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# 10.5 ANALYSES OF IRON AGE TEXTILE REMAINS FROM PEZDIRČEVA NJIVA IN PODZEMELJ

# 10.5 ANALIZA OSTANKOV ŽELEZNODOBNIH TKANIN S PEZDIRČEVE NJIVE V PODZEMLJU

Margarita GLEBA

## INTRODUCTION

We present preliminary investigations of textile traces excavated from Iron Age cemetery of Pezdirčeva njiva in Podzemelj, Slovenia. Textile traces were identified in 12 burials. All of the textiles survived in a mineralised state, primarily in contact with iron. Mineralised textiles are formations in which metal corrosion products form casts around fibres retaining their external morphology and size almost unaltered either as positive or, more frequently in the case of iron, negative casts (Chen et al. 1998). Even when minute, such traces can provide a considerable amount of information about ancient textiles.

The textiles were investigated using standard technological analytical procedures, which included textile and fibre characterisation. The results of the analyses provide important new information regarding textile technology and use in Iron Age Slovenia and, more widely, in north and central Balkans.

## SAMPLING PROCEDURES

Samples of the textiles were taken for SEM analyses during conservation and study of the material. The samples were about 1–10 mm in size and were taken with the greatest consideration for artefact conservation. Some of the artefacts were not sampled in order not to compromise their integrity.

## UVOD

Predstavljamo rezultate preliminarnih raziskav ostankov tkanin iz železnodobnega grobišča Pezdirčeva njiva v Podzemlju. Tovrstni ostanki so bili odkriti v 12 grobovih. Vse tkanine so se ohranile v mineraliziranem stanju, predvsem v stiku z železom. Mineralizirane tkanine so tvorbe, pri katerih korozijski produkti kovin ustvarijo okoli vlaken odlitke, ki ohranijo skoraj nespremenjeno zunanjo obliko in velikost vlaken, bodisi kot pozitivni ali, pogosteje v primeru železa, negativni odlitki (Chen et al. 1998). Takšni ostanki lahko nudijo obilo informacij o starodavnih tkaninah tudi, če so zelo majhni.

Tkanine so bile raziskane z uporabo standardnih tehnoloških analitičnih postopkov, ki so vključevali karakterizacijo tkanin in vlaken. Rezultati analiz zagotavljajo pomembne nove podatke o tekstilni tehnologiji in uporabi v železni dobi v Sloveniji ter širše, v severnem delu osrednjega Balkana.

## VZORČENJE

Vzorce tkanin za SEM analize, ki so merili približno 1–10 mm, so z največjo skrbnostjo za ohranitev predmetov odvzeli med konservacijo in preučevanjem materiala. Vzorcev iz nekaterih predmetov niso jemali, da s tem se ne bi ogrozili njihove celovitosti.

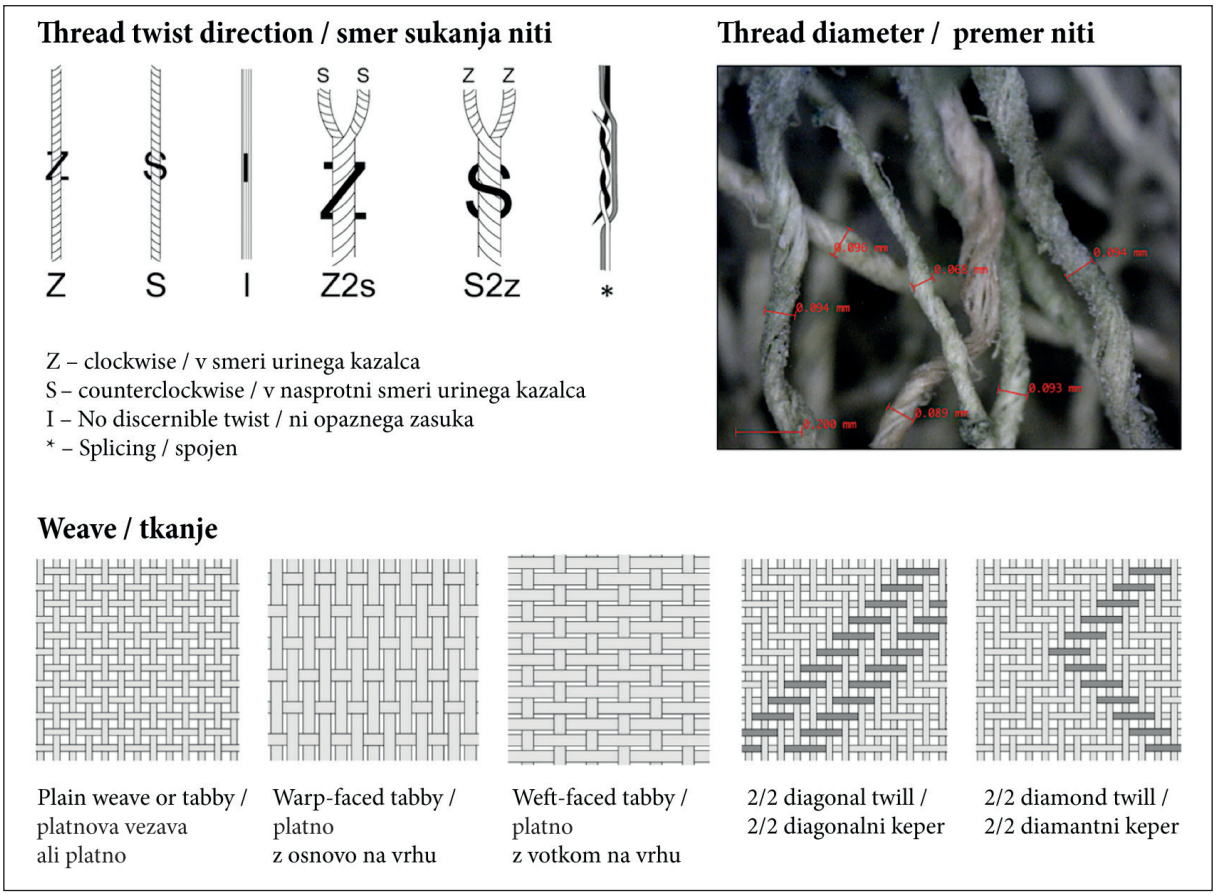



*Fig. 1:* Structural parameters recorded during textile analysis.
*Sl. 1:* Strukturni parametri, zabeleženi med analizo tkanin.

## ANALYTICAL PROCEDURES

### TEXTILE ANALYSIS

The purpose of technological textile analysis is to determine the culturally and chronologically relevant characteristics of the examined fabrics. Textile analysis includes the determination of structural parameters such as weave type and thread count per cm (which is indicative of textile quality); thread twist (z – clockwise; s – counter-clockwise, i – no discernible twist, * – spliced), diameter and angle; presence of edges and any other characteristic elements, such as pattern, sewing, etc. (*Fig. 1*)[1] (Emery 2009).

The structural examination of most artefacts preserving textile traces was conducted using direct visual observation and digital microphotographs taken with portable Dino-Lite digital microscope AM7115MZT at different magnifications (20x, 50x, 230x).

[1] All images were prepared by the author.

