The Archaeology of Textiles — Recent advances and new methods

Arheologija tekstila — Suvremena dostignuća i novije metode

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ABSTRACT: Archaeology of textiles has seen rapid development in recent years. The paper presents an overview of current knowledge on prehistoric textiles from Europe, surveying recent advances in methods of analysis such as fibre and dyes analysis, radiocarbon dating, and strontium isotope analysis that is promising to allow provenancing of textile fibres such as wool, flax or nettle. Experimental archaeology as a tool in textile studies will also be discussed.

KEYWORDS: *Prehistoric textiles, textile analysis, fibres, dyes, experimental archaeology*

SAŽETAK: Arheologija tekstila doživljava nagli razvoj posljednjih godina. U članku se predstavlja pregled dosadašnjih saznanja o prapovijesnom europskom tekstilu, prikazuju se recentna dostignuća u metodama analize, kao što su analiza vlakana i boja, datiranje radioaktivnim ugljikom te analiza izotopa stroncija koja bi mogla pridonijeti određivanju podrijetla tekstilnih vlakana kao što su vuna, lan ili kopriva. Raspravlja se i o eksperimentalnoj arheologiji kao metodi proučavanja tekstila.

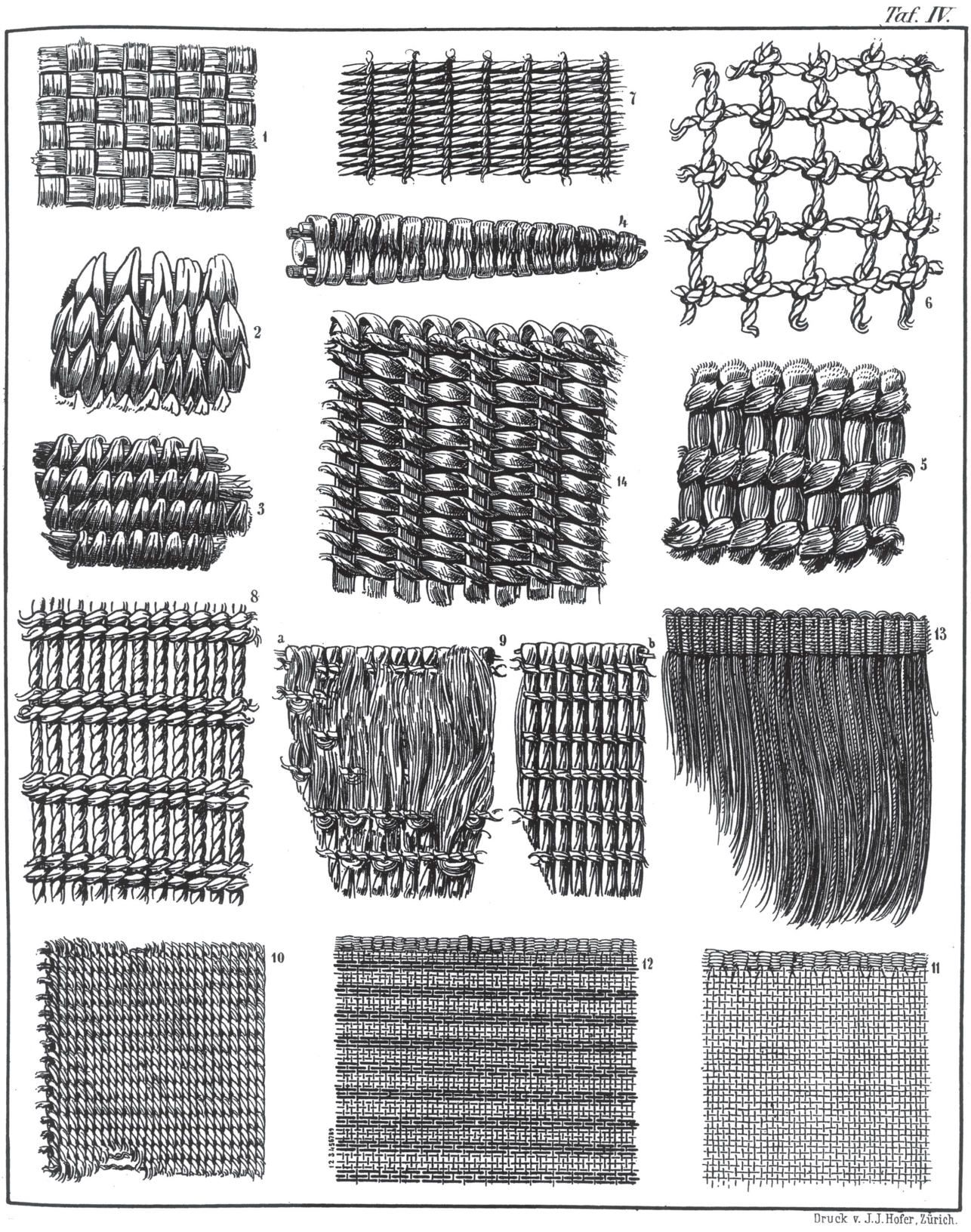
KLJUČNE RIJEČI: *prapovijesni tekstil, analiza tekstila, vlakna, boje, eksperimentalna arheologija*

