		2:3 or 3:4	picked-up	1 (8x); 2 (most of the gusset); near toe in one stocking 6 (1x), 4 (1x); in the other 4 (3x)	8; near toe c. 26 cs without incs	symmetrical	1 (8x)	yarn passed alternately through one sole loop and one instep loop	R	R
Tycho Brahe	**A**	7:10	increased	1 (3/5 of heel flap height); 2	6	symmetrical	1 (c. 16x), 2 (c. 10x)	<->	R, L	L
	B			2 (3/5 of heel flap height); 2	6 (rarely 4)		2 (c. 20x)	recto: <-> ; verso: chain of cast-off loops		
Emperor Rudolf II	**A**	4:5	indeterminable	1 (2/3 of heel flap height); 4	8-16 (-24) (irregularly, sides differ)	asymmetrical	1	<->	R, L	L?
	B				8 mostly, 1/3 near toe without incs					
Jan Diviš ze Žerotína		5:6	indeterminable	1 (2/3 of heel flap height); 4	12 or 16 mostly, 1/3 near toe without incs	asymmetrical	NA	NA	R, L	L
Markéta Františka Lobkowitz, née Dietrichstein		3:4 (rarely 4:5)	increased	1 (1/2 of heel flap height); 2	4; 12 cs near toe without incs	symmetrical	2 (15x)	<->	R	L
Václav Vilém Popel Lobkowitz		5:6 (mostly)	indeterminable	1 (2/3 of heel flap height); 4 (rarely 8)	8-16 (irregularly)	asymmetrical	NR (covered)	NR (covered)	R, L	L
Opava		3:4	increased	1 (c. 3/5 of heel flap height); 3	4-6	NA	NA	NA	R, L	L
Znojmo		4:5 or 5:6	increased	1 (2/3 of heel flap height); in one stocking 4 (7x), 20, 12, 8, 16, 12, 8; in the other NA (damaged part), 8, 6, 8 (2x), > 24 cs without dec till toe	12-16, 1/3 near toe without incs	symmetrical	1 (c. 16-20x)	<->	R	L
Brno		NA	increased	2 nearer to ankle; 4 nearer to toe (regularly, but both ends missing)	6-12 (irregularly)	NA	NA	NA	R, NA	L

Table 2b: Shaping of the stockings. Frequency indicates decreases/increases in every *n*th course, number following in brackets gives number of repeats or the length of this section. Decreases in the tip of the heel always occurred in alternate courses, therefore only their number is given. Abbreviations: dec(s) = decrease(s), inc(s) = increase(s), c(s) = course(s), R = right (leaning) decrease/increase, L = left (leaning) decrease/increase, <-> indicates two loops orientated in the opposite direction joined by a single section of yarn (see *Under-heel seam* section)

Owner or location	after cast-on edge (from the top)	along back of leg (between decs)	along back of leg (between incs)	along heel flap selvedge	along instep	along sole	in toe (between decs)	above gusset (clocks)
Emperor Maxmillian II	1(?)f, 2r, 1f, … 1f, 2r	2f, 1w, 2f	NA	2w, 2f	1w, 2f	L: 1w, 1f; R: 1w	2f	no
Tycho Brahe (A+B)	4w	1f, 1w, 1f	1f, 1w, 1f	1ch, 1w, 1f	1w, 1f	1w	3f	no
Emperor Rudolf II (A)	2r, 4f, 2r	1f, 1w, 1f	1f, 1w, 1f	3w, 1f, 1w	3s, 2f	1w	3s	no
Emperor Rudolf II (B)	1r, 4f, 2r, 1?2f, 1c with decorative holes, 1f, 2r				3s, 1f	2w, 1f	3s, 1f, 2w	
Jan Diviš ze Žerotína	6f, 2r	1f, 1w, 1f	1w, 1f	3w	2w, 2f	2w	NA	no
Markéta Františka Lobkowitz, née Dietrichstein	probably none (rolled edge)	1f, 1w, 1f	1w, 1f	3(?)w	2w, 2f	2w, 1f	5f	no
Václav Vilém Popel Lobkowitz	2(?3)r, 2(?3)f, 2r	1f, 1w, 1f	1f, 1w, 1f	2w	2w, 2f	2w, 1f	NR	no
Opava	probably none (rolled edge)	2f, 1w, ? (L seen only)	2f, 1w, ? (L seen ony)	3w, 1f	2w, 2f	1w, 1f	NA	no
Znojmo	c. 12f, 1r	1w	1w	4w	4w, 2f	2w	4f/4r (4r in each 4th c; 4-5x)	probably floral motive in s
					nearer toe 4r or 2r only in each 4th c, then in each 8th (with irregularities)			
Brno	NA	1f, 1w, 1f	1f, 1w, 1f	4(?)w	1w, 1f	1w, 1f	NA	NA

Table 3: Patterns of face and reverse loops. Abbreviations: dec(s) = decrease(s), inc(s) = increase(s), c = course, ch = chain selvedge, f = face loop(s), r = reverse loop(s), w = single ridge, s = seed pattern, R = right side, L = left side. For the pattern next to cast-on edge, numbers indicate numbers of courses, otherwise numbers of wales. Beside patterns of marker ribs, the number of face loops to nearby dec/inc is also given. No "f" means the patterned area adjoins the shaping, except in the heel flap, where it indicates there are no decreases next to the selvedge (central position of decreases). In asymmetrical patterns along the back of the leg, the sequence follows the visual, not the direction of knitting

picked up in modern handknitted socks, there were more loops in the gussets of these stockings. Either the rate of pick-up was more frequent or the number of loops was increased in the second course of the gusset (see table 2 for details).

Another distinctive feature of all the stockings was the presence of triangular gussets on both sides of the foot, bordered by the selvedge of the heel flap and two marker ribs (in various patterns) running from the ankle and from the under-heel seam to the toe. The marker ribs again served as lines, along which the foot was shaped: by decreases along the gusset/instep border and by increases along the side of the sole.

After all gusset loops were decreased and the lines bordering the gusset met, the toe was shaped along the continuations of these now-united lines, symmetrically on both sides of the foot, but sometimes

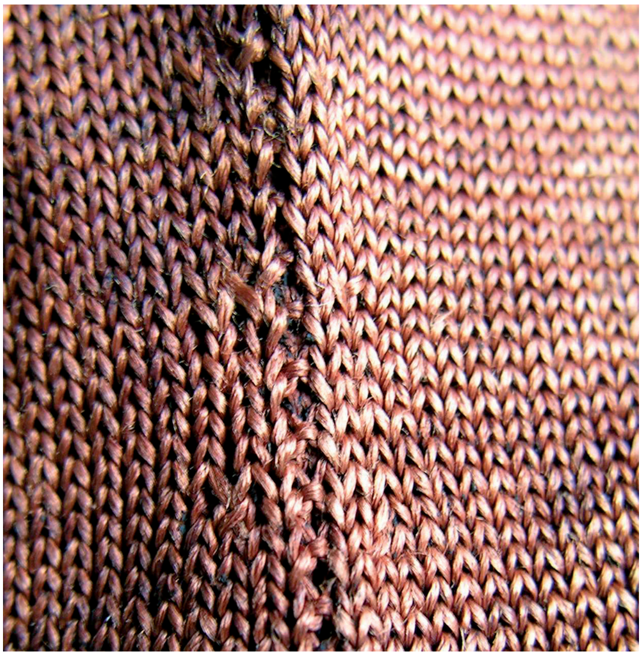

Fig. 3: The marker rib and decreases and increases along it in the knee section of the stockings of Markéta Františka Lobkowitz. The photograph is shown according to the orientation of the loops, with the top edge of the stocking at the bottom (Image: V. Otavská, © Regional Museum in Mikulov)

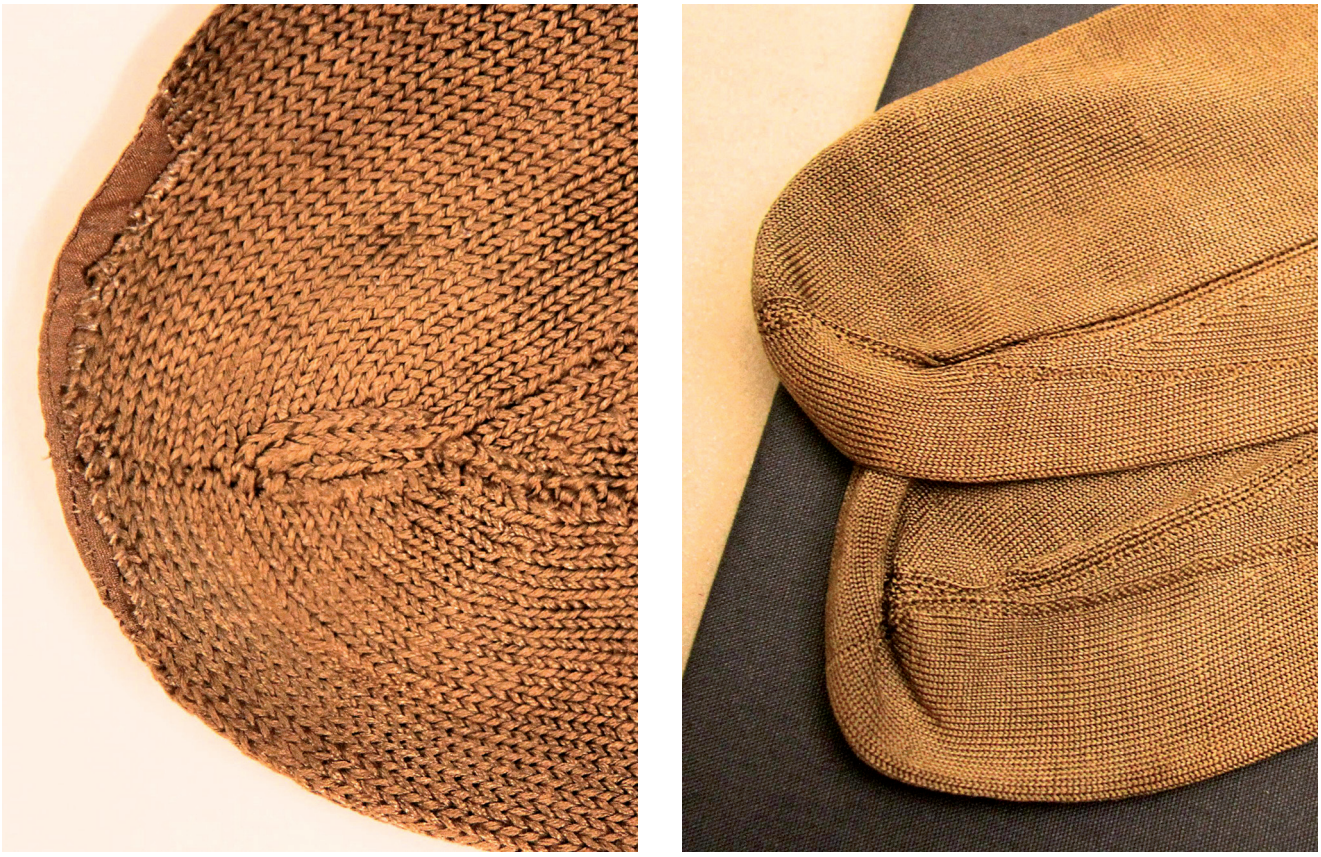

Fig. 4: Two types of toes: Left - symmetrical toe closed by the yarn passed alternately through one sole loop and one instep loop in the stocking of Maxmillian II. Right - asymmetrical toes on Rudolf II's stockings which are closed by the more common method described in the overview section (see below) (Images: S. Odstrčilová, © Prague Castle Administration)

asymmetrically in the vertical direction. When the instep contained a larger number of loops than the sole, the decreases took place in the instep only, until the numbers of loops evened, and only then the decreases continued symmetrically, one in the instep and one in the sole in the same course on each side of the foot (fig. 4b). The toe was then finished by a seam in the horizontal plane. With the exception of Emperor Maxmillian's stockings, where the toe was closed by the yarn passed alternately through one sole loop and one instep loop, it was usually closed by the method described in the section below entitled "Under-heel seam".

The current colour for most of the stockings was given as brown in former publications, but various shades of "archaeological brown" (Ringgaard & Scharff 2010) could be identified. No dye analyses have yet been undertaken.

Even though the provenance was given for three pairs of stockings found in Prague (Bravermanová 1997), it was based on assumptions rather than hard evidence. The provenance is not certain for any of these stockings.

General data for the examined stockings are given in table 1, data on shaping in table 2 and data on patterns of face and reverse loops in table 3. Specific features of individual stockings are described below.

Pair of stockings of Emperor Maxmillian II (1527 to 1576)

Both stockings are missing their heels and the upper back parts of the legs. A form made from woven fabric, which was inserted into them during conservation work and sewn to the original parts of the stockings with closely spaced stitches, makes it impossible to examine the insides and the top edges.

Despite having been described as single ridge (Bravermanová, Kobrlová & Samohýlová 1995; Bravermanová 1997), two upper and two bottom courses of reverse loops in the band along the top edge are probably adjacent to each other, and separated from the middle section by a single course of face loops. This middle section contains three more courses of reverse loops, but the existence of face-loop courses between them is uncertain, as the

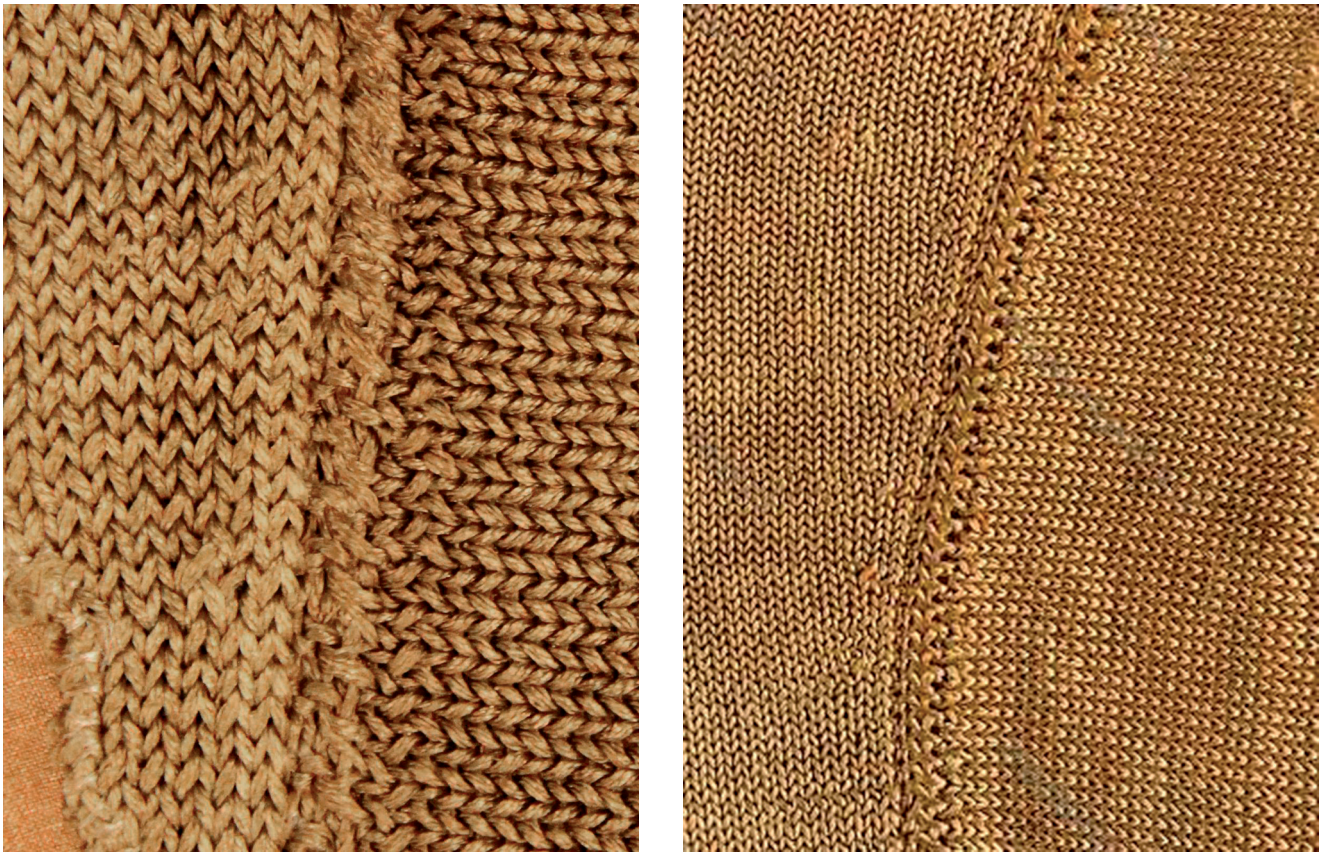

Fig. 5: Unusual picked-up loops for gussets: Left - in the stockings of Maxmillian II (Image: S. Odstrčilová, © Prague Castle Administration). Right - in the stockings of Tycho Brahe (Image: J. Diviš, © City of Prague Museum)

reverse loops are deformed and irregular, implying that the edge might have been lined originally and the sewn stitches deformed the loops.
The sides of the heel flaps look as though the gussets were sewn to them (fig. 5a) instead of worked with picked-up loops, but there are no seams along the other sides of the gussets or across the insteps the presence of which would suggest that the stockings were each sewn together from two parts.

Pair of stockings of Tycho Brahe (1546 to 1601)
The first stocking (A) was recovered from Tycho Brahe's grave in the Church of Our Lady before Týn in Prague, in 1901. After restoration in the 1970s (Vorlová 1974), it was placed under glass, so only the upper proper right recto can be seen currently. The stocking is well preserved, with only a few small holes. The other stocking (B) was taken out from the grave during its re-opening in 2010. Almost the full length of its leg is damaged along the shin.
Stocking A was identified as linen using textile analysis by microscopy, chemistry and the burn test (Pirník 1971). Stocking B was analysed during the conservation work in late 2017 only, when it was identified as silk (Knejflová 2017). This conservation work provided the opportunity for further examination of the stocking, including the verso.
The most distinctive features in both stockings are parallel sections of yarn running regularly from each ridge across the heel flap selvedge, which is dissimilar to typical picked-up loops for gussets (fig. 5b). In contrast to tightly knitted loops in selvedges seen in other historical stockings, the selvedges in both of Brahe's stockings are formed by larger, looser loops, suggesting the use of the chain selvedge technique (Hemmons Hiatt 2012, 73). The similarity of both heel flap selvedges, which are so distinct from other stockings, clearly shows that stockings A and B belong to the same pair, even though they were recovered from the grave separately (on different dates) and the material analyses disagree. (The analyses were done 50 years apart suggesting that stocking A needs re-examination).

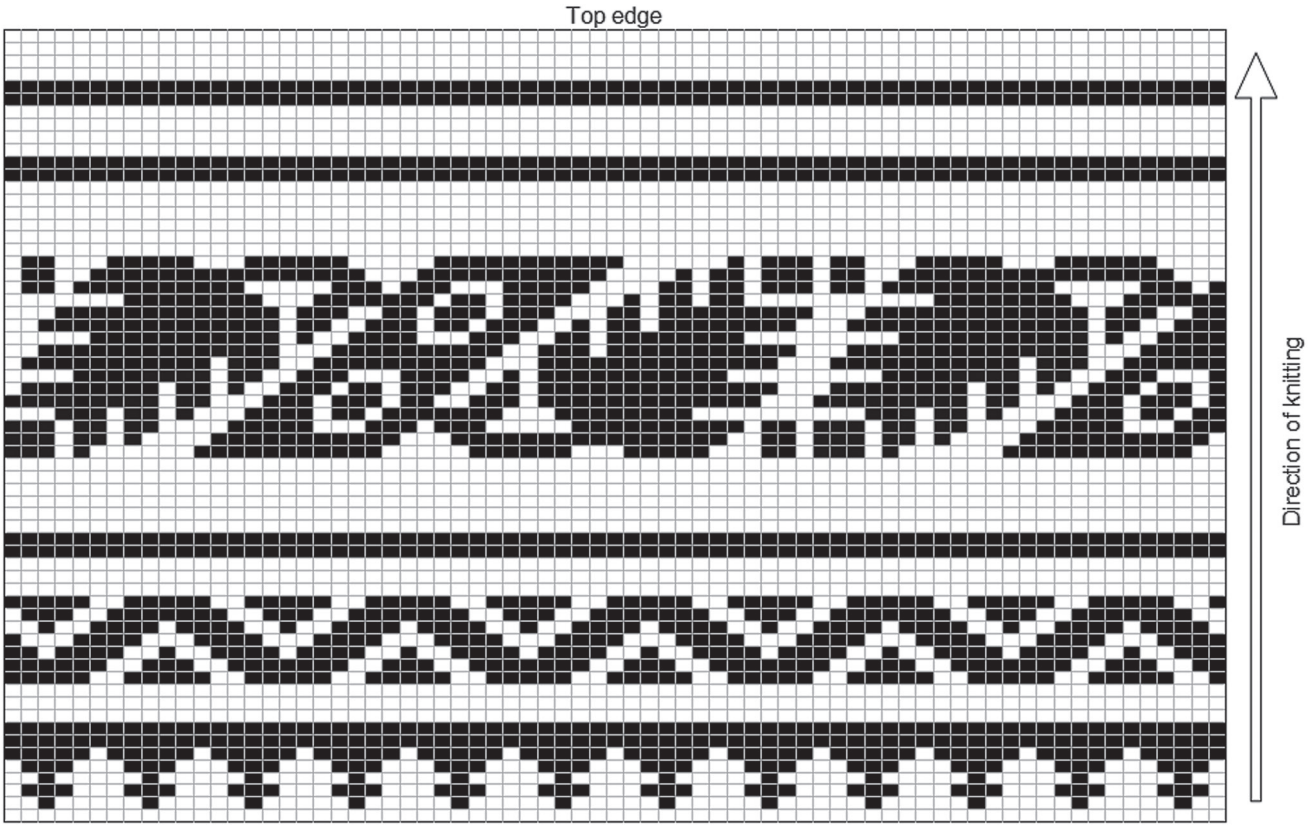

Fig. 6: Schema of the colour pattern in the stockings of Markéta Františka Lobkowitz. White = silk in main colour, black = metallic yarn (Image: S. Odstrčilová)

Pair of knitted stockings of Emperor Rudolf II (1552 to 1612)

Both stockings are well preserved with only minor damage along the top edge and in the foot. The feature described as a sewn seam in earlier publications (Bravermanová & Čierna 1997; Bravermanová 1997) is a wale of reverse loops.

The two stockings differ from each other in their decoration along the top edges and along the sole borders (differently patterned sole borders are partially visible in fig. 4b), but they show striking similarities in other features, such as several increases along the top edges (four in one stocking, fifteen in the other), and the change in the frequency of decreases in the thigh sections. Unlike most of the other stockings, the pattern along the instep/gusset border consists of alternating face and reverse loops in a vertical as well as a horizontal direction - so-called "seed stitch" (Hemmons Hiatt 2012, 180) or "moss stitch" (Stanley 2001, 95).

Stocking of Jan Diviš ze Žerotína (1576 to 1616)

The single stocking is very fragile, with the fabric broken in many places. Therefore, the research was based only on the study of photos taken during conservation work (Otavská 2010). A strip of silk fabric is attached to the top edge. This is probably the remnants of the edge with eyelets for fastening the stockings to the upper hose.

Pair of stockings of Markéta Františka Lobkowitz, née Dietrichstein (1597/1599 to 1617)

This well-preserved pair of stockings still has its original silk sash garters, embellished with metallic bobbin lace (fig. 1).

Two upper sides of the gussets are embroidered with a metallic yarn (made of a strip of what is probably silver wound around silk core) in simple chain stitch (Otavská 2006). Along the top edge, there is an 8.5 cm wide band with geometrical and floral decoration (see chart in fig. 6) knitted in metallic yarn. This top band

was worked in thicker silk yarn than the main part of the stocking, and the loops in it are orientated in the opposite direction to the main part of the stocking.

Pair of stockings of Václav Vilém Popel Lobkowitz (1598 to 1626)

The toes and heels of both stockings are covered with a woven silk fabric, and the sewn stitches running along the length of the foot indicate that there was a sole attached too. The top edge is lined underneath with a strip of woven fabric, and it has eight overcast eyelets, through which silk ribbons were drawn to fasten the stockings to the bottom edge of the hose.

There are many errors (missing reverse loops) in the marker ribs. Moreover, one of the soles is placed asymmetrically, starting with one of its marker ribs in the continuation of the under-heel seam (fig. 7).

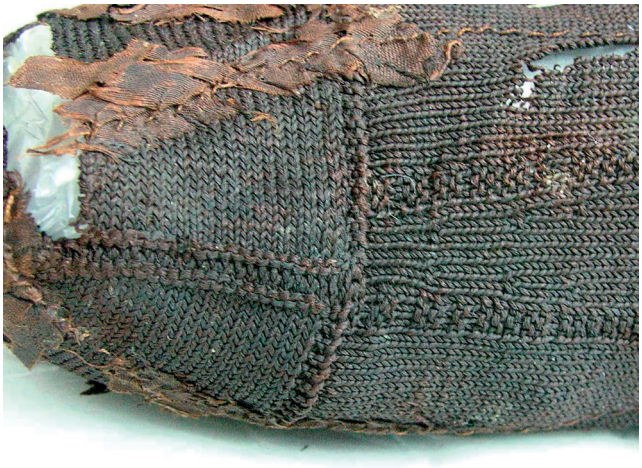

Fig. 7: The underside of the stocking of Václav Vilém Popel Lobkowitz showing a course of reverse loops in the heel flap and asymmetrical start of the sole (Image: V. Otavská, © Regional Museum in Mikulov)

Stocking from the Mošovský family crypt in the Dominican monastery in Opava (burial dates from 1599 to 1652)

Due to the fragile state of this stocking, only one side (the proper left) was observed. The bottom part of the foot is partially missing, including the toe. The tip of the heel was shaped along two lines on each side. This is what is today known as a Balbriggan heel (Bush 2011, 58).

A woven fabric was attached to the sole but is no longer there. Its outline is still visible due to differently coloured patches in the knitted fabric and a line of stitch holes.

Fragments of stockings from St Nicholas Church in Znojmo (date unknown)

Both feet and a few leg fragments are preserved. There is a pattern of reverse loops partially visible above the ankle creating what is commonly called a clock.

Marker ribs bordering the gusset start as simple ridge four wales wide, but the reverse loops are gradually thinned out (in each fourth and then in each eighth course only) and the lines do not meet at the toe, because the sole is much narrower than the instep. Besides the usual shaping, there are several decreases in the middle of the gusset.

Fragments of a stocking from St James's Church in Brno (date unknown)

The biggest fragment shows two directions of knitwork, perpendicular to each other, identifying it as a part of the foot of the stocking. Three vertical lines of alternating face and reverse loops (two sole borders and a part of a gusset/instep border) run across the simple knit fabric. Another such line runs across one of the smaller fragments, probably a part of the leg. A woven ribbon is attached to the verso of this fragment following this marker rib. A similar strip of woven fabric along the seam at back of the leg was recorded in the stockings of Johann Ludwig II von Sulz, which date to before his death in 1687 (Fingerlin 1992, 191).

Interpretation

Knitting direction

The orientation of the loops shows that all the examined stockings were knitted from top to toe. Only the two-coloured band along the top edge of each of Markéta Františka Lobkowitz's stockings was worked in the opposite direction, probably having been added later, after the stockings were finished.

Despite the previous reported descriptions of seams at the backs of the legs, the only true seams were observed under heels and in toes. However, there may originally have been a short sewn seam securing the small slit at the back and top of Tycho Brahe's stocking B. The selvedges on both sides of this slit show that the first four courses in single ridge were knitted back and forth, and then knitting continued round in simple knit. A future re-examination of the top edges of other stockings may produce evidence of other examples of knitting back and forth. The main parts of the stockings were knitted round (except for the heel flaps). This indicates that they were handknitted, because the early knitting frames could not produce tubular fabric (until the end of the 18th century).

Symmetry of decreases and increases

Right-leaning decreases were used in most cases. In the stockings where there are left-leaning decreases too, they were not placed in symmetry with all the right-leaning decreases, but only in the gusset on the proper left side of the stocking, and usually only in its upper part, where the decreases took place in each course. The only stocking with left-leaning decreases running along the whole length of the gusset was the stocking from Opava. As the other side of the leg was not available for examination, it is not yet known whether symmetrical decreases were placed along the back of the leg too. It is likely they were not because the last decreases in the tip of the heel lean to the right on both sides of the stocking.

All the decreases were placed at the same distance from the marker ribs on both sides of the stockings, regardless of their lean direction and position on the left or right side of the marker rib. The same is not true of the increases.

There are two main ways of increasing (each achieved in several ways): 1) adding a loop between two loops of the previous course, and 2) knitting two loops from one. If the direction of knitting is known, these techniques can be distinguished. In the stockings reported here, only the second method was used. Specifically, increases were made by knitting a loop from the previous course, either before or after knitting a loop in the same wale currently on the needle, the so-called "lifted increase" (Interweave Knitting Glossary) or "raised increase" (Hemmons Hiatt 2012, 208-209). However, in many modern knitting instructions, this term refers to knitting the additional loop from the previous course. To locate the exact position of such an increase, it is necessary to determine whether the additional loop was knitted before (right lifted increase) or after (left lifted increase) the loop on the needle. This is difficult to distinguish in very fine knitted fabrics (100 wales per 10 cm or more). Therefore, the term increase in this paper refers to the whole process of knitting two loops from one, and is the opposite of a decrease.

In most of the stockings, the increases were placed at the same distance from the marker rib at the back of the leg or symmetrically on both sides of the foot. The exceptions are the under-knee increases in the stockings of Markéta Františka (fig. 3) and Jan Diviš, and the sole increases in Emperor Maxmillian's stockings, which all have an increase immediately next to the marker rib on one side and one face loop between them on the other side. However, these increases are symmetrically spaced one loop from the marker rib, if the increase is understood to be the additional loop only. This is evidence that "increase" had different meanings for 16th and 17th century knitters than it does for today's knitters and knitwork scholars.

Under-heel seam

The most frequent appearance of the heel (and toe) seams is two loops orientated in opposite directions and joined by a single section of yarn. These connecting yarns are parallel to each other along the length of the seam, showing that the two parts were not grafted or whipstitched. Without seeing the verso, the exact method of joining them could not be determined. However, the inside of Tycho Brahe's stocking B and the verso of the fragment from Brno clearly show the chains of cast-off loops, proving that both parts of the heel were not sewn but knitted together, probably in the same way as was described in the 17th century knitting pattern in *Natura Exenterata* (Rutt 1987, 241). The direction of the chain loops shows that in Tycho Brahe's stocking the heel was closed from the centre to its selvedges, but in the fragment from Brno the closure was worked in the opposite direction, from the sides to the centre.

Sometimes, the direction of the under-heel seam can be determined, even though only the recto was observed. The last full course of the heel flap in Václav Vilém Lobkowitz's stockings was knitted in reverse loops (fig. 7), followed by half the course in face loops, which suggests that the under-heel seam was subsequently worked from the centre of the heel to the edge.