## POSTOPKI ANALIZE

### ANALIZA TKANINE

Namen tehnološke analize je določiti kulturno in kronološko pomembne značilnosti preiskanih tkanin. Tekstilna analiza vključuje določitev strukturnih parametrov, kot so tip tkanja in število niti na cm (kar je pokazatelj kakovosti tkanine); zasuk niti (z – v smeri urinega kazalca; s – v nasprotni smeri urinega kazalca, i – brez vidnega zasuka, * – spojene niti), premer in kot zasuka; prisotnost robov ter drugih značilnih elementov, kot so vzorci, šivanje itd. (*sl. 1*)[1] (Emery 2009).

Strukturna preiskava večine predmetov, ki ohranjajo sledi tkanin, je bila izvedena z neposrednim opazovanjem in preučevanjem digitalnih mikro fotografij, posnetih s prenosnim digitalnim mikroskopom Dino-Lite AM7115MZT pri različnih povečavah (20x, 50x, 230x).

[1] Vse slike je izdelala avtorica.

### FIBRE IDENTIFICATION AND ANALYSIS

The purpose of the fibre analysis is to identify first whether the fibres used to produce the textiles yarns were made of plant or animal fibre and, if the fibres are sufficiently well preserved, to identify the species. Fibre characterisation furthermore helps to understand fibre processing and microscopic thread structure, allowing to differentiate between different thread production methods, such as draft spinning and splicing. Fibre identification is essential to underpin the connections between technology and raw material and understanding wild and cultivated resource management.

Fibre identification and analysis was carried out at the Department of Chemistry, University of Padua, using Coxem EM-30AX Plus Scanning Electron Microscope (SEM) in order to determine the morphological characteristics of the fibre and to acquire more detailed surface information for fibre identification. The following instrumental settings were used: analytical condition mode at 20.00 kV accelerating voltage and working distance of 10–13 mm. The samples were not coated.

The fibre diameters for wool quality analysis (Ryder 1969; Rast-Eicher 2008; Gleba 2012) were measured using ImageJ software on SEM images taken at 300x magnification. Whenever possible, 200 fibres were measured.

## RESULTS

### STRUCTURAL TEXTILE ANALYSIS

Textile traces were identified in 12 burials on 14 artefacts, resulting in 13 identifiable fabrics. Fabric structure could not be determined in the case of two artefacts (from G 44 and G 84), although fibre identification confirmed the presence of textile traces; while on one artefact – iron fibula from G 76 (cf. here *t. 33: A1*) – two different fabrics were identified (*Tab. 1*).

#### Textile weave

Two types of weave structures were identified in the analysed material: tabby (or plain weave) and twill. A tabby is one the earliest loom-woven structures as it is the simplest textile binding attainable with two thread systems on a loom, with passive warp and active weft threads alternating one over one in each direction. The three tabbies identified in the recorded material can be divided into different types (*Fig. 2*): balanced, which have approximately equal number of threads per unit of length in warp and weft; and unbalanced, which have more threads per unit of length in one of the systems.

One textile was identified as a balanced tabby, with 10–11 threads per cm in both systems. Two tabbies, of



### OPREDELITEV IN ANALIZA VLAKEN

Namen analize vlaken je najprej ugotoviti, ali so bila vlakna, uporabljena za izdelavo tekstilnih niti, rastlinskega ali živalskega izvora, in če so vlakna dovolj dobro ohranjena, določiti njihovo vrsto. Opredelitev dodatno pomaga razumeti obdelavo vlaken in mikroskopsko strukturo niti, kar omogoča razlikovanje med različnimi metodami izdelave niti, kot sta predenje s prepletanjem in predenje z vlečenjem. Opredelitev vlaken je ključna za razumevanje povezav med tehnologijo in surovino ter za preučevanje uporabe nekultiviranih in gojenih rastlin.

Prepoznava in analiza vlaken, ki sta služili za določitev morfoloških značilnosti vlaken in pridobitev podrobnejših informacij o njihovi površinski strukturi, sta bili izvedeni na Oddelku za kemijo Univerze v Padovi z uporabo elektronskega mikroskopa Coxem EM-30AX Plus (SEM). Uporabljene so bile naslednje instrumentalne nastavitve: način analitskih pogojev pri pospeševalni napetosti 20,00 kV in delovni razdalji 10–13 mm. Vzorci niso bili prevlečeni.

Premeri vlaken za analizo kakovosti volne so bili izmerjeni s programsko opremo ImageJ na SEM slikah, posnetih pri 300-kratni povečavi. Kjer je bilo mogoče, je bilo izmerjenih 200 vlaken.

## REZULTATI

### STRUKTURNA ANALIZA TKANIN

Sledi tkanin so bile identificirane v 12 grobovih na 14 predmetih, kar je omogočilo prepoznavo 13 različnih tkanin. Pri dveh predmetih (iz gr. 44 in gr. 84) strukture tkanine ni bilo mogoče določiti, čeprav je prepoznava vlaken potrdila prisotnost tekstilnih sledi; na enem predmetu – železni fibuli iz groba 76 (glej tu *t. 33: A1*) – pa sta bili identificirani dve različni tkanini (*Tab. 1)*.

#### Tkanje

V analiziranem gradivu smo prepoznali dve vrsti tkanja: platnena vezava (ali preprosto tkanje) in keper. Platnena vezava je ena najzgodnejših tkalskih oblik, saj gre za najpreprostejšo obliko prepletanja, ki jo je mogoče doseči z dvema sistemoma niti na statvah, pri čemer se čez pasivne osnove izmenjujejo aktivni votki po vzorcu druga prek druge niti v vsaki smeri. Tri platnene vezi, identificirane v raziskanem gradivu, lahko uvrstimo v dva različna tipa tkanin (*sl. 2*): uravnotežene, ki imajo približno enako število niti na enoto dolžine v osnovi in votku ter neuravnotežene, ki imajo več niti na enoto dolžine v enem od sistemov.

| Grave / Grob | Special Find no. / Posebna najdba (PN) | Artefact / Predmet | Weave / Tkanje | System 1 count / Gostota niti 1 | System 2 count / Gostota niti 2 | System 1 twist / Vitje 1 | System 2 twist / Vitje 2 | System 1 diameter / Premer 1 | System 2 diameter / Premer 2 |
|---|---|---|---|---|---|---|---|---|---|
| 60 | 234 | Iron spear / železna sulica | tabby / platno | 8 | 15 | z | z | 0.5–0.7 | 0.6–0.8 |
| 61 | 181 | Iron belt / železen pas | 2/2 twill / keper | 12 | 12 | z,s | z,s | 0.5–0.7 | 0.5–0.7 |
| 65 | 169 | Iron spear / železna sulica | 2/2 twill / keper | 16–18 | 16 | 6z,6s | 6z,6s | 0.4–0.5 | 0.4–0.5 |
| 75 | 207 | Iron axe / železna sekira | 2/2 twill / keper | 10 | 10 | z | z | 0.6–0.7 | 0.6–0.7 |
| 76 | 199 | Iron fibula / železna fibula | tabby / platno | 10 | 10–11 | S2z*? | S2z*? | 0.6–0.7 | 0.6–0.8 |
| | | | 2/2 twill / keper? | 16 | 16 | z | z | 0.5–0.6 | 0.5–0.6 |
| 84 | 284 | Bronze fibula / bronasta fibula | ? | – | – | – | – | – | – |
| 90 | 292 | Bronze bracelet / bronasta zapestnica | 2/2 twill / keper | 10 | 10 | z | z | 0.6–0.7 | 0.6–0.7 |
| 96 | 301–2 | Iron belt / železen pas | tabby / platno? | 10 | 14 | z | z | 0.4–0.5 | 0.4–0.5 |
| 100 | 343–3b | Iron belt / železen pas | 2/2 twill / keper | 10 | 10 | z | z | 0.4–0.5 | 0.4–0.5 |
| | 343–3c | Iron belt / železen pas | 2/2 twill / keper | 10 | 10 | z | z | 0.6–0.7 | 0.6–0.7 |
| | 343–3d | Iron belt / železen pas | 2/2 twill / keper | 12 | 12 | z | z | 0.6–0.7 | 0.6–0.7 |
| 113 | 392–1 | Iron belt / železen pas | 2/2 twill / keper | 8 | 8 | z | z | 0.7–0.8 | 0.7–0.8 |
| 127 | 297 | Flotation / Flotacija | ? | – | – | – | – | – | – |
| 179 | 526 | Iron fibula / železna fibula | 2/2 twill / keper | 10 | 10 | z | z | 0.7–0.8 | 0.7–0.8 |