Introduction

Textiles are organic materials and easily disintegrate, especially if buried in the ground. Accordingly, textiles are rare in archaeological contexts, unless in specific conditions of preservation such as in the deserts of Asia and the Near East, or frozen or waterlogged environments.[1] The salt mines of Hallstatt in Austria have proved another rich source of prehistoric textiles.[2] Most of these are fragments that may inform us of textile types and textures, and sometimes offer constructional details that can be used to deduce their form, function and the technology that was used to make them.[3] Complete items are very rare indeed. In Northern Europe, oak-log coffins have preserved complete Bronze Age costumes;[4] a handful of complete

Uvod

Tekstil je organski materijal koji se lako raspada, osobito kada je zakopan u tlu. Stoga ga rijetko nalazimo sačuvanog u arheološkom kontekstu, osim u posebnim uvjetima, kakvi vladaju u azijskim ili bliskoistočnim pustinjama, ili pak u zamrznutom ili vodom natopljenom okolišu.[1] Rudnici soli u Hallstattu u Austriji pokazali su se još jednim bogatim izvorom prapovijesnog tekstila.[2] Većinom je riječ o fragmentima koji nam pružaju uvid u vrste tekstila i njihove teksture, a katkad i konstrukcijske detalje uz pomoć kojih možemo odrediti oblik, funkciju te tehnologiju korištenu pri izradi.[3] U cijelosti sačuvani predmeti prava su rijetkost. U sjevernoj Europi, hrastovi ljesovi u cijelosti su sačuvali odore iz brončanog doba,[4]



1. Mats, nets, twined fabrics, wicker-weave and woven fabrics from Wetzikon-Robenhausen in Switzerland, Late Neolithic (based on 3. Pfahlbaubericht, Antiquarische Gesellschaft Zürich 1860, Taf. IV).
Prostirke, opletene tkanine, pleteni ratan i pletene tkanine s nalazišta Wetzikon-Robenhausen u Švicarskoj, kasni neolitik (prema 3. izvještaju o sojeničkom nalazištu, Antikvarsko društvo Zürich 1860., Tab. IV)

Iron Age garments have been found in peat bogs.[5] At the site of Verucchio in northern Italy, two graves were found to contain several items of clothing dated to the Villanova culture.[6] The technically complete woollen textile found in a Bronze Age burial from Pustopolje in Bosnia-Herzegovina is therefore a very welcome addition to our data and our knowledge about prehistoric textiles in Europe.[7]

The great majority of archaeological textiles are tiny fragments, preserved in connection with metal artefacts such as bronze, iron or silver. Although often mineralised, and better designated as pseudomorphs than textiles, it is nonetheless possible to extract information from them on weave, yarn types and density, as well as identify if they had been made of flax or wool. The stratigraphic position of textile remain(s) holds important potential for interpreting their function.[8] Other fragments are still organic; in these cases data collection is less complicated, and it is possible to carry out further analyses, e.g. for traces of dyestuffs. When data from many fragments are put together it may be possible to make wider deductions on regional and chronological distributions and changes.[9] When sufficient data from a specific area are available it becomes possible to discuss details of function and form. Penelope Walton Rogers's work on Anglo-Saxon textiles and clothing is a good example.[10] Data from almost 2,000 individual burials has been used to reconstruct clothing from various parts of Britain including variations due to the age and gender of individuals, as well as charting changes over time.

Large, complete items are particularly valuable for the understanding of prehistoric textile craft and clothing. This especially applied to edges, i.e. transverse borders and selvedges as they hold important information on how the textile was made. The textile from Pustopolje, Kupres in Bosnia-Herzegovina now consists of almost 600 fragments, but as all four edges are preserved it has proved possible to establish its size, how it looked like, and how it was made. Further, the Pustopolje textile is still organic, i.e. it consists of wool rather than being mineralised. This has made it possible to carry out several types of scientific analyses: of the fibres, and for dyestuffs. Radiocarbon dating of the textile itself has also been possible, resulting in an adjustment to the dating that had been carried out in the 1980s based on material from the wooden structure of the burial. These methods of analysis are important tools for the textile archaeologist, in addition to the technical analysis of the textile. Further potential methods that might be applied are strontium isotope analysis and a DNA analysis – both recently developed or are in the process of being developed and are showing great promise.[11]