Picking up gusset loops

The sides of the heel flaps in three pairs of the stockings (Emperor Maxmillian's, Tycho Brahe's and fragments from Znojmo) are unusual compared to the others discussed here and in comparison to socks made by modern methods. They raise the question as to how new loops were picked up for the gussets and the sole. Picking up usually refers to inserting the knitting needle into the loop in the existing knitted fabric and drawing yarn through it to create a new loop on the needle. As a result, both legs of the new loop come out from the same parent loop. However, single yarns cross the heel flap selvedges of the stockings in question. This is most conspicuous in Tycho Brahe's stockings (fig. 5b). Each of the parallel yarns there can be interpreted as one leg of the new loop only, or the bar of the reverse loop two wales from the selvedge, which has stretched due to a new loop having been picking up from it. However, if the new loops were picked up from the loops two wales from the edge, the edge of the fabric should be visible in the verso.

	Group 1	Group 2
Shaping of heel flap	lateral (along selvedges), only in the tip of heel along the centre	central
Frequency of gusset decreases	1 mostly to 1/2 of heel flap height or less, then 2-4	1 to 2/3 of heel flap height, then 4
Frequency of sole increases	4-8, same interval in one stocking	8 or more, irregular frequency in one stocking
Toe	symmetrical	asymmetrical

Table 4: Characteristics distinguishing two categories of stockings with triangular gussets and shaped soles

The inside of stocking B shows no three-dimensional structure along the selvedge; the gusset continues in the same plane as the heel flap. This should be possible only if the selvedge loops were picked up (which is not the case), or if the yarn in question was not a bar of the existing loop but an independent thread encircling the selvedge (probably whipstitched), and each loop of it was then used as a starting loop for knitting the gussets.

The yarn running across the heel flap selvedge in the stockings from Znojmo looks even more convincingly like an independent thread. It is a little different in colour than the knitted fabric and its path shows a slight irregularity, as if the stocking maker did not care to pass the needle exactly into the centre of each loop, but was whipstitching the edge of fabric.

In the stockings of Maxmillian II, the single yarns across the selvedge alternate with Vs typical of the usual picking up technique. However, in some of the Vs, one of the legs contains more yarn strands than the other, and there is one new gusset loop for each yarn crossing the heel flap selvedge, regardless of whether it starts singly or as half of a V. In contrast to Tycho Brahe's stockings, where one loop from each ridge was picked up and the number of loops increased in the second course of the gusset, in Maxmillian's stockings, the number of new loops was already greater in the first course. This was most likely achieved by passing the yarn twice through some of the heel flap loops. As the yarn in Maxmillian's stockings is combined (consisting of several parallel strands), it was probably difficult to separate the strands belonging to these two sewn stitches, and this led to different thicknesses of yarns being drawn out from the same loop, as mentioned earlier.

The idea that the selvedges were whipstitched is also supported by the observation of several yarn ends inside the heel area of the stockings from Znojmo and a knot near the upper tip of the gusset inside Tycho Brahe's stocking B. When the heel is closed from the centre to the sides and loops for gussets are picked up in the usual way, the whole stocking can be worked with one continuous yarn, but for whipstitching the working yarn must be cut to be threaded on to a sewing needle or another piece of yarn must be used.

Comparable items

No similar items to the stockings from Znojmo with their partially closed gussets have been located yet. However, there are several examples of stockings with shaped soles and triangular gussets bordered on all three sides. These include the burial stockings of King Johan III of Sweden (Ekstrand 1982, 166-168), Pfalzgraf Philipp Ludwig of Neuburg (Stolleis 1977, 73-74), Duke Barnim X of Pomerania (Rutt 1987, 73; Januszkiewicz 1995, 90-92) and one of his relatives (Januszkiewicz 1995, 124-125), and the stocking foot found in London (Museum of London A13833). The dates of all these stockings coincide with the stockings in the Czech Republic - from the mid-16th century to the mid-17th century.

The foot from London differs from the rest because the toe decreases start before all the gusset loops are decreased. The photograph of one of the stockings from Pomerania (Januszkiewicz 1995, 124-125) is too vague for any conclusions to be drawn. The rest of these stockings show (apart from minor differences in shaping and distribution of reverse loops) distinct similarities to the stockings found in the Czech Republic.

They can be divided into two groups based on the shaping of their heel flaps, gussets and soles (table 4). The first group contains the stockings of Maxmillian II, Tycho Brahe, Markéta Františka Lobkowitz, the stocking from Opava, the stockings of Barnim X of Pomerania and Johan III of Sweden. The other group contains the stockings of Rudolf II, Jan Diviš ze Žerotína, Václav Vilém Lobkowitz and Philipp Ludwig of Neuburg.

It is clear to see how the frequency of gusset decreases

and sole increases influenced the symmetry of the toe. But as there is no reason for the correlation of these features to the shaping of the heel flaps, these two styles may represent different, probably regionally based, knitting traditions. Moreover, there are other stocking types known from the same period in other countries. Further research into the distribution of these various stocking types through Europe may help to determine the provenance of the individual stockings.

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Knitted fragments of clothes excavated from the Swedish 17th century flagship *Kronan*

Abstract
Clothing excavated from the Swedish flagship *Kronan*, which sank in 1676 as the result of an explosion, includes fragments of civilian garments such as knitted headgear, gloves, stockings and embroidered silk waistcoats belonging to some of the 800 crewmen who died. The location and distribution of these fragments suggest which types of knitted clothing belonged to men of different social standing in the late 17th century.

Keywords: Knit, early modern, Sweden, Kronan, twined knit, glove, cap, hat, metal thread embroidery, waistcoat, stocking

Introduction

Since the wreck of the Swedish flagship *Kronan* was discovered at a depth of 26 m off the eastern shore of Öland in the Baltic Sea in 1980, more than 90% of the wreck site has been excavated and more than 30,000 artefacts have been recovered (Einarsson 2013, 1, 3). Among these artefacts are remains of the crew's clothing. Not much has been published regarding the clothing finds, and nothing specifically focused on the knitwork. Mary Pousette has studied the clothing on board *Kronan* in general, based upon the cut and construction of a few better preserved items (Pousette 1999; 2009). This article focuses on knitted fragments that have been recovered from the wreck (Lundin 2016). There are few preserved knitted items from the 17th century or earlier in Swedish museum collections and therefore the knitted fragments from *Kronan* are important to our knowledge of knitted goods in Swedish men's clothing in the 1670s. They may also be helpful in dating other finds or in tracing the trade routes for knitted goods at that time.

The wreck is exactly dated, as *Kronan* sank as the result of an explosion, during a naval battle against the allied Danish-Dutch fleet on 1 June 1676 (Einarsson 2013, 1, 7). The ship sank fully equipped ensuring that everyday objects and those related to lower levels of society were among the recovered artefacts. Most of the crew of 800 men (women were not allowed on board) died and there were just over 40 survivors. As the Swedish fleet had not introduced uniforms at that time, they all served in their civilian clothes. The crew represented a cross-section of the Swedish male population in age, place of residence and social rank (Einarsson 2013, 1, 7).

Close examination (using digital Dino-Lite microscopes AM-7013MZT4 and AM-4013MZT(R4) and a digital camera) of knitted fragments from more than 70 items revealed that most of them were knitted in wool and only a few in silk. Today, no traces of original colours or of patterns formed by changes of colour are visible to the naked eye, all fragments are now in various shades of archaeological brown. The fact that no fragments knitted of plant fibres were found at the wreck site does not necessarily reflect the original conditions on board. We know from written records and preserved items that knitted linen stockings were used in the higher levels of society (Zettersten 1903, 238; Hazelius-Berg & Waldén 1937, 4 & 7). Several finds of linen items, of which only the buttonholes sewn with silk thread remain, indicate that textiles made of animal fibres had far better chance of survival in the time and conditions at the wreck site than those made of plant fibres.

Most of the now monochrome items were knitted in

Fig. 1: Five-fingered glove found on the orlop deck, accession number KLM 15286 KR (Image: Helena Lundin/Kalmar County Museum)

simple knit and sometimes patterned with reverse loops. Four types of garments were identified: stockings, gloves, headgear and silk waistcoats with metal thread embroidery. By analysing information from the excavation reports regarding the contexts of each knitted item, it was possible to link some of them to different ranks of men on board the ship.

Gloves and a twined knit mitten

Three wool gloves were found on the orlop deck, below the three gun decks. One of the gloves (accession number KLM 15286 KR) was found in an area characterised by upper-class artefacts (Einarsson 2005, 20-21, Appendix VI; Fält2014, 15286). This indicates that the owner belonged to the higher levels of society on board. The glove is worked round in simple knit with no visible pattern. The cuff is missing, and the fragmented wrist has been tightly knit by using fewer loops, thinner yarn and finer needles than the rest of the glove (fig 1). The glove is worked from the cuff towards the fingers. Although parts of the thumb and the area next to it are torn, there is no visible evidence of any increasing for a thumb gusset. It is likely that the thumb was knitted straight, without shaping. The fingers have been decreased around the tips.

A pair of napped gloves was found in a wooden chest containing personal belongings, such as books and silk ribbons, together with tools and material connected to glazing (Einarsson 2006, 22-23, Appendix I and VI; Fält2014, 15760:1-92). The contents indicates that the presumed glazier was of relatively high social standing. One of the gloves is almost intact (KLM 15760:68 KR), while only two small fragments of the other remain (KLM 15760:28 KR). The preserved glove (fig. 2) has holes from wear near the fingers at one side suggesting that it is the left glove. It is worked round in simple knit and decorated with a few courses of reverse loops at the bottom edge of the cuff and at the middle

Fig. 2: Napped glove from a presumed glazier's chest on the orlop deck, accession number KLM 15760:68 KR (Image: Helena Lundin/ Kalmar County Museum)

Accession number	KLM 308 KR	KLM 1287 KR	KLM 3603 KR	KLM 3960 KR	KLM 4288 a KR	KLM 4288 b KR	KLM 5891 KR	KLM 7015:1 *tillhör* KR	KLM 7133:15 a KR	KLM 7186 h KR	KLM 11592:45 a KR	KLM 13245 KR	KLM 14922 KR	KLM 15143 *tillhör* KR	KLM 15286 KR hand (wrist)	KLM 15414:11:3 KR	KLM 15760:28 KR	KLM 15760:68 KR	KLM 16597:18:1 KR
Item	stock-ings (pair)	stock-ings (pair)	?	stock-ing	stock-ing	stock-ing	cap	mitt-en	hat?	hat	stock-ing	stock-ing	stock-ing	waist-coat	glove	waist-coat	glove	glove	stock-ing
Simple knit (mainly)	yes	yes		yes	yes	yes	yes	yes	yes	yes	yes	yes	yes		yes		yes	yes	yes
Face- and reverse loop pattern	yes	yes		yes	yes	yes		yes			yes	yes	yes	yes		yes	yes	yes	yes
Twined knit								yes											
Single rib			yes																
Number of items/fragments	2	2	1	1	1	1	1	1	1	6	11	2	3	13	11	23	2	2	2
Weight (g)	5.1	*	2.3	*	60,8	36.6	*	32.2	7.2	**	12.1	134.4	19.2	130.2	64.1	109.2	7.2	65.2	⁂
Length, maximum (cm)	41.1	73.0*	22	27.0#	46	27.5	53*	19	9.2	(brim) 9.1	27.5	84	32.5	25.5	24.3	30	10.6	27	64.5
Width, maximum (cm)	5.5	28.0*	13.6	10.0#	21.8	21.8	26.5*	15.2	12.1	(brim) 24.1	12.7	26.7	15.6	30	15.4	32	9	18	15.4
Material	wool	wool	wool	wool	wool	wool	wool	wool	wool	wool	wool	wool	wool	silk	wool	silk	wool	wool	wool
Fibre diameter (micron)	23	*	23	*	26	26	*	26	23	25	32	28	20	12	28 (32)	12	34	34	26
Yarn analysis	2-ply	*	2 com-bined	*	2-ply	2-ply	*	2-ply	3-ply?	3-ply?	2-ply	2-ply	2-ply	single	2-ply (2-ply)	single	2-ply	2-ply	single
Yarn diameter (mm)	0.53	*	0.27	*	0.89	0.89	*	1.76	3.48	3.06	0.5	1.03	0.55	0.38	1.97 (0.99)	0.38	0.77	0.77	0.68
Visible final twist	s	*	|	*	s	s	*	z	|	|	s	▲	s	|	z (z)	|	s	s	s
Visible final twist angle (degrees)	20.6	*		*	22,3	22,3	*	15,3			17.1	▲	24.5		23 (20.2)		25.7	25.7	26.8
(If plied/ combined) Single yarn diameter (mm)	0.26	*	0.14	*	0.45	0.45	*	0,87	0.8	0.8	0.26	▲	0.25		0.94 (0.56)		0.39	0.39	
(If plied/ combined) Single yarn twist	z	*	z	*	z	z	*	s	z	z	z	▲	z		s (s)		z	z	
(If plied/ combined) Single yarn twist angle (degrees)	19.2	*	18,1	*	18.1	18.2	*	30.4	22.1	23	13.6	▲	15.7		19.8 (19)		21	21.2	
Loop heights (mm)	1.89	*	1.82	*	2.69	2.69	*	3.91	5.53	5.8	2.32	▲	2.04	2.02	4,3 (3.24)	1.97	3.77	3.78	2.43
Loop width (mm)	1.61	*	1.35	*	2.96	2.95	*	3.85	7.28	7.05	1.64	▲	1.86	1.41	3.2 (2.58)	1.32	3.25	3.24	2.39
Wales per 10 cm	50#	*	58 face-loops	*	34	33	*	31	15	15.5	53	27	53	62	22 (35#)	63	26#	27	42
Courses per 10 cm	77	*	84	*	49	50	*	34	27#	26	80	47	74	89	34 (55#)	88	45	45	57
Fulled	yes	yes	no	no	yes	yes	no	no	yes	yes	no	yes	no	no	no	no	yes	yes	no

Table 1: Catalogue of all items mentioned in the article.
* The items were on display 20 February 2018 and not accessible for closer analysis with digital microscopes.
** The largest fragments of KLM 7186 h KR have been mounted on cardboard during conservation. Weight 89.2 g (including cardboard).
⁂ Due to their fragile and decomposed condition, it was not possible to weigh the fragments of KLM 16597:18:1 KR.
▲ Fulling and decomposition made closer analysis of the yarn difficult.
The gauge is an extrapolation as the fragments are smaller than 10 × 10 cm.

of the wrist. As a result of wear and degradation of the wool fibres, the nap is partly missing. The thumb has been knitted straight, without a gusset and the finger tips have symmetrical decreases on either side.
One example of twined knit fabric was found (knitted by alternating two working elements which are twisted after making each loop, creating characteristic horizontal stripes on the verso of face loop courses (Dandanell & Danielsson 1989, 56-57, 62-64). The wool fragment (KLM 7015:1 KR) was knitted round and decreased at the top on one side (fig. 3). The opposite side is missing. The other end of the fragment has a decorative eyelet pattern above the remains of a knitted pattern consisting of twined knitted reverse loops and a few face loops, too small to analyse (fig. 4). The form, with the decreasing at the top and no remains of knitted fingers, as well as the size of the fragment suggests that it is either the remains of a mitten or a stocking foot. As an eyelet pattern constitutes a weakening of a textile, it is more likely a decorative pattern at the wrist or cuff of a mitten than the foot of a stocking. The fragment was found inside a red doublet, or possibly the remains of a coat, together with arm bones, which also confirms the assumption that the fragment is a mitten. The man wearing the doublet was found beside the wreck, next to a bronze gun from the lower gun deck (Einarsson 1991, 11, Appendix I and V). Men from the lowest social level on board, the seamen

Fig. 3: Twined knitted fragment, accession number KLM 7015:1 KR (Image: Helena Lundin/Kalmar County Museum)

Fig. 4: Twined knitted fragment with eyelet pattern above the remains of a knitted pattern with twined knitted reverse loops and a few face loops, accession number KLM 7015:1 KR (Image: Helena Lundin/Kalmar County Museum)

who sailed the ship, were issued with blue clothes, a doublet and a pair of blue breeches, closed with hooks and eyes. In wintertime, they were also given a pair of shoes and a pair of wool (knitted) or cloth (sewn) stockings (Zettersten 1903, 238-239). The fact that the doublet is red and has 24 buttonholes sewn with silk thread places the twined knitted mitten in a higher level of society than that of a sailor.

Headgear

A knitted wool cap (KLM 5891 KR) was found during excavations near the stern on the quarter deck, the deck above the upper gun deck (Einarsson 1989, 17; Fält2014, 5891). As the cap is currently on display in a case, a closer analysis was not possible (fig. 5). The height is estimated at 53 cm. The yarn appears to have been plied with more than two single elements. The cap is worked round in simple knit with two courses of reverse loops at the lower edge. It is worked from the edge and up and has decreases around the top. Some knitted caps that were found in Dutch whalers' graves at Svalbard appear to be of similar, but not exactly the same kind (Rijksmuseum Catalogue 2017). Fragments of a wool hat with a double-layered brim folded at a course of reverse loops at the outer edge (KLM 7186h KR) were found during excavations on the lower gun deck, the deck above the orlop deck (Einarsson 1991, 14; Fält2014, 7186). At some point, during conservation, the larger fragments of the hat have been mounted on cardboard which complicated the analysis of the brim. A piece of 2-ply yarn, probably wool, with the remains of a silk bow is fastened between the brim and the crown of the hat (fig. 6).

Fig. 5: Knitted cap, accession number KLM 5891 KR on display in the museum, with a vertical shadow from the corner of the case on the left side (Image: Helena Lundin/Kalmar County Museum)

Another, very similar fragment (KLM 7133:15a KR; fig. 7) with the same gauge was excavated together with human remains, fragments of clothing, a button and a brass buckle in the same area (Einarsson 1991, 13-14, Appendix I and V; Fält2014, 7133:1-18). It is possible that the fragment (fig. 7) originates from the hat (fig. 6) or from a similar kind of headgear. Similar hats have been excavated in Copenhagen (Warburg 1987, 91); in a grave at Danskøya, Svalbard (Lütken, 1987, 89-98) and a hat with a double-layered brim is also preserved in a museum collection in St Petersburg, Russia, allegedly purchased in Amsterdam by Tsar Peter I (Turnau 1973 [1968], 14).

Silk waistcoats with metal thread embroidery

According to the accession numbers (KLM 15143 KR and KLM 15414:11:3 KR), several similar knitted silk fragments were found inside two chests standing two metres apart on the orlop deck. The knitted silk fragments have a very typical pattern of face and reverse loops of eight-pointed stars in a grid of oblique lines (figs 8 and 9), metal thread embroidery, silk pile on the verso, and one has a cuff (fig. 10); taken together, these features identify them as parts of waistcoats of a type that was popular in Early Modern Scandinavia (Ringgaard 2014, 75-78). One of the chests was broken and some of its contents had fallen out. Both chests also contained other personal belongings and thousands of silver coins (Einarsson 2005, 10, 18-20; 2006, 19-20; Fält2014, 15143:1-25; 15414:1-34). The contents of the chests place the waistcoats at the highest social rank. The coins have been interpreted as a cash reserve intended for unexpected domestic expenses, administered by someone of an appropriate social position on board, such as Baron Lorentz Creutz, commander of the Swedish fleet (Einarsson 2005, 20; 2006, 19-20). At some point, the fragments may have been given accession numbers linked to two different chests by mistake. Thus far, it has not been possible to clarify which items belonged to which chest.

Fig. 6: Knitted hat with a double-layered brim, accession number KLM 7186 h KR. The largest fragments of the hat were mounted on cardboard during conservation (Image: Helena Lundin/Kalmar County Museum)

Fig. 7: Fragment of a knitted hat with a brim (?), accession number KLM 7133:15a KR (Image: Helena Lundin/Kalmar County Museum)

Fig. 8: Right shoulder of a waistcoat where the sleeve is joined to the body. Reverse loops create a grid of oblique lines and eight-pointed stars on the sleeve. A stitch of pile yarn sewn over several courses is visible on the eight-pointed star at the lower right side of the photograph, accession number KLM 15414:11:3 KR (Image: Helena Lundin/Kalmar County Museum)

There is only one report from the textile conservation of knitted silk fragments found inside a chest (*Konserveringsrapport, Textilt material från Regalskeppet Kronan, registreringsnr 15143. Tillhör 15143*), but similar knitted fragments with patterns of both face and reverse loops are clearly visible on photographs taken at the conservation of the contents of the other chest (*Regalskeppet Kronan, Konserveringsrapport, Fynd nr: 15414:11*) No knitted fragments of similar kind can be seen on photographs taken during the conservation of the other chest (*Regalskeppet Kronan, Konserveringsrapport, Fynd nr: 15143*). It is therefore possible that only one waistcoat was on board.

There are considerable similarities between these two (?) waistcoats. They are both worked in silk with patterns in reverse loops: a grid of oblique lines and eight-pointed stars. The gauge is the same. Some fragments from each waistcoat are embroidered with metal thread in the same floral pattern and stitches (figs 10 and 11). Maj Ringgaard has analysed several waistcoats of this kind. Many of them have pile on the verso, either knitted in or sewn on afterwards (Ringgaard 2014, 78-79). Both (?) waistcoats from *Kronan* have silk pile on the verso. Most of these fragments appear to have been dried on a flat surface with the pile downwards during conservation, which made it difficult to decide if the pile had been included in the knitting process or stitched on afterwards. Several knots are visible on a fragment that was dried with the pile surface turned upwards during conservation (fig. 12). Occasionally, stitches of pile yarn are visible on the recto, sewn over several courses and secured with knots on the verso (fig. 8). This suggests that the pile was, at least to some extent (maybe in repair), stitched on afterwards.

Two larger fragments, one from each chest, consist of two parts, knitted in different directions and sewn together with silk yarn. These are identified as parts where a sleeve is joined to a body (fig. 8). The knitted pattern on the upper front side of the body, with stripes of reverse loops in oblique checks (figs 11 and 13), shows a yoke pattern typical for waistcoats of this type (Ringgaard 2014, 81). The metal thread embroidery on these fragments are also placed where they normally occur on other waistcoats, around the neckline and front slit (Ringgaard 2014, 89). The fact that the fragment from chest KLM 15143 KR is the left shoulder-part of a waistcoat (fig. 11), and the fragment from chest KLM 15414 KR is the right shoulder of a seemingly identical item (fig. 8), suggests that they may originate from the same waistcoat.

The direction of the face loops in the course at the centre of each eight-pointed star shows that the sleeves were knitted from the wrist edge up. As the same pattern occurs at the back and lower front side of the body, it is possible to determine that the body was knitted from the lower edge up.

There are at least 14 well-preserved damask-knitted silk waistcoats in museum collections. Most of them

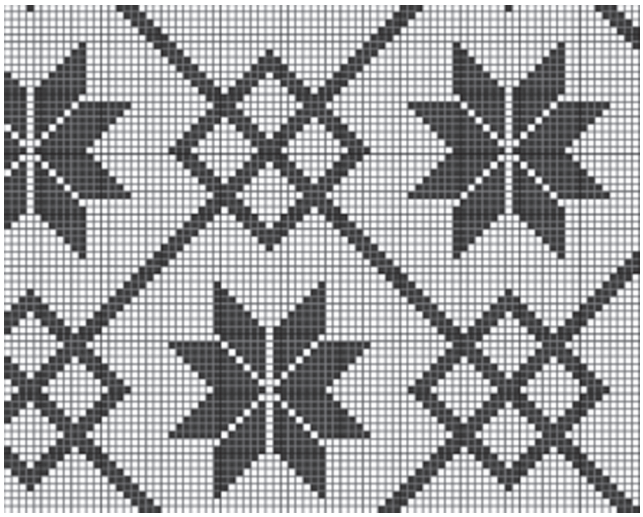

Fig. 9: Grid of oblique lines and eight-pointed stars, ■ = 1 reverse loop (Image: Helena Lundin)

Fig. 10: Cuff embroidered with metal thread, accession number KLM 15143 KR (Image: Helena Lundin/Kalmar County Museum)

Fig. 11: Left shoulder of a waistcoat where the sleeve is joined to the body. Reverse loops create stripes in oblique checks on the yoke. Metal thread embroidery, accession number KLM 15143 KR (Image: Helena Lundin/Kalmar County Museum)

are in Norway but others are also in Sweden and the United Kingdom. Fragments from at least four have been excavated in Denmark and one was discovered in a tomb in the church of Askersund, Sweden (Hazelius-Berg & Waldén 1937; Ringgaard 2014, 76). These damask-knitted waistcoats should probably be understood as a north European, or Scandinavian, variant of the brocade-knitted (patterned by change of colour) silk waistcoats that were popular all over Europe at that time (of which at least 35 are preserved), possibly of Italian manufacture (Ringgaard 2014, 75-82, 97-100).

Stockings

Fragments from 11 single, and four pairs of wool stockings were identified, as well as fragments from two silk stockings and one decomposed stocking (also most likely wool). Stockings where the entire leg is preserved are long - one pair (KLM 13245 KR) measures 84 cm from the upper edge to under the heel (fig. 14). Most upper edges of the stocking legs have raised bands consisting of two courses of reverse loops and two courses of face loops repeated two, four or five times, completed with two courses of reverse loops.

All the wool stockings in which the back of the leg is preserved have a so-called "false seam" (more properly a marker rib), knitted with reverse loops. The absence of a real seam suggests they were knitted round. Three types of marker ribs have been identified. Two pairs and four single stockings have the marker rib type a (fig. 15), for example KLM 4288 a+b KR and

Fig. 12: Silk pile on the verso, secured with knots, accession number KLM 15143 KR (Image: Helena Lundin/Kalmar County Museum)

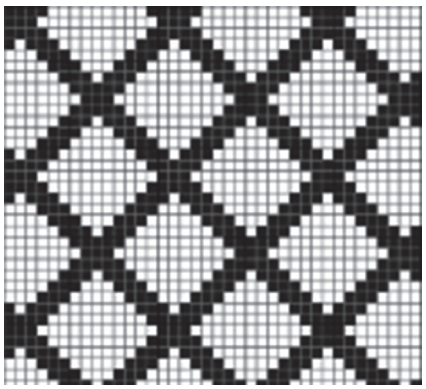

Fig. 13: Grid of oblique checks, ■ = 1 reverse loop (Image: Helena Lundin)

Fig. 14: A single wool stocking, 84 cm long from the upper edge of the leg to underneath the heel. The cuff is 27 cm wide, accession number KLM 13245 KR (Image: Helena Lundin/Kalmar County Museum).

KLM 13245 KR. Two pairs and one single stocking have the marker rib type b (fig. 16), for example KLM 308 KR. Only one stocking (KLM 3960 KR) has marker rib type c (fig. 17). The legs were shaped to fit the thighs and calves by parallel increases and decreases on both sides of the marker rib at the back. On either side, all three marker rib types have one wale of face loops before any increases or decreases occur. These single face wales reveal that all wool stockings with preserved marker rib, upper edge and/or heel were worked from the upper edge down towards the foot.

Many of these stockings have clocks of reverse loops at both sides of the ankles. It was possible to analyse, at least to some extent, some of them. Floral patterns (carnation flowers?) (figs 18 and 19) were found on two single stockings (KLM 11592:45 a KR and KLM 14922 KR). One pair (KLM 4288 a+b KR) has a more geometric clock pattern (fig. 20) and on one stocking (KLM 16597:18:1 KR) the clock almost resembles a building with three towers (fig. 21).

Two different ways of shaping the heel have been identified. Heel, type a: On two pairs and one single

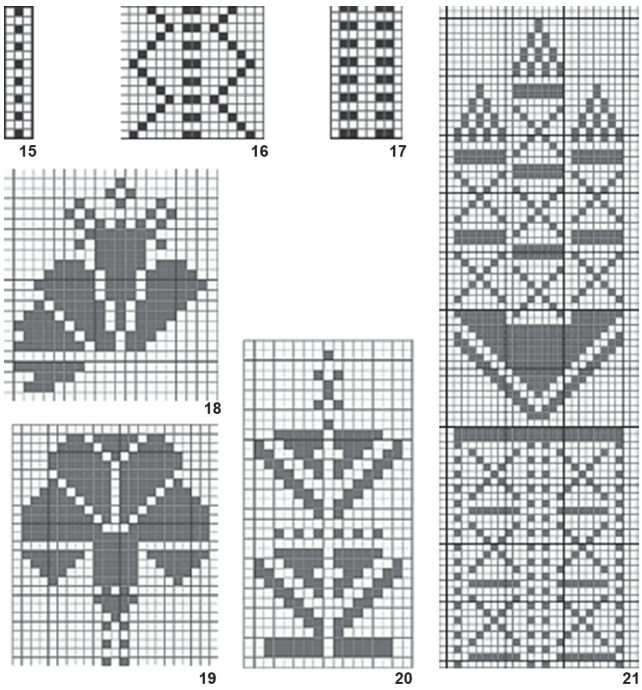

Fig. 15-17. Knitted marker rib, type a (15); type b (16); type c (17). Fig. 18-21: Clock charts, accession number KLM 14922 KR (18); KLM 11592:45 a KR (19); KLM 4288 a+b KR (20); KLM 16597:18:1 KR (21). ■ = 1 reverse loop (Images: Helena Lundin)

Fig. 22: Detail of knitted marker rib (type b) and heel, type a. Wales from both sides are decreased towards the marker rib to shape the heel, accession number KLM 308 KR (Image: Helena Lundin/Kalmar County Museum)

stocking (KLM 308 KR, KLM 1287 KR and KLM 13245 KR) the wales at the back and back sides of the leg are decreased in parallel towards the marker rib until the heel is shaped (fig. 22). After the heel was completed, loops were picked up around the sides of the heel and the instep was knitted perpendicularly to the courses of the heel. In this way, gussets were formed at both sides of the foot, often surrounded by raised bands of reverse loops. The pair KLM 1287 KR is currently on display in a case and a closer analysis was not possible, but the feet seem to be worked round and the toes shaped with symmetrical decreases on either side.

Heel, type b: The stocking foot KLM 3960 KR was knitted differently. Some knitted irregularities above the heel first suggested that the heel had been inserted. However, a new analysis of photos showing the top of the stocking foot showed what looks like a course of loops, reaching from one side of the foot to the other about 3.5 cm from the (later) mending with a darker yarn, where some loops seem to have been twisted or crossed over one another as if they at some point had been dropped and picked up on the needles, which instead would suggest that the forefoot and toe were inserted. The technique is the same in either case. Both heel and toe are worked round and shaped with symmetric decreases on either side (fig. 23 and 24). The stocking foot has a possible shaping, or a mistake, on top where a few loops have crossed over one another where the new instep was knitted (fig. 24).

Some of the wool stockings with gussets were found in chests together with upper-class artefacts, for example accession numbers KLM 11592 KR and KLM 16597 KR (Einarsson 1998, 14-17; 2009, 21-25; Fält2014, 11592:1-88; 16597:1-48), and could therefore be linked to the higher levels of society. Stockings of similar construction and decoration have been found in Denmark (Warburg 1988, 129-133, 190-197, 202). The fragment KLM 3960 KR was found next to a cannon on the upper deck (Einarsson 1988, 9, Appendix I; Fält2014, 3960).