*Tab. 1:* Structural characteristics of textiles (thread counts are in threads per cm; diameters measured in mm).
*Tab. 1:* Strukturne značilnosti tkanin (število niti je v nitih na cm; premeri merjeni v mm).

similar quality, are denser in one of the systems, with 8 and 10 threads per cm in one system and 15 and 14 thread per cm in the other. Although no edges survive in any of the textiles to determine warp and weft direction, based on comparison with other, contemporaneous finds from other sites, it is likely that these textiles are weft-dominant.

Eight textiles were identified as 2/2 twills (*Fig. 3*), as the fabric remains on various iron belt elements from G 100 very likely belong to the same textile. In a twill, the horizontal weft threads pass over and under verti-

Ena tkanina je bila v obeh sistemih identificirana kot uravnotežena platnena vezava s 10–11 nitmi/cm. Dve platneni tkanini podobne kakovosti sta gostejši v enem od sistemov, pri čemer imata ena 8 in 10 niti na cm v enem sistemu ter 15 in 14 niti na cm v drugem. Čeprav se pri nobenem od teh tkanin robovi niso ohranili, da bi bilo mogoče določiti smer osnove in votka, je na podlagi primerjav s sočasnimi najdbami z drugih najdišč verjetno, da so bile te tkanine votkovno dominantne.

Osem tkanin je bilo identificiranih kot 2/2 keper (*sl. 3*), saj ostanki blaga na različnih delih železnega


*Fig. 2:* Close-ups of tabbies: a – G 60, b – G 96 (unbalanced), c – G 76 (balanced).
*Sl. 2:* Bližnji posnetki platna: a – grob 60, b – grob 96 (neuravnoteženo), c – grob 76 (uravnoteženo).

cal warps in a regular staggered pattern (in a 2/2 twill case every two threads in each system), each row being stepped to one side of the row above, creating a diagonal effect. All twills are balanced and the quality is quite homogeneous at 10–12 threads per cm, with only two samples reaching 16–18 threads per cm. It is possible that textiles were originally more complex twill variants (such as chevron or diamond), but the fragments are too small to allow their definitive identification.

**Yarn structure**

Two types of thread structure were identified in the analysed material. All tabbies and twills are woven in single thread. At least three of the twills have both s- and z- twisted yarn in both systems, indicating the use of spin- or shadow- pattern (*Fig. 4*). One textile stands out due to its thread, which appears to consist of two possibly spliced yarns plied in counter-clockwise direction (S2z*) (*Fig. 5*). Poor preservation precludes definitive identification of spliced structures, however

pasu iz groba 100 zelo verjetno pripadajo isti tkanini. Pri keperju vodoravne votkovne niti prehajajo prek navpičnih osnovnih niti in pod njimi v enakomernem zamaknjenem vzorcu (v primeru 2/2 keperja vsaki dve niti v vsakem sistemu), pri čemer se vsaka vrsta premakne za eno nit vstran glede na zgornjo vrsto, kar ustvarja diagonalen učinek. Vsi keperji so uravnoteženi, njihova kakovost pa je precej homogena pri 10–12 niti/cm, le dva vzorca dosegata 16–18 niti/cm. Možno je, da so bile tkanine prvotno bolj kompleksne različice keperja (npr. ribja kost ali rombi), vendar so fragmenti premajhni za dokončno identifikacijo.

**Struktura preje**

V analiziranem gradivu sta prepoznani dve vrsti strukture niti. Vse platnene in keprove vezi so stkane iz enojne preje. Vsaj trije keperji imajo tako s- kot z-zasukane niti v obeh sistemih, kar kaže na uporabo vzorca s senčenjem ali izmeničnega vzorca predenja (*sl. 4*). Odstopa tkanina, ki ima prejo sestavljeno iz niti, prepletenih