Prehistoric Textiles from Europe: a brief overview

Impressions of ropes and netting in fired clay recovered from a number of Upper Palaeolithic sites form the earliest evidence of fibre technologies in Europe, and are identi-

dok je nekoliko cjelovitih željeznodobnih odjevnih predmeta pronađeno u tresetištima.[5] Na nalazištu Verruchio u sjevernoj Italiji pronađena su dva groba koji sadrže nekoliko odjevnih predmeta datiranih u vilanovsku kulturu.[6] U brončanodobnom ukopu iz Pustopolja u Bosni i Hercegovini pronađen je tehnički cjelovit vuneni tekstilni predmet, koji je stoga doista dobrodošao prilog našem poznavanju prapovijesnog tekstila u Europi.[7]

Veliku većinu arheoloških tekstilnih nalaza čine sitni fragmenti, sačuvani zajedno s metalnim predmetima od bronce, željeza ili srebra. Iako su nalazi često mineralizirani i bolje bi ih bilo označiti kao pseudomorfe nego kao tekstilne predmete, mogu nam pružiti podatke o tkanju, tipovima prediva i njihovoj gustoći, a moguće je odrediti i jesu li bili izrađeni od lana ili od vune. Stratigrafski položaj ostat(a)ka tekstilnog predmeta pruža nam mogućnost interpretiranja njegove funkcije.[8] Neki fragmenti su još u organskom stanju; u tim slučajevima skupljanje podataka nije toliko složeno te je moguće provesti dodatne analize, npr. tragova bojila. Prema podacima prikupljenima iz većeg broja fragmenata, moći će se izvoditi detaljniji zaključci o regionalnoj ili kronološkoj distribuciji i promjenama.[9] Kada postoji dovoljno podataka s određenog područja, možemo raspravljati o detaljima forme i funkcije predmeta. Dobar je primjer rad Penelope Walton Rogers o anglosaksonskom tekstilu.[10] Korišteni su podaci iz gotovo dvije tisuće pojedinačnih ukopa kako bi se rekonstruirali odjevni predmeti iz raznih dijelova Britanije, uključujući varijacije, ovisno o starosti i rodu pojedinaca, a praćene su i njihove promjene tijekom vremena.

Za razumijevanje načina izrade prapovijesnog tekstila i odjeće osobito su vrijedni veliki, cjeloviti predmeti. To se posebno odnosi na rubove, tj. poprečne obrube i žive rubove koji pružaju važne informacije o tome kako je izrađen tekstilni predmet. Predmet iz Pustopolja pokraj Kupresa u Bosni i Hercegovini danas se sastoji od šest stotina fragmenata, no budući da su sačuvana sva četiri ruba, bilo je moguće utvrditi njegovu veličinu, izgled te način izrade. Osim toga, tekstilni predmet iz Pustopolja još je u organskom stanju, tj. sastoji se od vune i mineraliziran je. Stoga je bilo moguće provesti nekoliko tipova analize vlakana i bojila. Rezultati analize radioaktivnim ugljikom modificirali su dataciju koja je bila izvršena 1980-ih na drvenom materijalu iz istog ukopa. Osim tehničke analize, sve navedene metode analize čine važna sredstva istraživačima arheološkog tekstila. Daljnje metode koje se mogu primijeniti su analiza izotopa stroncija i DNK analiza – obje su razvijene u novije vrijeme ili se tek razvijaju i vrlo su perspektivne .[11]

Prapovijesni europski tekstil: kratki pregled

Na velikom broju nalazišta iz gornjeg paleolitika pronađeni su otisci užadi i mreža u pečenoj glini, koji su najranija svjedočanstva o tehnologiji vlakana u Europi. Tkanine su

2. Garments from (a) Borum Eshøj grave C and, (b) Muldbjerg (after Boye 1896, Taf. IV and XI).
Odjevni predmeti iz (a) groba C na nalazištu Borum Eshøj i (b) Muldbjerg (prema Boye 1896., Tab. IV i XI)

fied as made of plant fibres.[12] Some of them are reported to be made in twining, a technique that may be used to produce flat sheets of material, i.e. textiles.[13] Although sparse, these finds represents the first glimpses of textiles in Europe, reminding us that items made of perishable materials like fibres were an important part of the material culture of early Europeans. Mesolithic textiles are equally rare, and appear as a variety of mainly string, rope, nets and netting made of bast fibres.[14]