Single rib fabric

One example of single rib fabric (KLM 3603) was found at the entrance to the quarter gallery on the port side of upper gun deck (Einarsson 1987, 14; Fält2014, 3603). The fragment has torn edges and is still very soft and elastic. It is knitted of a wool yarn with long fibres.

Fig. 23: Detail of heel type b, knitted in the round and decreased at the sides, accession number KLM 3960 KR (Image: Helena Lundin/Kalmar County Museum)

Fig. 24: The stocking foot has been mended with a new toe, knitted with a darker yarn. There is a possible shaping or a mistake on top, where a few loops have crossed over one another when the new toe was knitted. The toe is shaped with symmetrical decreases on either side, accession number KLM 3960 KR (Image: Helena Lundin/Kalmar County Museum)

Conclusion

While the evidence of the *Kronan* provides a better understanding of the knitwork worn by men of a higher social standing in the late 17th century, no knitted item could with any certainty be linked to men from the lowest level of society. Knitted high-class items are easier to link to men of a higher level of society as some are recognisable as luxury garments and also because the find context, chests and associated finds are more identifiable for men of higher social standing. Fragments of clothing belonging to men from lower levels of society are more difficult to identify as we still know very little about their clothing. Further analysis of the textile finds from Kronan and their contexts is required to identify men from lower social standing and their clothing.

Abbrevations (accession numbers)

KLM = Kalmar läns museum (Kalmar County Museum)
KR = Kronan
Please note that some of the inventory numbers given in this article refer to more than one item.

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Annemarieke Willemsen

Two knitted mittens from a 17th century Dutch shipwreck

Abstract
Two knitted mittens (but not likely a pair) were found in the same shipwreck, known as Burgzand Noord 8, in the Dutch Wadden Sea off the island of Texel. They were knitted round, narrowing at the wrist and tips of the thumbs. One of the mittens was dyed blue according to chromatographic analysis. Both show traces of wear and spots of tar, which indicate they were used on board. Coins corroded on to the blue mitten indicate that it was close to money in the officers' quarters where it was found at the time of the wreck. The wool mittens were with other wool clothing, which suggests that the ship was lost in winter, while other finds pinpoint it to an infamous December storm of 1660. These mittens are two rare examples of knitted garments in the Netherlands, where gloves and mittens made from cloth seem to have been more usual.

Keywords: Mittens, knitting, clothing, maritime archaeology, Wadden Sea

Introduction

There is a long tradition of warm, wool, knitted mittens in the northern, colder parts of Europe. In Scandinavia, most of the excavated Medieval and Early Modern mittens and gloves are knitted, often with ornamentation, sometimes with fringes or in a range of colours. In the Netherlands, find contexts are often and famously favourable for the preservation of textiles (and other organic materials) due to the high water table. But surprisingly few of the excavated mittens are knitted, and they are of a very simple construction. This article focuses on two knitted mittens from a shipwreck in the Wadden Sea, lost near the island of Texel in the third quarter of the 17th century.

Mitten A

The two knitted mittens come from the same shipwreck. They are not likely to have been made as a pair (see gauges) although they may have been worn together. Mitten A (Willemsen 2015b: catalogue number H017) is for a right hand (figs 1 and 2). It is now in storage at the Cultural Heritage Agency, Maritime Archaeology (now in the Nieuw Land Erfgoed-building) at Lelystad, The Netherlands, inventory number BZN8-220. It is 23.5 cm in length. The mitten could only be measured lying flat; the 2-ply yarn is approximately 1 mm in diameter and is lightly S-twisted. The gauge of the mitten is 42 to 43 wales per 10 cm and about 50 courses per 10 cm. The width at the cast-on edge of the mitten is 12 cm and the width over the palm of the hand is 11.5 cm, making a circumference of 23 cm to 24 cm. These dimensions suggest it was made for a man: modern fitted leather gloves for women are less than 9 cm wide, whereas for men their widths ranges from 10 cm to 12 cm (Willemsen 2015b: 82).

Mitten A is simple knit fabric, from a single yarn, starting at the cuff, which appears to have a cast-on edge; that is, the edge shows the half-loops typical of common casting on, not the rotated complete loops left by the usual method of casting off. It was knitted in the round, which is indicated by the lack of a sewn seam. At the top, the mitten rounds off over the fingers by means of decreases placed approximately over the index finger, on the side of the palm (not the back of the hand). The decreases are on either side of a band of five wales; every two courses, one wale on the right and one wale on the left vanish "under" this

band (fig. 3). A more usual way would be placing the decreases symmetrically on the folds of the mitten, as was done on the thumb of this one. There is a slight narrowing of the mitten at about 6 cm above the cuff edge. Three decreases are found between the cuff edge and the wrist; only two increases have been detected between the wrist and the thumb. The exact method of decreasing and increasing could not be established. The cuff edge is slightly rolled up into a tube with a diameter of 0.8 cm. The mitten is 0.5 cm thick with the back and palm measured together; the fabric thickness is about half that.

The thumb is 6 cm long, 4 cm wide at the base (32 wales), and starts 11 cm above the cuff edge. Half the wales are continuous from the wrist up the thumb to the tip (the "outside", visible in the figure). On the other side (towards the palm), there is a discontinuity, which corresponds to a common method of adding a thumb when knitting in the round. In the course corresponding to the base of the thumb, one diverts a few stitches from the course one is knitting onto a spare knitting needle or a piece of yarn, and replaces them with newly cast-on stitches, then knits on in the round as if nothing had happened, simply leaving behind a short slit. To start the thumb, half the stitches are the ones previously set aside, and the other half are picked up from the cast-on replacement stitches; knitted in the round, they grow into a tubular thumb

Fig. 1: Upper side of Mitten A from wreck Burgzand Noord 8, off Texel, The Netherlands, dating to shortly before 1660 AD (Image: Cultural Heritage Agency, Lelystad, inventory number BZN8-220)

Fig. 2: Underside of Mitten A from wreck Burgzand Noord 8, off Texel, The Netherlands, dating to shortly before 1660 AD (Image: Cultural Heritage Agency, Lelystad, inventory number BZN8-220)

Fig. 3: Detail of Mitten A (Cultural Heritage Agency, Lelystad, inventory number BZN8-220) showing the shaping by decreasing the number of wales towards the fingertips end
(Image: Annemieke Willemsen)

Fig. 4: Upper side of Mitten B from wreck Burgzand Noord 8, off Texel, The Netherlands, dating to shortly before 1660 AD (Image: National Museum of Antiquities, Leiden, inventory number g 2017/9.1)

rising from the preparatory slit. This tube is flattened by the decreases that shape the thumb-tip. These decreases are symmetrically placed on either side of the "fold" of the flattened tube. They are achieved by knitting together each third and fourth loop, counted from the fold; in knitters' terms, one course is: knit two, knit two together, knit the rest until there are four loops before the fold, then knit two together and knit two, for one face of the thumb, then repeat with the other half of the stitches for the other face of the thumb (see fig. 3). The mitten's surface seems to be intentionally abraded at the back of the hand where there are traces of tar too. There is damage where the thumb is attached on the inside.

Mitten B

Mitten B (Willemsen 2015b, catalogue number H015) is for a man's left hand (figs 4 and 5). It is now kept in the stores of the National Museum of Antiquities at Leiden (RMO), inventory number g 2017/9.1. This mitten was donated to the museum by its finder, Hans Eelman, in 2017, together with some other textile fragments from this wreck, including a knitted stocking. It is 21.5 cm long, but some of the top of the hand and most of the thumb are now missing. This mitten was also measured lying flat; the diameter of the yarn was measured at 1 mm to 1.2 mm and it is lightly S-spun with a light Z-ply. The gauge of the mitten is 35 wales per 10 cm and 55 courses per 10 cm. The width over the wrist is 12 cm; the maximum width over the palm of the hand is 12.5 cm, making a circumference of 24 cm to 25 cm. These dimensions suggest it was made for a man. It is 0.6 cm thick with the back and palm measured together; the fabric thickness is about 0.3 cm.

Mitten B was knitted with one element (a plied yarn) in simple knit fabric, starting at the wrist and working towards the fingertips, and knitted round. The cast-on edge (fig. 6) is slightly rolled up and seems to be what is known today as a "purl cable cast-on" (Hemmons Hiatt 2012, 67, bottom right), probably using a double thread just for the edge.

There is a slight narrowing of the mitten at about 7 cm from the cast-on edge. The decreases achieving this shaping are symmetrical, on the back and palm of the

Fig. 5: Under side of Mitten B from wreck Burgzand Noord 8, off Texel, The Netherlands, dating to shortly before 1660 AD (Image: National Museum of Antiquities, Leiden, inventory number g 2017/9.1)

mitten, on both the left and the right sides. They were made five times after four courses; the method used is 'slip slip knit left decrease' Hemmons Hiatt 2012, 216-7) and 'knit two together right decrease' (Hemmons Hiatt 2012, 217). This is visible in the fabric where two loops in the same course have been knitted together from the same direction: either from the right or from the left. The new loops made by these methods lean in opposite directions.

Increases were made symmetrically five times after four courses on the back and palm, on both the left and right (fig. 7). The method used is 'knit right raised increase' (Hemmons Hiatt 2012, 209) on the right side of the mitten; on the left side it could not be determined. The thumb is now almost separated from the mitten, hanging on by two loops, which makes it difficult to see how it was started.

Mitten B has a lightly matted surface, either from fulling when it was made or through use. On the upper side is a circular piece of corroded metal, now stuck to the mitten but not originally part of it (see fig. 4). Two smaller fragments of similar metal are on the inner side, where there are also black spots, possibly from tar.

Colour

A sample was taken from the Mitten B on 21 September 2015, which was analysed using ultra-high-performance liquid chromatography (UHPLC) by Ineke Joosten (Cultural Heritage Service) in 2016. In the sample, indigotin and isatin were identified, which point to an indigoid blue dye plant. It is not possible to distinguish between woad (*Isatis tinctoria*) and indigo (*Indigofera tinctoria*) with this chemical analysis. Indigo was introduced into Europe in the course of the 16th century and had completely replaced woad by the beginning of the 17th century. Because the mitten is dated to the third quarter of the 17th century, indigo seems the most likely dye plant.

Fig. 6: Cast-on edge on Mitten B showing evidence that the item was knitted from the cuff towards the fingertips. National Museum of Antiquities, Leiden, inventory number g 2017/9.1 (Image: Chrystel Brandenburgh)

Fig 7: Detail of Mitten B showing the shaping by increasing the number ol wales on the right side (Image: National Museum of Antiquities, Leiden, inventory number g 2017/9.1)

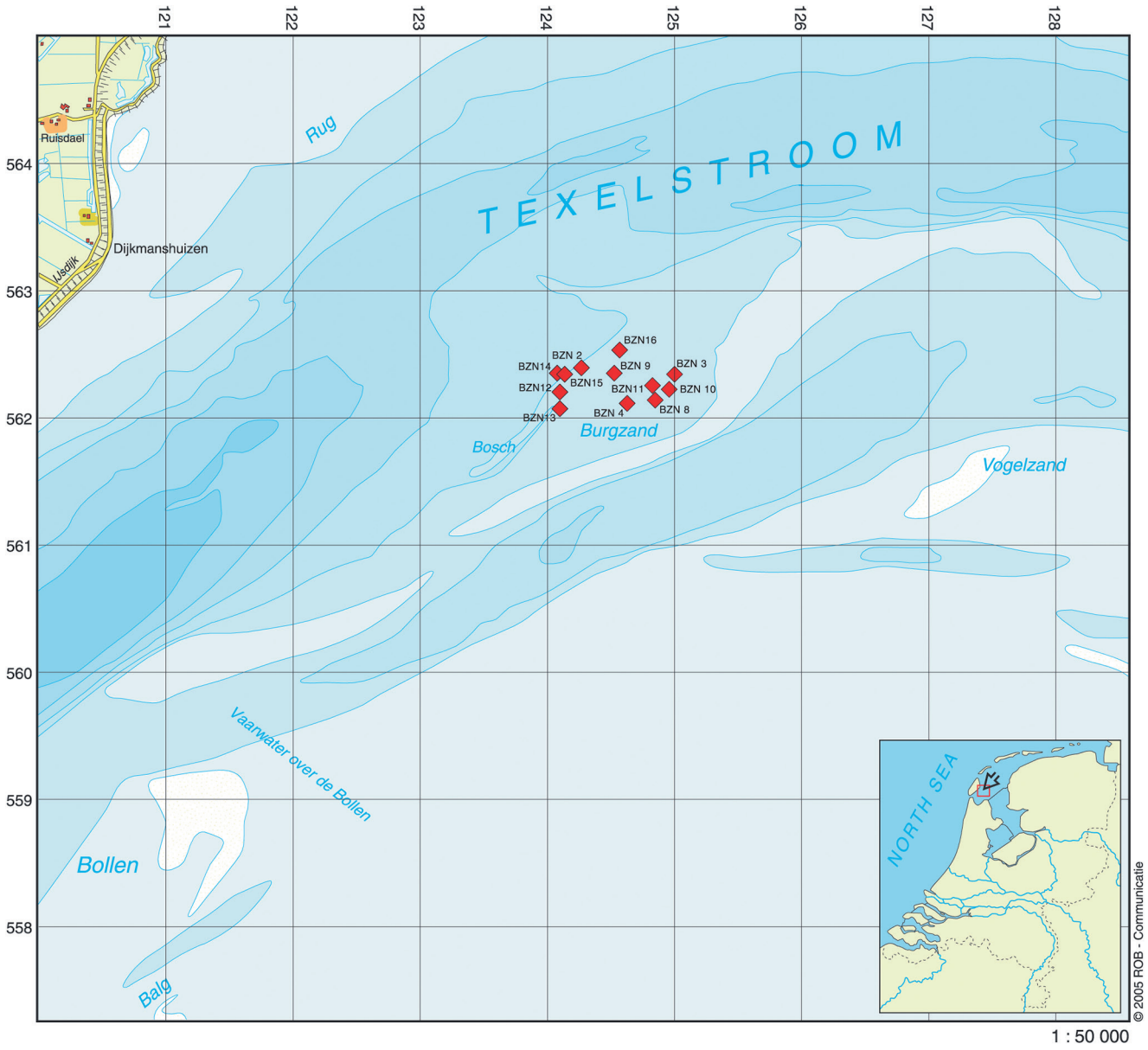

Fig. 8: The wreck location at Burgzand Noord by the island of Texel (Image © Arent Vos)

Analyses with a scanning electron microscope with x-ray microanalysis (SEM-EDX) show that typical elements from a marine environment such as salt and pyrite are on the fibres of this mitten. The presence of copper sulphite indicates that the fabric sample was close to copper-based metal (Joosten 2017). This might be from the metal stuck to the mitten, which was manually tested and found not to be magnetic. Both Hans Eelman and Arent Vos, experienced Texel wreck divers, mentioned that this is the way coins, especially silver ones, commonly corrode on to textiles in wrecks. This means that the mittens may have been in the same location (such as a chest, a cupboard, a bag or a pocket) on the wreck when it sank. Mitten A (Cultural Heritage Agency), inventory number BZN8-220) has not yet been analysed for dye traces.

The mittens are of a similar size, and both narrow at the wrist. In addition, the find locations make it possible that these two mittens were originally worn together. However, the variations in the gauge and the characteristics of the knitted fabrics make it unlikely they were knitted as a pair.

Mittens on board

The shipwreck, called Burgzand Noord 8 (BZN 8) after its find location, was found by Texel diver Hans Eelman in 1997. It is one of ten wrecks identified

from hundreds of ships that are known to have been wrecked at this spot, called the Reede van Texel. It an infamous ridge in front of the Wadden Sea where ships had to wait for favourable winds to sail into Dutch harbours further south (fig. 8). Eelman reported the wreck and recovered some loose items from the site, including Mitten B (inventory number g 2017/9.1) and two knitted stockings with decorative stitching; the latter are still in his personal possession.

Following Eelman's report, the archaeological diving unit (now closed) of the Cultural Heritage Service inspected the site in 1998 and concluded that it was under threat due to continuous sand erosion. A limited underwater excavation was carried out in 2002, which revealed a medium-sized ship of non-Dutch build with cargo including a bronze bell that was cast, signed and dated by the famous Hemony brothers in 1658. Among the more than 300 personal items of the ship's officers in the collapsed aft-deck was Mitten A (inventory number BZN8-220), and a left-handed leather mitten with a needlebound inner mitten (fig. 9; Cultural Heritage Agency, Lelystad, inventory number BZN8-219; Willemsen 2015b, catalogue numbers H054 and H016). In 2003, the wreck was covered with gauze to let sand flush in and keep it there to slowly cover the wreck. A monitoring dive in 2016 showed the wreck still safely covered.

The wreck must date later than 1658, but not much after that, because of the presence of the bell and some other items inscribed 1657 or 1658. This means that BZN8 may be one of 100 or so ships that were lost off the coast of Texel in a ferocious overnight storm from 18 to 19 December 1660. The wool clothing, a protection against the cold but very rare on wrecks of seagoing ships in the Netherlands, is suggestive of a winter date for the wreck (Vos 2012, 193-217). The lining of the leather mitten is thus far the only securelyidentified needlebound item of the Early Modern era in the Netherlands, and it is possible (although impossible to prove) that it belonged to a crew member from Scandinavia, where needlebound mittens are common, rather than to a Dutchman.

It is not surprising that people took their warm mittens to sea. There are a few other wool mittens recovered

Fig. 9: Leather mitten with needle-bound inner mitten from wreck Burgzand Noord 8, off Texel, The Netherlands dating to shortly before 1660 AD (Image: Cultural Heritage Agency, Lelystad, inventory number BZN8-219)

Fig. 10: Knitted mitten from a waste assemblage at Prinsenstraat, Groningen dated 1500 to 1600 (Image: Stichting Monument & Materiaal Groningen, inventory number 15T15)

from Dutch shipwrecks (Willemsen 2015b, catalogue numbers H014 and H018). Four are known from the Dutch whaling station on Svalbard or Spitsbergen (Willemsen 2015b, 57). But these are all mittens cut and sewn from wool cloth, as are the majority of excavated mittens from the Netherlands. The wreck BZN 8 is the only one to have both knitted mittens and a needlebound mitten. There are at least another 12 woven wool mittens from the Netherlands (Willemsen 2015a, 4-8), in some of which traces of red or yellow dye were found (Joosten 2017). There is one other excavated knitted mitten, from Groningen (inventory number 15T15), for a man's left hand (28 cm high × 15 cm wide with an estimated circumference of 30 cm) and dated 1500 to 1600 (fig. 10). The same find assemblage also contained four knitted gloves, one of which must have been coloured red, and some with decorative stitching (Zimmerman 2007). Finally, two fragments of a possible knitted mitten were excavated from the metro track at Amsterdam, dated 1450 to 1600 (Willemsen 2015b, catalogue number H004). An extensive review of the archaeological record for mittens in the Netherlands (Willemsen 2015b) indicates that needlebinding was probably never used for mittens in the Netherlands.

Conclusion

Two knitted mittens, found in the same shipwreck (BZN 8) in the Dutch Wadden Sea near the island of Texel in 1997 and 2002, were probably not a pair. They do have similar dimensions, and one is for a right hand and the other for a left, but both the gauge of the knitted fabric and the techniques used for shaping by increasing and decreasing are different. At least one of the mittens was originally blue in colour (RMO, inventory number g 2017/9.1).

Both mittens were worn and used on the ship, as they show traces of wear and have spots of tar, which dripped on to them. The metal, which is likely a coin, corroded on to the blue mitten, indicates that at the time of wreck, the mitten was in contact with money. Their find location places them in the officers' quarters on the aft deck. With the other pieces of wool clothing recovered from this wreck, they are consistent with the idea that the ship went down in the winter season. That is also indicated by the possible dating of the loss of this ship to the December storm of 1660, based on dated items in the cargo. This dates the knitted mittens to shortly before 1660 AD. They remain two rare examples of knitted hand garments in the Netherlands, where

making mittens from cloth seems to have been more common.

Acknowledgements
The author wishes to thank Hans Eelman (Texel) and Arent Vos (Cultural Heritage Agency) for providing access to the finds and for their information and support; Klaas Helfrich (Stichting Monument & Materiaal, Groningen) for access to the Groningen mitten; to Chrystel Brandenburgh (Municipality of Leiden/Brandenburgh Textile Archaeology) for her expertise in looking at the mitten in Leiden; and to Jane Malcolm-Davies for her encouragement to put these shipwrecked mittens into focus.

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Investigating 16th century knitting with citizen science:

An archaeological experiment into fleece and fulling

Abstract
An archaeological experiment was undertaken as part of the *Knitting in Early Modern Europe* (KEME) project to determine the best modern match for the fleece used in surviving 16th century knitted caps. Circular test swatches, known as 'swircles', were created by volunteers from a variety of fleece. The experiment demonstrated that, through citizen science, members of the public can contribute meaningfully to academic textiles research. It recorded a number of useful insights into the process of involving volunteers in experimental archaeology. The aim was to recreate the thick nap observed on the extant cap linings. Half the swircles were hand-fulled and brushed to raise a nap by the volunteers. The nap raised from a Wensleydale yarn most closely resembled the length of the preserved naps but Bluefaced Leicester fleece provided a softer and more even coverage. No tested fleece provided a combination of these features to sufficiently mimic the extant nap.

Key words: Knitting, 16th century, cap, fleece, fulling, experimental archaeology, citizen science, crowdsourcing, volunteer

Introduction
A surprising number of 16th century knitted caps and cap linings are preserved in museum collections across Europe. Numbering more than 100, these somewhat unglamorous items have, until recently, remained largely unstudied. Little is known about early knitting, the treatments applied to the finished caps or the materials used to construct them. Yet, with the growth of historical reenactment as a serious leisure pursuit (Hunt 2003), as well as an increased interest in historic dress and knitting generally, more information on how these items were constructed is now in demand. Research, conducted by the *Knitting in Early Modern Europe* (KEME) project and others, has provided some insights, but questions remain about how the neat, silky nap observed on the extant caps and linings was achieved.
The KEME project recognised that this wide public interest in knitting history could provide a wealth of knowledge, and designed an experiment to investigate the method and materials used to create the nap using volunteer knitters. Volunteers worldwide were invited to knit circular test swatches, known as 'swircles', from a yarn of their choice. Half of these were then hand-fulled and napped with the remaining half left untreated as controls. These were compared to one another and the extant record to determine which yarn, and the fleece from which it was made, produced the best reconstruction of the 16th century nap.
The experiment was also intended to test whether members of the public could meaningfully engage in academic textile research through citizen science, also known as crowdsourcing. Using its broadest definition, citizen science is the involvement of non-specialist volunteers in the collection of scientific data (Clark & Illman 2001; Lewenstein 2004; Silvertown 2009; SOCIENTIZE/European Commission's Digital Science Unit 2013). The *Oxford English Dictionary* now defines it as: "Scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions" (2014).

Fig. 1: Reconstructed split-brimmed cap prototype made by Rachel Frost for The Tudor Tailor based on a range of similar caps (inventory nos: Museum of London 5013; 5004; A6347; A7608A; Cuming Museum TN3338/1506). See https://kemeresearch.com/caps to view the originals (Image: © The Tudor Tailor)

Crowdsourcing has been widely employed in biology and other natural sciences with, for example, volunteers recording species sightings or rare phenomena. It has, however, had limited published use in textile archaeology (for some reported examples, see Hopkins 2013). The KEME project was designed to test the feasibility of citizen science in the field by using volunteers for the fleece and fulling experiment. The swircles provided by the volunteers and the results they produced were intended to link directly to the scientific outcomes of the KEME project (Malcolm-Davies 2016).

Background – The KEME Project

KEME aimed at investigating the development of knitting in Europe as a distinct form of textile craft in the Early Modern period (University of Copenhagen, 2017a). It is generally acknowledged that knitting emerged in Europe during the Middle Ages and quickly developed into an industry in the Early Modern period (Thirsk 2003, 562). Due to its similarity in appearance to netting, needlebinding, sprang and others, very close examination is often needed to determine whether an archaeological find is knitted or constructed in another way (Rutt 1987, 7-9). This difficulty has led to knitting being overlooked in the archaeological record and museum collections. Yarn-based objects are often incorrectly or minimally labelled (Malcolm-Davies 2018a, 2). The KEME project sought to address this by identifying knitted objects in museum collections across Europe and north America which resulted in more than a 100 16th century knitted caps and cap linings being brought together as comparative evidence (University of Copenhagen 2017a).

Despite their geographically diverse locations, the way in which these caps were constructed was found to be relatively uniform (Malcolm-Davies 2018a, 2). Most appeared to have been knitted in the round using more than two needles with random increases or decreases to create a circular crown and/or to form one of six shape variations (Malcolm-Davies & Davidson 2015, 223, 225-8; Buckland 2005, 31-32). Two-ply or two-thread unplied yarn spun from a variety of fleece was most commonly used with no apparent preference for S or Z spin (Malcolm-Davies & Davidson 2015, 225-6). After being knitted, the caps appeared to have been treated to produce a thick nap. This raised nap was then clipped to an even finish producing a surface similar to that found on modern plush toys (Museum of London 2016). Dyeing appears to have been the final process after knitting, fulling and napping. This is

indicated by the fact that some caps showed evidence of the dye not having penetrated to the core of the yarn and the surface of the caps appearing paler where the nap had been lost (Maeder 1981).

Using this information, the reconstruction of a split-brimmed cap (fig. 1) was undertaken (Malcolm-Davies & Davidson 2015, 224). Although the final shape of this reconstruction was close to the original, the surface treatment did not replicate the silky nap seen on the extant caps (Malcolm-Davies & Davidson 2015, 230). It was hypothesised that this was partly due to the type of fleece used. Modern European fleeces differ from those available in the 16th century but the precise differences are unknown (Malcolm-Davies 2018a, 4; Schjolberg 1992, 152; Ryder 1984, 342-343; Ryder 1964, 7).

A microscopic investigation of the extant caps also revealed that the fleece fibres appeared to have been stripped of their outer scales. This led to the conjecture that fulling had been applied as part of the construction process as, unlike felting which is designed to enmesh loose fibres by rubbing them together, fulling smoothes woven or knitted fibres. Therefore, an experiment was designed to test these theories.

Experiment Design

To narrow the investigation to a manageable experiment, it was decided that a test swatch should be developed to avoid the need to construct a complete cap for each type of fleece to be tested. The extant knitted circular cap linings, which have the same nap as the caps, were chosen as the basis for this swatch. As a flat piece of knitting, their construction was easily explained in modern knitting instructions, with a reduction in diameter to 12.75 cm to make them even more practical to produce (fig. 2). The linings also provided a clear subset of items to which the swatches could be compared. The circular swatches were nicknamed 'swircles'. These swircles were to be constructed from a wide range of sheep's fleece and then fulled to test which knitted and finished fleece most closely resembled the original nap on the extant linings. Volunteers would be recruited to choose the fleece, knit and full swircles, and report their results. The volunteers would have access to the original material via an online database, which they could examine and comment on to contribute to the scientific record.

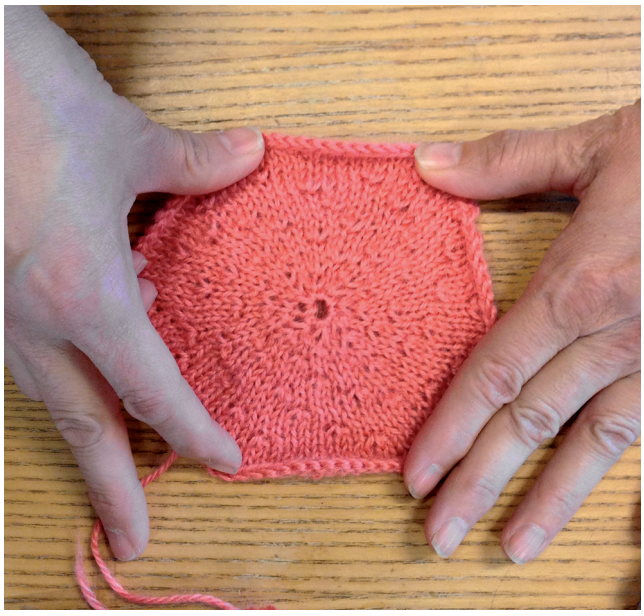


Fig. 2: A completed Wensleydale swircle (circular swatch) before fulling during a phase 1 workshop (February 2017)

The decision to involve volunteers, however, posed several challenges for the design of the experiment. For example, the widespread public interest in knitting history had the potential to provide a large pool of volunteers but there was no guarantee that those recruited would have the necessary familiarity with archaeological material to provide useful samples and observations. Access to the KEME database was seen as a potential solution as it would allow volunteers to consult the archaeological record directly and learn from it. The database was hosted online (fig. 3) and made accessible via usernames and passwords issued to the volunteers. Initially, the database contained high-resolution photographs and relevant accession information on the cap linings, and this was expanded to include one category of caps (the split-brimmed examples) towards the end of the experiment (Malcolm-Davies 2018a, 3-4). A link to an online questionnaire provided the opportunity for the volunteers to add observations on each item in the database, if they wished to do so.

Concern about a lack of archaeological expertise proved to be unfounded. The registration information collected confirmed that many volunteers already had appropriate skills. A quarter identified themselves as being primarily motivated to volunteer for professional or tertiary education reasons (fig. 4). A further 21% came from a reenactment background. This gave nearly half the KEME volunteers a wide basis of professional or amateur knowledge of experimental archaeology and the reconstruction of historic textiles.

