Bronze Age wool textile of the northern Eurasia: new radiocarbon data

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The Bronze Age of northern Eurasia is characterised by major socio-economic changes. A secondary products revolution defined an overall trajectory in these global economic transformations. Innovative changes in fibre technologies led to the appearance of woven wool textiles and the production and consumption of new types of garment. Analysis of the first direct AMS 14C dates from woven wool fibres from Bronze Age sites across northern Eurasia allow us to define key stages in the directional spread of woven wool textiles and to determine the cultural context of this process of technological transmission.

INTRODUCTION

Introduction of wool production in Prehistoric societies has been studied by many scholars [1-6]. Unfortunately, woollen textiles are often poorly preserved in the archaeological record and, as a result, the reconstruction of woollen textile production across different periods of Prehistory is largely reliant on the study of indirect evidence such as imprints, weaving tools, written sources, non-pollen palynomorphs and the zooarchaeological analyses of animal bones [2, 3, 5, 7-13].

The earliest archaeological evidence of wool textiles in northern Eurasia—a fragment of cloth found in the later Maikop culture dolmen burial at Tsarskaya— can be dated around 4000 calBC. However, because it was made from a mix of wool and cotton yarns, this fabric was likely imported from the South. This conclusion is also supported by evidence for the use of tannin-based dyes, which were unknown at this time in the Caucasus [14].

At present, the almost complete lack of direct radiocarbon dates of preserved wool samples—and in the absence of other datable material from the same contexts—makes it difficult to present a clear picture of the cultural-chronological associations of this material. In the main regions of northern Eurasia where woolly-fleeced sheep/goats appeared in the Bronze Age (eastern Europe, the Urals, Siberia, and Kazakhstan) the process behind the emergence and transformation of this novel textile technology remains unclear.

Thus far, only the fragment, described above, from Dolmen No. 2 at Tsarskaya in the northern Caucasus [15] and another from the site of Stepnoye VII in the Ural Region [16] have been directly radiocarbon dated.

The aim of this project was to conduct a new programme of radiocarbon dating, focussed on the earliest surviving samples of woven wool textiles (or directly associated carbon-rich materials) from the Eurasian Bronze Age, from the Caucasus to Siberia. Based on a statistical analysis of these data— Bayesian modelling— we were able to resolve the chronological and spatial components of the data to investigate the spread of woollen fibre through this vast study region,

**Methods and Samples**

Fifty-two fragments from Bronze Age 26 sites located in the Caucasus, steppe and forest-steppe eastern Europe, the Ural region, Kazakhstan, and Siberia were sampled for the analysis (fig.1). According to the technological analyses, these samples were divided into several groups: fragments of non-plied and plied yarn, cords, plaited braids, and woven cloth and so forth (fig.2). Some of these technological results are published [17-21], the rest are currently being prepared for publication.

To explore the transmission of wool textile across northern Eurasia, we obtained direct AMS 14C measurements on 16 wool samples (fibres from woven textiles) from well-defined cultural contexts in order to establish their absolute age. Before sampling, the conservation history of the fragments was studied in as much detail as possible. The fragments were also examined under the microscope for evidence of unreported conservation, to exclude textiles which has been subjected to restoration. Radiocarbon data obtained were calibrated with the OxCal 4.3.2 program [22], using the calibration curve IntCal13 [23]. All dates with reported instrumental error >70 radiocarbon years were rejected from our dataset. The second phase was to exclude samples which showed a substantial offset from the expected C/N values for keratin. However, C/N ratios were not always reported in the legacy data and were not available from all laboratories even for new samples.

Wherever possible, a detailed cross-comparison between the textile samples and the associated radiocarbon dates on other materials was carried out to verify our results. Existing data were supplemented by new AMS 14C measurements on other datable materials from the same archaeological contexts: wood (6), nuts/seeds (2), leather (1) and animal bone (1). The results confirmed that samples showing minor C/N offsets were found to be consistent with other materials in the graves. Similar findings have also been reported elsewhere [24]. Larger shifts in C/N ratios for woollen textile samples always showed a substantial negative offest between their radiocarbon age and the radiocarbon age of other associated datable materials samples.

