



Nettle as a distinct Bronze Age textile plant

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SUBJECT AREAS:
ARCHAEOLOGY
CULTURAL EVOLUTION
GEOLOGY
MICROSCOPY

Received
15 August 2012

Accepted
29 August 2012

Published
28 September 2012

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It is generally assumed that the production of plant fibre textiles in ancient Europe, especially woven textiles for clothing, was closely linked to the development of agriculture through the use of cultivated textile plants (flax, hemp). Here we present a new investigation of the 2800 year old Lusehøj Bronze Age Textile from Voldtofte, Denmark, which challenges this assumption. We show that the textile is made of imported nettle, most probably from the Kärnten-Steiermark region, an area which at the time had an otherwise established flax production. Our results thus suggest that the production of woven plant fibre textiles in Bronze Age Europe was based not only on cultivated textile plants but also on the targeted exploitation of wild plants. The Lusehøj find points to a hitherto unrecognized role of nettle as an important textile plant and suggests the need for a re-evaluation of textile production resource management in prehistoric Europe.

Textiles in all forms are an essential part of human civilization. The earliest textiles known from an archaeological context in Europe are made of wild plant fibres^{1–6}. However, it is generally assumed that the development of plant fibre textile production, especially woven textiles for clothing, was closely linked to the development of agriculture through the use of cultivated textile plants (primarily flax and hemp)¹ and hence that the use of wild plants in the production of woven textiles ceased to be important as agricultural plant fibre production became established, just as it is generally accepted that sheep breeding impacted directly on the exploitation of wool fibres in prehistoric societies. Here, we present results, which suggest that the production of woven plant fibre textiles in Bronze Age Europe, a society with an established agricultural character, was based not only on the use of cultivated textile plants but also on the targeted exploitation of wild plants. Specifically, we show that the 2800-year-old Bronze Age textile found in the Lusehøj burial mound in Voldtofte, one of the richest Bronze Age grave finds in Denmark, is made of imported nettle, most probably from the Kärnten-Steiermark region, an area which at the time had an established flax production. Thus the Lusehøj find points to a hitherto unrecognized important role of nettle as a textile plant and suggests the need for a reevaluation of the organisation and resource management of textile production in prehistoric (Bronze Age) Europe.

The investigation of textile crop cultivation (flax and hemp) versus the collection of wild species (nettle) has been hampered by the fact that it is very difficult to distinguish between flax, hemp and nettle fibres. Ancient textile samples have frequently been identified as flax on the basis of superficial microscopic examinations. This may have caused a distorted view of the relative importance of flax, nettle and hemp in ancient textile production^{7,8}. Fortunately new methods are now opening up for proper identification and interpretation of ancient plant textile samples.

Results

The Lusehøj textile (National Museum of Denmark B26436) (Fig. 1 A), found in 1861/2, was wrapped around cremated human remains and placed inside a bronze urn⁹. It is a dense and balanced tabby weave with approximately 16 threads/cm in both thread directions^{10,11}. The yarn is fine and evenly spun, measuring 0.3–0.5 mm in diameter and with an S-twist in both thread directions. The fibre material was originally identified as flax, while later publications suggest nettle based on microscopic investigations which were however, not conclusive^{12–13}.

