MIGRATION OF DYES IN ARCHAEOLOGICAL TEXTILES FROM WET SITES.

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ABSTRACT

Knowledge of how the dyes in archaeological textiles are affected by the anoxic conditions in the wet soil is limited. An experiment was conducted to investigate how dyed textiles react during burial in waterlogged soil, if mordant and dyestuffs affect the rates of fiber deterioration; if dyes will stay in the textile or leak into the surrounding soil or if dye components can migrate from one textile to another.

Identical sets of textiles dyed with a range of different natural dyes were buried in waterlogged peat for several months to imitate textiles from bog-finds. Some of the samples had small swatches of natural white fabric attached to investigate if dyes do migrate from one textile to another. After excavation dyes were detected with HPLC.

The experiments showed some of the dyes were identified in samples not dyed with this dyestuff. Primarily, the red dyes such as madder and cochineal as well as Indigo were able to migrate from one textile to another. Furthermore, there was an indication of dye lost during aqueous rinsing of the textiles.

The result of the experiments must be taken to account when interpretations are made of dye analyses of archaeological textiles are made in the future.

Migración de colorantes en textiles arqueológicos procedentes de sitios húmedos

RESUMEN

Es limitado el conocimiento sobre cómo se afectan los colorantes de los textiles arqueológicos por las condiciones de anoxia en suelos húmedos. Se llevó a cabo un experimento para investigar cómo reaccionan los textiles con tintes durante un entierro en suelos muy húmedos; si los mordientes o tintes afectan los rangos de deterioro de las fibras, si los tintes permanecen en el textil o si se filtran en el entorno del suelo, o bien, si los componentes de los colorantes migran de un textil a otro.

Un conjunto idéntico de textiles teñidos con varios colorantes naturales diferentes fueron enterrados durante varios meses en tumbas llenas de agua para imitar los textiles provenientes de excavaciones en pantanos. Algunos de los textiles llevaban muestras de tela blanca para investigar si los tintes migraban de un textil a otro. Después de la excavación, los textiles fueron identificados con HPLC.

Los experimentos mostraron que algunos de los colorantes fueron identificados en muestras que no fueron teñidas con esos tintes. En primer lugar, los tintes rojos como la rubia y la cochinilla, así como el índigo, fueron capaces de migrar de un textil a otro. Igualmente, hubo un índice de pérdida del tinte durante el lavado acuoso de los textiles.

El resultado de los experimentos se debe tener en cuenta para interpretaciones sobre análisis de tintes en textiles arqueológicos que tengan lugar a futuro.

1. INTRODUCTION

Due to the preservative effects of waterlogged or wet soil, many archaeological textiles have been recovered from wet sites. These textiles have often lost their original colors and appear in different brownish shades; thus dyestuff identification is necessary in order to visualize the textiles' original look. In recent decades the knowledge of dye identification has improved greatly. Although the focus has been on dyes in historical textiles, where the degradation of the dyes is mainly due to oxidation, it has proved possible to identify dyes successfully in archaeological textiles. Nevertheless, there is still little knowledge of how the dyes are affected by the anoxic conditions in the wet soil and how to interpret the results.

2. EXPERIMENT

An experiment was conducted to see how textiles react during burial in soil in wet conditions, and how different factors- mordant, dyestuff, natural pigmentation and oxygen - affect the rates of deterioration (Ringaard and Scharff 2010, Ringgaard 2011, Ringgaard & Scharff 2011), The result of these experiments will help us to interpret what the archaeological finds of brown rags may have looked like when they were in use. This poster will focus on the migration of dye and mordant with a focus on the following questions:

-Are dyes affected by the reductive conditions that may arise in anoxic soil?

-Does dye or mordant stay in the textile or will they leak into the surrounding soil?

-Can the dye components migrate or bleed from one textile to another?

The evaluation of deterioration degrees and color changes were documented by spectrophotometry; observation of fibers by stereo and transmitted light microscopy; quantitative and qualitative element analysis using SEM-EDX; and the testing of dyestuff remains with HPLC-PDA.

Wool and silk fabrics were dyed with a series of natural dyes and mordants. Identical sets of the dyed swatches were buried in large boxes with waterlogged peat to mimic textiles from bog finds. Each set was placed horizontally on peat and covered with another layer of peat.

The boxes were placed at a stable temperature and humidity for up to 4 years, - in a greenhouse because this gave the opportunity for a slightly raised temperature accelerating the processes. Boxes, imitating anoxic (anaerobic) conditions, were in waterlogged peat and covered with a lid to ensure an oxygen-free atmosphere. Other boxes imitating low oxygen conditions were without lids but watered monthly.

After 8 months burial, the first set of textiles were excavated and freeze-dried. Fiber samples from each of the textiles were sent to the KIK-IRPA Laboratories for HPLC-PDA analyses. All dye analyses were conducted by Ina Vanden Berghe at the KIK-IRPA Royal Institute for Cultural Heritage, Laboratories in Brussels using high performance liquid chromatography with photo diode array detection.