To minimize the effects of any uncertainty about the validity of these dates, all textile dates were treated as *terminus post quem* dates employing the *Outlier\_model* command in OxCal 4.3.2 with the following model parameters—(Exp(1,–10,0),U(0,3),"t") и p = 1— using assumptions that are often used to model dates made on wood and charcoal fragments. Other forms of short-lived material were included with standard assumptions — (T(5),U(0,4),"t") и p = 0.05. These steps, while far from a perfect solution, represent a reasonable compromise in the combination of data from multiple sources into a single analytical study. Future research will enable us to test the robustness of these decisions.

Using OxCal 4.3.2, the new 14C data were combined into a single Bayesian model with a wider set of previously published AMS 14C dates on textiles and associated materials from the Caucasus [25], Anatolia [26] and China [27-29].

This allowed us to combine, radiocarbon, archaeological and geological information and to define a series of chrono-spatial stages in the spread of woollen textile technologies in the steppe and explore their wider cultural historical significance.

Ten samples of wool and animal bone were dated at the Centre of Isotope investigation of the Groningen University, the Netherlands; five samples of textiles and wood at the Poznan Radiocarbon laboratory, Poland; six textile samples were dated as a collaboration between the Laboratory of radiocarbon dating and electronic microscopy, Institute of Geography, Russian Academy of Sciences and the Center of Isotope investigation, University of Georgia, USA; and two samples of textile and leather at the Oxford Radiocarbon Accelerator Unit, University of Oxford, UK.

RESULTS

AMS data 14C obtained from samples of woollen textiles and other directly associated materials allow us, for the first time to discuss a series of phases in the appearance and spread of wool fibres and fabrics in northern Eurasia during the Bronze Age (tabl. 1; fig. 3). In figure 4, the radiocarbon results are superimposed upon a map of northern Eurasia.

To investigate these data more robustly, a Bayesian model was constructed, placing the data into phases (using the *Phase* command in OxCal 4.3.2) based on their cultural associations and geographical location*.* No prior assumptions of about the chronological order of these “phases”. The chronological relationship of the modelled dates for the lower “boundaries” of each phase (*Boundary* command) was statistically checked using the *Difference* function in OxCal 4.3.2 based on a previously published approach [30]. In the subsequent descriptions of our results, we employ the “modelled dates” for individual samples and the overall probability distributions for each phase (generated using the *Date* function in OxCal 4.3.2).

DISCUSSION

The results obtained show a clear, if somewhat extended, chronological sequence that correlates well with the relative chronology of Bronze Age cultures across northern Eurasia, enabling us to identify the cultural communities associated with the transmission of these innovative technologies for the production of woven woollen fabrics. It is quite evident that the pastoralist cultures of the Eastern European steppe transferred these traditions to their neighbours in the forest zone of Eastern Europe and further to the forest-steppe and steppe regions of the Volga region and Urals, and ultimately into Kazakhstan, Xinjiang, and South Siberia (tabl. 2).

The earliest date for wool in our database was obtained from the late Maikop culture from a northern Caucasus. It dates to 2910-2600 calBC (GrA-21334) and correlates with another AMS 14C date obtained on animal bone from the same grave (GrA-24441) [31].

This date correlates with the date for a wool textile from the “Royal tomb” from Anatolia (Arslantepe) [2, 26]. But the North Caucasus textile is made from a mix of wool and cotton yarns. This garment could be non-local, and imported from some south-eastern Near east cultural environment, or from areas located to the south. Cotton is known from sites in the Kachi Plain of central Baluchistan since the 6th millennium BC and in northern Arabia and the Levant since the 4th millennium BC [32, 33]. The only fibres identified in textiles from earlier periods in the Caucasus were flax and wild plant fibres [14, 34-35].

This preference for the use of plant fibres in textile production, as well as the chronological gap between the 14C-date of the cotton-wool textile from Tsarskaya and the 14C-dates obtained from other Caucasian woollen textiles (or associated material)— Ananauri Kurgan III (2470–2350 calBC, RTD-7520-A) [25] and woollen cord from Bedeni (2140–2040 calBC, IGANams-6418)—highlights the absence of a stable technological tradition of woollen textile production in the region in this time. It may have taken several centuries for the weaving of wool fibres to become an established craft choice outside southwestern Asia and Anatolia.

It seems significant that the 14С data from the Catacomb and Bedeni culture graves at Shakhaevsky, Yergueni and Bugurusta show the introduction of wool textile into the eastern European steppe in the same period, 2400-2000 calBC (68%).