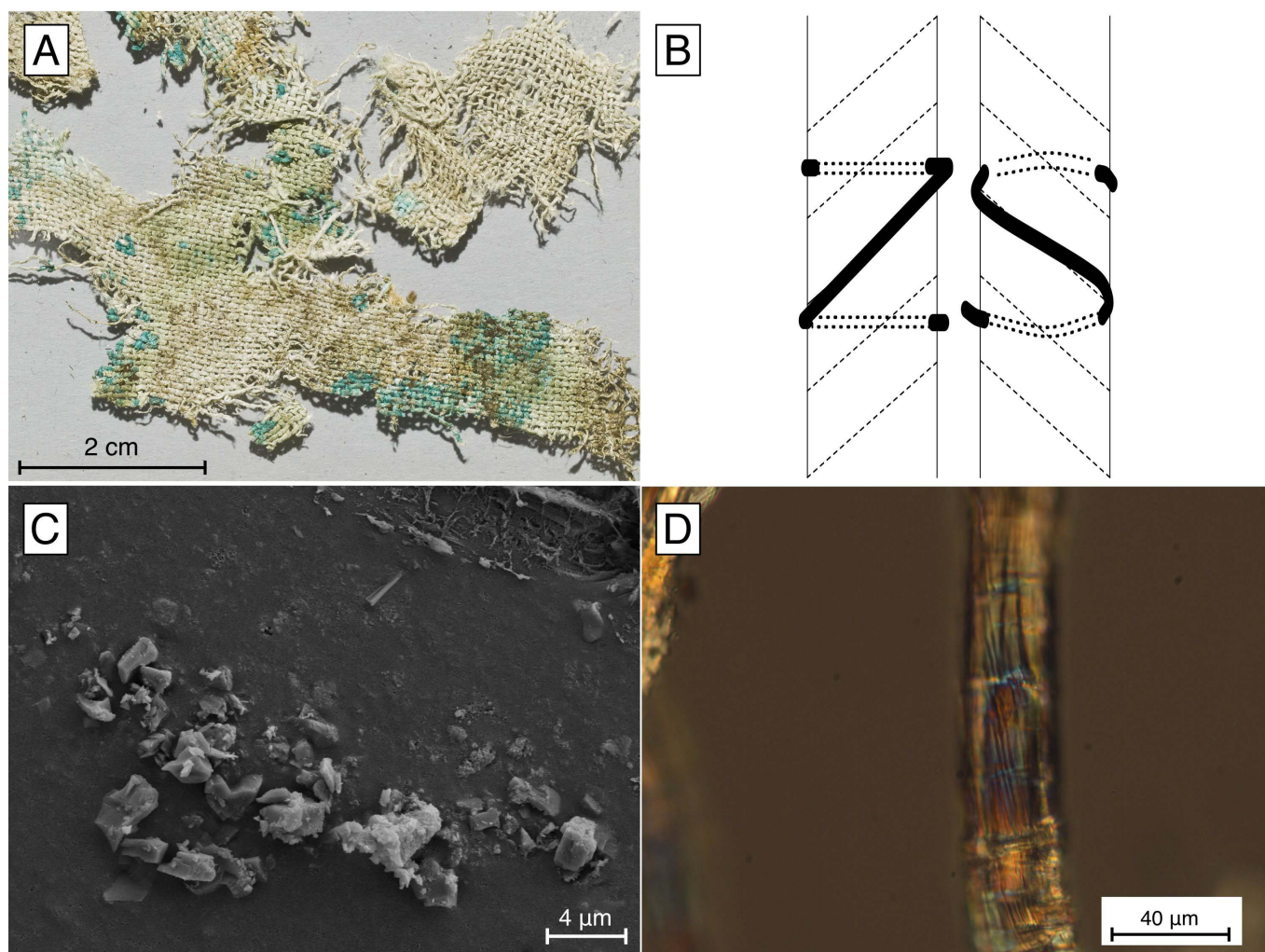


Figure 1 | (A) The 2800-year-old Lusehøj Textile. Photo by Roberto Fortuna, The National Museum of Denmark. (B) A diagram of Z- (left) and S-twist (right). (C) Scanning Electron Microscopy image of calcium oxalate crystals found in association with the fibres. The sample has been plasma ashed to reveal the crystals. The remains of a fibre can be seen in the top right corner. (D) The fibrillar orientation in the ancient fibre is visible in a polarising microscope. As can be seen, the fibrillar orientation corresponds to an S-twist.

The typological features of the bronze urn in which the Lusehøj textile was placed, indicate that it was originally imported from the Kärnten-Steiermark region in the south-western area of Austria. The bronze urn and the other impressive grave goods make this find one of the richest Bronze Age graves in Denmark⁹. The bronze urn is typologically dated to the Scandinavian Late Bronze Age Period V 900-700 BC⁹. As part of the present investigation, the Lusehøj textile was also ¹⁴C dated to 940-750 BC, which matches the typological and contextual dating.

Fibre Identification. We have investigated the Lusehøj textile using a new plant fibre identification method developed by authors of this paper¹⁴. The new method consists of measuring the fibrillar orientation of the fibres (Fig. 1 B) using polarised light microscopy and verifying the presence of calcium oxalate crystals in association with the fibres. To ensure that the identification was done correctly a blind test was performed by testing the ancient fibre sample together with modern fibres of known origin, so that it was not known during the testing if the ancient fibre or a modern fibre was being examined. Blind testing is particularly important in an archeological context, since the uniqueness of the samples prevent measurements from being readily repeated. We found that calcium oxalate crystals were present (Fig. 1 C) and that the fibrillar orientation corresponded to an S-twist (Fig. 1 D). The combination of these two

measurements proves conclusively that the Lusehøj textile is made of nettle.

Fibre Provenance. The provenance of the Lusehøj textile was investigated using strontium isotopes as a tracing system. Similar studies have been successfully performed for example in basketry associated with the western Great Basin's Lovelock archaeological culture, USA (2500 BC-AD 1300) suggesting that at times inhabitants of the various rock shelters may have gathered raw plant materials from local sources as well as from more distant sources or exchanged materials to complete some textiles¹⁵. In our study we followed a multi-step deep pre-cleaning method recently developed by one of the authors of this paper^{16,17} to ensure the removal of contaminants such as dust particles after long time burial which may stick to the fibres. Moreover, we monitored the ⁸⁷Sr/⁸⁶Sr compositions of the various leachates, enabling a control of removed signals and comparison with the ⁸⁷Sr/⁸⁶Sr composition of the residual (i.e. decontaminated) fibre fraction. The ⁸⁷Sr/⁸⁶Sr ratio of 0.72105 (± 0.00006 2 σ) measured on a so-treated thread sample of the Lusehøj textile points to a “non-local” (i.e. non-Danish) origin of the nettle. Denmark (the island of Bornholm excluded) consists of a pre-Quaternary geological basement primarily composed of Tertiary and Cretaceous sediments, all characterized by relatively low strontium isotopic compositions¹⁸. The elevated ⁸⁷Sr/⁸⁶Sr ratio



measured in the Lusehøj textile sample is compatible with strontium isotopic characteristics of older rocks from Precambrian shields. This proves that the nettles used in the Lusehøj textile did not grow in Denmark. This alone is a highly surprising result since in contrast to flax and hemp, nettle grows naturally in Denmark and therefore the raw material would have been easily available in the local area.