Figure 1. Some of the dyed swatches had a small patch of natural white wool sewn on top to investigate if the dye or mordant can migrate from one fabric to another. Swatches in the top line are non buried, left to right dyed with weld, galls+iron, cochineal, madder and indigo, in lower line are similar swathes after 8 months burial. Cochineal was found in trace level in the white patch on the black galls+iron swatch migrated from the pink swatch.

3. RESULTS

Dye source	Dye components	Migration Anoxic conditions	Migration Low oxygen conditions
Indigo *Indigofera tinctoria*	Indigotin	+	++
	Indirubin	-	-
Weld *Reseda luteola*	Luteolin	-	-
	Apigenin	-	-
Madder *Rubia tinctoria*	Alizarin	+++	-
	Purpurin	+	-
Cochineal *Dactylopius Coccus*	Carminic acid	+++	++
	Kermesic acid	+	-
Oak Galls	Gallic acid	-	-
	Ellagic acid	+*	?
	Quercetin	-	-
Walnut	Gallic acid	-	-
	Ellagic acid	+*	?
	Quercetin	-	-

Table 1.The table shows if the dye component was traced in a textile not dyed with this component = component able to migrate from one textile to another.

Legend:

- = none of this component was detected in textiles not dyed with this specific dye.

+ = the component was detected near trace level in textiles not dyed with this specific dye

+++ = the component was clearly detected in textiles not dyed with this specific dye

** ellagic acid was detected in some - but only some - textiles not dyed with this acid and not placed near a textile dyed with ellagic acid. It is therefore uncertain if the detected ellagic acid originates from the soil or from a dye.*

Some of the dyes were identified in samples not dyed with this dyestuff, primarily the red dyes, madder and cochineal. These dyes were able to migrate not only to the “white migration patch” directly in contact with the dyed fabric, but also in significant amounts into textiles in the nearest surroundings. Cochineal was even found in the “white migration patch” on a ferro-gall-dyed textile lying nearby.

Although no significant trace of Indigo was found in the “migration patch”, indigo was found in two swatches - weld dyed- that had been placed next to an indigo-dyed textile during the burial. If it had not been known the textile was dyed with weld only, the interpretation of this analysis would have been that the textiles originally were dyed green.

Ellagic acid was traced in textiles not dyed with dyes containing this component – it is not certain if this acid has migrated from dyed textiles or originates from the surrounding peat.

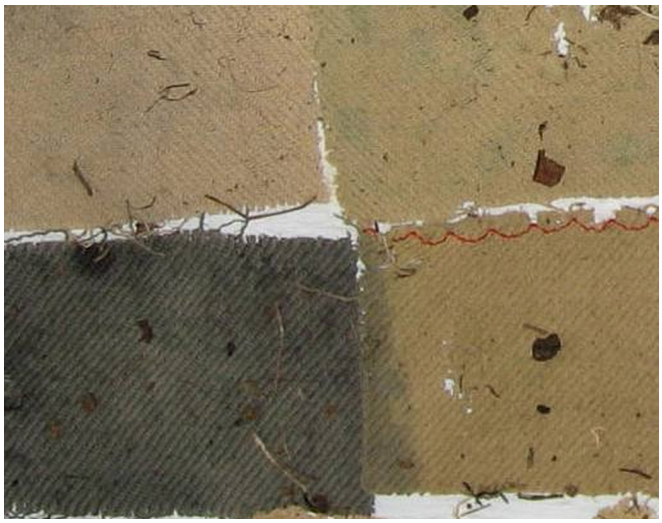

Figure 2 The copper mordant did migrate to textiles lying next to the copper-mordanted textile. As the copper- mordanted textile turned dark in the anoxic burial, the migrated copper was clearly visible as dark stains on the near lying textile.
Mordants also showed abilities for migration from the textiles. Nearly no traces of iron were left in any of the textiles after burial, while the copper mordant did migrate to textiles lying next to the copper-mordanted textile.

Figure 3 Significant amounts of alizarin and purpurin had migrated from the madder-dyed textile lower left and were found in the cochineal dyed textile centre u. An interpretation of the dye-analysis would have been the textile was dyed clear red with a combination of the two dyes. If the sample for analysis had not been taken in this corner, the results would have been different.

4. CONCLUSIONS

Dye components are able to leek from one textile to another in wet soil. This migration of dye components was traced after only 8 months of burial; longer time burial will possibly allow even more dye to migrate. These results must be taken into account in the future when taking samples and interpreting dye analyses.

Fibers from more than one place on the textile could be mixed to minimize the effect of dye migrated from other textiles.

If more than one dye is traced in an archaeological textile one has to consider if this is an intended mixture of dyes or if it could be due to migration from other sources.

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Maj Ringgaard holds an MSc in conservation from the Royal Danish Academy of Arts, and is also educated in textile crafts. She received her PhD in archaeology at the University of Copenhagen on the theme of the degradation phenomena in 18th-century archaeological textiles from city excavations. She has subsequently conducted research on knitted historical garments from an archaeological, historical and a terminological point of view under the aegis of the international project Fashioning the Early Modern. Ringgaard has contributed to numerous exhibitions on textiles and dress. Her research interests and publications also include dyes in prehistory and history and textile preservation.

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