This correspondence in date suggests that the transmission of this technology was a result of contact between communities in the steppe and their southern neighbours. It is interesting to note that the earliest South Caucasian textile indicates the use of a blend of plant fibres and wool, though the plant fibre selected in both these cases was flax; the steppe textiles of this time were pure wool.

Moving northwards, we see a steady trend in the date of early woollen textiles. The samples from the Early Pozdnyakovo (Borisoglebovsky) burials (from the eastern European forest) date between 2150–1900 calBC (68%). But to the east there is a far more dramatic transmission. All textiles associated with the Timber-grave and Alakul burials from the steppe areas of the Volga, Urals and Kazakhstan are dated between 1925–1475 calBC (95%) or 1775-1625 calBC (68%). Dates previously obtained on woven textiles and associated materials from Xinjiang Province (western China) are almost synchronous with this trend 1675–1500 calBC (68%) or 1800–1425 calBC (95%). The southern Siberian Federovo (Late Andronovo) textiles date between 1550–1325 calBC (68%) or 1750-1225 calBC (95%).

Thus, new 14C data indicate that wool textiles moved from the south to the north, where they were rapidly assimilated into local technical systems. This assimilation and the emergence of a secondary products economy based (at least in part) on woollen textiles was likely facilitated by the widespread pre-existence of mobile sheep/goat herding, which became a dominant economic model during the mid-third millennium BC [15, 36].

In the last quarter of the third millennium BC a wider preference for wool textile gradually spread, stretching north into the forest-steppe and forest zone. Within 250 years the production of wool textiles was fully integrated into the social economy of Eurasian pastoralists and wool textiles became increasingly widespread across northern Eurasia, spreading east towards the Urals and across Siberia and Kazakhstan.

The 14C dates associated with the earliest samples appear to trace a rapid dispersal across the central steppe and a general trend from west to east. The 14C data obtained from the analysis of woven wool textiles and felt from the sites of the Xiaohe-Gumugou culture [29] indicate the rapid spread of this technology. Wool textiles in Xinjiang certainly appeared a little later than those of the South Caucasus, the steppe Catacomb culture, and the forest zone cultures of Eastern Europe. However, these fabrics are essentially synchronous with those from Alakul and Timber-grave textiles of the Volga region, the Urals and Kazakhstan.

Thus, the obtained 14C AMS dates clearly record two geographic trends in the spread of wool fibre. Initially from south to north and then, far more rapidly, from west to east.

CONCLUSION

Direct radiocarbon dating of the Bronze Age wool textiles and synchronous carbon-contained samples enables new details to be added to our understanding of the chronology of early wool economy and associated textile technologies and its transmission within northern Eurasia.

Chronological phases and comparative analyses (including 14C- dates from Anatolia, South Caucasus, and China) reveal different phases of cultural and technological exchanges between the Near East and the Caucasus and special role of steppe groups (a few generations of weavers) in a dispersal spanning of new technology during the third millennium BC (fig.3, 4). Chronological and historical phases of the process are summarized as follows:

* after 3000 calBC: Early exchanges of prestige goods across Near east and the North Caucasus, with wool-cotton textiles moving as part of the elite exchange networks; mixed wool-cotton textile dates around 2910-2600 calBC.
* the mid third millennium BC: spread of wool textile technologies and associated management strategies out of the Near East/Anatolia and into the southern Caucasus; according to 14C data obtained for textiles and synchronous samples this happened between 2550-1925 calBC; an almost synchronous date was obtained from the dates of the northern steppe regions, suggesting that the spread of innovative technology from the South Caucasus to the steppe zone and further north up to the forest zone occurred as part of the same process between 2450-1900 calBC.
* Between 1925-1775 calBC there was rapid eastward transmission of the wool (and associated technologies) across the steppe and forest-steppe of the Volga and southern Urals, out across Kazakhstan and into western China. Between 1700-1225 calBC.
* This same process of transmission through the steppe ultimately brought woven wool textiles into societies around the western Altai and the Sayan Mountains of southern Siberia

Textile communities in the Caucasus and the adjacent areas of the steppe (Bedeni, Catacomb and Babino synchronous cultures) shared the same economic pathways and began to communicate and exchange technological knowledge of wool textile production during the second half of the third millennium BC, stimulating the expansion of pre-existing local networks of exchange. In about 200 years, these networks brought a new approach to the management and exploitation of animal herds from communities in the steppe and the piedmont area of the northern Caucasus. A new secondary product appeared: woven woollen textiles. Was this the result of imported livestock or an intensive phase of selective breeding by Catacomb culture shepherds? What is clear from the early production of wool items in the steppe is that it was a small scale, domestic activity of the local communities.