A second concern was the volunteers' anticipated level of craft skill. In order for the swircles to be suitable simulations of the cap linings, consistency across the knitted samples was required. The use of knitting instructions, although one step towards

uniformity, was no guarantee of consistency across multiple volunteers. A suitably large cohort was identified as the best way of counteracting any outliers in craft skill. A target of 100 volunteers was set for the experiment. Details were promoted on social media to achieve this. KEME accounts were set up on Facebook and Twitter as well as on the knitting forum Ravelry (*Strickersvej – Knitters Way*; *#Strickersvej; Early Modern Knitting*, 2017b). Potential volunteers were directed to an online registration form hosted by SurveyMonkey (*Early Modern Knitting*, 2017). SurveyMonkey, as the name suggests, facilitated the collection of information on the volunteers, including data on self-assessed knitting skill. Of the volunteers recruited, 40% identified themselves as being expert knitters with this figure increasing to 43% when the 'other' responses were recategorised (fig. 5). Only two non-knitters were identified in the whole group with both stating that their interests lay in analysing the archaeological record rather than contributing knitted

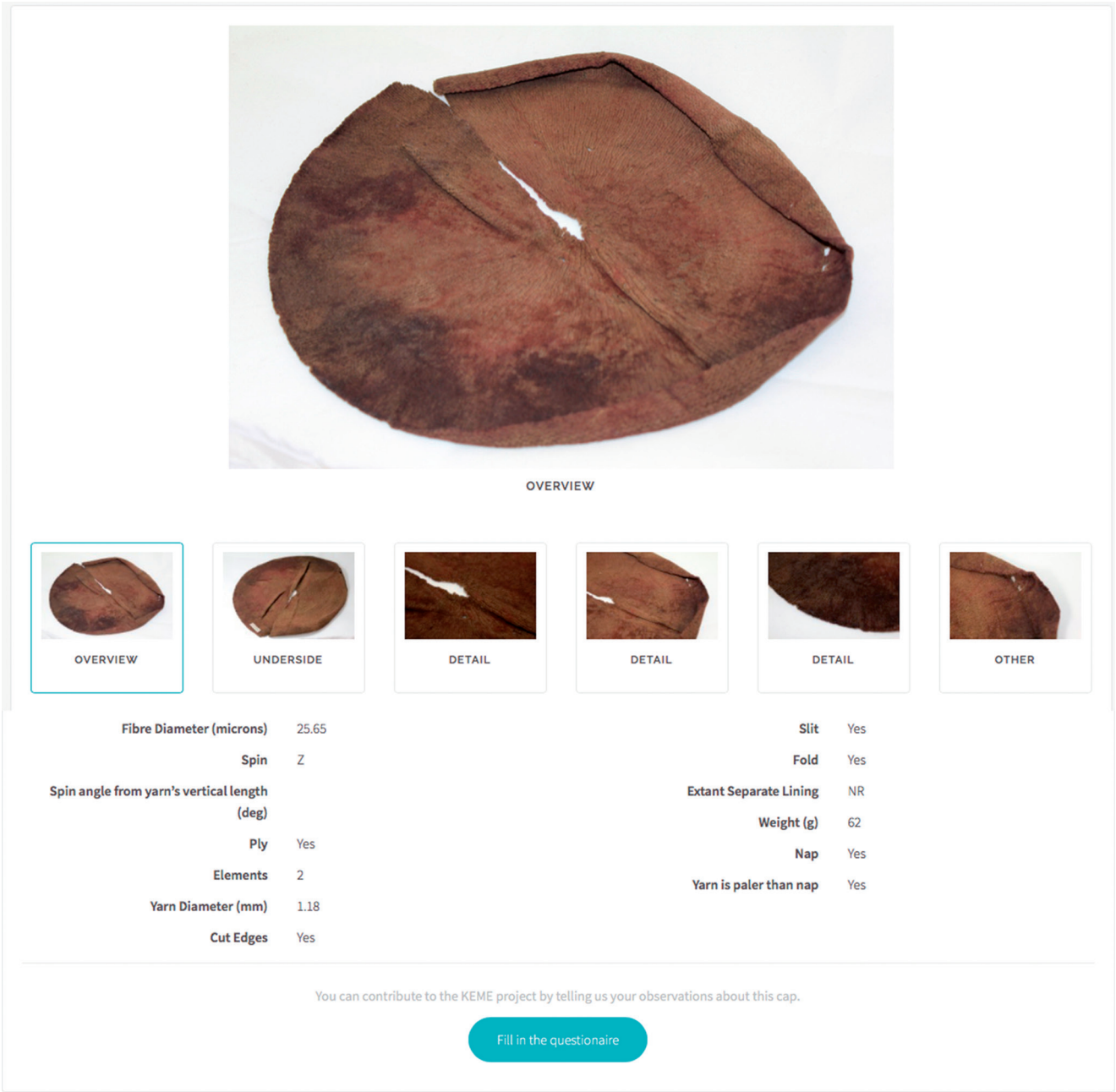


Fig. 3: Screenshot of part of the KEME database entry for a cap lining at the Victoria & Albert Museum, London (inventory no 1563A-1901). Visit: https://kemeresearch.com/caps/44 for more details.

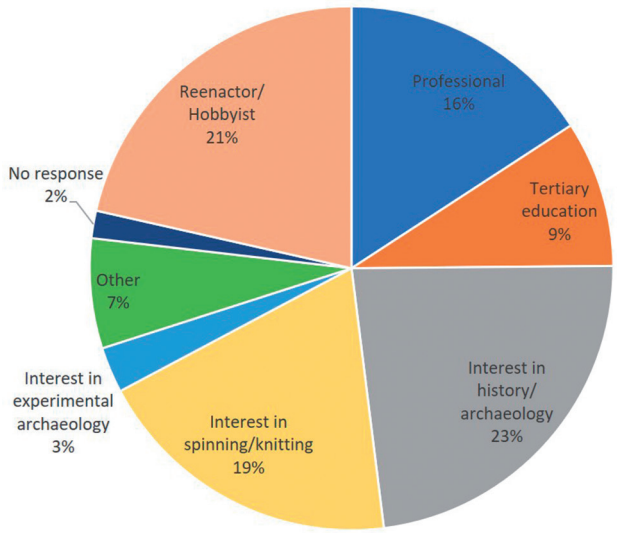


Fig. 4 (left): KEME citizen scientists' primary motivations for volunteering (based on 177 volunteers' responses). Many respondents gave multiple reasons for volunteering but, as these varied in number, only the primary motivation is represented here

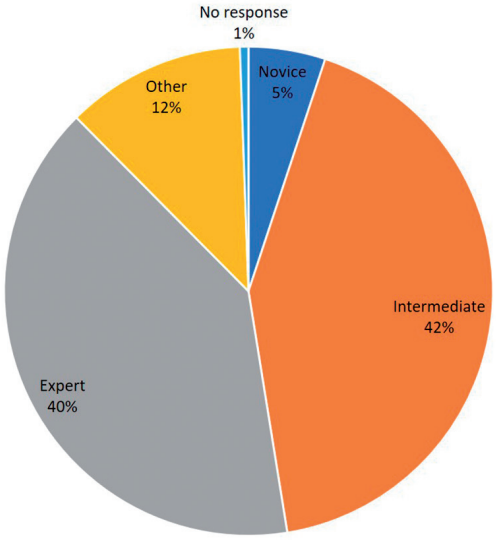


Fig. 5 (right): Self-assessed knitting skill of KEME citizen scientists (based on 177 volunteers' responses)

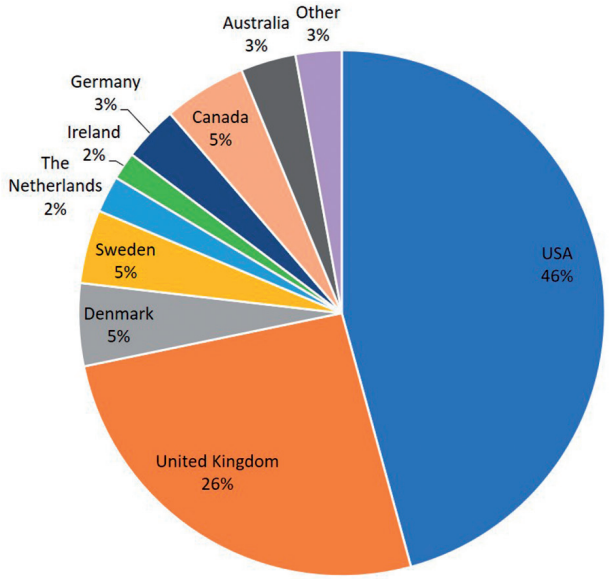


Fig. 6 (left): The locations of KEME citizen scientists around the world (based on 177 volunteers' responses)

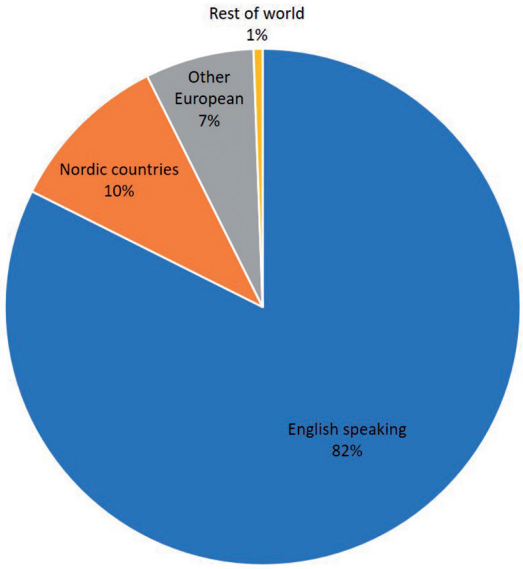


Fig. 7 (right): KEME citizen scientists divided into language groups (based on 177 volunteers' responses)

samples. Therefore, as with archaeological awareness, concerns about craft skill were largely unfounded.

By promoting the experiment online, it was also hoped that volunteers from a wide geographical area would be recruited and that this would increase the number of locally sourced fleece included in the results. Of those recruited, 46% of volunteers were in the United States followed by 26% in the United Kingdom (fig. 6). The remainder were located worldwide but, when divided into language regions, English-speaking countries accounted for 82%. This is likely due to the fact that English was the only language used to promote the experiment. Nordic countries provided the bulk of the remainder at 10% and this can be explained by the KEME project being based at the University of Copenhagen in Denmark (fig. 7).

The success of online recruitment, however, created another challenge for the KEME team – how to communicate with the volunteers. A mailing list was set up using MailChimp from which e-newsletters

Guidelines for Utilising Textiles in Experimental Archaeology

- Raw materials should be selected according to our knowledge of fibres.
- Tools should be reconstructed on the model of precise copies of archaeological artefacts.
- The primary parameter to be investigated is the function.
- All processes must be performed by skilled craftspeople.
- Each test should be performed by at least two skilled craftspeople, in order to secure a more objective assessment of the results.
- All processes must be documented, and some filmed.
- All products must be submitted to textile analysis by external persons.
- On the basis of the established typology, the tools will be reconstructed by experienced craftspeople. Experimental testing will be conducted with the aim of analysing the functioning of the tools, time consumption, and the quality and quantity of thread and textile.

Fig. 8: Guidelines for experimental archaeology developed by the Centre for Textiles Research, University of Copenhagen

could be sent. These were designed to report updates on the experiment, additional instructions and news from the wider KEME project. Newsletters were emailed to volunteers about every two to four weeks, depending on the stage of experimentation. Additionally, two seminars were held at the Centre for Textile Research in Copenhagen. One was at the start of the experiment in February and another in August 2017. During these seminars, local volunteers were introduced to the database and shown how to full and nap their swircles. These events were free to attend, and an overview of each seminar was emailed to all volunteers. Further workshops were held in the United States for volunteers attending conferences on reconstructing historic dress (Malcolm-Davies 2016, 70; Wolfe 2018).

Another important consideration during the design phase was the question of copyright, especially for photographs. Although details of the knitted linings and caps were made available on the database, the copyright for some of the photographs remains with the museums which hold them. Sharing this information, even to progress the research aims of the project, was therefore problematic. The project leader needed to ensure that the data was appropriately secured to satisfy the concerns of some of the participating museums. It was decided that a formal agreement with each volunteer was the best means of achieving this assurance. All volunteers were asked to agree to the terms of the experiment, which included following all copyright restrictions, before they were issued with login details for the database. This agreement was included in the registration process.

Method

The methodology adopted for the experiment was one focused on producing empirical results. This drew on previous work on the need for standards in archaeological textiles research and aligned with the wider KEME project aims (Vajanto 2014). The *Guidelines for Utilising Textiles in Experimental Archaeology*, developed by the Centre for Textiles Research, were also followed (fig. 8). However, some of the requirements, such as the use of historically accurate tools, were not relevant for the experiment (University of Copenhagen, 2017b; Andersson Strand 2015). But other guidelines, such as the need to control key variables (for example, swircle size), were adopted. Volunteers were issued with instructions and asked to knit four identical swircles, each with a diameter of 12.5 cm. It was decided not to restrict the volunteers to certain fleeces but to allow them to draw upon their own expertise in making a selection. Although the original caps showed evidence of being knitted from undyed yarn, it was decided not to make this a requirement because this would be too restrictive. The only condition placed on yarn choice was that no anti-shrinking agent (such as superwash brands

Fig. 9: A Shetland swircle fulled and napped with a teasel (*dipsacus fullonum var sativus*) (Image: Rosalind Mearns)

employ) had been applied to the chosen fleece as this would hinder the fulling process. Once a volunteer had completed four swircles, they were instructed to subject two of them to hand fulling for a period of 45 minutes.

Once dry, the same two swircles were napped, again for a period of 45 minutes. Ideally, a natural teasel would be used to raise the fleece fibres but, if this was not available, a brush with soft bristles could be used instead (fig. 9). Volunteers were advised to avoid cat combs and other similar metal brushes as the stiffness of the bristles would break the fibres rather than lift them from the knitted fabric. Finally, one fulled and one untreated swircle were to be sent to the project leader with the volunteer retaining the other two swircles so they could complete an online questionnaire. This asked volunteers to document their swircles including the type of fleece used, details of the yarn and knitting needle size.

Concurrently, volunteers were asked to use the KEME database to record the characteristics they observed in the photographs of the extant cap linings. In particular, measurements of the diameter of the yarn, spin and ply were requested. Instructions on how to take these measurements were provided in a project newsletter. These observations were recorded via another online survey which was linked to the database (*Knitting in Early Modern Europe*, 2017). This information would then be coupled with the swircle results to inform the final evaluation of the project.

Results

The experiment was initially designed to conclude in August 2017 but, when this date arrived, it became apparent that there was enthusiasm from some of the volunteers to continue the experiment into 2018. Therefore, for the purposes of this report, the results presented here are from the initial phase and were collated in August 2018. These figures have since risen as more volunteers have joined the experiment.

A total of 177 people volunteered to participate in the KEME experiment, by September 2017. This was well in excess of the 100 initially sought. All volunteers who completed the online registration and copyright agreement were accepted as there was no methodological or logistical reason to exclude them. A total of 13 volunteers sent completed pairs of swircles to the project leader and completed the online swircles questionnaire (table 1). Some volunteers sent more than one set of swircles which brought the total to 20 pairs. Three of the fleeces (Ryeland, Shetland, and Wensleydale) were tested by more than one volunteer allowing for the comparison of results from different experimental contexts (table 1). Control sets of swircles were also constructed by a member of the KEME project team to provide materials for participants to full and nap at the seminars. The phase 1 set fulled at the February 2017 seminar consisted of commercial yarns made from Shetland; Ryeland; Black Welsh Mountain; Zwartbles/Merino; and Wensleydale fleece (see Malcolm-Davies 2016 for results). The phase 2 set fulled at the August 2017 seminar were knitted from specially spun yarn from Wensleydale; Romney; Lincoln Longwool; Early Merino; and Shetland fleece (detailed results forthcoming).

The fulled and napped Bluefaced Leicester swircle provided the softest and smoothest coverage from the range of fleece tested by the citizen scientists, but it lacked length when compared to the 16th century cap linings. One of the Wensleydale swircles more closely achieved this length but did not produce consistent coverage (fig. 10, left). The two volunteer-made Wensleydale swircles were knitted at different gauges (table 1). One was knitted very tightly and the other more loosely (fig. 10, left and centre). When subjected to fulling, they reacted in different ways. The tightly-knitted swircle became fluffy while the loosely-knitted swircle developed a ridged texture. The volunteer's Ryeland swircle was also of interest because, after napping, it had developed a texture similar to fur (fig. 10, right). This was noteworthy as it has been hypothesised that the original purpose of napping was to imitate the texture of European furs and velvets (Malcolm-Davies 2018a, 1). However, none of the experimental fleeces provided the combination of even coverage and fibre length to mimic the extant plush nap on the originals.

Online response number	Fleece	Handspun	Yarn diameter (mm)	Spin	Spin angle (degrees)	Ply no. of elements	Wales per 10 cm	Courses per 10 cm	Needle size (mm)	Cover factor before fulling*	Diameter before fulling (mm)
25	Bluefaced Leicester	No (carded)	5	None	NR	1	28	34	3	0.13	130
23	Ryeland	Yes (carded)	3	Z	11-25 (Medium)	1	30	40	2.3	0.19	127
1	Romney	Yes	2	S	11-25 (Medium)	1	40	50	2	0.23	125
32	Highland Wool	No	3	S	1-10 (Loose)	4	24	38	2.75	0.23	132
22	Merino (medium)	No	3.5	S	26-45 (Tight)	3	21	29	2.75	0.23	134
26	Wensleydale	No	2	Z	NR	4	36	48	2	0.24	130
24	Unknown	No	3	S	NR	3	25	30	3	0.24	120
31	Shetland (pre-washed)	No	2.5	Z	11-25 (Medium)	2	35	24	2.5	0.28	128
17	Romney	Yes	1	Z	NR	1	65	65	2	0.31	125
15	Polwarth	Yes	2	S	NR	2	30	32	2.25	0.32	120
30	Shetland (unwashed)	No	2	Z	1-10 (Loose)	2	35	24	2.5	0.35	127
29	Shetland	Yes (combed)	2	S	26-45 (Tight)	1	35	24	2.5	0.35	125
13	Shetland	No	2	S	11-25 (Medium)	2	25	33	2.75	0.35	120
9	Border Leicester	No (combed)	1.5	I	1-10 (Loose)	3	25	38	2.75	0.44	125
14	Wensleydale	Yes	2	Z	1-10 (Loose)	2	25	16	4	0.51	134
27	New Zealand lambswool	No	1	S	26-45 (Tight)	2	30	40	2	0.58	120
16	Gulf Coast Native	Yes (combed)	1	Z	11-25 (Medium)	2 unplied	28	33	3.5	0.66	133
19	Shetland	Yes (carded)	1	Z	11-25 (Medium)	2 unplied	28	28	3.5	0.71	134
21	Babydoll Southdown	Yes (carded)	1	Z	11-25 (Medium)	2 unplied	28	28	3.5	0.71	144
18	Ryeland	Yes (carded)	1	Z	11-25 (Medium)	2 unplied	28	28	3.5	0.71	140

Table 1: A summary of the swircles received from KEME citizen scientists (NR= not recorded; NA = not applicable).

Hand fulling (mins)	Mallet fulling (mins)	Diameter after fulling (mm)	Shrinkage %	Nap height (mm)	Napping time (mins)	Description	Spinning	Participant
Up to 20	61 to 80	115	12	4	Up to 20	Soft	NA	Carol Evered
21 to 40	Up to 20 mins	118	7	3	Up to 20	Soft	Lendrum double-treadle spinning wheel	Margaret Gouin
NR	NR	125	0	0	Up to 20	Soft; Matt (dull)	NR	Cindy Craft
21 to 40	21 to 40	122	8	1	Up to 20	Soft; Rough (fuzzy); Matt (dull)	NA	Kristen Howard
21 to 40	21 to 40	140	-4	1	Up to 20	Rough (fuzzy); Matt (dull)	NA	Sigrid Ellis
Up to 20	60 to 80	125	4	4	Up to 20	Soft	NA	Carol Evered
Up to 20	62 to 80	115	4	4	Up to 20	Soft	NA	Carol Evered
29	29	120	6	4	Up to 20	Soft; Matt (dull)	NA	Barbara Logan
Up to 20	Up to 20 mins	115	8	4	21 to 40	Rough (fuzzy)	Drop spindle	Grace Vibbert
30	30	117	3	3	Up to 20	Soft	Majacraft Suzie spinning wheel	Sandy Bardsley
32	32	115	9	3	Up to 20	Soft; Matt (dull)	NA	Barbara Logan
30	30	125	0	4	Up to 20	Rough (fuzzy)	NA	Barbara Logan
Up to 20 mins	0	104	13	1			NA	Anna Gunnar
30	30	128	-2	1	Up to 20	Rough (fuzzy); Matt (dull)	NA	Lesley O'Connell Edwards
41 to 60	41 to 60	90	33	3	41 to 60	Rough (fuzzy)	Replica c15th spindle & distaff	Amie Flory
NR	NR	95	21	0,5	NR	NR	NA	Tine Jensen
10	10	97	27	2	Up to 20	Soft; Matt (dull)	Bobbin & flyer wheel	Ann Durham
30	30	110	18	2	21 to 40	Soft; Matt (dull)	Bobbin & flyer wheel	Ann Durham
25	25	115	20	2	21 to 40	Soft; Matt (dull)	Bobbin & flyer wheel	Ann Durham
40	40	115	18	2	21 to 40	Rough (fuzzy); Matt (dull)	Bobbin & flyer wheel	Ann Durham

*Cover factor W per cm × YD) + (C per cm × yd) divided by (W per cm × YD) × (C per cm × YD) where W refers to wales, C to courses and YD to yarn diameter (Malcolm-Davies et al. 2018, 10-24, in this issue)

Fig. 10: Three swircle pairs knitted by KEME citizen scientists: the left (by Carol Evered) and centre (by Amie Flory) pairs are made from Wensleydale fleece; the set on the right (by Ann Durham) is made from Ryeland fleece. The yarns used for the centre and right pairs were handspun from fleece for the project by the volunteers (Image: Rosalind Mearns)

The high quality of the swircles demonstrated an interesting variable in the creation of the nap. As might be expected, the gauge of the knitting made a difference to the length and density of the nap. The tighter the knitting (that is, the more wales and courses per 10 cm), the more even and dense the nap (Malcolm-Davies et al. 2018, 10-24, in this issue). None of the swircles were loosely knitted; the gauge range was 21 to 65 wales per 10 cm and 16 to 65 courses per 10 cm before fulling, which provided a useful range of tightly-knitted fabrics for comparison (table 1). The cover factor is calculated from the yarn diameter and the gauge. It provides an indication of the extent to which the area is covered by yarn and provides a useful comparison between fabrics. The higher the number, the closer the fabric, with a maximum of 1 for the complete cover provided by heavily finished fabrics (Malcolm-Davies et al. 2018, 10-24, in this issue). The cover factor for the swircles ranged from 0.13 for the Bluefaced Leicester to 0.71 for the Babydoll Southdown, one of the Shetlands and one of the Ryelands (table 1). This compares with a smaller range for the extant linings which is from 0.14 to 0.44 (table 2). This comparison suggests that a longer fulling time may be more important than coverage since the most successful yarns (two Wensleydales and a Bluefaced Leicester) were fulled for more than 40 minutes.

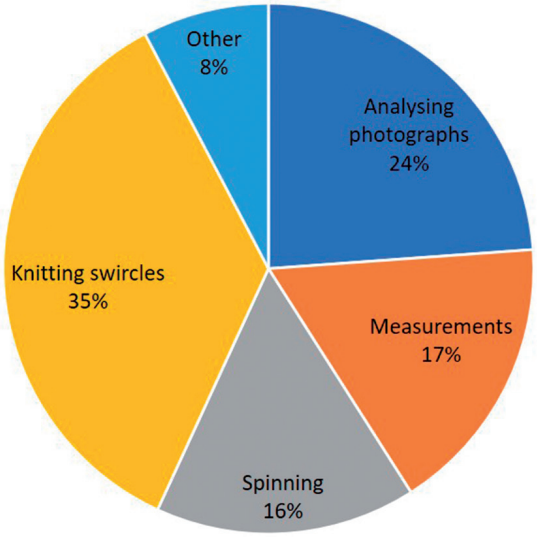
Interestingly, ten of the 20 pairs of swircles from citizen scientists were made from hand-spun yarns even though this was not a requirement of the experiment. Volunteers were invited to spin their own yarn, if they wished to do so. The high return rate of hand-spun yarn was unexpected as only 11% of volunteers identified themselves as expert spinners during registration. A further 16% stated that they had no spinning experience. This suggests that those with spinning skills were more likely to commit additional time to the experiment by producing their

Lining	Location	Yarn diameter (mm)	Wales per 10 cm	Courses per 10 cm	Cover factor
EkBc-1:39762H(L)	Memorial University, Newfoundland	5.68	24	28	0.14
22392(L)	Museum of London	2.15	24	40	0.31
1562A-1901(L)	Victoria & Albert Museum	1.45	36	56	0.31
74.42/1(L)	Museum of London	2	24	40	0.33
5005(L)	Museum of London	1.28	36	64	0.34
1563A-1901(L)	Victoria & Albert Museum	1.18	48	48	0.35
22390(L)	Museum of London	1.38	32	56	0.36
A5456(L)	Museum of London	1	48	64	0.36
A6060(L)	Museum of London	1.28	36	52	0.37
T.191A-1958(L)	Victoria & Albert Museum	1.29	40	44	0.37
A6342(L)	Museum of London	1.35	32	52	0.37
4570*(L)	Museum of London	1.1	40	56	0.39
C21.1939.2.2.2(L)	Leicester City Museum	1.33	32	48	0.39
MA1315(L)	Museum of London	1.32	32	48	0.39
T.618-1913(L)	Victoria & Albert Museum	1.76	28	28	0.41
1574-1901(L)	Victoria & Albert Museum	1.73	28	28	0.41
22389(L)	Museum of London	1.23	28	64	0.42
MR81A6961(L)	Mary Rose Trust, Portsmouth	1.08	36	56	0.42
22391(L)	Museum of London	1.52	24	44	0.42
5004(L)	Museum of London	1.43	28	40	0.42
A6346(L)	Museum of London	1.01	36	56	0.45
T.618B-1913(L)	Victoria & Albert Museum	1.08	32	48	0.48
T.618A-1913(L)	Victoria & Albert Museum	1.44	28	28	0.50
ABCM: 1948.5HN(L)	Buckinghamshire County Museum	1.17	28	40	0.52
T.188-1958A(L)	Victoria & Albert Museum	1.25	24	40	0.53
22388(L)	Museum of London	1.05	28	44	0.56
A26567(L)	Museum of London	1.59	20	24	0.58
5010(L)	Museum of London	1.00	28	40	0.61
T.619A-1913(L)	Victoria & Albert Museum	1.38	20	28	0.62
1575-1901(L)	Victoria & Albert Museum	1.08	24	32	0.68
5013(L)	Museum of London	1.02	20	36	0.76
Averages		**1**	**30**	**44**	**0.44**

Table 2: Data from extant Early Modern knitted cap linings

own yarn specifically for the project. Such a generous contribution of time-consuming labour and expertise had not been anticipated when the experiment was designed and represented a welcome bonus to the project.

A total of 13 people completed swircles questionnaires which matched the 20 pairs received in the post (although a few questions were skipped). There were also some incomplete questionnaires which suggest that some volunteers created additional swircles but they were not sufficiently motivated to finish the questionnaire and send their samples to the KEME project team. It also suggests that there may have been even more volunteers who knitted and napped



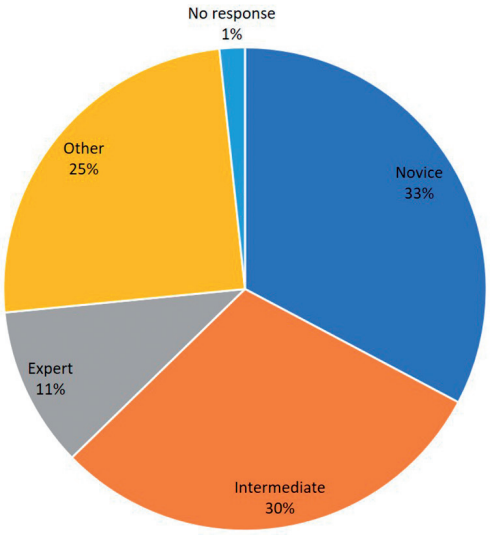


Fig 11 (left): KEME citizen scientists' interests in different aspects of the experiment (based on a total of 415 selections from 177 volunteers' responses). No restriction was placed on the number of options volunteers could select

Fig. 12 (right): Self-assessed spinning skill of KEME citizen scientists (based on 177 volunteers' responses)

swircles but were not inspired to record their results or send them for further analysis (Malcolm-Davies 2018a, 6).

None of the volunteers described their finished swircles as 'silky' or 'shiny', which were key characteristics of the better-preserved nap found on the original caps and linings. The most common descriptor was 'soft' (12 out of 20), followed by 'matt (dull)' (10 out of 20) and 'rough (fuzzy)' (7 out of 20) (table 1). Respondents were able to select more than one option. These results highlight that further work is needed to accurately replicate the original texture.

Only seven responses to the online database questionnaire which asked for observations of the original material were received from three different people as of September 2017. This was despite 41% of volunteers expressing an interest in contributing to the examination of the extant material online at the point of registration (fig. 11). The small return rate was particularly counterintuitive as the KEME database exhibited a high level of traffic throughout the project, and this was well in excess of what it had been designed to handle (Cox 2017). This small number of database observations could not be used to test the interpretation of the archaeological record proposed by the KEME project. However, this result suggested that more effective ways of inviting and encouraging 'engagement' with the online resources were necessary (Stiller & Petras 2015,163-164).

There was some discrepancy between the number of people who subscribed to the mailing list (190 people) and the number of completed registrations (177 people). It was presumed that the additional mailing list subscriptions were from people interested in the project but unable to commit to volunteering. Using the 'open rate' feature on the MailChimp site, the number of volunteers opening each newsletter, and thereby their collective level of enthusiasm, was tracked. At its peak, 71% of subscribers, or 135 people, opened the newsletter and, at its lowest point 47%, or 90 people, opened it.

Assuming that those who opened the e-newsletters were also those who completed the online registration, thereby displaying the greatest interest in the project, these figures suggest that only half of the volunteers continued to engage with the project after initially registering and receiving some information. This is useful to know as it demonstrates that, in accepting a higher number of volunteers, the experiment was able to stay close to its target of 100 despite losses to the original cohort. It also lessened the significance of receiving only 20 swircle sets as it became reasonable to assume that this number was representative of a share of approximately 90 volunteers rather than 177. The aim of the fleece testing was to achieve a wide range rather than a large quantity. The 20 pairs of swircles tested a total of 13 different fleeces, which was far more than could have been achieved by the core project team in the same time. A swircle completion rate of 15% to 20% is a fair achievement for a far-flung

experiment requesting demanding work and some expense from its volunteers.

Discussion

The inconclusive results provided by the swircles suggest that, despite a variety of fleece being tested, none of them are close to the original, as sheep husbandry history confirms (Ryder 1964). However, other contributing factors became apparent. First, although the methodology was designed to be an empirical one, human error played a part. Volunteers were instructed to full their swircles for at least 45 minutes but how conscientiously this was done seems to have varied. Some swircles showed signs of only being partially fulled and some records indicated swircles had not been fulled for long enough. This was perhaps due to a lack of familiarity with the process amongst the volunteers. They were uncertain of the end result and so stopped rather than continuing until the process was complete and documenting a longer fulling period. Such errors would then have had a direct impact on the resulting nap as the scales on the fleece fibres would have only been partially removed. Therefore, a suitable 16th-century match may have been tested but, due to incomplete fulling, the correct length of nap and coverage was not achieved. Further testing of the same range of fleece with more rigorous observation and recording of the fulling process is needed to resolve this issue.

The way in which the different fleeces were spun into yarn may also have influenced results. The archaeological record indicates that most of the extant caps and linings may have been knitted from a worsted-spun yarn. Fleece prepared for this style of yarn is combed to align the fibres. In contrast, many modern knitting yarns are woollen spun which produces a fluffy, air-filled yarn. Fleece for this style of yarn is carded before spinning. In designing the experiment, volunteers were not restricted in their choice of yarn but, in hindsight, this may have affected the results.

Another explanation for the inconclusive results might be that the extant caps were not actually fulled. The absence of scales observed on the fleece fibres recovered from the archaeological linings could be due to deterioration over time. However, this seems unlikely because a lack of scales was observed in numerous fibre samples from caps preserved in a wide variety of conditions (Malcolm-Davies 2018b, 192). If such an archaeological deterioration marker were to be credible, some variation in the preservation of the fibres would be expected. A more likely explanation is that the caps were subjected to expert manual or mechanical fulling which provided a more vigorous treatment than the hand fulling applied by the volunteers. The use of mechanised fulling mills by cappers in the Early Modern period was much protested on the basis that it was not as effective as that done by hand or foot (Malcolm-Davies 2016, 59). Further experimental research using mechanised fulling could yield interesting results.