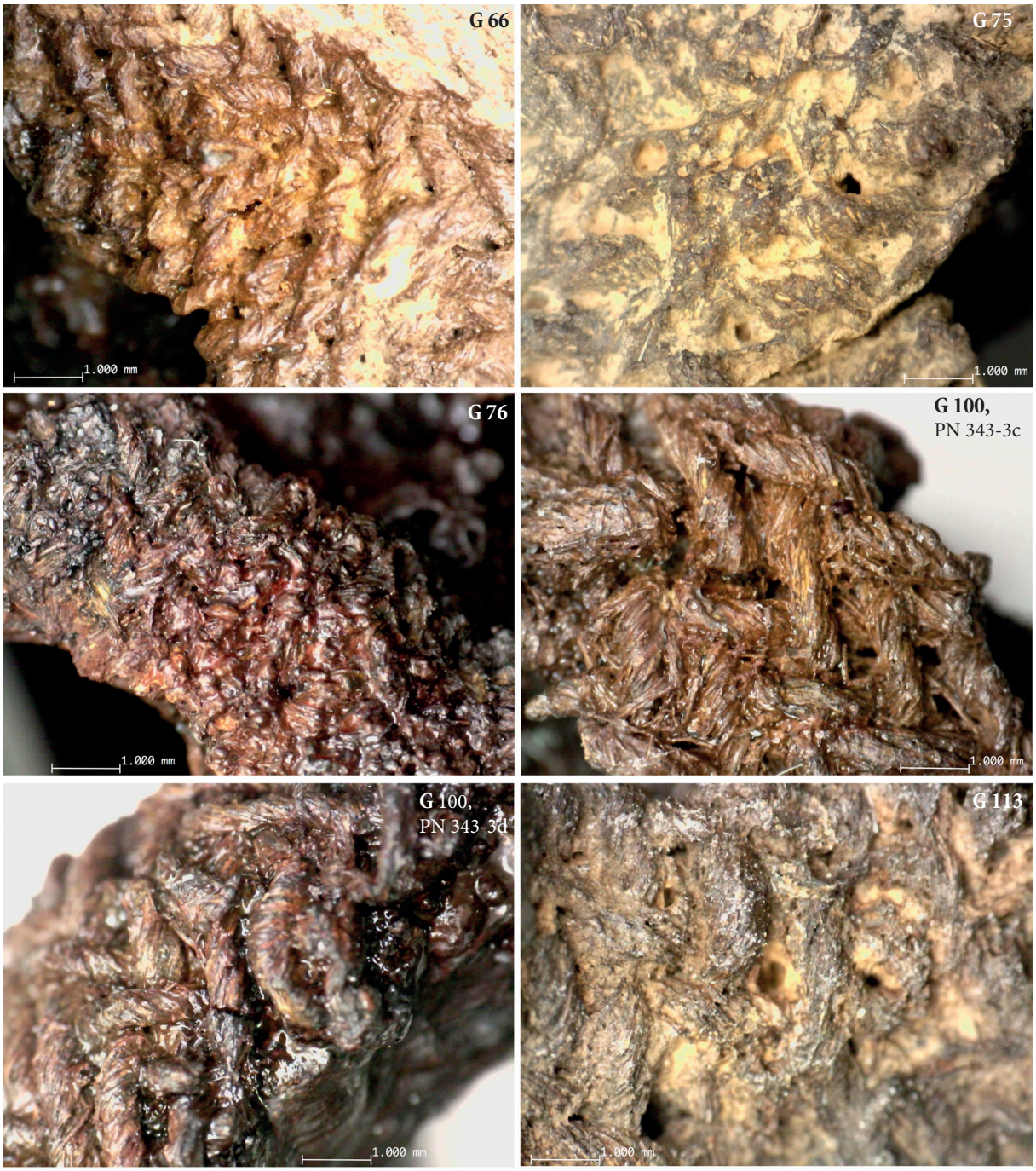



*Fig. 3:* Close-ups of twills.
*Sl. 3:* Bližnji posnetki keperjev.

the fact that the material is plant bast in this case is a strong indicator of splicing. Across the European and Mediterranean regions, splicing as plant fibre thread-making technique appears to have been replaced by draft spinning around 600 BCE (Gleba, Harris 2019). Indeed, the only other textile in the collection made of plant bast fibre has single z-twisted thread.

v nasprotni smeri urinega kazalca (S2z*) (*sl. 5*). Zaradi slabe ohranjenosti sukanja dveh niti ni mogoče dokončno potrditi, vendar pa dejstvo, da gre za niti iz vlaken rastlinskega izvora, močno nakazuje na opisano tehniko. V evropskih in sredozemskih regijah se sukanje kot tehnika izdelave niti iz rastlinskih vlaken pojavi okoli leta 600 pr. n. št., ko nadomesti predenje z vlečenjem (Gleba, Harris 2019). Tovrstna je edina druga preja rastlinskega izvora, ki je sestavljena iz enojne niti z z-zasukom.

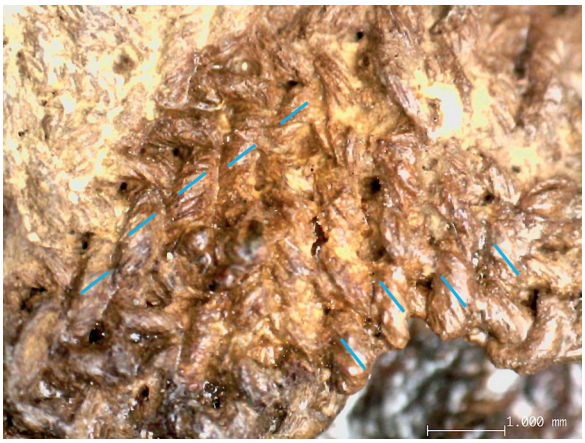



*Fig. 4:* Close-up of a twill from G 65 with blue lines showing different thread twist direction forming a spin pattern.
*Sl. 4:* Bližnji posnetek keperja iz groba 65 z modrimi črtami, ki prikazujejo različno smer zasuka niti, ki tvori vzorec predenja.


*Fig. 5:* Close-up of S2z* thread from G 76.
*Sl. 5:* Bližnji posnetek navoja S2z* iz groba 76.

## FIBRE IDENTIFICATION AND ANALYSIS

### Fibre identification

Fibres and fibre casts were more or less well preserved, with variable preservation within individual samples. Most are preserved as negative casts but some samples have both negative and positive casts. Thirrteen samples were taken for fibre identification and analysis. (*Table 2)*.

## OPREDELITEV IN ANALIZA VLAKEN

### Določitev izvora vlaken

Odlitki vlaken so bili različno ohranjeni,pri čemer se je stopnja ohranjenosti med posameznimi vzorci razlikovala. Večina jih je ohranjenih v negativni obliki, nekateri vzorci pa vsebujejo tako negativne kot tudi pozitivne odlitke. Za identifikacijo in analizo je bilo odvzetih štirinajst vzorcev (*tab. 2)*.

| Grave / Grob | Special Find no. (PN) / Posebna najdba (PN) | Weave / Tkanje | Characteristics / Značilnosti | Material |
|---|---|---|---|---|
| 60 | 234 | tabby / platno | nodes / vozli | plant bast / rastlinsko ličje |
| 61 | 181 | 2/2 twill / keper? | cuticular scales / kutikularne luske | wool / volna |
| 65 | 169 | 2/2 twill / keper | cuticular scales / kutikularne luske | wool / volna |
| 75 | 207 | 2/2 twill / keper | cuticular scales / kutikularne luske | wool / volna |
| 76 | 199 | tabby / platno | nodes / vozli | plant bast / rastlinsko ličje |
| | | 2/2 twill / keper? | cuticular scales / kutikularne luske | wool / volna |
| 84 | 284 | ? | cuticular scales / kutikularne luske, kemp / grobo | wool / volna |
| 90 | 292 | 2/2 twill / keper | cuticular scales / kutikularne luske | wool / volna |
| 96 | 301-2 | t abby / platno? | cuticular scales / kutikularne luske | wool / volna |
| 100 | 343-3b | 2/2 twill / keper | cuticular scales / kutikularne luske | wool / volna |
| | 343-3c | 2/2 twill / keper | cuticular scales / kutikularne luske | wool / volna |
| | 343-3d | 2/2 twill / keper | cuticular scales / kutikularne luske | wool / volna |
| 113 | 392-1 | 2/2 twill / keper | cuticular scales / kutikularne luske | wool / volna |
| 179 | 526 | 2/2 twill / keper | cuticular scales / kutikularne luske | wool / volna |

*Tab. 2:* Summary of fibre identification.
*Tab. 2:* Povzetek prepoznave vlaken.

One tabby and one possibly weft-dominant tabby have the characteristics typical for plant bast fibre, such as nodes or dislocations, however the preservation is insufficient to identify the species (*Fig. 6*). The diameter of 26 fibres in G 60 ranges from 11 to 24 micron, with an average of 16.6, which is consistent with flax (*Linum* sp.).



Ena platnena vezava in ena verjetno votkovno dominantna platnena vezava kažeta značilnosti rastlinskih vlaken kot so členki ali prečne diskontinuitete, vendar pa je ohranjenost nezadostna za določitev rastlinske vrste (*sl. 6*). Premer 26 vlaken iz groba 60 se giblje med 11 in 24 mikroni, s povprečjem 16,6 mikrona, kar je skladno s povprečjem za lan (*Linum* sp.).