The lakes of the Alpine region have supplied a substantial body of textiles and basketry from the Neolithic and

bile izrađene od biljnih vlakana.[12] Smatra se da su neke bile izrađene tehnikom prepleta i/ili opleta kojom se mogu proizvesti tanke plohe materijala, odnosno tekstil.[13] Takvi su nalazi oskudni, no predstavljaju prve naznake tekstilnih predmeta u Europi i podsjećaju nas na to da su predmeti izrađeni od trošnih materijala poput vlakana bili važna sastavnica materijalne kulture ranih Europljana. Tekstilni predmeti iz mezolitika jednako su rijetki, a pojavljuju se u raznim inačicama uzica, užeta, mreža i mrežastih tkanina izrađenih od likovih vlakana.[14]

Early Bronze Age.[15] They show that reeds, grasses and bast fibres were processed and utilised to produce a wide range of items, such as rope and string, nets, mats, baskets, and items of clothing. The clothing of Ötzi, or Similaun Man, comprised a grass mantle and other items that have fragmented parallels in the lakes.[16] Techniques such as knotless netting, knotted nets, coiled basketry, plaiting and twining were used (fig. 1). A new technique, weaving, appears from the late 6th millennium BC, along with a new fibre: flax. The earliest finds of tabby weaves–impressions in clay–derive from the earliest Linear Pottery culture in Central Europe, e.g. at Hessenrode, Germany.[17]

While the main fibres of the Stone Age were various vegetable fibres, wool became a major feature of the Bronze Age. The best preserved examples of Bronze Age textiles derive from a series of oak-log coffins found in Denmark in the late 19th and early 20th centuries (fig. 2).

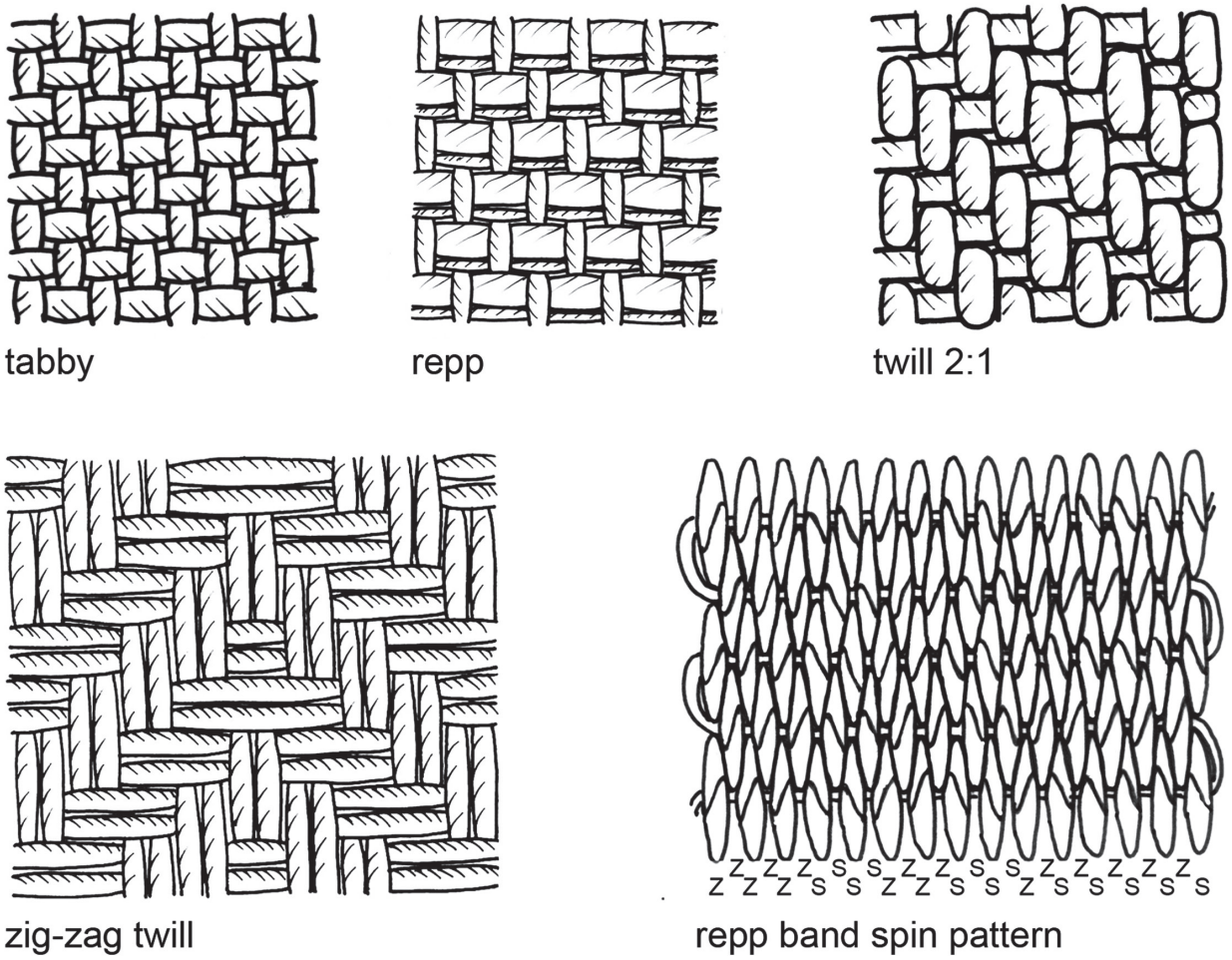
Seven complete Bronze Age costumes have been recovered, forming a highlight of the exhibition of the National Museum of Denmark.[18] They are also an invaluable source of knowledge on Bronze Age textiles and clothing. Four of the costumes belonged to men. They suggest that male costume consisted of a short kilt or a longer wrap around the body, held in place by a sash or belt; a semicircular or oval cloak; and one or two caps. Female costume, as represented by three female burials, consisted of a blouse with half-long sleeves, and either a short skirt made of cords, or a large, cylinder-shaped garment covering the lower body and tied with a sash. Head coverings in the form of hair nets and sprang caps, a kind of socks and elaborate, tasselled sashes also formed part of female clothing. So-called blankets, i.e. large, rectangular pieces of textiles also formed part of the burial furnishings. All items are made of wool; almost all textiles are woven in tabby or variations of tabby such as repp. Fringes are used as a decorative aspect. Further techniques comprise sprang, netting, embroidery, and the insertion of pile. In addition, almost four hundred fragments of Bronze Age textiles have been recovered from southern Scandinavia and northern Germany.[19] They help adding nuances to perceptions of Scandinavian Bronze Age clothing and textiles. While textile remains are relatively frequent, textile tools are not. Hardly any Bronze Age spindle whorls have been found in Scandinavia, and loom weights that serve as evidence of the warp-weighted loom are also largely missing.