The low return rate of the database questionnaire from volunteers had an impact on the scientific aspects of the experiment. The KEME project team hoped that close inspection of the extant artefacts by a diverse group of people would lead to new insights. However, due to the limited number of database questionnaire responses received, this could not be tested. This is important because constructing swircles may help to identify the best modern fleece for reconstruction but only the study of the extant material can verify these findings.

Maintaining volunteer enthusiasm was a somewhat unexpected aspect of the experiment. At the outset, it had been assumed that, given the wide public interest, volunteers would be motivated to actively participate in the project. However, as shown by the discrepancy between volunteer registrations and swircles received, this assumption proved optimistic. It may have been that the cost of postage for the swircles was too expensive or that the online swircle questionnaire was too demanding; with a maximum of 60 questions, it was not a quick or easy task to complete. Yet, no feedback was received to indicate these were issues.

Some volunteers made assumptions about what to do rather than seeking clarification. For example, some original cap linings appear to have been knitted from two single unplied yarns rather than one two-ply yarn. In communicating this information to the volunteers as an interesting observation of the archaeological evidence, some assumed that they were required to knit swircles in this way, which made sourcing yarn much more challenging. This caused confusion until the original swircle instructions were confirmed by the project team. The lack of questions and requests for clarifications from volunteers was puzzling since multiple means of contacting the project team were provided. If the experiment were to be repeated or similar projects devised, more local events for volunteer groups with face-to-face contact with the project team is recommended. This would help to manage misinterpretations and keep volunteers motivated.

Better control of the experiment could have been achieved by providing a list of fleece/yarn, with sources of supply, and inviting volunteers to sign up

to obtain and test a specific example. Alternatively, the materials could have been purchased by the project team and sent out to the volunteers. This would have prevented duplicates and widened the range of materials under review. However, the model used invited volunteers to use yarn they already owned or would like to test, which kept the costs down.

The high non-participation rate between those who registered for the experiment and those who continued to engage with it also needs to be addressed. There are several possible causes for this. First, although the swircles were designed to reduce the amount of time volunteers needed to commit to the experiment, they caused some disappointment. After registration, a small number of volunteers contacted the KEME project team to ask if they would receive instructions to knit a cap as part of the project. Knitting swircles may not have been as inspiring for some volunteers as an actual cap, which may have contributed to the drop-out rate. Other motivations for wanting to participate may also have contributed to this figure. For example, in the initial phase of promoting the experiment online, a cluster of registrations were received from a single university. When the results were collated, no samples or questionnaires were received from this group. These people may have joined collectively as part of their studies without any intention of participating in the experiment. It seems likely that this was not an isolated case. This could also explain the sustained high level of database traffic yet low return rate of the questionnaire.

A further possibility for the discrepancy between registrations and participation may have been a lack of familiarity with academic language. At the outset of the experiment, all volunteers were given free online access to a copy of a journal article recently published by the project leader (Malcolm-Davies 2016). It detailed the results of the KEME project so far and gave the basis for the citizen science experiment. However, although nearly half of the volunteers expressed familiarity with archaeological practices, the formal language of this article, combined with graphs and technical terms, may have intimidated some participants leading to a loss of interest. The combination of all these factors, coupled with illness, personal crises and a lack of time (which were mentioned in some emails and personal conversations with volunteers) could account for the non-participation rate of nearly 50% seen between initial registration and ongoing engagement.

A lack of clarity in communications from the project team may also have contributed to volunteer attrition and the small number of results received. For example, no end date was given at the start of the experiment. A clear start date and end date, communicated at the outset of the experiment with intermediate targets, might help drive volunteer motivation. Publication of some features of the database were delayed and more time than had been anticipated was needed to edit the e-newsletters and other communications. Longer periods passed between updates than was originally intended.

If a similar experiment were undertaken, a planned schedule of e-newsletters and pre-drafting of social media updates would be recommended. Each social media post and newsletter required at least one new and engaging photograph. Sourcing these during the experiment contributed to some of the delays. Unlike the database, the distribution of the newsletters beyond the registered volunteers could not be controlled which precluded the use of any copyrighted images. Stockpiling a variety of suitable promotional photographs would also be advantageous. Yet, despite these issues, very few people chose to unsubscribe from the mailing list suggesting that they wanted to remain connected to the experiment even if they were not actively contributing.

In terms of citizen science, the experiment was successful. The receipt of 20 pairs of swircles added substantially to the material available for review – both in quantity and range of fleece. There was a high level of knitting skill and pre-existing archaeological awareness amongst the volunteers, who demonstrated sufficient expertise to contribute meaningfully. This requirement for expertise in academic research, however, should be questioned before final conclusions are drawn.

There is a predisposition for recruiting experts for experimental archaeology projects but whether this accurately reflects the historical situation that produced the extant items should be considered (Shimada 2005, 607; Millson 2011, 3). It is not necessarily the case that the knitters who produced the extant caps were experts in their craft. Whilst it is true that some understanding is needed to determine which questions are appropriate to ask of a craft, pre-existing contemporary skill can be a hindrance when attempting a reconstruction (Hein 2009, 4; Wood 2010, 13). It can introduce modern assumptions and techniques that were not present in the minds of the original creators (Hudson 2014).

In this context, the provision of knitting instructions for the swircles could be seen as problematic. Although it was deemed necessary to ensure consistency across the volunteer group, 16th century knitters did not use instructions (Botticello 2003, 8). The experiment diverged from the archaeological and historical record

to serve the modern requirements of the volunteers. In doing so, it introduced a new form of expertise – the ability to read instructions. It might have been feasible to ask volunteers to look at the extant material online and work out their own way of knitting a miniature version of a lining. This would have stimulated more engagement with the extant evidence and avoided introducing a modern technique into the experiment. However, the aim of the project was not to compare the presence or lack of knitting instructions or compare the knitted fabric but to establish the best modern material for reconstructing the caps. A swircle knitted by a novice could be fulled and napped in the same way as one made by an expert. That only well-made samples were received from volunteers provides an insight into the willingness of highly skilled individuals to contribute to academic research.

Each volunteer who sent swircles committed a great deal of time and effort to the experiment, well in excess of what had been anticipated. Most of the volunteers who submitted swircles also recorded highly detailed, scientific information via the online swircles questionnaire which made it possible for the project team to compare variables in a systematic way. Nearly everyone uploaded photographs to the specifications requested providing the KEME project with a valuable visual digital record of the experiment's results.

The success of citizen science in this experiment is not just important for the KEME project but the wider study of textile archaeology. Many archaeological projects seek to engage volunteers in order to make them viable. Funding is often restrictive and volunteers are seen as a way of achieving research ends within tight budgets. The large number of volunteers who initially registered for the KEME experiment suggests that not only is citizen science feasible for research but that there is a thirst amongst the public to become involved in such activities. In saying this, the experiment has demonstrated that such activities do need to be carefully planned with a great deal of time invested in communication and encouragement in order to achieve far-reaching results. Care should also be taken not to under value the skills required to participate.

The crowdsourcing lessons learnt by the KEME team have already been applied elsewhere. The Texel Silk Stockings Project is using a modified KEME model of citizen science to reconstruct a pair of 17th century knitted silk stockings recovered from a shipwreck found off the coast of the Dutch island of Texel. The project has also solicited online financial support to buy materials through crowdfunding. It has hosted two workshops in the Netherlands during which swatches of knitted silk were created by volunteers (Leiden Textile Research Centre 2017). Volunteers further afield are now knitting stockings according to the instructions and guidelines developed during the workshops. Preliminary results suggest that this modified approach will produce useful results.

Further research

There is scope for further experimentation because the range of swircles received did not test the full range of potential fleeces for fulling. Another way forward would be to identify the best performing fleece during this first phase of citizen science and ask further volunteers to test them to check that they perform as well in a range of experimental conditions. Investigation into the role of mechanised fulling and the results this can produce would also provide valuable insights. The KEME experiment has continued into 2018, which may widen the range of fleece for which results are available (Malcolm-Davies 2018c).

Conclusion

No satisfactory match for 16th century fleece was found as a result of the fleece and fulling experiment. This was due to a number of factors such as the range of fleeces tested and volunteer awareness of spinning and fulling methods. The design of the experiment sought to limit these human factors, but it was found that room for error persisted. Despite these issues, volunteers were successfully engaged in providing a small number of knitted, fulled and napped swircles. Volunteers were found to possess a level of knitting knowledge in excess of expectations which could be seen in the quality of the samples they submitted. Approximately 50% of initial registrations did not follow through with participation but, as double the number of people initially sought signed up for the experiment, this had minimal impact on the way in which the experiment was conducted. Despite inconclusive results, the experiment demonstrated that, through citizen science, members of the public can be engaged to contribute meaningfully to academic textiles research.

Acknowledgements

We would like to thank the many volunteers who contributed to this project. Without their input, this experiment would not have been possible within the resources available. There are too many people to name here but the KEME Team hopes that in seeing these results our volunteers will be able to appreciate the weight of their contribution to our

collective understanding of 16th century knitting and fulling.

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Antoinette Rast-Eicher and Lise Bender Jørgensen

News from Çatalhöyük

Introduction

Çatalhöyük (Anatolia/Turkey) is a classical site in archaeology, mentioned in archaeological text books as one of the most important Neolithic sites in Old World Archaeology (Scarre 2009, 222). It was excavated from 1961 to 1965 by James Mellaart and his team (Mellaart 1967). Finds also included textiles that were examined and published by Harold B. Burnham (1965). In 1993, the Çatalhöyük Research Project, directed by Ian Hodder, resumed excavation of the site (Hodder 2014 for latest published overview; for detailed information see www.catalhoyuk.com). In August 2017, Hodder's project ended. Textile remains were found occasionally, the first during the 2003 season, and then in 2008, 2012, 2013, 2015, 2016 and 2017. The textile team comprising the present authors arrived two weeks before the site's closure in order to investigate and record the textiles, cordage and basketry (Bender Jørgensen & Rast-Eicher 2017). Baskets (coiled) and mats from Çatalhöyük had previously been catalogued and discussed (Wendrich 2005; Wendrich & Ryan 2012). New finds have now been documented and are to be further discussed by Wendrich. Most of the baskets and mats were preserved through silicification. The remaining phytholiths in the plant epidermis identified the plants used as mostly sedges or reeds (Ryan 2015).

The auhors also looked for spindle whorls and loom weights. It was not possible to see the textiles found by the Mellaart excavations in the archaeological museum in Ankara, but in November 2017, the authors had the opportunity to study an item from these early finds at the Textile Research Centre in Leiden (Netherlands). Apart from this, Burnham's publication is relied upon for reports of the first finds. The textile remains were examined on site with a stereo microscope and a digital microscope (Optilia). Samples for SEM analysis were taken and sent to Switzerland, and are now awaiting analysis. The results are to be published in a monograph in the Çatalhöyük Research Project series (in preparation).

Dating

Mellaart and Burnham dated the textiles found in the 1960s to the beginning of the sixth millennium BC (Burnham 1965, 69; Mellaart 1967, 52). They derived from Mellaart's Levels VI A/B that were then C14 dated to between 6200 and 5800 BC (Mellart 1964, 116). They have now been calibrated to between 6550 and 6350 cal BC (Cessford 2005, 76; Hodder 2014, 10). Except for two pieces that proved to be post-Neolithic and are not further discussed here, the new finds documented by the authors belong to deposits given a preliminary date of between c. 6700 and c. 6300 cal BC (Bayliss and Tung 2017). The two find groups are thus more or less contemporary, dating to the mid-seventh millennium.

Textiles and fibres

Remains of textiles (woven as well as non-woven) were recovered from buildings B49, B52, B131 and possibly B77, cordage from B49, B52, B77 and B131. They are all from the north area of the site. They were found in connection with burials under the floors, and were preserved because the houses in question had burnt and the burials under the floors were therefore "baked". This means that plant fibres are partly charred; animal fibres and skin melt in such conditions. Small skin remains in some of the find boxes indicate that – along with textiles – skins were used to wrap or cover the dead. The skin remains have bubbles from the heat and are mostly melted. SEM-analysis of one sample may be able to identify the species of animal. Cordage and string is mostly silicified material, but some strings were burnt. One of these appears to be tree bast with visible rays seen under the stereo microscope.

The plant fibres of the textiles are either completely charred and black or/and very brittle and dark brown. In previous reports, fibres from the woven textile in a burial in B52 have been determined as flax (Fuller 2014, 122). For some textile samples from Çatalhöyük,

Fig. 1: Layered tabby-woven textile 30503 X9 from Çatalhöyük B52, burial 7 (Image: A. Rast-Eicher)

whether they are flax or well prepared tree bast fibres comparable to Neolithic textiles from Europe is still in question (Rast-Eicher & Dietrich 2015, e.g. cat. 1001, fig. 55: fine woven textile made of lime bast). It is hoped that SEM analyses will provide more conclusive results. A second question also applies to the fibres from B52: if it is flax, is it domesticated or wild? Çatalhöyük is situated in the Konya plain that was flooded from time to time providing ideal ground for wild flax, which could be harvested at the right moment. Fuller argues that domesticated flax had to be imported from another place, as there are almost no flax seeds found in Çatalhöyük. On the other hand, flax seeds have been found in PPN sites of the Levant and the eastern Fertile Crescent (Fuller 2014, 122). Linseeds found in the PPN site of Çayönü (Anatolia/Turkey) have been determined according to their small size as wild flax, maybe *linum bienne*. As wild flax has seeds under 3 mm in length, the exact determination is not possible. As at Çatalhöyük, very few flax seeds were found at Çayönü, except for one sample where flax seeds formed the majority (90 seeds). The earliest larger seeds pointing to cultivated flax have been found in Ramad (Syria) and are dated to between 7190 and 6700 cal BC (Van Zeist & Roller 2015, 81). The lack of flax seeds in the settlement of Çatalhöyük could be due to the use of wild plants. No measurements of the few seeds from Catalhöyük have yet been published. There are many wild flax species in Turkey (Özcan & Zorlu 2009) and, in the Levant, experimental threads have been produced with wild flax (Abbo et al. 2014). It is important to collect wild flax grown on good ground with a wide stem because small plants will have little bast.

Yarns and techniques

The threads of the textiles found in Çatalhöyük are spliced (S-plied of two spliced single yarns). This fact could support the assumption of the use of wild flax. The fibres were thus neither retted, hackled, nor combed. Recent research has identified splicing of Neolithic threads in Europe (Leuzinger & Rast-Eicher 2011). Remains of epidermis on flax threads found in the Neolithic layers of Zürich-Opéra (Switzerland) prove the use of green flax, which means that fine flax bast has been taken from the stem to splice in a fresh state (Rast-Eicher 2016, fig. 350). This form of thread production is basically the same as with tree bast. The preservation of the threads in Çatalhöyük by heat is unfortunately far too bad to be able to see epidermis remains, but hopefully SEM analyses will show more details.

Fig. 2: Finishing border in weft-twining, textile 30503 s10 from Çatalhöyük B52, burial 7 (Images: A. Rast-Eicher)

The woven textiles from Çatalhöyük are all in tabby, in medium to fine quality. There is no evidence of their original size, which makes it difficult to discuss which weaving tool or loom may have been used. Burnham documented a warp-faced tabby with a simple selvedge, a rolled hem and a textile with a heading cord (Burnham 1965, plate XXXIII) This points to a larger textile. Others were narrow bands, 7 to 8 and 15 mm wide (Burnham 1965, 172). The textile found in building 52 was clearly folded in several layers (fig. 1) and was used as a layer between two bodies. In this case, narrow bands can be excluded. This object shows what is probably a finishing border with rows of weft-twining, a simple row and also a double row of weft-twining, creating a herringbone effect (fig. 2). The textile thus finished in fringes. These combinations of techniques in the finishing part of textiles have been found in the Levant in later contexts, such as the Chalcolithic textile C ('Sash') found in the Cave of the Warrior (Israel) (Schick 1998, colour plate fig. 3.9, and figs 3.48, 3.50). The textiles from the Cave of the Warrior are likely to have been woven on a ground loom, or perhaps a backstrap loom (Schick 1998, 20; Shamir 2015, 18). This may also be the case with the Çatalhöyük textiles.

Textile tools

Currently, Çatalhöyük appears to be a standard reference for the earliest finds of spindle whorls and loom weights in Anatolia and the Near East (Barber 1991, 51, 59, 98-99, 127-130; Rahmstorf 2015, 6; Shamir 2015, 19). This is in contrast to the findings of the recent excavations at Çatalhöyük directed by Ian Hodder, and indeed of the excavations in the 1960s. In 1967, James Mellaart wrote that "out of over 200 rooms we have but […] a single spindle-whorl and not a single loom-weight" (Mellaart 1967, 211). During the excavations from 1993 to 2017 neither loom weights nor spindle whorls were found in the Neolithic levels. They appeared only in later or disturbed contexts. This is known by some experts (Gleser 2016; Rooijakkers 2012; Schoop 2014, with useful maps; Völling 2008, 194), but textile scholars in general do not appear to have realised it. It is time for an adjustment.

Loom weights of baked clay and spindle whorls of unbaked clay were mentioned by Mellaart in his first report on the site (Mellaart 1962, 56). He interpreted these, together with weaving needles and white loincloths worn by men depicted in the wall-paintings as evidence for weaving. He did not specify in which levels the textile tools were found. As described above, he later revised this first impression. Burnham (1965, 173) wrote: "As Level VI is virtually aceramic, no loom weights have been found in any of the shrines and houses of this date. In the higher levels, where pottery occurs, recognisable loom weights have been recovered. The only objects that might be loom weights from Level VI are two carefully worked stones of unknown use which would have served the purpose admirably. […] It is only with the more extensive excavations of this important mound that the characteristic two rows of weights lying where they fell *may* yet be found, and these will definitely establish the use of this ancient weaving tool" [italics added].

No loom weights are listed in the finds database for the 1993-2017 project. As the excavations have investigated burnt as well as unburnt layers, any unburnt loom weights would have been found in the burnt houses. This was further confirmed by the project's Finds Manager, Lisa Guerre. It may therefore be stated

Fig. 3: Loom weight and spindle whorl from the upper layers of the IST area of Çatalhöyük (Image: A. Rast-Eicher)

with confidence that no loom weights were found in Neolithic layers at Çatalhöyük. Burnham's assumption that loom weights would turn up has not been fulfilled. Burnham's paper appeared just after the publication of Marta Hoffmann's book *The Warp-weighted loom* (1964). He refers to it, and his discussion of the borders and edges of the Çatalhöyük textiles and how they may reflect the weaving technology of Neolithic Çatalhöyük is certainly influenced by Hoffmann's work.

The database lists 183 spindle whorls; these all derive from the uppermost layers of areas TP and TPC, in which many artefacts that are Hellenistic and Roman have been found.

Checking the report on the IST area at the bottom of the hill excavated by researchers from Istanbul (www.catalhoyuk.com/archive_reports, see reports 2005-2008) revealed that a small number of spindle whorls and loom weights were found in upper or disturbed layers, but none in undisputed Neolithic contexts. These finds may serve as examples of the types and forms of textile tools from mixed and late layers that also appear in the top layers of the TP and TPC layers (fig. 3). The textile tools from the IST area are all made of unfired or lightly fired clay. They also appear to be doughnut shaped. They vary in size and weight; the larger and heavier ones (>100 g) are clearly loom weights; the smaller ones vary between 25 g and 40 g. Several of the smaller ones show wear marks that suggest they too were used as loom weights, but some are spindle whorls. As there is a relationship between weight of the spindle whorl and the thread produced, it may be assumed that any yarn made with these spindle whorls will have been thick (Andersson Strand 2015; Grömer 2010, 90-97).

In summary, there are no loom weights or spindle whorls in the Neolithic layers of Çatalhöyük, and the site cannot serve as evidence for the early use of the warp-weighted loom in Anatolia. However, a Neolithic site in Anatolia, Ulucak, in the Izmir region, may now take the place of Çatalhöyük as the earliest find site for loom weights. A group of 11 doughnut-shaped loom weights were found in levels Va (dated between 6200 and 6000 cal.BC) and IVb (5900 to 5800 cal.BC), while spindle whorls (and a preserved tabby-woven textile) were found in level Vb which dates between 6400 and 6300 cal.BC (Çilingirŏglu 2009; Gleser 2016).

Looms and loom weights

Loom weights are often automatically linked to a vertical loom (i.e. the warp-weighted loom) intended for *woven* textiles. This, as we have seen, has been the case with Çatalhöyük. However, Neolithic finds from Switzerland have shown that loom weights were used to make large and flat objects in weft-twining technique on a vertical frame without heddles (Rast-Eicher 1994; Rast-Eicher & Dietrich 2015, 112ff.). Furthermore, the weft-twined fabrics of the Swiss lake dwellings (comprising more than 1,000 objects including cordage from the canton of Zürich alone) demonstrate that there is a clear link between the starting borders of the large weft-twined fabrics and the starting borders of the woven textiles on the warp-weighted loom. Last, but not least, a very fine and large item in weft-twining technique was found in 1999, together with loom-weights in Wetzikon-Robenhausen in the canton of Zürich, Switzerland (Rast-Eicher & Dietrich 2015, cat. 564, plate 53 & 54). It may be concluded that the presence of loom weights cannot be used as evidence for the warp-weighted loom, or for the making of woven textiles. This may well apply to Neolithic Anatolia as well as Neolithic Switzerland.

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TexMeroe:
New approaches to cultural identity and economics in ancient Sudan and Nubia through textile archaeology

Background to the project

The TexMeroe project focuses on the textile industry of the kingdom of Meroe, located along the Middle Nile valley in modern Sudan and Nubia, and covering the Late Antique period from c. 350 BCE to c. 550 CE. At the very margins of the Roman empire, between the Mediterranean basin and the African savannahs, this kingdom developed a unique culture blend its sub-Saharan cultural roots with its pharaonic heritage and Hellenistic influences. Its history is well-known through impressive displays of royal power on the walls of its many temples and pyramids but aspects of its social organisation and economic system remain in the shadows. Due to the absence of relevant historical texts, craft material studies present valuable evidence and quantifiable data documenting these fundamental components of the Meroitic society. In this context, the study of textile production opens particularly interesting research avenues.

Since the beginning of archaeological exploration in Sudan and Nubia, thousands of textile fragments have been discovered in both cemeteries and settlements (fig. 1). Excavations also yielded numerous tools (fig. 2) used for their manufacture, as well as iconographic representations of people dressed in various costumes (fig. 3). More recent research has also revealed archaeobotanical remains shedding light on the ancient agricultural system and land use patterns. Taken together, these different sources document the entire *chaine opératoire* of textile production, from fibre collection, to spinning, weaving and dyeing, all the way to tailoring and dressmaking. They also highlight the diversity of textile use in settlements – in homes, towns and temples – as well as illustrating the clothing habits of a diverse population and the importance of textiles in funerary rites.

These questions were first studied in the doctoral dissertation *From fibres to cloth. Archaeology, production and uses of textiles in ancient Sudan and Nubia during the Meroitic period*, presented in 2015 in Lille University (France). Born out of the discoveries of the UNESCO International Rescue Nubia campaign in the 1960s and subsequent excavations at the exceptional sites of Qasr Ibrim, Ballana and Qustul, previous works on the subject were mainly focused on textiles from selected sites or regions (Bergman 1975; Mayer-Thurman & Williams 1979; Crowfoot 1984; Adams 2010; Adams & Adams 2013). A more comprehensive study was needed, taking into consideration all aspects of Meroitic textile production and the whole range of data from the entire breadth of the kingdom's territory. As recent excavations produced more craft and textile-related finds, it became paramount to place the still unpublished Meroitic textiles at the heart of the newly developing research on production organisation and the economy of ancient Sudan. The study of textile artefacts encompasses a wide range of key issues, such as agriculture and manufacturing techniques, the organisation of labour and trade, and the definition and communication of social status (Andersson et al. 2010; Harlow & Nosch 2014). With the support of the European Union's Horizon 2020 Research and Innovation Program, TexMeroe was developed as a Marie Skłodowska Curie fellowship (MSCA 743420) to help answer these lingering questions, using textile studies to better understand Meroitic society. The project has found a welcoming

Fig. 1: Fragments of a cotton textile from Gebel Adda cemetery (Lower Nubia, c. 300 CE), showing an openwork border and long fringes, torn from the original fabric and used as binding tapes for a shroud, inventory number ROM 973.24.2895 (Images: Elsa Yvanez with the authorisation of the Royal Ontario Museum © ROM)

home at the Centre for Textile Research (CTR) at the University of Copenhagen.

Aims and methods

TexMeroe has been designed with two aims. The first is to study three different textile techniques characteristic of ancient Sudan, each of them embodying the relationship that existed between crafts and cultural identity. The second aim is to place Meroitic textile production within its economic environment, building a socio-economic model which integrates textile activities and products that can be used by archaeologists and historians in Sudan and beyond. In addition, several objectives and research questions are at the core of TexMeroe's activities. These include: producing a detailed analysis of manufacturing techniques specific to Meroitic populations; understanding the place of Meroitic textiles within the greater context of Mediterranean and African production; recognising textiles as a socially important medium, displaying social, religious, and ethnic belonging; using the textile industry's raw materials as case studies to help define the nature of Meroitic economy; understanding the organisation of textile production and its industrial model/s at both settlement and state levels; and identifying trading mechanisms by tracking textiles along exchange and diplomatic networks.

The different research themes explored through TexMeroe follow the entire life cycle of textiles, from raw material collection, through manufacturing processes, the multiple everyday uses and reuses of the fabrics to their final interment in the graves. The methodology is first and foremost archaeological: the research is firmly based on the analysis of the objects in interaction with their context of use and discovery. The project also combines the methods and resources from other fields including history, art history, ancient textile studies, material studies, anthropological theories, and archaeobotany, building on the CTR's experience in multidisciplinary approaches.

Project structure and preliminary results

Meroitic textile techniques and identities in craft are often overshadowed by the famous Late Antique Egyptian tapestries, despite a remarkable synthesis between diverse influences coming from their African and Mediterranean neighbours. TexMeroe attempts to better define this rich tradition, by focusing on the detailed study of three characteristic techniques, including the openwork decorative borders created at the end of many fabrics in a technique apparently unique to Sudan. Resembling macramé or lace, it consists of grouping and regrouping the warps, and wrapping them with a supplementary weft thread so as to create bands of geometric lattice-work (Crowfoot

1984). The project analyses several examples of these openwork borders to understand and reproduce their construction. They will be compared to earlier macramé specimens, discovered on the Bronze Age site of Kerma (2400 to 1500 BCE), in order to trace the history of this technique and the evolution of this distinctive local taste. The second type of textile under consideration is pile weave. The extensive use of looped pile weave for the creation of soft and thick covers is undoubtedly the main characteristic of Meroitic furnishing textiles. The project aims to establish technical criteria for their study and comparison of specimens discovered at several Nubian sites, in order to highlight their diversity, track their evolution, and compare them with other contemporary productions. This study aims to unearth new information on the role of pile weave in clothing and/or furnishing and new elements regarding the transfer of craft techniques through time and space. The third aspect of Meroitic textile manufacture to be observed during the project is the use of dyes or pigments. About 40% of Meroitic textiles bear traces of dyes and tannins, which are mostly unidentified. The plants, pigments, and techniques used to apply colour on textiles will be investigated using high performance liquid chromatography connected to tandem mass spectrometry (LC-MS/MS) for dyes and UV radiation and visible-induced luminescence (VIL) imaging for pigments in collaboration with Magdalena Biesaga, from the Laboratory for Flow Analysis and Chromatography at the University of Warsaw (Poland) and Cecilie Brøns, who leads a pioneering project in ancient polychromy with the support of the Carlsberg Foundation (Denmark).

The economic landscapes of textile production will be scrutinised from fibres to consumers. Typical of the Sahelian regions of the Sahara, the Meroitic economy seems to have stood on the shifting patterns of production between sedentary populations and pastoral groups, the seasonal exploitation of the desert hinterlands, and the political centralisation and redistribution of goods (Edwards 2004: 164-169; Fuller 2014). In this theoretical framework, textile activities occupied a crucial position, both at settlement level and in the kingdom as a whole. Their remains have not been studied in detail and the influence of textile production remains under-represented in the understanding of Meroitic economy. Following the textiles' life cycle, TexMeroe intends to test the current economical hypotheses with quantifiable data.

At the beginning of the *chaine opératoire*, the project focuses on the development of cotton production as a main raw material for textile manufacture. Recent archaeobotanical studies (Fuller 2014; Clapham & Rowley-Cowny 2010) have shown that cotton was cultivated locally in Nubia and Central Sudan, dating back to at least the beginning of the first century CE. These discoveries corroborate the many cotton textiles found on Meroitic sites, sometimes representing more than 80% of the total assemblage. Widely used by the elite, this fibre is one of the main characteristics of textile production in ancient Sudan. Together with Charlène Bouchaud, archaeobotanist from the Muséum d'Histoire Naturelle (France), TexMeroe strives to assemble and analyse all available data from textile, environmental, and botanical studies, in order to understand the role of the Meroitic kingdom as an essential contributor to the cultivation and diffusion of cotton in the ancient world.

Further along in the manufacturing process, TexMeroe is working to place textile crafts in their domestic and industrial contexts, concentrating especially on spinning and weaving. In Sudan and Nubia, textile implements such as spindle whorls and loom weights are common finds (fig. 2). Present in both rural and urban settlements, from the southern site of Abu Geili on the Blue Nile to the northern Nubian city of Qasr Ibrim, these convey the importance of textile activities in the daily life of the Meroitic population. The sum of this material paints a vivid image of textile

Fig. 2: Spindle whorls from Meroe artisanal quarter and loom weights from Wad ben Naga palace and Meili Island settlement (c. 100-300 CE), Sudan National Museum inventory numbers 62.10.148, 24513, 24519 & 14573 (Images: © Elsa Yvanez)

Fig. 3. Funerary stelae of a Meroitic lady and her son (?), from the cemetery of Karanog (Lower Nubia, c. 100-200 CE), Cairo Egyptian Museum inventory number JE40229. (Image: Reproduced from Wenig 1978: 205-206, no 127.)

manufacturing, from domestic production in living quarters to the creation of multitasking industrial areas. In collaboration with ongoing excavation programmes in the "Island of Meroe", this research aims to restore the tools to their archaeological locations in order to understand how textile production was integrated into the urban landscape, in a single settlement as well as on a broader regional scale.

At the end of the production line, the TexMeroe project also studies the textiles' destinations: the consumers and their modes of textile consumption. In a world where most of the population did not wear any clothing beside a small loincloth or a belt made of leather, garments of woven textiles had a tremendously important status. Mainly used by the administrative and religious elite of the kingdom, textiles were embedded in a complex network of resource management and central policies. Easily transportable and sometimes of considerable value, they were also prime candidates for exchange and diplomatic gift-giving, playing a central role in cementing political ties between the royal family, the court and the local elites. TexMeroe explores these questions, investigating the textiles' position as luxury items in Sudan and identifying the evolving demands of a noble class as its members chose different clothing according to their political allegiance, and their cultural identity and ethnic identity.