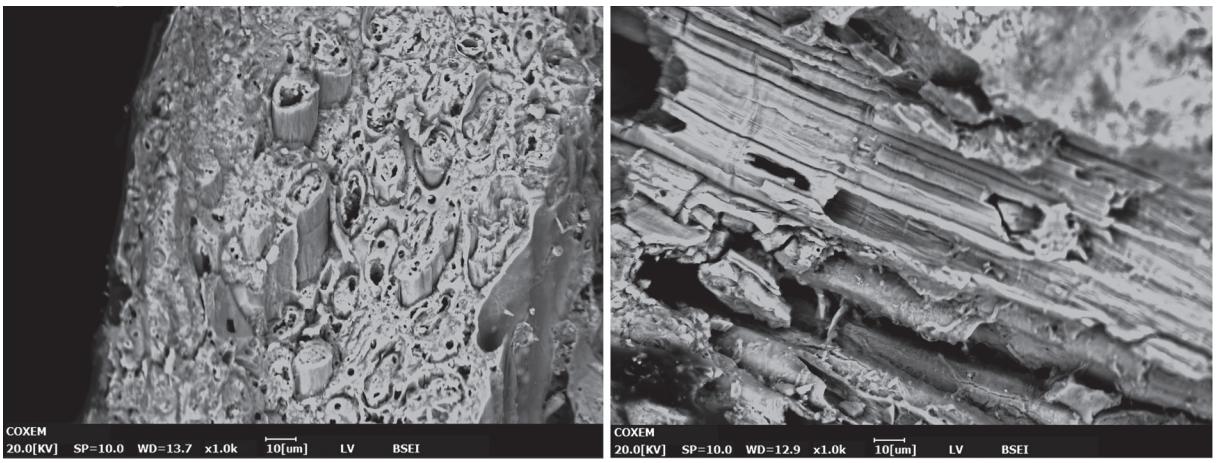
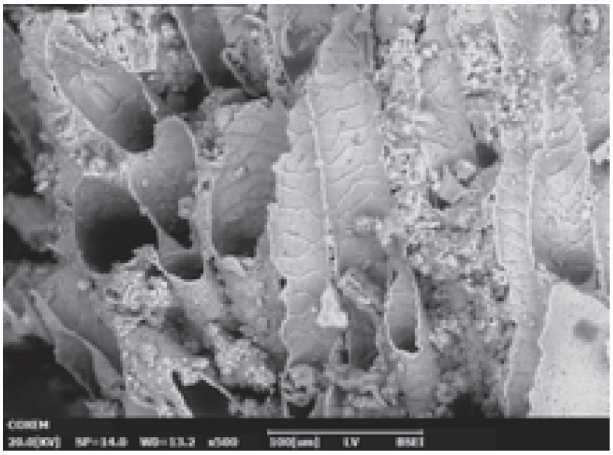
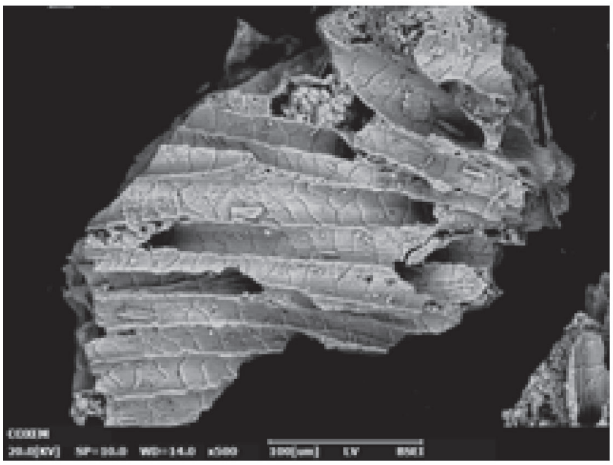



*Fig. 6:* SEM micrographs of positive fibre casts with characteristics of plant bast fibre from G 60 (left) and G 76 (right).
*Sl. 6:* SEM mikrofotografije pozitivnih odlitkov vlaken z značilnostmi rastlinskih vlaken iz ličja iz grobov 60 (levo) in 76 (desno).