In Central Europe, the salt mines of Hallstatt have supplied another important body of Bronze Age textiles, along with lakeside settlements in Northern Italy and sparse grave finds.[20] Here the picture is multi-faceted. In Early Bronze Age settlements and graves flax is the main textile fibre–caused by the strong Neolithic traditions[21] as well as by the environmental influence on the pile dwelling sites, which destroy textiles of animal origin. Early Bronze Age textiles are usually of plied yarn and tabby, sometimes

Jezera u alpskoj regiji bogat su izvor tekstilnih predmeta te predmeta od pruća iz neolitičkog i ranog brončanog doba.[15] Nalazi pokazuju kako su se trska, trave i likova vlakna prerađivala i koristila za proizvodnju širokog raspona predmeta, poput užadi i uzica, mreža, prostirki, košara te odjevnih predmeta. Odjeća Oetzija, ili Čovjeka iz Similauna, sastojala se od ogrtača od trave i drugih komada odjeće kojima paralele nalazimo u fragmentima iz jezera.[16] Za izradu su se koristile tehnike poput pletenja bez čvorova, mreže s čvorovima, tehnike spiralnih stukova, pletenja i pletenja s kosturom (**sl. 1**). Nova tehnika – tkanje – pojavila se potkraj 6. tisućljeća pr. Kr., kao i novo vlakno: lan. Najstariji nalazi tzv. običnog tkanja su otisci u glini koji potječu iz najranijeg razdoblja kulture linearne keramike u srednjoj Europi, npr. s nalazišta Hesenrode u Njemačkoj.[17]