Less than a year after its start, the project is still in the data collection phase visiting museums to analyse their textile collections and making detailed studies of relevant specimens. Experiments will soon be conducted to verify the accuracy of technical reconstructions for the openwork borders and looped pile weaves. Sampling procedures are currently underway and will soon lead to laboratory analyses for dating, and dye and pigment identification. Work is progressing on the publication of an interdisciplinary volume about the archaeology of Old World cotton (Bouchaud & Yvanez, forthcoming), and material has been assembled from excavated settlements in order to reconstruct their textile production models. The study of elite clothing and the use of textiles as prestige goods has borne interesting results, published as articles in upcoming volumes (Yvanez 2018 and forthcoming, Yvanez & Wozniak forthcoming). The project will continue to benefit from the many learning opportunities offered by the CTR and its network of experts, deepening the understanding of Meroitic textile production and opening new avenues of research. It will also focus on more dissemination activities, such as seminars, classes, and online content in order to make this rare and precious material available to many more people within academia and beyond.

Acknowledgements

This work would not be possible without the collaboration of many archaeologists in the field, who agreed to share their unpublished material with me, opening their stores and digital archives. Special thanks go to Marie Millet, Pawel Wolf, Saskia Büchner, Vincent Rondot, Vincent Francigny, Claude Rilly, Mahmoud Suleiman Bashir, Liliane Mann, Jane Humphris, and David Edwards. TexMeroe would not exist without the incredible support received from Marie-Louise Nosch and Eva Andersson Strand at the Centre for Textile Research, since the very beginnings of the project. My gratitude goes to them both, and to the many people contributing to make CTR such a welcoming and stimulating research environment.

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The Salt Mummies of Zanjan:

Textile research in Iran in a conservation and exhibition project

At the salt mine Douzlakh near Chehrābād in Iran, the remains of mummified miners from between 400 BCE and 400 AD were discovered. They died due to repeated collapse of the mine. However, these catastrophes present an extraordinary opportunity for scientific research, which has resulted in international cooperation projects.

Fig. 1: Work on salt man 4 in Museum Zanjan, October 2015 (Image: DBM/RUB/MFZ)

Owing to favourable preservation conditions, Chehrābād (for a site overview see: Aali et al. 2012; Aali & Stöllner 2015) is a rich source of organic finds: for example, in 1994 salt man 1 was found, and later rescue excavations by Abolfazl Aali in 2004-2005, brought the discovery of further mummies.

Under the leadership of the Cultural Heritage Management (ICHTO) Zanjan in Iran and German-Mining Museum Bochum/Ruhr-University Bochum in Germany, several excavation campaigns have taken place as part of the *International Chehrabad Salt Mummy & Salt mine Exploration Project* from 2009 to 2018. During the excavations, remains of six human mummies and also large numbers of organic materials (for example, wood, botanical remains, human faeces, textiles and ropes) have been found. More than 1,000 textiles are known so far, most of them covering roughly a time-span between the fifth century BC to the sixth century AD, encompassing the Achaemenid and Sassanid Period of the Persian Empires. The salt mine was also used during the Islamic period, relating to the Safavid and Qajar periods (between the late 14th and early 20th centuries AD).

The most impressive textiles from the Achaemenid period (fifth/fourth centuries BC) are the more or less complete garments associated with salt man 3, 4 and 5 (e.g. Aali & Stöllner 2015, fig. 56; Grömer & Aali 2016). Among the other textile fragments found in Achaemenid layers are some textiles in tabby and its variants. There are also textiles with various patterning techniques such as stripes and textiles with weft-floating patterning. Remarkable among the Achaemenid textiles are the marks of repair. The main

part of the dated textiles are from the Sassanid Period (third to sixth century AD). There is one complete upper garment and fragments of trousers (from salt man 2 and one further find) described by Krug-Ochmann (2014). Among the patterned and dyed textiles (see also Mouri et al. 2014) we can find fragments decorated with tapestry techniques, striped items, some items made in compound-weave techniques (Hadian et al. 2012), and warp-based patterning.

The Patrimonies Project

In 2017, the German Gerda Henkel Foundation approved support for a heritage project (2018-2020),

Fig. 2: Sassanian textile with spots for dyestuff sampling marked (Image: DBM/RUB/MFZ, F. Schapals)

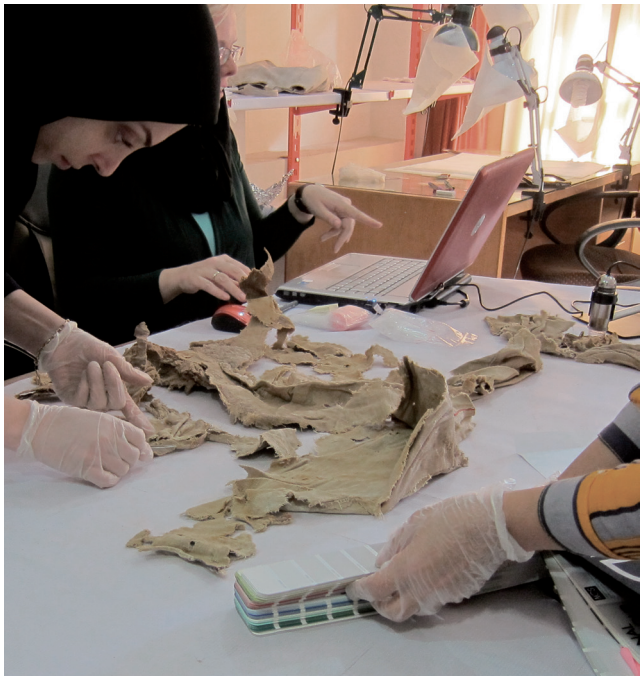

Fig. 3: Textile research by the Iranian-Austrian team, February/ March 2018 (Image: DBM/RUB/MFZ, K. Grömer)

which builds on the knowledge and results of long-term excavations and research at Chehrābād salt mine. Within the foundation's Patrimonies-programme the new project *The Saltmen of Zanjan. Heritage of the Salt Mummy-Museum Zanjan* deals with conservation and restoration of the mummies and of the numerous organic finds from Chehrābād salt mine. They are exhibited and stored in Zanjan, north-western Iran. There are also plans to bring finds to Mainz, Germany, for restoration and for special exhibitions in other parts of Germany, Austria and Teheran, the capital of Iran. The last, but not the least challenge is to rework the permanent exhibition of the Zolfaghari-Museum Zanjan within the exhibition planning and corresponding conservation measures.

Under the leadership of the German Mining-Museum and the Ruhr-University Bochum, the following institutions recently signed a contract with the Iranian Cultural Heritage and Tourism Organisation Zanjan, the Zolfagari-Museum Zanjan and the National Museum Tehran: the Natural History Museum Vienna, the Romano-Germanic Central Museum in Mainz and the Archaeological Museum Frankfurt: www.iran.ir/en/News/82854609. All partners are going to support the heritage project in different areas. The Natural History Museum Vienna is participating with its expertise on "salt textiles".

Fig. 4: Conservation treatments by the Iranian-Austrian team, March 2018 (Image: DBM/RUB/MFZ, K. Grömer)

Textile research within the Patrimonies Project

Scientific research on salt mines has been part of the Prehistoric Department, Natural History Museum Vienna since the 19th century, as finds from the prehistoric salt mine at Hallstatt in Austria form an important aspect of its collections. Next to excavation and research of finds both from the salt mine as well as the Iron Age cemetery Hallstatt, textile research is also an important task in research activities at the Natural History Museum Vienna. With international cooperation and research projects about the salt mine in Chehrābād in Iran, trainee agreements and knowledge-transfer between scholars from Europe and the Near East are underway.

As part of this project, a research visit to Zanjan in Iran was carried out in February/March 2018, in order to collect data about Achaemenid and Sassanid textiles from Chehrābād that have been selected for restoration and exhibition. From the site, as well textiles of the period between the 17th and 20th century AD have been found. Also new data about the garments of the salt mummies has been obtained or re-accessed from previous studies (e.g. Hadian et al. 2012; Krug-Ochmann 2014). Further scientific analyses are planned with dyestuff analysis, fibre analysis and wool fibre measurements.

An important aspect of the activities within the Patrimonies Project is the cooperation with Iranian textile researchers and conservators. Together with S. Amin Shirazi (Textile Conservation Department, Research Centre for Conservation of Cultural Relics in Tehran, Iran) and S. Borhan, some fragmented garments and other textiles have been assessed for conservation treatment, and also the shape of the garments and a large wool sack have been identified. The local scholars S. Borhan and N. Kanani have been trained in common analytical tools for textile research, including measurement of technical data using a digital microscope. The textiles from Chehrābād are an important source for our understanding of textile technology of the Near East and the Persian Empires. In a long term perspective, the activities within the Patrimonies Project are an important contribution to research in this area, and to get a complete catalogue of the textiles from the salt mine. Important research questions in focus for the following years are:

* Raw materials and dyestuffs: Fibre analysis, wool fibre measurements and dyestuff analysis are to be carried out in cooperation with specialised laboratories.
* Context and function: What function did the textiles from the salt mines have: garments, textile bags, do they represent primary or secondary use?
* Reconstruction of garments, also in a chronological perspective: Are there different design concepts of how to make a garment? Use of different stitch and seam types.
* Reconstruction of weaving techniques: To understand them, methods of experimental archaeology in combination with research on Iranian traditional hand craft will be applied.
* Development of textile technology, especially from Achaemenid to Sassanid period: How does the use of raw materials, weave types, qualities, patterns, and dyes change? Is a cross-fertilisation with the Roman world visible?
* Typology and iconographic studies on patterns and garment types: What general observations of garment types can be made, how do they reflect the social hierarchy? Can we observe the garments from the salt men from those pictures? What is similar, what is different?

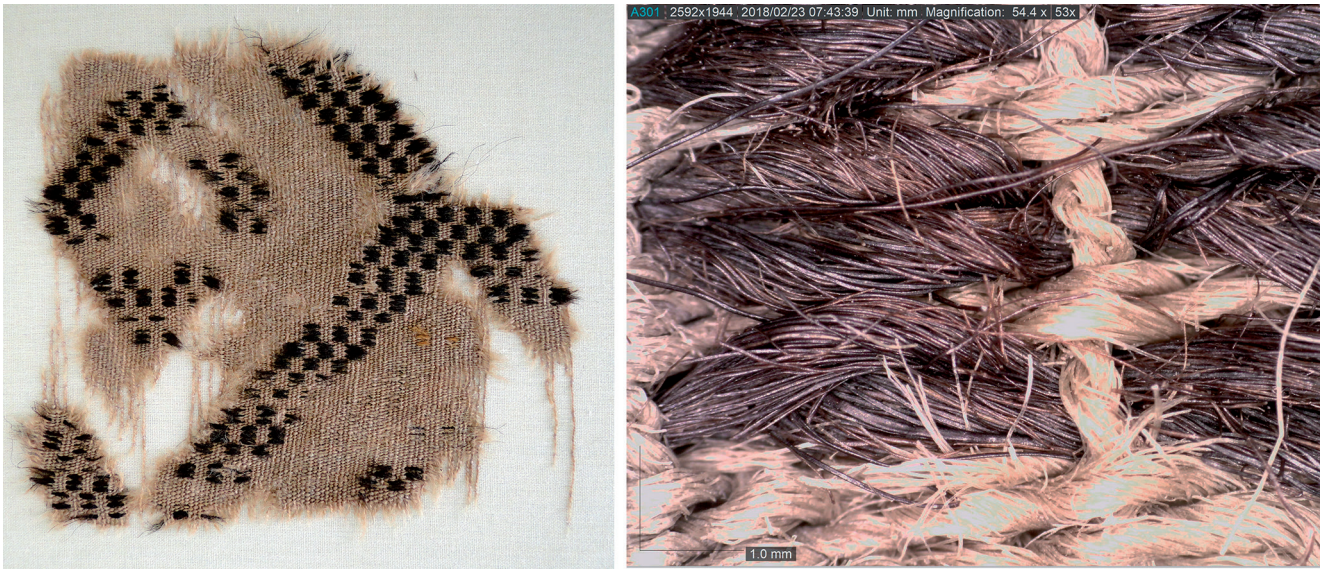

Fig. 5: Achaemenid textile with embroidered pattern, previously mentioned in Aali & Stöllner (2015, fig. 55), re-assessed in March 2018 (Images: DBM/RUB/MFZ, K. Grömer)

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Ulla Mannering

Fashioning the Viking Age

In September 2018, a new three-year research project (2018-2021) funded by the Velux Fonden was launched at the Department for Ancient Cultures of Denmark and the Mediterranean at the National Museum of Denmark. The general aim of the project *Fashioning the Viking Age* is to create new and archaeologically well-founded interpretations and reconstructions of Viking Age textiles and clothing.

By combining the latest knowledge of Viking Age textile and skin production in southern Scandinavia with analysis of a selected range of contemporary textile finds, the project will renew the dissemination of textile, skin and clothing design and transform this data into a format that can be used in exhibitions, teaching and popular visualisations of multifaceted life in the Viking Age.

In Scandinavia, the Viking Age is generally defined as the last period of the Late Iron Age ranging from AD 800 to 1050 (Jensen 2013). Even though the Viking Age is often treated and understood as a period with its own unique cultural development, its textile production was deeply rooted in the process and design traditions of the preceding period (Bender Jørgensen 1986). In order to understand the developments in textile production and clothing design that took place during the Viking Age, it is necessary to include data from earlier periods (Mannering 2017; Mannering & Skals 2018). Likewise, in recognition of the fact that the developments recorded in Viking Age cloth culture also had an impact reaching beyond this period, materials and sources from after it will also be included in the project (Østergård 2004). The project covers the period from AD 650 to 1200.

Most archaeological material and finds relating to the Scandinavian cloth culture is unequally represented in different contexts and geographical areas. In this project, the team will primarily work with finds recovered from southern Scandinavia and present-day Denmark. This decision is based on the fact that regional differences in Scandinavian cloth culture are not yet fully documented and understood, and this presents a task beyond the scope of this project.

In popular dissemination, the term "Viking" is often used to denote the population living in Scandinavia during the Viking Age. In fact, this term was only used to describe the warriors and seafarers who raided and traded from their north European homelands across wide areas of Europe (Croix 2015). Today, the idea of the wild and fiery Vikings who created wealth and fame is cultivated in popular dissemination. But, at the time, the majority of the population lived and worked as farmers, fishermen and craftsmen in small-scale societies that depended on self-sufficiency. In this society, clothing, textile and skin production were integrated into agriculture, and it is the outcome of this and its associated cloth culture on which the project will focus.

In the Viking Age, society was divided into hierarchical segments defined by status and profession, and this structure is also visible in textile and skin production (Andersson Strand 2015). Textiles were needed and produced in many different qualities and for different purposes: clothing, the household, for warfare, transportation and trade. Glass beads, gold, silver and silk, commodities that played an important part in the clothing construction and the display of status and wealth, were traded from the south, most likely in exchange for slaves and fur from wild species such as beaver, fox and sable which were hunted in the northern regions of Scandinavia and Russia (Kovalev 2001; Vedeler 2014; Mannering 2015). It is the sum and meaning of all this data, which will create a new and clearer perception of Viking Age textile, skin and clothing production.

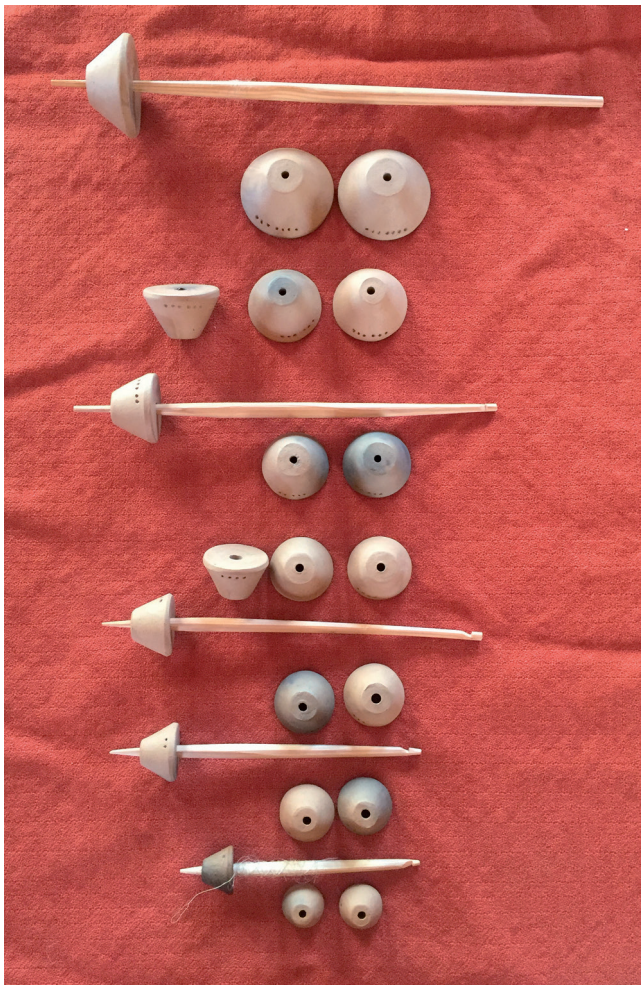

Fig. 1: Reconstructed Viking Age spindles and spindle whorls to be used in textile experiments in part 1 of the project (Image: Ida Demant)

The outcomes of the project will be achieved through the work and results of three sub-projects. Part 1: **Viking Age Textile Production** takes as its starting point the analyses of known archaeological finds of tools, textiles, skins and fibres from graves and settlements (see, for example, Bender Jørgensen 1986; Hägg 1984, 1991; Andersson 2003). These results will be combined with controlled fibre sorting, spinning (fig. 1) and weaving experiments in order to create a variety of textiles samples that convey tactile and visual aspects of the Viking Age cloth culture.

In Part 2, **Viking Age Male and Female Clothing:** Two reconstructions of complete men's and women's outfits will be produced. The reconstructions will primarily be based on data selected from the textile and skin fragments found in the Mammen and Hvilehøj (fig. 2) grave finds in Jutland, Denmark (Iversen et al. 1991; Krag & Ræder Knudsen 1999).

In Part 3, **Viking Age Clothing Catalogue**, the team will review the many different sources linked to Viking Age clothing design, including archaeological, iconographic and written sources (see, for example, Mannering 2017). The product will be an online open-access catalogue providing a new and updated foundation for future interpretations and reconstructions of Viking Age clothing in different societal and status groups.

In today's digital world and with the speed of information circulating in various international media, it is important to provide up-to-date information to aid understanding of the importance of archaeological finds and materials to the scientific world and the general public. Our past is fragmented and incompletely preserved, and it is our responsibility as researchers to make sense of and interpret it. This is definitely not an easy task, and it is difficult to answer in a single sentence the frequent question: "What did the Vikings wear?" Through the three sub-projects, we aim to provide well-founded and robust answers with new data to underpin our textile and clothing interpretations; data that have, for a long time, been demanded by fast-moving media, living history museums and reenactors. Thus, the project will, through its many different parts, give Scandinavian Viking Age textile research renewed focus and impact, and result in a new visual and tactile understanding of textile production and clothing which can be used in museums, media, research, and by the broader public.

The project is a cooperation between Ulla Mannering and Charlotte Rimstad, from the National Museum of Denmark, Eva Andersson Strand, from the Centre for Textile Research at the University of Copenhagen, and Ida Demant, of Land of Legends in Lejre, Denmark (fig. 3). Irene Skals, who will undertake fibre analyses is also a member of the team, together with Luise Ørsted Brandt, who will analyse skin samples from selected finds from the Danish Viking Age. Lise Ræder Knudsen, who is a tablet-weaving expert, and other specialists including craftspeople, many from the Land of Legends, will be in charge of dyeing, embroidery, sewing leather, and the production of accessories and textile tools.

Follow the project at the CTR homepage (ctr.hum.ku.dk) or on Instagram@fashioningthevikingage. We also welcome applicants for Marie Skłodowska-Curie Individual Fellowships. If you have a research idea that falls within the scope of this project, pre-applications can be forwarded to evaandersson@hum.ku.dk at the latest by 1 April 2019. Applicants will be included in

Fig. 2: Textile and skin fragment found in the Hvilehøj women's grave dated to the 10th century AD (Image: Roberto Fortuna, National Museum of Denmark)

the CTR Marie Skłodowska-Curie workshop to be held later in the spring.

The project also invites masters students to choose topics related to the Viking Age for their final dissertations such as cloth cultures, tool technology, textile production, or written sources related to clothing etc.

Fig. 3: The project team (left to right) - Irene Skals, Ida Demant, Eva Andersson Strand, Ulla Mannering and Charlotte Rimstad (Image: Charlotte Rimstad)

In the autumn semester 2019, the team will give a course in *Textile Archaeology – a Hands-on Approach* with the focus on this theme.

Fashioning the Viking Age also collaborates with the newly established network **Cloth Cultures in and Beyond the Viking Age** initiated by Eva Andersson Strand at the Centre for Textile Research at the University of Copenhagen in collaboration with Ulla Mannering from the National Museum of Denmark, Charlotte Hedenstierna-Jonson from University of Uppsala, Amica Sundström from the Swedish History Museum, Stockholm in Sweden, and Marianne Vedeler from the Museum of Cultural History, University of Oslo in Norway. The aim of the network is to conduct front-line investigations and dissemination of scientific studies of clothing, household textiles, and textiles for warfare and trade. The network also offers a forum for discussion and dissemination (for more information see ctr.hum.ku.dk/people/ctr-networks/cloth-cultures-in-and-beyond-the-viking-age/).

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VELUX FONDEN

VELUX FONDEN (a part of THE VELUX FOUNDATIONS) is a philanthropic foundation that supports scientific, cultural, social and environmental purposes. Further grant areas are active senior citizens, gerontology and ophthalmology. In 2017, VELUX FONDEN granted approx. EUR 28 million.

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Jane Malcolm-Davies and Marie-Louise Nosch

THREAD: a meeting place for scholars and refugees in textile and dress research

Introduction

One day, long ago in the 1980s, a young Kurdish immigrant girl visited Lejre, the centre for experimental archaeology outside Copenhagen in Denmark. She watched a weaving demonstration as the textile team reconstructed the Huldremose woman's dress on a loom 1.85 m wide. Four adults were weaving together to reproduce the "three weft-crosses of each weft-pick in the original Iron-Age textile" (Stærmose Nielsen 1987, 207). They were cramped for space and struggling to work comfortably. The Kurdish girl unexpectedly opened the weavers' eyes to a new interpretation of how to work. She explained that in her home region, where she had seen the same system in operation, the two middle weavers were children, which not only solved the space problem, it also helped them learn to weave while the more complicated and time-consuming edges were handled by the experienced adults (Stærmose Nielsen 1987, 207).

This story was, in part, the inspiration for THREAD (Textile Hub for Refugee Empowerment, Employment and Entrepreneurship Advancement in Denmark), a 33-month, 4.8m kroner (€645,000; £575,000) project led by the Centre for Textile Research (CTR), University of Copenhagen, which aims to tackle the challenge of refugee integration (Nosch 2017). The so-called "Grand Solution" financed by the government-backed Innovation Fund Denmark takes the view that refugee and immigrant women are a valuable resource rather than a problem group – as demonstrated by the Kurdish girl who shared valuable knowledge about weaving from her memories.

When the European refugee crisis grew increasingly acute in 2015, citizens in universities, education, the creative sectors and museums began multiple initiatives to help create new lives for the new arrivals. Pop-up schools appeared to offer training in software design among many other projects such as the HackYourFuture coding training which started in The Netherlands. German universities opened their auditoria and libraries (for example, Universität Trier, Universität Koblenz and Georg-August-Universität, Göttingen). The international network Scholars at Risk arranged temporary academic positions for asylum-seeking academics and the Philipp Schwartz Initiative sponsored by the Alexander von Humboldt-Stiftung funds such hosting arrangements.

In the field of textile research, scholars saw an opportunity for closer societal engagement, a way of helping to solve a serious problem, and to open new routes to new knowledge. The Natural History Museum in Vienna helped asylum seekers (who were archaeology students) to arrange training and internships. In particular, in 2016 an archaeologist from Aleppo (Syria), Nver Simon, participated in analysing an historical Syrian textile (Grömer et al. 2016). The THREAD project set out to explore whether textile culture and craft could be catalysts for improved refugee integration. At the heart of THREAD is the concept of a themed network of contacts who can help facilitate social and professional advancement for women forging new lives in Denmark.

Craft knowledge and expertise drawn from practitioners has long been closely integrated along empirical and theoretical studies of textiles. CTR scholars have actively collaborated with hand-weavers and spinners in Denmark, Sweden and Greece as informants and participants in experiments and research (Andersson Strand & Nosch 2015; Andersson Strand et al. 2016). In 2013, textile scholars launched a

research project and international network *Traditional Textile Craft*, in collaboration with weavers and textile craft organisations in Jordan, India, Sweden and Turkey, as well as Danish textile design company Kurage (Ebert et al. 2014). This initiative was rooted in UNESCO's strategic focus on intangible craft and cultural heritage. Knitters were crowd-sourced to explore Early Modern knitting technology (Malcolm-Davies 2018) and collaboration with a weaving cooperative in Peru to conduct experiments with bone textile tools provided a deeper understanding of Neolithic examples from Greece, the Balkans and Turkey (Sarri 2017).

Partners in this imaginative initiative represent a wide cross-section of organisations including the Danish fashion brand Vibskov, an open-air Viking Age Village heritage attraction, the Copenhagen teacher training college (UCC), the School of Design in Kolding (DSK), a private company specialising in terminology (TermPlus), a design company involved in social work (Design Vanilie) and an association of female refugees and migrants (FAKTI).

The CTR's contacts share a passion for textiles, dress and fashion from prehistoric archaeology to cutting-edge design, which is not only the focus of academic endeavour but also represents real market opportunities for economic growth – especially in the context of "modest fashion" which is relevant to many of the refugees extending beyond those who are Muslim (Lewis 2013). This worldwide market was worth US$254 billion in 2016, increasing by four per cent from 2015 and expected to grow by seven per cent per year to reach US$373 billion by 2020 (Thomson Reuters 2018, 103).

THREAD activities

THREAD offers a series of targets built around the partners' shared passion for textiles:

Enhancing empowerment

Refugees need to feel they can take charge of their new lives if they are to take advantage of opportunities presented to them. Empowerment has been characterised as interventions, which "enhance wellness while they also aim to ameliorate problems, provide opportunities for participants to develop knowledge and skills, and engage professionals as collaborators instead of authoritative experts" (Perkins & Zimmerman 1995, 570). The proven therapeutic effects of craft activity for women include a sense of achievement, possibilities for personal growth and the development of cognitive and physical skills (Pöllänen 2015, 58). Art therapy has also been used in the treatment of post-traumatic stress disorder (PTSD) with specific examples of traumatised refugee women from Bosnia who undertook embroidery, needlepoint, crochet, knitting, needle-lace, and quilting reporting an increase in social interactions (Ramirez 2016).

Embroidery, knitting and weaving "Textile Techniques" workshops with Danes offer opportunities to share craft skills and socialise. Pop-up "Textile Talks", where artists, refugees and scholars share experiences of textiles such as wedding clothes, the memories sparked by fabric textures, and how garments can narrate a life story. There have been more than 50 of these sessions held at different venues and hosted by THREAD project team members and guest facilitators. Weekly activities and workshops now run several places in Denmark. Participants at the textile workshops in Køge received a certificate of attendance to help overcome their lack of conventional qualifications. Design Vanilie in Tingberg and Husum is helping participating women find internships with Copenhagen businesses and at UCC. At DSK, participants are building portfolios of textile handicraft work to help showcase their skills in the jobs market. This has resulted in job offers, both in private companies by designers and as teachers in Danish evening schools where adults of all ages go to increase their knowledge and skills and enjoy craft.

Facilitating employment and education

Denmark has historically had few refugees and migrants coming to the country, and currently the proportion of the population share with non-western backgrounds is circa 350,000 people in a total population of 5.7 million (Statistics Denmark). During the 2015 peak influx, the country had few facilities for integration, and the municipalities faced major challenges which needed to be overcome swiftly. Traditionally, learning Danish has been a key way of accessing the labour marker, and language schools were seen as core facilities for integration. However, during the refugee crisis, integration policy shifted focus from language skills towards labour market experiences as the successful keys to integration. This is supported by experience from other western countries. The Canadian Council for Refugees identified access to employment as the top priority for successful integration in 2011. Recent studies demonstrate that women face different challenges from men as they integrate – in particular in finding appropriate work (Premji et al. 2014). Recent research on senior Turkish settlers in Denmark (Liversage & Jakobsen 2016) shows that a lack of access to appropriate employment opportunities results in considerable inequalities in old age, and this observation is particularly relevant to women. While only 1% of elderly Danes live below

OECD poverty levels, 29% of elderly migrants do so. This financial disadvantage results partly from the accumulation of a lifetime of disadvantages, especially in the labour market, and continuing into pension age. The percentage of the population which is in the labour force (aged 15 to 64 years) is known as the professional activity rate. Danish women have a professional activity rate of 74%, while non-western women in Denmark have a lower professional activity average of 47% (Ritzau 2018).

Since 2015, most refugees in Denmark come from Syria and, although there are fewer women than men seeking asylum, their numbers are significant (just over 3,000 in 2015). The highest proportion of women refugees from Syria are aged 20 to 29 years. Nearly 1,000 individuals in this age group came to Denmark in 2015, and many of these women seek to enter the labour market for the first time. Other women from Syria are older (circa 500 women refugees aged 40 to 50 years settled in Denmark in 2015), and these are likely to have transferable skills (Udlaendingestyrelsen 2016).

THREAD brokers relationships between organisations and refugee women to arrange internships to help them familiarise themselves with the Danish workplace and aspects of Danish life. Several of these internships have been at educational institutions (CTR, DSK, UCC) giving them the confidence to take a first step into the Danish educational system. Research has shown that female non-western citizens in Denmark succeed particularly well in the Danish education system. Among the non-western female migrants and refugees, 13% come to Denmark with a vocational education, and 14% come with a professional bachelor education. In contrast, among non-western girls and young women who embark on their education in Denmark, 36% accomplish a vocational education and 22% a professional bachelor's education. Thus, more than 50% more non-western women complete these educational opportunities than non-western men (Rockwoolfonden 2016, 17-19). In order to facilitate this positive trend, THREAD offers enrolment for refugees in the annual CTR summer school with the theme of "3,000 years of textiles and dress", which is part of the curriculum of the University of Copenhagen. Here, refugee students can widen their professional and social networks, practice their academic English and Danish, and gain a first Danish university diploma. So far, two women archaeologists with bachelor's degrees from Aleppo University (Syria) and Kurdistan University (Iraq) have attended the summer school. They can use the diverse academic, business, social and educational environments as a stepping stone for new career choices.