G 61

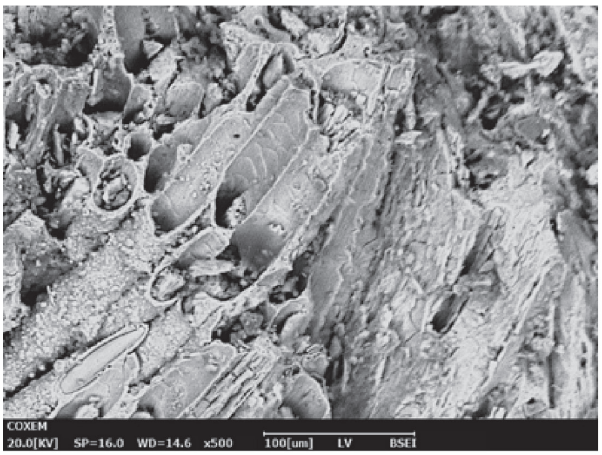
G 65



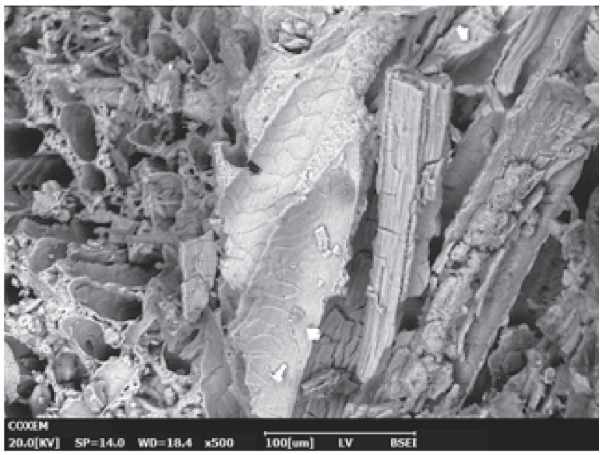
G 75

G 76

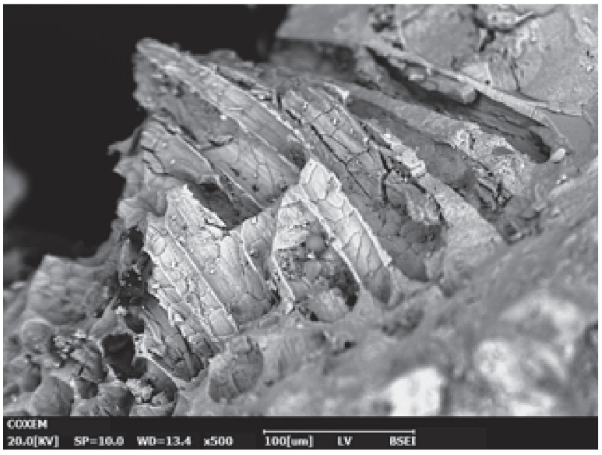
*Fig. 7 / Sl. 7 →*



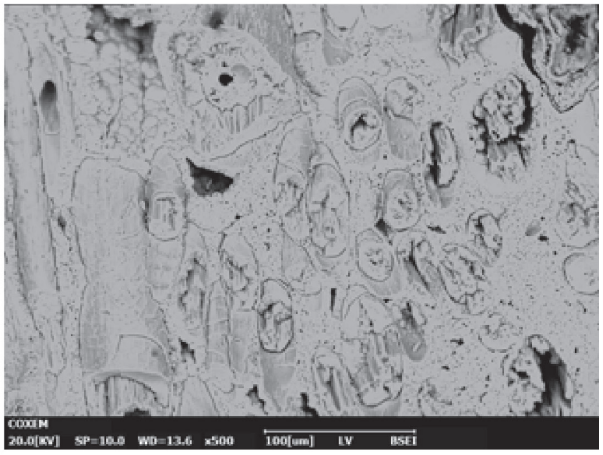

G 84



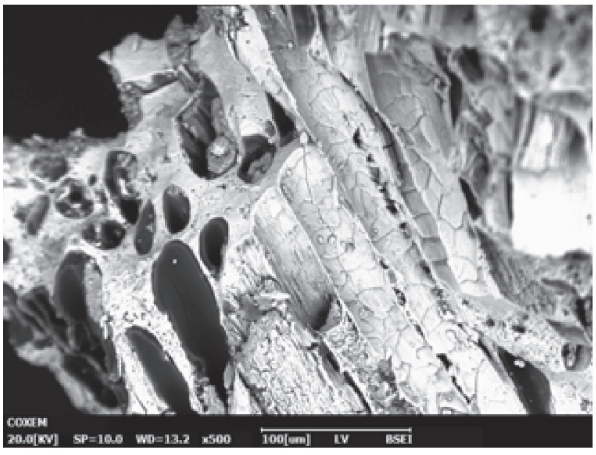

G 90



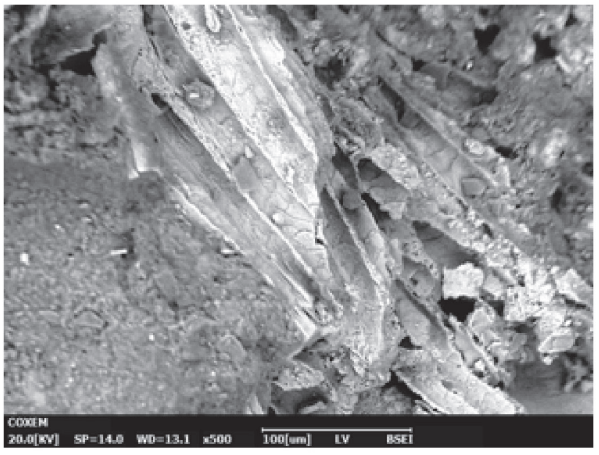

G 96




G 100




G 133




G 179

*Fig. 7*: SEM micrographs of fibres preserving cuticular scales indicative of sheep wool fibre.
*Sl. 7*: SEM mikrofotografije vlaken, ki ohranjajo kutikularne luske, ki kažejo na vlakna ovčje volne.

In all other textiles the raw material is of animal origin, most likely sheep wool, as indicated by the characteristic cuticular scales (*Fig. 7*) and fibre quality analysis (*Table 3*).

Pri vseh drugih tkaninah je surovina živalskega izvora, najverjetneje ovčja volna, kar potrjujejo značilne kutikularne luske (*sl. 7*) in analiza kakovosti vlaken (*tab. 3*).

| Sample / Vzorec | No. fibres / Št. vlaken | Median / Mediana | Mode / Način | Mean / Povprečje | StD | Range / Obseg | % rel. variab. ** | Skewness of distribution / Zakrivljenost distrib. *** |
|---|---|---|---|---|---|---|---|---|
| G61 PN181 | 88 | 25.9 | 23 | 28.5 | 9.76 | 16–55 | 0.34 | 0.8 |
| G65 PN169 | 200 | 27.17 | 27 | 28.04 | 8.1 | 13–51, 59*, 65–67 | 0.29 | 0.32 |
| G76 PN161 | 169 | 21.26 | 15, 21 | 24.95 | 9.76 | 11–51, 55–57, 61–63 | 0.39 | 1.13 |
| G84 PN284 | 133 | 23.05 | 21, 25 | 26.91 | 14.47 | 11–43, 49–55, 59, 69, 81, 97, 111 | 0.54 | 0.8 |
| G90 PN292 | 200 | 21.7 | 19, 27 | 26.33 | 12.58 | 11–59, 69, 83, 97 | 0.48 | 1.1 |
| G96 PN301–2 | 134 | 20.03 | 17 | 23.85 | 12.55 | 13–47, 55, 67, 71–73, 89 | 0.53 | 0.91 |
| G100 PN343–3d | 68 | 25.95 | 23 | 29.5 | 10.55 | 15–49, 59–61 | 0.36 | 1.01 |
| G113 PN392–1 | 115 | 27.12 | 19, 27 | 28.83 | 11.88 | 13–51, 57–61, 73, 79 | 0.41 | 0.43 |
| G179 PN526 | 200 | 22.85 | 17, 25 | 25.2 | 11.39 | 7–57, 61, 69, 73 | 0.45 | 0.62 |

*Diameter outside the main range listed separately / Premer zunaj glavnega dosega je naveden ločeno
** % relative variability= standard deviation/mean / % relativne variabilnosti = standardni odklon/povprečje
*** Pearson's coefficient of skewness = 3x (mean-median)/standard deviation /
Pearsonov koeficient asimetrije = 3x (povprečje-mediana)/standardni odklon

*Tab. 3:* Wool fibre quality data.
*Tab. 3:* Podatki o kakovosti volnenih vlaken.

**Wool quality analysis**

Wool fibre quality analysis was possible in the case of 9 samples, where negative casts of wool fibres permitted measuring the diameter. The analyses reflect the entire textile since it was not possible to distinguish and sample warp and weft separately. The results are summarized in *Table 3*. Histograms are presented in *Fig. 8*. Overall the wool appears to be of comparable quality in all analysed samples, with the histograms skewed to the right, the range between 11–50 micron and multiple outliers (reflected in high standard deviation) and mean diameter mostly between 25 and 29 micron and two modes in five cases. The similarities suggest that wool of similar quality was used in all analysed textiles, possibly deriving from the same (local?) sheep variety.

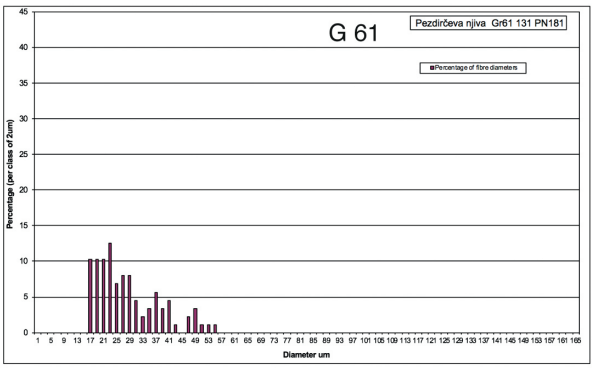
In some cases, combing of wool in preparation for spinning is indicated by adjacent fibres with opposing scale direction (*Fig. 9*). The wide range and the fact that some guard hair and kemp (*Fig. 10*) are still present in all samples indicate that fibre processing was not very thorough.