Tijekom kamenog doba glavnina vlakana bila je biljnog porijekla, dok je vuna karakteristična za brončano doba. Najbolje sačuvani primjerci brončanodobnog tekstila potječu iz nekoliko hrastovih ljesova pronađenih u Danskoj potkraj 19. i početkom 20. stoljeća (**sl. 2**). Sačuvano je sedam cjelovitih odora iz brončanog doba, koje su činile okosnicu izložbe postavljene u Nacionalnom muzeju Danske.[18] Te su odore neprocjenjiv izvor spoznaja o tekstilnim predmetima i odijevanju u brončanom dobu. Četiri kostima pripadala su muškarcima. Sudeći po njima, muška se odora sastojala od kratkog kilta ili dužeg ogrtača oko tijela, pričvršćenog tkanicom ili pojasom, polukružnog ili ovalnog plašta te od jedne ili dviju kapa. Ženska odora, pronađena u tri ženska ukopa sastojala se od košulje poludugih rukava te suknje od konopa ili širokog valjkastog odjevnog predmeta koji je pokrivao donji dio tijela i bio povezan tkanicom. Dio ženske odjeće bila su i pokrivala za glavu, u obliku mreža za kosu i jalbe, zatim neka vrsta čarapa te fino izrađene tkanice s resama. Ponjave, odnosno veliki pravokutni komadi tekstila također su bili dio pogrebne opreme. Svi komadi odjeće bili su izrađeni od vune; gotovo svi predmeti izrađeni su tehnikom običnog tkanja ili njezinim varijacijama, primjerice ripsom. Rubovi su korišteni kao dekoracija. Ostale tehnike uključivale su jalbu, tkanje mreža, vezenje te oblikovanje omčice. Uz spomenute, u južnoj Skandinaviji i sjevernoj Njemačkoj pronađeno je još gotovo četiri stotine fragmenata brončanodobnog tekstila[19] uz pomoć kojih možemo steći detaljniju sliku o odijevanju i tekstilnim predmetima iz brončanog doba u Skandinaviji. No dok su fragmenti tekstila relativno čest nalaz, alatke za njihovu izradu to nisu. U Skandinaviji gotovo da nisu pronađeni brončanodobni pršljenovi za vretena, kao što nema ni nalaza tkalačkih utega koji bi svjedočili o postojanju okomitih tkalačkih razboja s utezima.

U srednjoj Europi, još jedna važna skupina brončanodobnih tekstilnih predmeta potječe iz rudnika soli u Hallstattu te iz naselja na jezerima sjeverne Italije, uz