A far more rapid transmission occurred during the early second millennium BC through culturally connected communities of pastoralists known to archaeologists as the Timber-grave culture in the Middle Volga and Ural regions, Alakul (Early Andronovo*)* in the Urals region, and northern Kazakhstan as well as Federovo (Late Andronovo) in southern Siberia.

By the mid second millennium BC, through the steppe and forest-steppe zones of northern Eurasia— from the Caucasus and the adjacent steppe to Kazakhstan— a “Wool Road” consisting of extensive networks of multi-direction and multicultural exchange, ran through the communities of Eurasia both in and around the steppe zone. This pattern of transmission was operating in parallel with the spread of wool technologies through the very different cultural environment of Western and Central Asia [37].

We assume that the wool clothing found in the Tarim Basin fits within the same processes of transmission through this northern Eurasian ‘Wool Road’. The coincidence of the date of these finds, various similarities seen in the details of their clothing with those from Timber-grave and Alakul cultures of the Volga region, the Urals, Kazakhstan, and a basic similarity of their technological traditions suggest that the origins of these Chinese woollen textiles and textiles of the Eurasian steppe and forest zones are closely related. Weavers shared a preference for red-coloured dyes and a special interest in composite hats or headdresses ornamented with feathers and other organic materials [38, 28]. They also showed a strong preference for the use of leather, fur, and wool textiles together in the production of composite garments.

These tendencies seem to be in contrast with wool items from the southern Caucasus dated to the second half of the third millennium BC, known for the use of combined wool and plant fibres and their distinctive patterns of weaving [34].

In summary, the results of this study define a clear spatio-temporal trajectory of the emergence and rapid spread of woven woollen textile production across northern Eurasia and offers new insight into the processes underlying this transformation.

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List of illustrations

Fig. 1. Bronze Age burial grounds with remains of woollen and cotton textiles.

1 – Tsarskaya (Novosvobodnaya); 2 – Bedeni; 3 - Shakhaevsky 1; 4 – Yergueni; 5 – Bugurusta; 6 – Alekseevsky II; 7 – Zolotaya Niva II; 8 – Gerasimovsky III; 9 – Gerasimovsky II; 10 – Alekseevsky; 11 – Tavlykaevsky II; 12 – Chernyaki II; 13 – Agapovka II; 14 – Stepnoye VII; 15 – Alakul; 16 – Ushkattinsky I; 17 – Tundyk; 18 – Kairan I; 19 – Berezovy Rog; 20 – Borisoglebovsky I; 21 – Ust'-Yerba; 22 – Uzhur; 23 – Uibat; 24 – Bestamak; 25 – Dzhangildy-5; 26 – Lisakovsky; 27 – Shahr-i-Sokhta; 28 – Arslantepe; 29 – Bogolubovka; 30 – Girsu; 31 – Ur; 32 – Ananauri; 33 – Dhuweila; 34 – Gumugou; 35 – Xiaohe; 36 – Keliyahe

Fig.2. Fragments of wool textiles. Yergueni, kurgan 6, grave 3, Catacomb culture: 1 – textile sample, 2 – photomicrographs of wool fibres; Ust-Yerba, grave 1, Federovo (Late Andronovo) culture: 3 – wool textile, 4 – photomicrographs of wool fibres

Fig.3. Summary of the modelled radiocarbon dates, revealing a series of broad phases in the spread of woollen textiles and associated technologies. Made using OxCal v4.3.2 [22]

Fig. 4. Spatial summary of the radiocarbon dates for early woollen textiles displayed site-by-site across northern Eurasia.

Table 1. 14C data of wool, mixed cotton/wool textile, animal bones, nuts, wood, and leather from Bronze Age sites of northern Eurasia

Table 2. Calibrated *Date* intervals for the various geographical phases (modelled data).

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