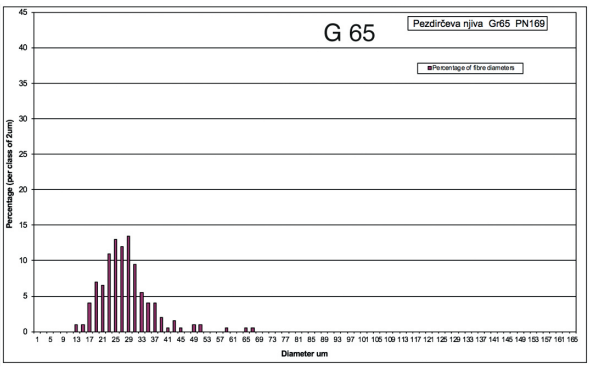
**Analiza kakovosti volne**

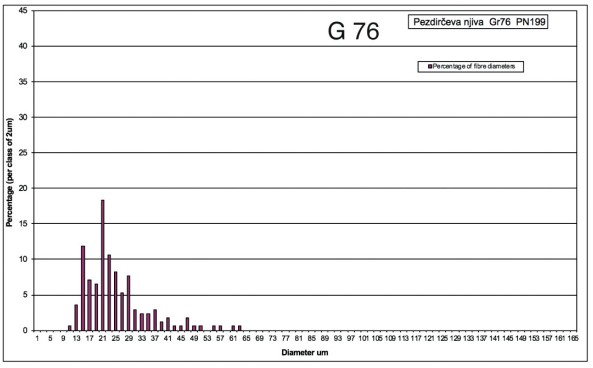
Analiza kakovosti volnenih vlaken je bila mogoča pri devetih vzorcih, kjer so negativni odlitki volnenih vlaken omogočili merjenje premera. Analize odražajo celotno tkanino, saj ni bilo mogoče ločeno razlikovati in vzorčiti osnovnih in votkovnih niti. Rezultati so povzeti v *tabeli 3*, histogrami so prikazani na *sliki 8*.

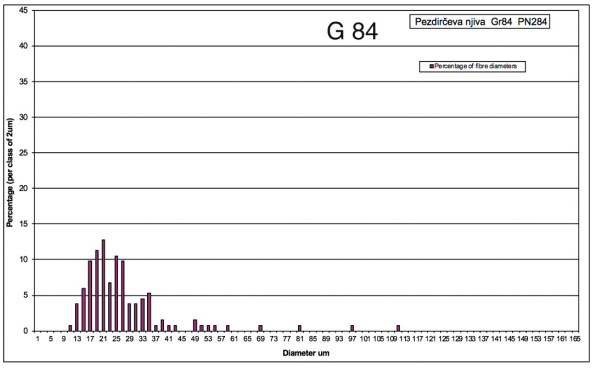
Na splošno je volna v vseh analiziranih vzorcih primerljive kakovosti. Histogrami so pomaknjeni v desno, razpon premera vlaken sega od 11 do 50 mikronov, z več izstopajočimi vrednostmi (kar se odraža v visoki standardni deviaciji), povprečni premer pa se večinoma giblje med 25 in 29 mikroni, petkrat z dvema vrhovoma porazdelitve. Podobnosti nakazujejo, da je bila v vseh analiziranih tekstilih uporabljena volna podobne kakovosti, ki je morda izvirala iz iste (lokalne?) ovčje pasme.

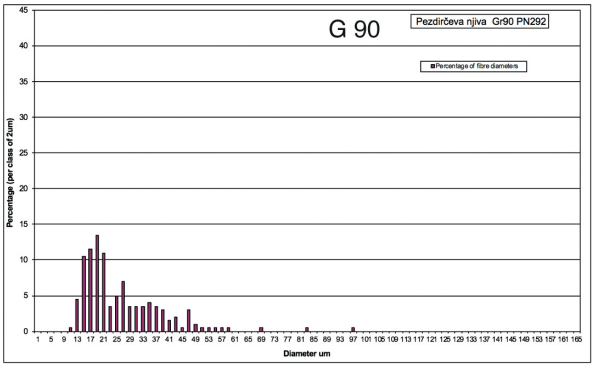
Sosednja vlakna z nasprotnimi smermi lusk *(sl. 9)* v nekaterih primerih nakazujejo česanje volne pred predenjem. Širok razpon premerov in prisotnost zaščitnih in grobih vlaken (*sl. 10*) v vseh vzorcih kažeta, da obdelava vlaken ni bila zelo temeljita.

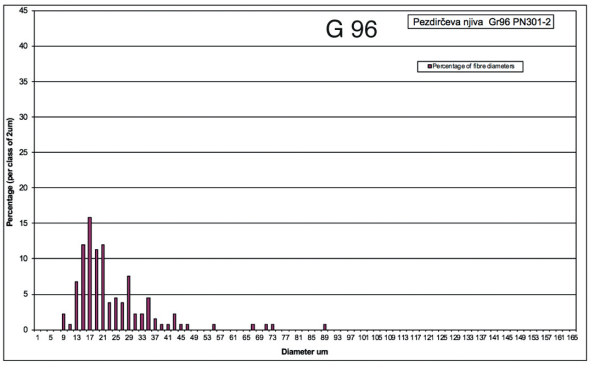


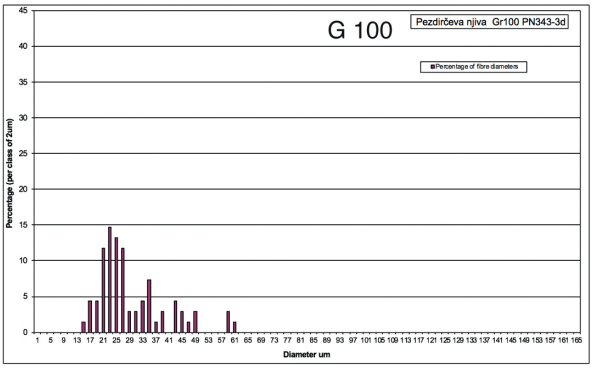



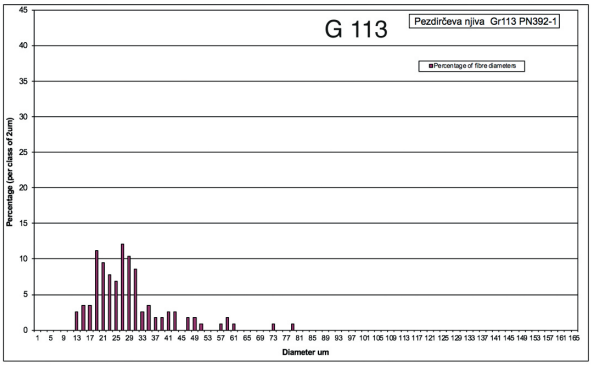



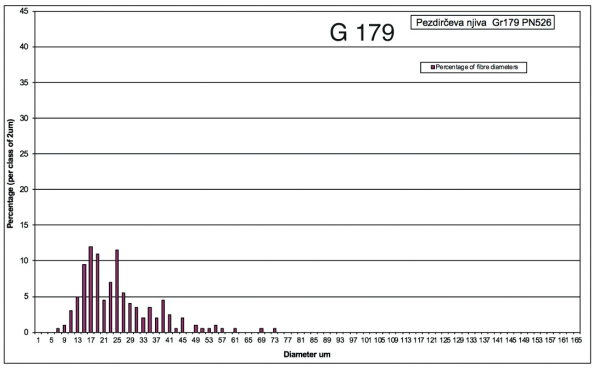




*Fig. 8:* Histograms showing fibre diameter distribution.
*Sl. 8:* Histogrami, ki prikazujejo porazdelitev premera vlaken.