Fig. 1: A THREAD workshop programme at the community college in Køge culminated in a "show and tell" event with participants bringing their handiwork to display. Each participant received a diploma certifying their handicraft skills, which will go some way to demonstrating their capacity for work in the absence of more conventional certification (Image: Pernelle Fagerland)

Encouraging entrepreneurship

The THREAD project includes an initiative to explore self-employment as an option for refugee women. Immigrants are often successful entrepreneurs since they are risk-taking, resourceful and innovative (Halkias et al. 2010). There is a combination of factors which stimulate entrepreneurial activity usually categorised as push and pull factors. One of the latter is presented by the 'enclave effect' whereby members of a cultural group live and work in close proximity and are able to provide each other with same-language networks beneficial for marketing (Fong et al. 2007, 129-130). The shared perception of gaps in the availability of stylish modest clothing (see below) shows there are opportunities for women refugees to set up enclave businesses tackling these. A workshop on the benefits of self-employment, the

support offered by state agencies, and case studies from successful immigrant entrepreneurs will provide inspiration for those refugee participants who wish to explore this possibility.

Academic outcomes

All these activities are helping to build good practice for a themed model of integration, which is the ultimate aim of the THREAD project. The hypothesis is that the themed network integration model is transferable from textiles to other themes such as food, sport, gardening, or personal grooming – all activities in which people undertake social activities, share with friends and/or with which they have a professional or economic concern. The current phase of the project is working on capturing the essential characteristics of the THREAD network in order to provide a blueprint for future networks based around other themes. THREAD is a work in progress and this transfer of the themed model is yet to be tested.

In addition to this, the project includes two main academic lines of enquiry: wardrobe studies and terminology development.

Wardrobe studies

These have a well established methodology (Klepp & Bjerck 2012) in which scholars conduct interviews about a person's wardrobe, clothing combinations, histories, contexts, and gain insights into private histories, biographies, processes over time, and also consumer behaviour and patterns of consumption.

Wardrobe studies were undertaken with refugee participants during the period August 2017 to June 2018 by design historian Else Skjold and designer Solveig Berg Søndergaard of DSK. They documented the personal collections of dress objects stored by eight immigrant women. The study showcases how incomers try to manage their own integration process through what they wear and do not wear. It demonstrates the literal integration of dress as they negotiate relationships between clothing and values they brought from their countries of origin with the clothing and values they encounter after arrival in Denmark. The wardrobe biographies of these women become key to understanding journeys of immigration in which dress objects connect past, present and future, and express memories, dreams and aspirations for individual people (Bang 2013). The wardrobe enquiries work as explorative, deep insights into a limited sample of individuals (eight women). The research results cast light on the way in which modest fashion is played out and practiced in local Danish contexts such as the city of Kolding (Malcolm-Davies & Skjold forthcoming).

Most of the dress objects worn for social events with fellow countrypeople – particularly other women - are not purchased in Denmark, as the interviewees find it impossible to source appropriate garments. This means that they often depend on family and friends who travel abroad and bring garments home, sales platforms such as Turkish We-Chat, ethnic bazaars (such as Bazar Vest, a mall of primarily ethnic shops in the vicinity of the large settlement of flats and social housing Gellupparken near Aarhus), or self-made garments fabricated in their homes with materials from abroad. There were many attempts to bridge these two main categories in their wardrobes by 'sparkling up' the Danish wardrobe through accessories, constructing three-piece ensembles through combining objects that colour matched, or finding dress objects in Danish shops that provided the right silhouette and then styling them in their own way.

Textile and dress terminology research

This is currently an expanding international, interdisciplinary research field. However, in the area of clothing and textiles, focus has been on technical/industrial vocabularies and on ancient languages and scripts (Lervad et al. 2016; Michel & Nosch 2010; Gaspa

Fig. 2: A *Hijab Me!* participant, who spent a week working with a Henrik Vibskov designer following the process of designing and then creating an original design for a hijab. There were four participants in the programme, which was a pilot project for an academic/commercial collaboration offering refugees the opportunity to learn about work in the fashion industry (Image: Jes Saatterup)

et al. 2017). Collaboration with refugees provides access to other languages and dialects, which are otherwise difficult to study because few dictionaries focus on clothing and textiles, and studies of specialised vocabularies rarely encompass craft, fashion, clothing, textile tools or patterns. Earlier studies have shown that mistranslation occurs in this area, due to the translators' and philologists' lack of knowledge of the field and modern alienation from textile production generated by industrialisation. In addition, the errors introduced by gender bias are numerous because terminology and philology were driven mainly by male scholars, while textile and clothing knowledge was largely a female domain (Michel & Nosch 2010, xiii-xiv). Examples of mistranslations are distaff instead of spindle whorl, or embroidery as translation for in-woven patterns on the loom, or linen instead of hemp (Barber 1991, 263-264; Nosch 2014, 35 note 101).

However, in order to conduct terminological research in the THREAD project, the methodologies had to be redesigned because the participants may have specialised textile vocabulary but little technical knowledge and no conceptual framework for terminological work. The new methodology for textile terminological fieldwork includes using images of looms and types of clothing in order to grasp the dialectal, regional and semantic differences. The international team who interviews refugees is composed of terminologist Susanne Lervad (director of TermPlus), linguist Christian Gaubert (Institut Français d'Archéologie Orientale in Cairo) who works with Arabic, Tigrinya, and Gez, and classical philologist Egzona Haxha works with Albanian clothing and textile terms. Results will be presented at international conferences on linguistics and terminology in 2019.

The CTR's first recruit from the refugee community was Manhal al-Barazi, an archaeologist from Syria, who undertook a comprehensive translation of a scholarly paper about CTR's textile research into Arabic, thereby disseminating the research to a much wider range of scholars (Andersson Strand et al. 2015). Farzana Khosrawi is an Iranian Kurd from Iraq with a bachelor's degree in Near Eastern archaeology from Kurdistan University who has joined CTR for a two-year integration contract from 2018 to 2019. Both colleagues received specialised training in textile archaeology and joined the annual international summer school on textile history and archaeology, thereby facilitating their re-entry into the academic community. Their contribution to CTR in terms of translations, networking with refugee communities, their international outlook, and artistic work illustrates the two-ways benefits of this collaboration process.

Thus far, THREAD has approached the challenge of integration by focusing on the rich array of resources women refugees bring with them to Denmark. These include multiple and varied domestic skills, social skills, knowledge of and skills in ancient textile crafts such as special embroidery techniques, sewing, tailoring, crochet and knitting. It also includes an interest in modern and modest fashion, knowledge of consumer behaviour in Middle Eastern countries, and knowledge and experience with styling and accessorising in the burgeoning market for covering rather than exposing the body. Initial investigations into the size and growth of the modest fashion market has not only revealed what a vast opportunity for creativity and profit it offers but thrown into stark focus how narrow-minded it is to consider modest fashion as niche, alternative, embryonic or "other". Modest fashion is here, now and is the mainstream market for much of the world.

Fashion brands and companies play a significant part in the Danish economy, with a €6 billion turnover and exports of €3.7 billion with 4 per cent annual growth in 2015. However, exports are low to Muslim and Arabic countries, and Danish companies are actively seeking to enter this consumer market for clothing. The involvement of refugee women could constitute an important key to gaining market share.

Conclusion

THREAD taps into the central discussion of the role of universities in the 21st century. The prevailing model of the "Triple Helix" forms a scaffolding of interactions between universities, public and private sectors where excellence is fostered through the transfer of knowledge (Etzkowitz & Leydesdorff 2000). The model was expanded into the "Quadruple Helix" by including civic society, non-governmental organisations (NGOs), cultural and non-profit institutions. This model embraces social and cultural innovation by reaching beyond traditional technology transfer in the shape of formalised collaboration and patents (Johansson et al. 2018). In its structure, THREAD encompasses all forms of the "Quadruple Helix" with interaction between national and municipal institutions as well as private companies and not-for-profit organisations participating. Its aim is social innovation but there is significant potential for participants to feed into research in highly specialised fields. The collaborative scope extends to refugee populations and unconventional partnerships

between diverse institutions. These have required the creation, development and testing of new collaborative methods.

THREAD has taken a few innovative first steps towards a new way of working with refugees to access the capacity they bring to the Danish knowledge and market economies. It has attempted to forge a collaborative approach between refugee women and textile scholars, which has generated new data about the process of integration (through wardrobe studies) and given rise to new methodologies (in terminology research). The extended network of contacts identified by the partner organisations has demonstrated the potential for a wide range of supportive activities for refugees – from craft workshops to internships – based around the theme of textiles. More work is required to refine the methods by which the enormous goodwill the project has harnessed can be converted into measureable benefits for refugee participants. But the potential for two-way learning between academics and refugees is also a very promising and exciting aspect of THREAD. How many more immigrants and refugees are there in Denmark (and beyond) who are just waiting for the opportunity to share their specialist knowledge with their new neighbours?

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Else Østergård 1940-2018

Textile conservator Else Østergård died on 21 March 2018 at the age of 78. Through her many years at the National Museum of Denmark, Else was always promoting the importance of textile research in the museum and was an eager advocate for general knowledge about textile history.

Else started as an apprentice in textile conservation at the museum in 1958 at only 18 years of age. She ended her employment when she turned 70 in 2010 but continued to work with her research projects until her health failed. At her debut, the department of conservation was small with only a handful of employees. Else was active in establishing the School of Conservation in Copenhagen in 1973, where she taught textile conservation during its early years. Throughout the 1970s and the beginning of the 1980s, museums in Denmark were favoured with funding from the state. The National Museum benefited from this and a large conservation department was established. Else and her colleague Sonja Støvring shared the responsibility of leading the textile conservation workshop until the end of the 1990s, when a major restructuring resulted in a merger between textile conservation and paper, skin and leather conservation.

Else was helpful and encouraging to everybody but could also be passionate and impulsive. She had a strong personality and her presence in the textile workshop did not go unnoticed.

Margrethe Hald's research on Danish Early Bronze Age and Iron Age textiles was a great inspiration to Else, and, in many ways, she became her successor at the museum. Else was innovative, lively and constantly thinking of ideas for research projects and topics for exhibitions with textiles being the key to them all. Her main passion was the history and technology of medieval textiles. She published much of her research and was a a keen lecturer in demand in Denmark and abroad. Over many years, her research focused on textiles from the Norse settlements in Greenland. This resulted in the publication *Woven into the Earth* in 2003. In 2011, she published an addenda, *Medieval garments reconstructed. Norse clothing patterns* in collaboration with Lilli Fransen and Anna Nørgård. Both books were eagerly received by the public. The pattern book has become a much needed aid in the growing public interest in reconstructing medieval garments.

Through her hard work, Else also built a large network both nationally and internationally. She was a member of the Centre International d'Étude Texiles Anciens (CIETA) and an eager participant in the North European Symposium for Archaeological Textiles (NESAT) meetings from the very beginning. Else took a great interest in young scholars and colleagues, serving as a mentor as well as helping them in practical ways by sending work such as dye and fibre analyses or the production of reconstructions their way. She made sure that the rich Danish collections of prehistoric and medieval textiles were kept safe and that they were examined according to the newest standards. She followed the establishment of the Centre for Textile Research at the University of Copenhagen with great interest, in particular the development of new scientific analytical methods that allowed for better dye and fibre identification, for improved dating of textiles, and for establishing their provenance.

Else was a kind and welcoming person as well as an acknowledged scholar, and she will be remembered with fondness.

Irene Skals and
Lise Bender Jørgensen

Dr Joanne Elizabeth Cutler 1962-2018

It is with deepest sorrow that I have to share the sad news that our friend and colleague Dr Joanne Cutler died on 24 January 2018. Jo lost the fight to aggressive cancer again at the age of 55.

Jo started her studies in archaeology as a mature student but, in a short time, she had an extremely successful career. She entered the field with typical enthusiasm, by undertaking two undergraduate degrees concurrently, one in archaeology at the Institute of Archaeology, University College London, which she completed in 2005, and another in humanities with classical studies at the Open University, which she completed in 2006, whilst also completing her masters. She was awarded first class honours for both BAs and in 2006 she received the John Stephen Kassman national prize from the Open University for the best essay on a classical subject. In 2006, she also finished her masters in archaeology of the Eastern Mediterranean and Middle East with her dissertation *Production Systems and Social Dynamics: Towards a Cross-Media Approach to the Minoanisation of the Southern Aegean in the Mid-Second Millennium BC*, and was awarded her MA with distinction. In 2011, she defended her PhD thesis in archaeology, entitled *Crafting Minoanisation: Textiles, Crafts Production and Social Dynamics in the Bronze Age Southern Aegean*. After being awarded her doctorate, she received several research fellowships: in 2013, an INSTAP Postdoctoral Research Fellowship, and in 2013 to July 2015, she held a Marie Curie Intra-European Postdoctoral Fellowship through the Gerda Henkel Stiftung, during which she was based at the Danish National Research Foundation's Centre for Textile Research, University of Copenhagen, Denmark. Her project during this period was entitled *Weaving the fabric of society: Bronze Age Aegean economies of cloth*.

From 2015, Jo held a position as a European Research Council research associate in the project *Production and Consumption: Textile Economy and Urbanization in Mediterranean Europe 1000-500 BCE (PROCON)*, at the McDonald Institute for Archaeological Research, University of Cambridge. This research expanded her research geographically into the central and western Mediterranean, and chronologically into the Iron Age. The principal focus of her research was textile production, weaving technology and she explored how technological skills and techniques are learned and transmitted, and the processes of technological innovation, material culture change, the construction of identity, and gendered networks of knowledge.

Jo's recent publications included: 'Something old, something new: non-local brides as catalysts for cultural exchange at Ayia Irini, Kea?', in N. Stampolidis, Ç. Maner and K. Kopanias (eds), *Nostoi: Indigenous Culture, Migration and Integration in the Aegean Islands and Western Anatolia during the Late Bronze and Early Iron Ages* (Istanbul 2014) (with E. Gorogianni and R. Fitzsimons), *Tools, Textiles and Contexts, Investigating Textile Production in Aegean and Eastern Mediterranean Bronze Age.* Ancient Textiles Series, 31. (Oxford 2015) (with E. Andersson Strand & M.-L. Nosch), 'Fashioning identity: weaving technology, dress and cultural change in the Middle and Late Bronze Age southern Aegean', in E. Gorogianni, P. Pavúk, and L. Girella (eds), *Beyond Thalassocracies. Understanding Processes of Minoanisation and Mycenaeanisation in the Aegean* (Oxford, 2016), 'Producing textiles: the evidence from the textile tools', in M. Tsipopoulou (ed.) *Petras, Siteia I. A Minoan Palatial Settlement in Eastern Crete. Excavation of Houses I.1 and I.2* (Philadelphia 2016), 'Textile production', in J. Soles (ed.) *Mochlos Period III: The House of the Metal Merchant and other Houses in the Neopalatial Settlement* (Philadelphia 2018), and 'Neopalatial and Mycenaean Knossos: urban expansion and collapse', in *12th International Congress of Cretan Studies*, (Herakleion 2018) (with T. Whitelaw).

As a scholar, Jo was meticulous, and unique in the

way she brought together theory and practice. She spent years travelling around different sites in the Aegean, recording and analysing archaeological materials, particularly textile tools, spindle whorls and loom weights, as well as pottery. One of her favourite places was Knossos, where she worked each summer between 2005 and 2016. This was a place to which she always returned, both for her own research on weaving tools from many Knossos excavations, and also to contribute to all aspects of the Knossos Urban Landscape Project, where she led field teams and developed her expertise in Neopalatial pottery. Her theoretical framework included both gender studies as well as theories of practice, approaches that she employed in her interpretation of the past. This work is well known. What is less familiar, and yet clearly demonstrates Jo's engagement in her work, is that, in order to understand the production of textiles and textile tools, Jo took classes in weaving as well as pottery. It was Jo's ability to combine these different aspects of textile production that made her research so successful and which led to its recognition through a number of awards: for example, she received the Michael Ventris Award and Samuel H. Kress Travel Awards and her aforementioned research scholarships. Jo also travelled and participated in conferences and workshops, latterly often as an invited speaker. For example, in 2014 she was invited to the Pennsylvania Museum and gave a lecture on *Weaving connections: textiles, networks of knowledge and the Minoanisation of the southern Aegean*. This lecture was sponsored by the INSTAP Study Center for East Crete, the History of Art Department of the University of Pennsylvania, and the Pennsylvania Museum. In September 2016, a session was organised for the European Association of Archaeologists in Vilnius, Lithuania, under the title *Ties that bind. Relationships between the movement of raw materials and the movement of artisanal knowledge across Europe 2000-1500 BC*.

Besides her research, Jo was frequently engaged in teaching at all university levels, giving courses such as *Women in the Ancient World and Textile Archaeology* at both University College London and the University of Cambridge. This was also something Jo enjoyed and, as ever, she spent a lot of time preparing in order to give the students the best possible experience and to share all her love for Aegean archaeology.

From 2009 to 2010, Jo took a break in her doctoral research to become a visiting scholar at the Danish National Research Foundation's Centre for Textile Research, University of Copenhagen. Her main task was to complete work on the project *Tools and Textiles – Texts and Contexts*, interpreting textile production in the Bronze Age Aegean and Ancient Near East. Jo's contribution was essential for the quality of the publication arising from the project. During this time, we worked very closely together; she was always happy to share her knowledge and I learned a lot from her.

However, it was Jo's personality which made her truly unique. She was considerate, always kind and very helpful with everything from proof reading to listening to the concerns of friends and colleagues. Jo was open to new ideas but not always easy to convince if you did not have the right arguments. After the sad news of her death, I received emails and condolences expressing a collective loss. One colleague wrote: "I feel that I lost somebody from my family today. Jo will always be in our hearts, our minds and she will always show us the way for splendid research". Another said "We have lost a lovely person and an outstanding scholar. I fully share your grief". These words fully express my feelings and those all Jo's colleagues and friends.

In order to honour her memory, we at CTR will continue her work and encourage young students to follow in her footsteps. Our thoughts and love go to her family, her sister, Lucy, and mother, Esther.

Eva Andersson Strand and
the Centre for Textile Research team, Copenhagen

Dr Karen Finch OBE 1921-2018

As a representative of the Early Textiles Study Group (ETSG) it is a great privilege to honour Karen Finch in this way. I first met Karen in 1980 when I was a young curator at the Petrie Museum at University College London. I went to a workshop at the Textile Conservation Centre (TCC), chatted with her afterwards, and we immediately set up an arrangement whereby the TCC would conserve the Petrie's Egyptian textiles *gratis*. Things were easier in those days, but it was Karen's vision that ensured it happened so quickly and so smoothly. It was an arrangement which lasted for the next 18 years until I left the museum, and saw the conservation of a range of unique textile treasures including a bead-net dress, a sprang cap, still *in situ* on the head of a female mummy, a rag doll's wardrobe, and an inside-out sock.

Image: Kirstie Buckland
www.knittinghistoryforum.co.uk

Karen was a most loyal supporter of ETSG, and regularly attended and contributed to our bi-annual conferences in Manchester. Hero Granger-Taylor, one of our committee members, remembers that it was her mother – Barbara Granger-Taylor – who, when secretary of the standing committee on Museums and Galleries, was able to help Karen set up the TCC. Hero recalls that Karen had a wonderful understanding of techniques, particularly of what we now call minor techniques. For example, she remembers Karen explaining to her how warp twining was done when the ETSG visited an exhibition at the Museum of Mankind. Karen painstakingly followed this up by sending Hero a photograph of Danish children doing warp twining.

Karen's legacy lives on in the library which she began. Our secretary Susanna Harris is using the TCC library in Glasgow, in her capacity as lecturer in archaeology there. This is what Susanna has to say: "I certainly think of Karen when I go in those stacks. It is not only me using the TCC library but all the archaeology Cloth & Clothing students. It is invaluable to have a library with many fundamental and now rare textile books, journals and leaflets that have been collected over decades. It's not possible to build this from new. It is a wonderful legacy and the archaeology students are benefitting from the TCC collection."

Karen's legacy also lives on in the conservation students – now professional conservators – who she trained over the years. To quote a personal example – a couple of years ago, it was suggested that a large 25 ft tapestry in the Dutch Church in London needed a good clean. My colleagues on the church council would easily have resorted to a vacuum cleaner, but I, of course, told them that it needed highly specialised conservation. The name of Poppy Singer and her colleague Annabel Wylie, two of Karen's 1980s students, immediately sprung to mind. I re-established contact, and thanks to their expertise the tapestry was transported to Belgium for cleaning at the De Wit Royal Manufacturers in Mechelen. It was then returned to Poppy's studio in St Albans for the painstaking hand stitching of its new cotton backing. Both conservators attended our reception to mark the rehanging of the tapestry, and I gained a few Brownie points with my Dutch colleagues on the church council in the process. When I emailed Poppy last week to tell her about Karen, this is what she wrote: "The end of an era! What a woman – she did so much!"

I can do no better than to conclude with the words of another of our ETSG committee members, Ruth Gilbert.: "Having started on textile history later in life and without any formal qualification, Karen was one of the people who took me seriously from the start and encouraged me to carry on. She was always generous with her knowledge and time and she radiated enthusiasm. Karen's smile was hers alone."

Thank you, Karen. You were inspirational, much loved, and will never, ever be forgotten.

Rosalind Janssen

European Textile Forum

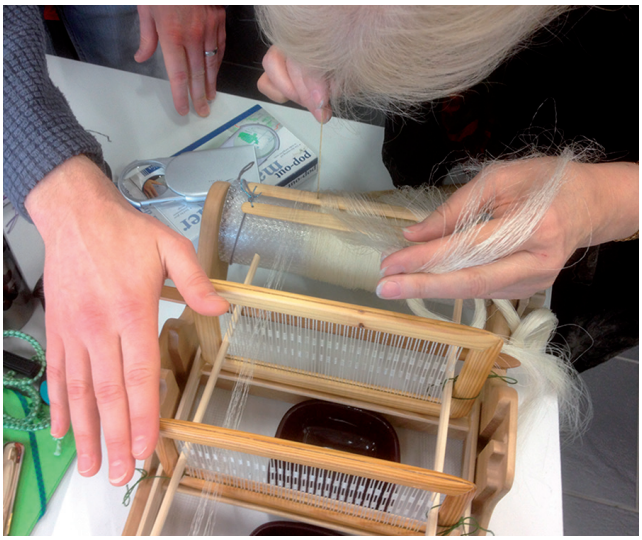
6-12 November 2017, Mayen, Germany

The eighth European Textile Forum (ETF), organised by Katrin Kania and Sabine Ringenberg in 2017, was held at its adopted home of Labor für Experimentelle Archäologie (LEA), a satellite of the Römisch-Germanisches Zentralmuseum at Mainz, at the invitation of Michael Herdick. The ETF is a gathering of academics, professional reenactors, textile specialists and enthusiasts, who, through scholarly presentations, practical experiments and round-table discussions, present new findings and test hypotheses, offering a proving ground between theory and practice. Previous findings have been published through Oxbow in 2013 as *Ancient Textiles Modern Science*. A new set of proceedings is currently being finalised.

The textile forum and the theme were introduced by Katrin Kania. The subject was 'Silk: Subtle and Sumptuous' including the use and meaning of silk to historic contemporaries, its place in the archaeological and historic record, and methods of acquisition and production. Tracy Niepold presented Early Modern silks excavated in Nuremberg, their find context, and posed questions about the production process. Petra Linscheid discussed finds of wild and cultivated silk from Amorium in Turkey. Beatrix Nutz presented Medieval and Early Modern silk textiles discovered in three Tyrolian castles, and discussed their discovery, use, production and trade.

All the practical workshops and experiments began with an introduction to the subject. Tracy Niepold presented finds of slashed silk, their use in contemporary dress, and their production methods. She then led a workshop testing possible methods for recreating the artefacts, and testing the tools and chemical treatments that could have been used. Ruth MacGregor demonstrated the difference in texture between Medieval and modern silks, theorising that this is caused by different degumming processes. She led an experiment to discern the effects of partial and complete degumming of silk threads and to compare these results with medieval finds. Margit Hofmann conducted tests investigating the pH changes when dyeing silk in indigo vats.

Other presentations and experiments involving different materials complemented the theme and gave a diverse overview of textiles from the archaeological record. Harma Piening discussed a mysterious plied shoe found concealed in a building. Through painstaking trials she was able to reconstruct its production method, which had not been apparent initially. Micky Schoelzke showed the partial reconstruction of the belt of Philipp of Swabia, then led a discussion of how to present archaeological artefacts that are challenging to a modern audience. The original 13th century belt contains the swastika symbol which is problematic due to its 20th century associations. Katrin Kania discussed possible methods of developing and recording historic tablet woven patterns without the assistance of modern graph paper or computing, and then held a workshop exploring this in practice.



To complement the forum, there was a day's excursion to the special exhibition *Expedition Mittelalter* held at the Schnütgen-Museum in Cologne. This featured several spectacular silk textiles, including the Anno-Kasel vestment potentially dating from AD 1001, dyed with true purple. Participants enjoyed viewing this in context with other exhibits and the other museum collections.

The most recent ETF was held 5-11 November 2018 at LEA in Mayen. It will be reported here next year. The call for papers for 2019 is in preparation, but the organisers can be contacted with suggestions or questions on: info@textileforum.org. The conference is always held in English. Information is available from a new website: www.textileforum.org/en/.

By Katrin Kania

A World of looms: Weaving technology and textile arts in China and beyond

June-September 2018, Hangzhou, China

The China National Silk Museum in Hangzhou opened the exhibition *A World of Looms: Weaving Technology and Textile Arts in China and Beyond* with an international conference gathering weavers and textile scholars from all over the world for invited research presentations on historical weaving technologies in combination with hands-on workshops in June 2018. The exhibition collected looms from all over the world and from different periods, from South America to Africa, Europe, and India. South-East Asian and Chinese looms were particularly well represented. Visitors had a unique opportunity to observe weavers at work with reconstructed, historical looms as well as many that remain in use today. The conference, lectures, workshops, and demonstrations underscored the continuity of historical weaving technologies as part of the exhibition opening. Wandering through the exhibition hall, however, it was the sheer multiplicity of technological solutions found for uniting warp and weft that made the strongest impression.

Eva Andersson Strand from the Centre for Textile Research in Copenhagen was invited to prepare and present a reconstructed, warp-weighted loom to illustrate early European weaving traditions. Initially, the organisers had in mind a loom reconstructed along northern European lines, based on Hoffmann's documentation of warp-weighted looms in Norway and connected to Andersson Strand's work on textile tools in Viking Age Scandinavia. However, a very different exhibit was created in collaboration with Magdalena Öhrman, whose Marie Skłodowska Curie project TEXREX (Textile Reflections) drew on experimental reconstructions of weaving to examine the soundscape of Roman weaving and its reflection in literary texts.

Striving to reflect work on a typical Roman loom, we sought a representative example of truncated pyramidal loom weights suitable for slightly coarser weaves, as weights of this type are common throughout the Mediterranean and especially widespread in the Roman world. From the carefully catalogued small finds from Insula VI.I in Pompeii, investigated by the Anglo-American project coordinated by the University of Bradford, we selected a weight of 365 g and 4 cm in width, belonging to the cluster of heavier weights discussed by Baxter, Cool & Anderson 2010.

Craftspeople at the Land of Legends (Sagnlandet Lejre) then set to work. Inger Heboll of the pottery workshop recreated 40 weights, ready to be fitted on a new loom, which would match the comparatively slender loom frames seen in Mediterranean iconography of the warp-weighted loom. The loom frame was made by Jens Barnkob, while Ida Demant at Draektvaerkstaden (the clothing workshop) prepared a warp 80 cm in width with Icelandic single-spun wool. The aim was to produce a fabric similar to a rough tunic weave, documenting the soundscape of weaving, and to offer a loom with a period-appropriate set-up already underway for the exhibition in China. As the weave grew, the sounds and rhythms of the weaver's work were documented for use in Öhrman's project, while students from the *Hands-On Approaches to Textile Archaeology* course led by Andersson Strand at the University of Copenhagen also visited the workshop.

Once on site at the National Silk Museum, the atmosphere created by weavers and textile experts assembling and setting up looms from all over the world was amazing. Different warping techniques could be observed in situ. By wandering through the exhibition rooms, participants (craftspeople and researchers alike) could study looms from different geographical regions and with different technological advantages such as the Indian Jaala loom, the Iranian zilu loom, and the Lao loom with vertical pattern heddles and compare their features in action. Many new perspectives on technical features were revealed in this context. A series of invited lectures by scholars such as Chistopher Buckley, Gillian Vogelsang-Eastwood, and Yoshimoto Shinobu added further depth to this juxtaposition of weaving techniques and tools; recordings of these lectures are now available via the Friends of China National Silk Museum YouTube channel. Over the course of this five-day conference, further workshops and hands-on practice gave scholars, craftspeople, and museum volunteers a unique opportunity to engage with each other. Aiming to preserve this remarkable, dynamic engagement between weavers, researchers, and visitors, museum volunteers were tutored by the invited weavers to ensure the museum continued the practical weaving demonstrations during the remainder of the exhibition. The warp-weighted loom, made in Denmark but shaped both by Graeco-Roman and Scandinavian archaeological finds and research, fitted perfectly into this international and interdisciplinary event.

The TEXREX: Textile Reflections project received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 701557.

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by Magdalena Öhrman

Textiles and Gender: Production to wardrobe from the Orient to the Mediterranean in Antiquity

3-6 October 2018, Nanterre, France

In October 2018, the three-day conference *Textiles and Gender. Production to Wardrobe from the Orient to the Mediterranean in Antiquity* was held at the Université Paris-Quest Nanterre La Défence. The conference was organised by Cécile Michel of the National Centre for Scientific Research (CNRS), Maison Archéologie et Ethnologie René-Ginouvès, France, Mary Harlow of the University of Leicester, UK, and Louise Quillien, secretary, Université Paris 1–Panthéon-Sorbonne, as the concluding meeting of the GDRI (Groupements de Recherche Internationaux) ATOM project (*Ancient Textiles from the Orient to the Mediterranean*). This multidisciplinary project, hosted by the CNRS, ArScAn – Histoire et Archéologie de l'Orient Cunéiforme, Maison Archéologie et Ethnologie René-Ginouvès (France), University of Leicester (UK) and the Centre for Textile Research (Denmark) aimed at examining the impact of textile production on economics, and the uses of textiles in the construction of gender and identity in antiquity.

The main focus of the *Textiles and Gender* conference was to investigate various modes of gendered division of textile labour, as well as the gendered attitudes to dress and clothing in a broad geo-chronological framework. The papers covered a vast geographical area from the Near East and Egypt to the Mediterranean, and a long timespan from c.3000 BCE to 300 CE. The presenters of 22 invited contributions were warmly hosted by the organisers in Nanterre and, for social events, in Paris.

In the opening address, Cécile Michel and Mary Harlow outlined the main activities and research results of the GDRI ATOM project. The conference papers were grouped in four sessions: "Gender and textile production" (4 October), "Gendered garments and accessories in the Ancient Near East" (4 & 5 October), "Garments for gods and goddesses, garments of the dead and of statues" (5 October) and "Gendered garments in the Greco-Roman world" (6 October).