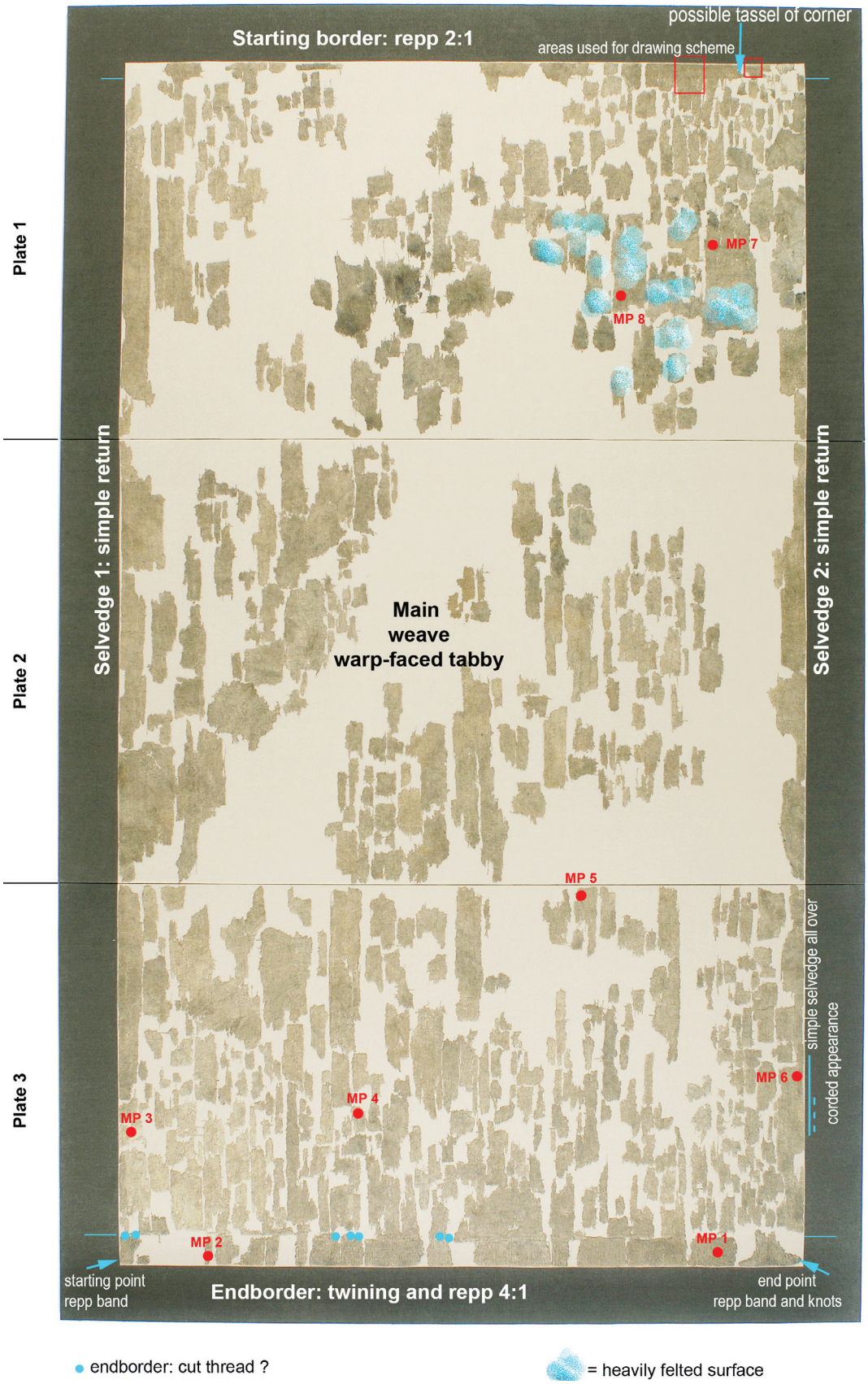


3. Weave types in Bronze Age Europe (graphics: K. Grömer).
Tipovi tkanja u brončanodobnoj Europi (grafički prikaz: K. Grömer)

decorated with sewn-on beads, fringes or floating threads. The copper and salt mines at Mitterberg and Hallstatt, both dated between 1600 and 1200 BC, show a full developed wool textile culture.[22] The woollen tabbies are made of single yarn and are coarser than the Early Bronze Age linens. But they offer something new: colour. Textiles dyed blue, yellow and red were found at Hallstatt.[23] Spin patterns are also a feature developed in this period, identified at both find spots. A new weave, twill, was introduced; fine chevron twills are known from Middle Bronze Age Hallstatt (fig. 3). Spindle whorls and loom weights are frequent in Bronze Age settlements of Central Europe.[24] The alpine lake dwellings even offer wooden textile tools like weaving swords or weaving combs.[25]

Bronze Age textiles are relatively rare in southern Europe, i.e. the Iberian Peninsula, Mediterranean Italy, the Balkans and Greece.[26] Most are linen tabbies, with some variations such as half-basket weave; wool, goat hair, hemp and nettle fibres appear occasionally. Decorative aspects comprise fringes, tassels and embroidery. Textile tools such as spindle whorls and loom weights are frequent.[27] The textile from Pustopolje in Bosnia-Herzegovina is a wool

sporadične grobne nalaze.[20] U pogledu toga, slika je vrlo složena. U naseljima i grobovima ranoga brončanog doba glavno tekstilno vlakno bio je lan, što je posljedica snažnih neolitičkih tradicija,[21] ali i utjecaja okoliša–u sojeničkim naseljima uništen je tekstil životinjskog porijekla. Tekstilni predmeti iz ranoga brončanog doba obično su bili izrađeni od višenitnog prediva, tehnikom običnog tkanja, katkad ukrašeni našivenim perlicama, ukrasnim rubovima i flotirajućim nitima. Rudnici bakra i soli u Mitterbergu i Hallstattu datiraju između 1600 i 1200 g. pr. Kr. te pokazuju posve razvijenu kulturu vunenog tekstila.[22] Vunene tkanine izrađene su tehnikom običnog tkanja, od jednonitnog su prediva i grublje od ranobrončanih platna. No donose novinu: boju. U Hallstattu su pronađene tkanine obojene plavom, žutom i crvenom bojom.[23] U navedenom su se razdoblju razvili tipični uzorci predenja, a pronađeni su na objema skupinama nalazišta. Pojavila se i nova vrsta tkanja – keper. Iz brončanodobnog Hallstatta poznata su nam i fina ševron tkanja (**sl. 3**). U brončanodobnim naseljima srednje Europe česti su nalazi pršljenova za vretena i tkalačkih utega.[24] Naseobine na alpskim jezerima



4. The textile from Postopolje in Bosnia Herzegovina, record of textile data (photo: Croatian Conservation Institute; graphics: K. Grömer). *Tekstilni predmet iz Pustopolja u Bosni i Hercegovini, zabilježeni podaci o tekstilu (snimak: Hrvatski restauratorski zavod; grafički prikaz: K. Grömer)*

5. Spindle-whorls, Iron Age. Collections of the Institute for Prehistory, University Vienna (photo: K. Grömer).
Pršljeni za vretena, željezno doba. Zbirke Instituta za prethistoriju Sveučilišta u Beču (snimila: K. Grömer)