The strontium isotopic signature of the Lusehøj textile can correspond to several different locations with similar geological backgrounds as, for example Precambrian rocks from Sweden or Norway¹⁹ or the European Hercynian or Variscan orogenies²⁰. However, based on the provenance of the bronze urn, which originally contained the textile, a plausible area of production for the Lusehøj nettle textile could also be Central Europe, in particular the Kärnten-Steiermark region, which also has a Precambrian crystalline basement with a strontium isotopic signature matching our measurements^{20,21}.

Discussion

The new results from our investigations of the Bronze Age textile from Lusehøj, Denmark, reveals that the Lusehøj textile is made of non-local nettle, contrasting previous interpretations based on conventional textile analysis. The results suggest that plant fibre cloth production in Bronze Age Europe was based not only on agriculture as hitherto assumed, but also on the targeted exploitation of wild plants. This is further supported by the fact that the nettle fibres most likely stem from the Kärnten-Steiermark region as discussed at the end of the previous section. This is an area where flax agriculture was known at the time, as evidenced by pollen and macrofossil plant remains^{22,23}. This indicates that the wild nettle fibres were deliberately chosen over flax fibres. This not only shows the survival of an ancient practice of gathering wild plants, but more importantly, a conscious strategy to obtain a variety of textile qualities, both from established cultivated textile crops and from wild plants such as nettle which cannot be cultivated but only collected in specific areas of nitrogen rich soils.

The new results also challenge the previous assumption that textile production in the Bronze Age in Northern Europe was solely based on a local and non-specialized production^{9,24,25}. An assumption which has been promoted, among others, by the fact that Bronze Age wool clothing in Scandinavia has a homogenous, visual appearance and style embedded in an established agriculture and breeding tradition of every community and farmstead with local craft tradition.

Furthermore, the result of the strontium isotope analyses suggest that during the European Bronze Age textile products were circulated on a much wider scale than previously assumed. In particular, textiles or textile fibers were imported even when similar raw materials were available in the local area. This suggests that textiles, perhaps especially nettle textiles, can be considered luxury items. This burial's wealth demonstrates that nettle cloth in the Bronze Age was neither a lesser substitute for flax nor a random choice of fiber. It represents here a significant choice linked to the deceased and burial context.

It is known that precious metals and bronze objects were widely circulated in the European Bronze Age²⁶; the Lusehøj find now demonstrate that textiles or textile fibers, too, were a part of this regional circulation. This circulation was fuelled not only by the need to acquire what was not available locally, indeed the Lusehøj nettle fabric testifies to circulation of a finely crafted good which could have been made anywhere in Europe but ended up in a rich burial in Southern Scandinavia.

For more detailed information on the experimental procedures see the Supplementary Information.

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Acknowledgements

This work was supported by Bergen's Research Foundation and the Danish National Research Foundation. We thank the National Museum of Denmark for providing access to the Lusehøj Textile and allowing us to take samples from it. We thank Robert Frei for providing access to the clean laboratories and the TIMS at the Danish Center for Isotope Geology hosted by the Department of Geography and Geology, Copenhagen University. We also thank Roberto Fortuna from the National Museum of Denmark for the new picture of the Lusehøj Textile and Henrik Thrane for fruitful discussions. Finally, we thank the anonymous reviewer for the comments to improve the manuscript.

Author Contributions

Authors UM, KMF, MLN and BH were responsible for writing the main manuscript text. UM, MG, KMF and MLN were responsible for the interpretation of the data in a textile-archaeological/anthropological context, UM performed the technical textile analysis

1. Barber, E. J. W. *Prehistoric Textiles* (Princeton University Press, New Jersey, 1991).
 2. Gleba, M. & Mannering, U. *Textiles and Textile Production in Europe from Prehistory to AD 400*, Ancient Textiles Series **11** (Oxford, Oxbow Books, 2012).



and description. KMF performed the strontium isotope analyses and CB and BH the fibre identification analysis. ABS assisted with the microscopy images. CB prepared the figure. The dating of the materials were performed in the laboratory of JH and IS was responsible for selecting the fibre material used in the interpretation.

Additional information

Supplementary information accompanies this paper at <http://www.nature.com/scientificreports>

Competing financial interests: The authors declare no competing financial interests.

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How to cite this article: Bergfjord, C. *et al.* Nettle as a distinct Bronze Age textile plant. *Sci. Rep.* 2, 664; DOI:10.1038/srep00664 (2012).