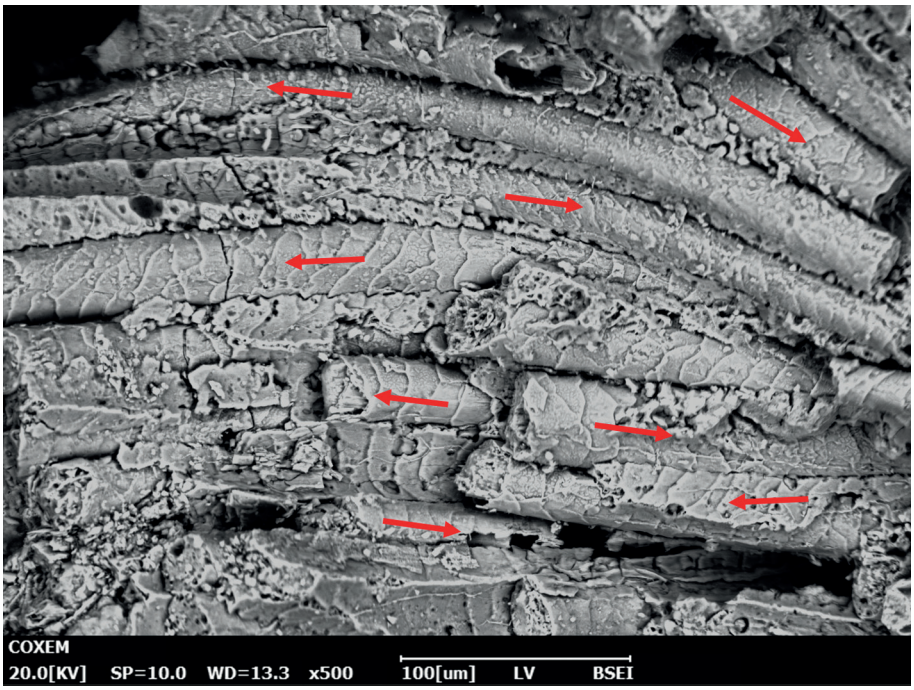



*Fig. 9:* SEM micrograph of adjacent wool fibres in G 65 (PN 196) with scales in opposing directions indicative of combing.
*Sl. 9:* SEM mikrofotografije sosednjih volnenih vlaken v grobu 65 (PN 196) z luskami v nasprotnih smereh, ki kažejo na česanje.

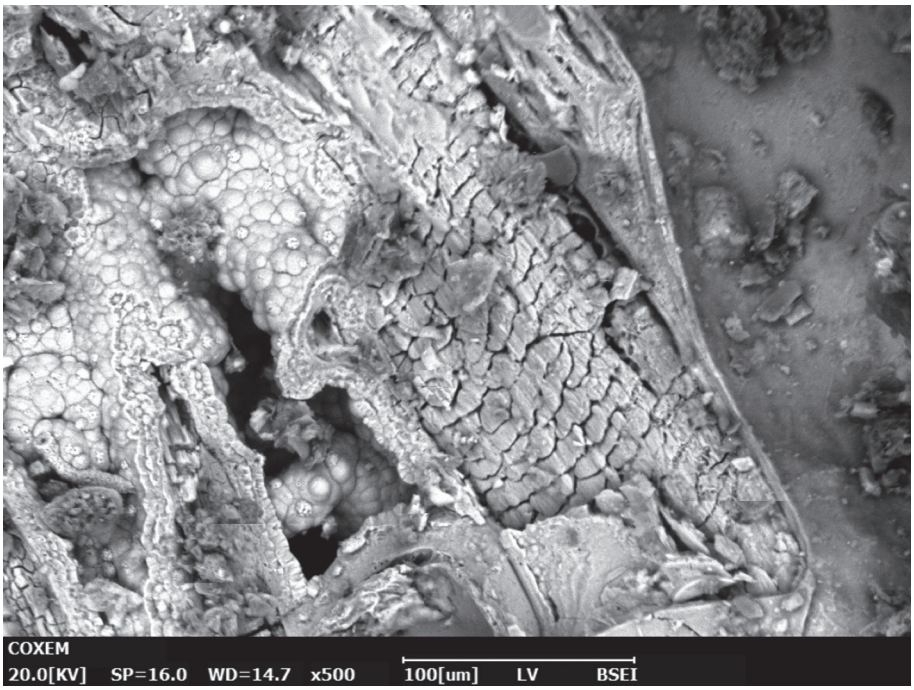



*Fig. 10:* A kemp fibre in the textile from G 84.
*Sl. 10:* Groba vlakna v tkanini iz groba 84.

## DISCUSSION

The textiles examined present different weave types – balanced and unbalanced tabby and twill made of wool, and plant bast fibre balanced and possibly weft-dominant tabby. Only two textiles – both tabbies – are made of plant bast fibre (most likely flax). Wool twills constitute the most prevalent weave among the newly analysed textiles from Pezdirčeva njiva.

The quality of textiles, expressed in number of threads per cm, demonstrates a relatively restricted range in comparison to other corpora from Slovenia and elsewhere, for example the recently analysed textile corpus from the Dolenjska Early Iron Age cultural group, mostly from Novo mesto (Gleba et al. 2024), or Vače and Magdalenska gora (Bender Jørgensen 2005, 143–145, Fig. 7; Lau 2022).

The thread structure is quite homogeneous across the examined corpus, with most textiles having z twist direction, but with several of the twills displaying a spin or shadow pattern. This contrasts with the textile corpus from Dolenjska, where textiles from the 5$^{th}$ century BCE onwards have s-twisted thread (Gleba et al. 2024).

Twills with spin pattern are typical for Italic-Central European textile culture during the Iron Age (Gleba 2017) and are common in Croatia and Slovenia (Gleba et al. 2024).

The general uniformity of wool fibre quality suggests that all of these textiles were made from similar wool of likely local origin.

ACKNOWLEDGMENTS

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## RAZPRAVA

Raziskane tkanine prikazujejo različne vrste tkanja – uravnoteženo in neuravnoteženo platneno in keper vezavo iz volne ter uravnoteženo in verjetno votkovno dominantno platneno vezavo iz rastlinskih vlaken (najverjetneje lanu). Volneni keperji predstavljajo najpogostejšo vrsto tkanja med novo analiziranimi tkaninami s Pezdirčeve njive.

Kakovost tkanin, izražena s številom niti na cm, kaže relativno omejen razpon v primerjavi z drugimi korpusi iz Slovenije in širše, na primer z nedavno analiziranim tekstilnim korpusom iz dolenjske halštatske skupine, večinoma iz Novega mesta (Gleba et al. 2024) ali Vač in Magdalenske gore (Bender Jørgensen 2005, 143–145, sl. 7; Lau 2022).

Struktura niti je precej homogena v celotnem preučevanem korpusu, saj ima večina tkanin niti z z-zasukom, pri čemer več keperjev prikazuje vzorec s senčenjem ali izmeničnim predenjem. To je v nasprotju s tekstilnim korpusom iz Dolenjske, kjer imajo tkanine od 5. stoletja pr. n. št. dalje niti s s-zasukom (Gleba et al. 2024).

Keperji z vzorcem predenja so značilni za italsko-srednjeevropsko tekstilno kulturo v železni dobi (Gleba 2017) in so pogosti na Hrvaškem in v Sloveniji (Gleba et al. 2024).

Splošna enotnost kakovosti volnenih vlaken kaže, da so bile vse raziskovane tkanine izdelane iz volne podobne kakovosti, verjetno lokalnega izvora.

ZAHVALA

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