The first session opened with the paper *Towards engendering textile production in Middle Bronze Age Crete* by Agata Ulanowska, who discussed the iconography and function of three-sided prismatic seals from Crete relevant to textile production and the social and gender identity of bearers of these prismatic seals and, possibly, textile producers. Hedvig Landenius Enegren examined the complexity of administrative practices documented in Knossian Linear B archives, focusing on a selected number of individual textile workers recorded on tablets, in her paper *Women, men, girls and boys – engendered textile work at Late Bronze Age Knossos*. She discussed their particular responsibilities and tasks, as well as their age, gender and social status. In the paper *A man's business? Washing the clothes in Ancient Egypt (second and first millennium BC)*, Damien Agut presented the pitiful life of an Egyptian laundry man and his daily chores, and discussed whether garment laundry businesses in Ancient Egypt were exclusively run by men. Beate Wagner-Hasel, in her paper *Female dues and the production of textiles in ancient Greece* focused on female textile producers whose work, although economically important and socially visible, is seldom recorded by the ancient Greek sources. In the paper *Women's work: the gendered practice, behaviours and identities of textile manufacture in ancient Greek and Italic communities,* Lin Foxhall contextualised the ontological association between textile manufacture and women in Greek and Italic societies before the fourth century BCE, as part of the construction of femininities and the key element of women's identities in both regions. Magdalena Öhrman, in her paper *Work gendering space? Roman*

gender, textile work, and time in shared domestic spaces examined Roman domestic textile work and its spatial and temporal setting, focusing on its display of feminine virtues and its impact on male understanding of textile work. She also pointed to the potential sexual attraction of textile activities such as spinning. In the paper *Textiles, femininity and masculinity in Roman society*, Lena Larsson Lovén discussed the epigraphic evidence for male and female textile work and labour forces in relation to a traditional view of textile production organised in a domestic setting by women in a household. She considered economic and social changes in Roman society between 200 BCE and 100 CE. In the last paper of this session, *The sense of weaving, cloth, garments and gender in the Central Andes*, Sophie Desrosiers discussed the complexity of the gendered division of textile labour in the Central Andes, and the gendered construction of garments where vertical and horizontal weave structures resulted in very different appearances in male and female clothing.

The next session "Gendered garments and accessories in the Ancient Near East" started with the paper by Barbara Couturaud: *Looking for women. A visual investigation on feminine garments in ancient Mesopotamia during the Early Bronze Age*. This paper, read by Mary Harlow, discussed the iconography of gender in small size representations of males and, especially, females on shell inlays from Mesopotamia. Louise Quillien, in her paper *The gender of garments in first millennium BC Babylonia, an inquiry through texts and iconography* investigated how and when non-gendered fabrics, described by generic terms reflecting their size, shape and material, became gendered attires of females and males. The basis for the discussion comprised evidence from Babylonian texts and iconographic depictions. In the paper *The gender of clothes in the Late Bronze Age*, co-authored by Brigitte Lion and Philippe Abrahami, the middle Babylonian texts enumerating lists of clothes offered on various occasions, were analysed with the aim of associating certain fabrics, garments and accessories with male or female recipients. Valérie Matoïan and Juan Pablo Vita in the paper *Textiles and gender in Ugarit* presented an overview of gendered patterns of burial offerings and various textual and iconographic sources in search of possible links between textiles, textile production and gender in the Ugaritic society. In the last paper of the session, *Belts and pins as gendered elements of clothing in third and second millennia Mesopotamia*, Cécile Michel examined the abundant evidence of textile terminology in Cuneiform texts and gendered iconography of textiles and cloths. She discussed how the observed use of specific textiles and accessories, such as headscarfs and pins for women and belts for men, could have expressed the gender of their wearers.

Maria Giovanna Biga was the first speaker of the next session entitled "Garments for gods and goddesses, garments of the dead and of statues". In the paper *Textiles and gender in the Syrian society of the third millennium BC according to Ebla texts*, she discussed the collection of more than 600 tablets from the Eblaic archives that refer to textiles. This collection, dated to a relatively short period of 40 to 45 years, permits the gendered distribution of textiles between the court, members of the royal family and deities to be tracked. Anne-Caroline Rendu Loisel in her paper *I made you put on garments, I made you dress in linen: Goddesses, gods and garments in Sumerian literature* investigated the symbolic meaning of textiles and clothes in the Sumerian mythology. She discussed how specific clothes may have enhanced divine powers and formed gendered divinities, while the lack or loss of clothes could remove divine powers. Francis Joannès in the paper *The goddess Nanaia's new clothes* discussed the religious role of garments made for her statues Uruk and Borsippa in the Neo-Babylonian period, and specific problems that may have appeared when the garments were transferred between these two locations.

The role of colour in male and female clothing in the Greco-Roman and Roman world was discussed in the last two papers of this session: *Gender, dress and colour: female garments in ancient Greco-Roman art* by Cecilie Brøns presented how the modern and non-invasive methods of analysis of ancient sculptures, such as UV fluorescence or induced luminescence, reveal the original colours of male and female garments; and Mary Harlow presented *White man and rainbow women: gendered colour coding in Roman dress*. She discussed the iconographic and textual evidence in order to demonstrate a variety of colours and dynamics of gendered colour coding in male and female garments in Roman society.

The last session of the conference comprised four contributions and concluding remarks. Catherine Breniquet presented the paper *Garments for potters? Textiles, gender and funerary practices at Les Martres-de-Veyre, France (Roman period)* which was co-authored with Marie Bèche-Wittmann, Christine Bouilloc and Camille Gaumat. By discussing gender aspects of clothing which were well preserved in the Gallo-Roman graves at Les Martres-de-Veyre she reported the first results of a new project ArchéoMartre which investigates this old collection with new methods and approaches. Nikki K. Rollason in her paper *Climate change and male clothing in the Later Roman Empire* analysed changes in Late Antique dress and the process

by which barbarian attire, seen by ancient authors as a sign of effeminacy and "otherness", became the dress of the elite Roman men. The climatic changes observed between the third and sixth centuries CE are considered an important factor influencing this change.
In the last paper of this session *Female "Fashion" in the early North African Church*, Amy Place discussed the concept of fashion in relation to Christian female dress and actual clothing, and clothing practices considered appropriate for Christian women of moral virtue by the early Patristic writings.
In the concluding remarks, Eva Andersson Strand presented a short overview of all the papers delivered during the conference, highlighting the observations that appeared in various papers dealing with evidence from distant cultures and periods. These included the need to contextualise the evidence for textile production and textile labour and the wide use of a veil or headscarf in women's dress and a belt in men's dress as clearly gendered accessories.
This inspiring conference was well organised with time scheduled for specific questions and general discussions. A monograph is planned to publish the proceedings.

By Agata Ulanowska

Exploring textiles and textile working from Prehistory to AD 500

29 October 2018, University of Liverpool, United Kingdom

This one-day conference was organised by Alistair Dickey, Gabriella Longhitano, and Sarah Hitchens, who are together leading a stimulating doctoral team of textile researchers at the University of Liverpool. Focused on current research in textile studies, the conference offered a welcome platform to new researchers in this field. Recent postgraduates and more seasoned scholars presented their ongoing work on newly excavated material and highlighted the potential of applying new analytical methods to older collections. The lively scene of textile research in the United Kingdom was particularly emphasised by the presence of many PhD candidates, who took the audience on an exploration of the many different spheres of textile production and use from Prehistory to Late Antiquity.
Many papers confirmed the great advantage of studying textile implements to understand past production models. In particular, new results are coming from the greater Italian area. Katarzyna Żebrowska is conducting a re-examination of Bronze Age tools found on Lipari, using experimental archaeology to conduct spinning tests to determine the tools' function. Critically assessing the advantages and limitations of this method, she managed to evaluate the practical results of a wide range of spindle whorl weights (c. 50 g to 200 g), leading to an appraisal of spinning techniques in Bronze Age Sicily. Gabriella Longhitano reinterpreted the deposit of loom weights found in a Bronze Age sacral pit, the so-called "Bothros of Aeolus", on Lipari Island. She used weight analysis to propose a distinction between votive and functional objects, while insisting on the important role of textile production and implements in a sacred context. On the basis of the Open Access Poggio Civitate Excavation archive, Sarah Reetz brought its large corpus of spindle whorls into a new light, emphasising the high symbolic value of this tool within Etruscan communities. The exploration of textile production in Italy was completed by Francesco Meo, who delivered a very comprehensive paper on the production, organisation and consumption of textiles in Magna Graecia during the first millennium BCE. Merging data acquired from vast corpuses of tools with new analyses of textile fragments and imprints, he traced the outlines of the different types of textile manufacture in the region, their relationship to Greek products, and the economic importance of textile production in southern Italy.
Our discussion on textile tools also covered the British Isles, and revealed the need for a methodological reappraisal of textile implements in the archaeological documentation. Lisa Venables presented the potential of Big Data to reassess our understanding of textile production in rural settlements of Roman Britain. She underlined the absolute necessity for a better representation of textile tools in archaeological reports and a standardisation of their description. Jennifer

Beamer also contributed to the interrogation of databases, as she walked us through the creation of new rubrics able to document an often-forgotten weaving tool, the long-handled comb used in Iron Age Britain. Finally, Lewis Ferrero reported on new data from Iron Age Cornwall, using tool dimensions and weights to characterise and compare textile production and craft organisation between sites.

A running thread through many of these papers was the method developed by researchers at the Centre for Textile Research, University of Copenhagen (Mårtensson, Nosch & Andersson Strand 2009; Olofsson, Andersson Strand & Nosh 2015) to extract as much information as possible from textile tools, namely spindle whorls and loom weights. Despite its obvious advantages in revealing previously unavailable data on textile production, the method was initially designed based on Scandinavian material and further developed on Aegean and eastern Mediterranean material from the Bronze Age. It would therefore be usefully completed by new sets of experiments taking into account the specifics of each chrono-geographical areas and the textile dataset under study by each researcher.

Prehistoric textiles were also in focus during the conference, illustrated by two unique and little-known bodies of material. Camila Alday showed the very beginnings of textile production along the Pacific coast of Peru, and the plant fibre artefacts manufactured by its marine hunter-gatherer populations. She contextualised this material within an innovative theoretical framework, which sees fibre preparation as people dancing through the landscape. Alistair Dickey then presented his preliminary observations on the Predynastic textile fragments discovered in the elite cemeteries of the Egyptian city of Hierakonpolis. This material will offer new insights in the early textile production along the Nile Valley, a neglected but essential aspect of the prehistoric economy of Egypt.

Two other papers explored the social importance of dress practices in Antiquity. Guilia Muti used a corpus of female "plank" figurines to define fashion in Early and Middle Bronze Age Cyprus. She decoded the iconographic representation of clothing and adornment items, while trying to assess concepts of self-representation and body perception. Then, Natasha Andronikou tracked the evolution of clothing practices in the images of prostitutes in Classical Attic art, mainly pottery. She showed how nudity and several "ethnic" garments were used at different times to portray prostitutes and convey their otherness in Greek society.

A lively discussion was also started between participants around three posters illustrating the multi-disciplinarity of textile research: the archaeology of textile production in the Sudanese kingdom of Meroe (Elsa Yvanez), experimental archaeology on Bronze Age braiding techniques from the United Kingdom (Celia Elliott-Minty), and new scientific imaging methods to identify red dyes and pigments on Pharaonic mummy bandages (Joanne Dyer).

The conference was concluded by a keynote lecture by Margarita Gleba, who highlighted the many new advances of the past few years in textile research. Stimulated by a rich and diverse interdisciplinary approach, new studies on ancient textiles and textile production are increasingly synthesising new knowledge about the culture, society, technology, and economy of past communities.

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Olofsson, L., Andersson Strand, E. & Nosch, M.-L. (2015) Experimental testing of Bronze Age textile tools. E. Andersson Strand & M.-L. Nosch (eds), *Tools, Textiles and Contexts: Investigating Textile Production in the Aegean and Eastern Mediterranean Bronze Age*. Oxford: Oxbow, 75-100.

By Elsa Yvanez

Recent publications

***Archaeological Textiles — Links Between Past and Present: NESAT XIII* (2017) edited by Milena Bravermanová, Helena Březinová and Jane Malcolm-Davies. Praha: Akademie věd České republiky. Archeologický ústav**

Publication of the Proceedings of the North European Symposium on Archaeological Textiles XIII, held in Liberec and Prague, Czech Republic 23 to 26 May 2017. The three-day conference in the setting at the Technical University of Liberec included 45 lectures and 20 poster presentations. The programme was divided into 12 sections: 1) Prehistory and protohistory; 2) Protohistory; 3) Overviews; 4) Analyses; 5-6) Early Middle Ages; 7) Middle Ages; 8) Dyeing; 9) Modern era; 10-11) Experimental Archaeology and textile tools; 12) Garments. The individual lectures covered a broad spectrum of subjects and methods related to textile production in the past, and both new finds and current analyses of earlier artefacts were presented.

ISBN: 9788075810038

www.alescenek.cz/zbozi/116734/archaeological-textiles-links-between-past-and-present/

***Arabic Script on Christian Kings: Textile Inscriptions on Royal Garments from Norman Sicily*. Das Mittelalter. Perspektiven Mediavistischer Forschung. Beihefte 5 (2017) by Isabelle Dolezalek. Walter de Gruyter**

Roger II's famous mantle and other royal garments from 12th and 13th century Sicily prominently display Arabic inscriptions. While the phenomenon is highly unusual in the context of Latin Christian kingship, the use of inscriptions as a textile ornament was common and imbued with political functions in the Islamic courts of the medieval Mediterranean. This case study of the inscribed garments from Norman Sicily draws attention to the diverse functions of Arabic textile inscriptions using various contextual frames. Such a contextual approach not only highlights the specificities of the Norman textile inscriptions and emphasises the practical and political choices underlying their use at the Sicilian court, it also pinpoints the flaws of universalising approaches to transcultural ornament in circulation in the medieval Mediterranean. This new perspective on the royal garments from Norman Sicily draws from a variety of disciplines, including Islamic and European art history, the history of textiles, epigraphy, legal history and historiography, and aims to challenge established notions of cultural and disciplinary boundaries.

ISBN: 9783110532029

Price: £82.00

www.oxbowbooks.com/oxbow/arabic-script-on-christian-kings-textile-inscriptions-on-royal-garments-from-norman-sicily.html

***Climate, Clothing, and Agriculture in Prehistory: Linking Evidence, Causes, and Effects* (2018) by Ian Gilligan. Cambridge: Cambridge University Press**

Clothing was crucial in human evolution, and having to cope with climate change was as true in prehistory as it is today. In *Climate, Clothing, and Agriculture in Prehistory*, Ian Gilligan offers the first complete account of the development of clothing as a response to cold exposure during the ice ages. He explores how and when clothes were invented, noting that the thermal motive alone is tenable in view of the naked condition of humans. His account shows that there is considerably more archaeological evidence for palaeolithic clothes than is generally appreciated. Moreover, Gilligan posits, clothing played a leading role in major technological innovations. He demonstrates that fibre production and the advent of woven fabrics, developed in response to global warming, were pivotal to the origins of agriculture. Drawing together evidence from many disciplines, *Climate Clothing, and Agriculture in Prehistory* is written in a clear and engaging style, and is illustrated with nearly 100 images.

ISBN-10: 1108455190

ISBN-13: 978-1108455190

www.cambridge.org/core/books/climate-clothing-and-agriculture-in-prehistory

***Creativity in the Bronze Age: Understanding Innovation in Pottery, Textile, and Metalwork Production* (2018) by Lise Bender Jorgensen, Joanna Sofaer and Marie Louise Stig Sorensen. Cambridge: Cambridge University Press**

Creativity is an integral part of human history, yet most studies focus on the modern era, leaving unresolved questions about the formative role that creativity has played in the past. This book explores the fundamental nature of creativity in the European Bronze Age. Considering developments in crafts that we take for granted today, such as pottery, textiles, and metalwork, the volume compares and contrasts various aspects of their development, from the construction of the materials themselves, through the production processes, to the design and effects deployed in finished objects. It explores how creativity is closely related to changes in material culture, how it directs responses to the new and unfamiliar, and how it has resulted in changes to familiar things and practices. Written by an international team of scholars, the case studies in this volume consider wider issues and provide detailed insights into creative solutions found in specific objects.

ISBN: 9781108421362

Price: £75.00

www.oxbowbooks.com/oxbow/creativity-in-the-bronze-age-understanding-innovation-in-pottery-textile-and-metalwork-production.html

***Excavating, Analysing, Reconstructing. Textiles of the First Millennium AD from Egypt and Neighbouring Countries* (2018) by Antoine de Moor. Lanoo: ACC Publishing Group**

A richly illustrated overview of textile art of the Nile Valley from the first millennium AD. A richly illustrated overview of the current-day knowledge on the textile art of the Nile Valley from the first millennium AD, in response to the ninth conference on "Textiles from the Nile Valley" in Antwerp on 27-29 October, 2017. This is one of only a handful of books devoted to the textile art of the Late-Roman, Early-Byzantine and Early-Islamic textile art in Egypt. Over 20 essays by specialists elaborate on the pieces of textile art that were found in excavations and museums and discuss the radiocarbon dating, iconography and weaving techniques around the extraordinary clothing.

ISBN-10: 9401443998

ISBN-13: 978-9401443999

Price: €115,29

www.blackwells.co.uk/bookshop/product/Excavating-Analysing-Reconstructing-by-Antoine-De-Moor-editor-Cecilia-Fluck-Petra-Linscheid/9789401443999

***Gods in Color: Polychromy in the Ancient* World (2017) by Vinzenz Brinkmann, Renee Dreyfus and Ulrike Koch-Brinkmann. Prestel**

This stunning book uses 21st-century technology to reveal the original colours of ancient sculpture. When Renaissance artists sought to imitate ancient sculpture, their medium of choice was pure, white marble, but little did they know that the works they emulated were originally painted in dazzling and powerful hues—from red ochre and cinnabar to azurite and malachite.

By illustrating painted reconstructions of well-known sculptures in relation to original examples, this volume reveals how ancient artists in Egypt, Mesopotamia, the Aegean, Greece, and Rome brought unexpected and breathtaking colour to their artworks. Accompanying these reproductions are watercolors of Greece's landscapes dating from different years, which show how our perception of ancient art has changed over time. Generously illustrated, this book testifies that the study of ancient sculpture is incomplete without an understanding of the many ways that colour was employed to bring such art to life.

ISBN-10: 9783791357072

ISBN-13: 978-3791357072

ASIN: 3791357077

Price: US$25.94

www.amazon.com/Gods-Color-Polychromy-Ancient-World/dp

***Medieval Clothing and Textiles 14* (2018) edited by Robin Netherton and Gale R. Owen-Crocker. Boydell Press**

The essays here continue in the journal's tradition of drawing on a range of disciplines. Topics include evidence for dress in multicultural sixth-century Ravenna; the incidence of Byzantine and Oriental silks in ninth to 13th century Denmark; a new analysis of the chronology of and contexts for the French hood; an examination of the mysterious garment called a *bliaut* in French literature; a discussion of the vocabulary and loan words in Italian/Anglo-Norman mercantile transactions; and revelations that fashions in body hair were an important feature of women's appearance.

Multicultural Clothing in Sixth-Century Ravenna - Olga Magoula. Byzantine and Oriental Silks in Denmark, 800-1200 - Anne Hedeager Krag. The Bliaut: An Examination of the Evidence in French Literary Sources - Monica L. Wright. Eyebrows, Hairlines, and "Hairs Less in Sight": Female Depilation in Late Medieval Europe - John Block Friedman. Lexical Exchange with Italian in the Textile and Wool Trades in the 13th to 15th Centuries - Megan Tiddeman. Hidden in Plain Black: The Secrets of the French Hood - Karen Margrethe Høskuldsson.
ISBN: 9781783273089
Price: £40.00
www.boydellandbrewer.com/medieval-clothing-and-textiles-14-hb.html

***Silk: Trade and Exchange along the Silk Roads between Rome and China in Antiquity.* Ancient Textiles Series 29 (2017) edited by Berit Hildebrandt. Oxford, Oxbow Books**
Already in Greek and Roman antiquity a vibrant series of exchange relationships existed between the Mediterranean regions and China, including the Indian subcontinent, along well-defined routes we call the Silk Roads. Among the many goods that found their way from east to west and vice versa were glass, wine spices, metals and precious stones as well as textile raw materials and fabrics of wool and silk, a precious fibre that was highly appreciated in many of the cultures along the roads that were named after it by modern scholars.
These collected papers bring together current historical, philological and archaeological research from different areas and disciplines in order highlight the use, circulation and meaning of silk as a commodity, gift, tribute , booty, and status symbol in varying cultural and chronological contexts between east and west, including technological aspects of silk production. Rome and China in antiquity provide the geographical and chronological frame for this volume (from about after the third century BCE to the fifth century CE), but also earlier and later epochs and cultures in between these empires are considered in order to build an intercultural and diachronic understanding of long-distance relations that involved silk.
ISBN: 9781785702792
Price: £40.00
www.oxbowbooks.com/oxbow/silk-trade-and-exchange.html

***Spätantike und Byzanz. Bestandskatalog Badisches Landesmuseum Karlsruhe Textilien.* Reihe: Römisch-Germanisches Zentralmuseum 8 (2017) by Petra Linscheid. Schnell & Steiner**
Die umfangreichste Gattung unter den byzantinischen Altertümern des Badischen Landesmuseums Karlsruhe stellen Textilfunde aus dem frühbyzantinischen Ägypten.
Insgesamt 207 Objekte, darunter Tuniken, Kopfbedeckungen, Polsterstoffe, Decken und Vorhänge, vermitteln einen lebendigen Eindruck vom Aussehen frühbyzantinischer Kleidung und textiler Raumausstattung. In einem ausführlichen Katalogteil und einleitenden Kapiteln finden besonders die Herstellungstechnik und die Funktionsbestimmung der Textilien Beachtung. Mit wenigen Ausnahmen waren die Objekte bisher unveröffentlicht.
ISBN: 78-3-7954-3280-5
Price: €45,00
www.schnell-und-steiner.de/artikel_9182.ahtml

***Tel Anafa II, iii: Decorative Wall Plaster, Objects of Personal Adornment and Glass Counters, Tools for Textile Manufacture and Miscellaneous Bone Artefacts* (2018), edited by Andrea M. Berlin and Sharon C. Herbert. Ann Arbor, MI: Kelsey Museum of Archaeology**
This book is the last volume of final reports on the excavations at Tel Anafa by the University of Missouri and the University of Michigan between 1968 and 1986. Tel Anafa is at the foot of the Golan Heights in Upper Galilee in modern Israel. Includes studies of several categories of finds from the excavations: pottery of the Bronze and Iron Ages, imported Attic pottery, medieval pottery, jewellery, equipment related to textile manufacture, figurines, and the stucco wall decoration that inspired the name of the site's main structure: the Late Hellenistic Stuccoed Building (LHSB). The variety of the finds, coupled with the clear chronological context and careful recording techniques employed by the excavators, have made Tel Anafa extremely valuable to all those interested in the Hellenistic world, providing a rare opportunity to study Greek culture in direct contact with Phoenician. Indeed, for many bodies of Hellenistic material, Tel Anafa serves as a typological and chronological "type site," presenting a broader and more closely dated range of material than ever before possible.
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***Textiles and Cult in the Ancient Mediterranean.* Ancient Textiles Series 31 (2017) edited by Cecilie Brøns and Marie-Louise Nosch. Oxford, Oxbow Books**

Twenty-four experts from the fields of Ancient History, Semitic philology, Assyriology, Classical Archaeology, and Classical Philology come together in this volume to explore the role of textiles in ancient religion in Greece, Italy, The Levant and the Near East. Recent scholarship has illustrated how textiles played a large and very important role in the ancient Mediterranean sanctuaries. In Greece, the so-called temple inventories testify to the use of textiles as votive offerings, in particular to female divinities. Furthermore, in several cults, textiles were used to dress the images of different deities. Textiles played an important role in the dress of priests and priestesses, who often wore specific garments designated by particular colours. Clothing regulations in order to enter or participate in certain rituals from several Greek sanctuaries also testify to the importance of dress of ordinary visitors.

Textiles were used for the furnishings of the temples, for example in the form of curtains, draperies, wall-hangings, sun-shields, and carpets. This illustrates how the sanctuaries were potential major consumers of textiles; nevertheless, this particular topic has so far not received much attention in modern scholarship. Furthermore, our knowledge of where the textiles consumed in the sanctuaries came from, where they were produced, and by whom is extremely limited. *Textiles and Cult in the Ancient Mediterranean* examines the topics of textile production in sanctuaries, the use of textiles as votive offerings and ritual dress using epigraphy, literary sources, iconography and the archaeological material itself.
ISBN: 9781785706721
Price: £48.00
www.oxbowbooks.com/oxbow/textiles-and-cult-in-the-ancient-mediterranean.html

***Textiles in the Neo-assyrian Empire: A Study on Textile Terminology in Assyrian Texts* (Studies in Ancient Near Eastern Records) (2018) by Salvatore Gaspa. Walter de Gruyter**

This book brings together our present-day knowledge about textile terminology in the Akkadian language of the first-millennium BC. In fact, the progress in the study of the Assyrian dialect and its grammar and lexicon has shown the increasing importance of studying the language as well as cataloging and analysing the terminology of material culture in the documentation of the first world empire. The book analyses the terms for raw materials, textile procedures, and textile end products consumed in first-millennium BC Assyria.

In addition, a new edition of a number of written records from Neo-Assyrian administrative archives completes the work. The book also contains a number of tables, a glossary with all the discussed terms, and a catalogue of illustrations. In light of the recent development of textile research in ancient languages, the book is aimed at providing scholars of Ancient Near Eastern studies and ancient textile studies with a comprehensive work on the Assyrian textiles.
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Price: £119.95
www.oxbowbooks.com/oxbow/textiles-in-the-neo-assyrian-empire-a-study-on-textile-terminology-in-assyrian-texts-studies-in-ancient-near-eastern-records.html

The Medieval Clothier (Working in the Middle Ages) (2018) by John S. Lee. Boydell & Brewer Ltd.

Cloth-making became England's leading industry in the late Middle Ages; clothiers co-ordinated its different stages, in some cases carrying out the processes themselves, and found markets for their finished cloth, selling to merchants, drapers and other traders. While many clothiers were of only modest status or "jacks of all trades", a handful of individuals amassed huge fortunes through the trade, becoming the multi-millionaires of their day.

This book offers the first recent survey of this hugely

important and significant trade and its practitioners, examining the whole range of clothiers across different areas of England, and exploring their impact within the industry and in their wider communities. Alongside the mechanics of the trade, it considers clothiers as entrepreneurs and early capitalists, employing workers and even establishing early factories; it also looks at their family backgrounds and their roles as patrons of church rebuilding and charitable activities. It is completed with extracts from clothiers' wills and a gazetteer of places to visit, making the book invaluable to academics, students, and local historians alike.
ISBN-10: 1783273178
ISBN-13: 978-1783273171
Price: £ 25.00
www.boydellandbrewer.com/the-medieval-clothier.html

***Threads of Global Desire: Silk in the Pre-Modern World. Pasold Studies in Textile, Dress and Fashion History* (2018) edited by Dagmar Schafer, Giorgio Riello and Luca Mola**

The silk industry was one of the most important fields of production in the medieval and early modern world. For several centuries, silk fabrics were globally identified as luxury goods. Silk cloth was an important medium for the transmission of design and a taste for luxuries, and silk textiles were part of gifting practices in diplomatic and private contexts. Silk manufacturing also fostered the circulation of skilled craftsmen, connecting different centres and regions across continents and linking the countryside to urban production. The production and consumption of silks spread from China to Japan and Korea and travelled westward as far as India, Persia, and the Byzantine Empire, Europe, Africa, and the Americas. In this process of diffusion, silk fostered technological innovation and allowed new forms of organisation of labour to emerge. Its consumption constantly reshaped social hierarchies, gender roles, aesthetic and visual cultures, and rituals and representations of power. This book examines the integration of silk production and consumption into various cultures and its relation to everyday and regulatory practices. It considers silk as a major force of cross-cultural interaction through technological exchange and trade.
ISBN: 9781783272938
Price: £60.00
www.oxbowbooks.com/oxbow/threads-of-global-desire-silk-in-the-pre-modern-world.html

***Vetus textrinum. Textiles in the ancient world. Studies in honour of Carmen Alfaro Giner.* Colleccio Instrumenta 59 (2018), edited by Manel García** Sánchez **and Margarita Gleba. Barcelona Universitat de Barcelona Editions**

Vetus textrinum. Textiles in the Ancient World. Studies in honour of Carmen Alfaro Giner reúne un conjunto de trabajos internacionales e interdisciplinares sobre el tejido en la antigüedad, tanto desde el punto de vista técnico del trabajo textil como de su significado simbólico, identitario o cultural, aportando no solo información sobre la tecnología, la conservación museística y la economía antiguas, sino también sobre el simbolismo social y religioso de la vestimenta antigua. El homenaje a la profesora Carmen Alfaro Giner incluye contribuciones sobre el próximo oriente antiguo, desde Mesopotamia a la Persia aqueménida; sobre Egipto, desde la época faraónica a la época bizantina; sobre el Egeo, desde la época minoica a la época helenística; sobre la Italia perromana, el mundo romano y la producción de púrpura; o sobre la protohistoria de la Europa continental o la producción fenopúnica.

Todos los participantes en este homenaje reflexionan sobren el vestido, el género, el color, la conservación, el simbolismo, la economía o muchísimos otros de los aspectos del tejido en la antigüedad, desde la historia, la arqueología, la filología y todas las otras ciencias de la antigüedad, a partir de las fuentes literarias, epigráficas o papirológicas, o el estudio de las fusayolas, el uso de las pinzas de precisión o del microscopio.
ISBN: 978-84-9168-081-9
Price: €36
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PhDs

Charlotte Rimstad was awarded a PhD by the SAXO-Institute, University of Copenhagen, Denmark, for her dissertation "Dragtfortællinger fra voldgraven. Klædedragten i 1600-tallets København, baseret på arkæologiske tekstilfund fra Københavns Rådhusplads" ("Clothing Tales from the Moat. The Clothes of 17th Century Copenhagen, based on archaeological textile fragments from Copenhagen City Hall Square").

General Information

Guidelines to Authors

The *Archaeological Textiles Review* aims to provide a source of information relating to all aspects of archaeological textiles. Archaeological textiles from both prehistoric and historic periods and from all parts of the world are covered in the ATR's range of interests.

1. Contributions can be in English.

2. Contributions may include accounts of work in progress. This general category includes research/ activities related to archaeological textiles from recent excavations or in museums/galleries. Projects may encompass technology and analysis, experimental archaeology, documentation, exhibition, conservation and storage. These contributions can be in the form of notes or longer feature articles.

3. Contributions may include announcements and reviews of exhibitions, seminars, conferences, special courses and lectures, information relating to current projects and any queries concerning the study of archaeological textiles. Bibliographical information on new books is particularly welcome.

4. Authors' guidelines can be found at www.atnfriends.com

5. All submissions are to be made in electronic text file format (preferably Microsoft Word) and are to be sent electronically.

6. Illustrations should be electronic (digital images or scanned copies at 600 dpi resolution or higher). Preferred format is TIFF (maximum size is 17.4 x 21.6 cm). Illustrations should be sent as separate files and not imbedded in text. Colour images are welcome.

7. All contributions are peer-reviewed by invited specialists.

8. The editors reserve the right to suggest alterations in the wording of manuscripts sent for publication.

Please submit contributions by post to:
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