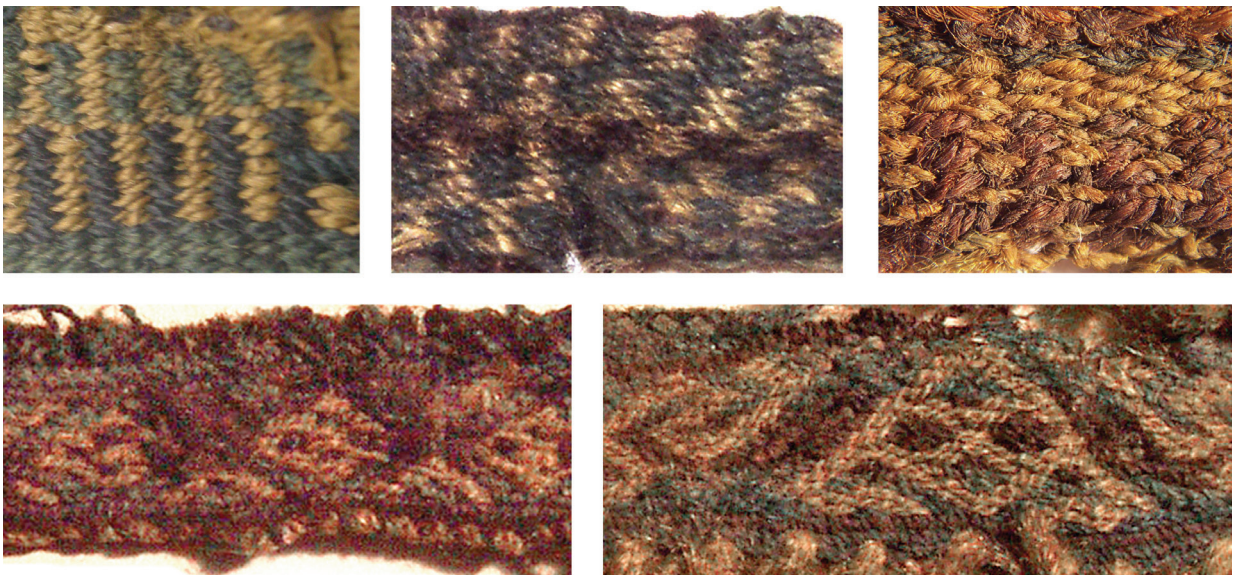
tabby complete with starting and finishing borders as well as selvedges[28]. The textile is well made, and the evenness of yarns and fabric shows that Bronze Age textile craftspeople in the Balkans were skilled spinners and weavers who knew how to work their raw materials into a high-quality fabric, using drop spindles and the warp-weighted loom (fig. 4).

Textile tools remained much the same in the Bronze Age and Iron Age of South and Central Europe.[29] Spindle whorls are often found in female graves. Different sizes and weights indicate that yarns were made with different thickness (fig. 5). Iron Age textiles have been found at many sites in Europe. In northern Europe, acid bogs have proved a source for well-preserved wool textiles and garments, such as cloaks, skirts and various forms of wraps.[30] In Central Europe, the salt mines of Hallstatt and Dürrnberg form major sources of well-preserved textiles in full colour (fig. 6). Fancy weaves, stripes and checks, patterns with floating weft or warp are known as well as multi coloured repp bands and tablet-woven borders with meanders, triangles, lozenges and swastikas.

sačuvale su čak i drvene alatke za izradu tekstila poput tkalačkih mačeva ili tkalačkih češljeva.[25]

U južnoj Europi, tj. na Iberskom poluotoku, sredozemnoj Italiji, na Balkanu i u Grčkoj nalazi brončanodobnih tkanina su razmjerno rijetki.[26] Većinom su to platna izrađena tehnikom običnog tkanja, s nekim varijacijama poput polukošarastog tkanja; povremeno se pojavljuju vuna, kozja dlaka, kudjelja i vlakna koprive. Dekoracije uključuju ukrasne rubove, resice i vez. Česti su nalazi oruđa za izradu tkanina poput pršljenova za vreteno i tkalačkih utega.[27] Tekstilni predmet iz Pustopolja u Bosni i Hercegovini izrađen je od vune tehnikom običnog tkanja s početnim i završnim obrubima te živim rubovima.[28] Tekstil je kvalitetno izrađen, a ujednačenost prediva i tkanine opisuje nam brončanodobne majstore s područja Balkana kao vješte predioce i tkalce, koji su znali kako preraditi sirovinu u kvalitetnu tkaninu, služeći se vretenom i okomitim tkalačkim stanom s utezima (sl. 4).

Alatke za izradu tekstila nisu se mijenjale tijekom brončanog i željeznog doba u južnoj i srednjoj Europi.[29] U ženskim grobovima često nalazimo pršljenove za vre-



6. Multi-coloured repp bands and tabletwoven bands from the saltmine Hallstatt, Iron Age (© Natural History Museum Vienna).
Višebojne rips trake i trake izrađene tehnikom tkalačkih daščica iz rudnika soli u Hallstattu, željezno doba (© Prirodoslovni muzej, Beč)

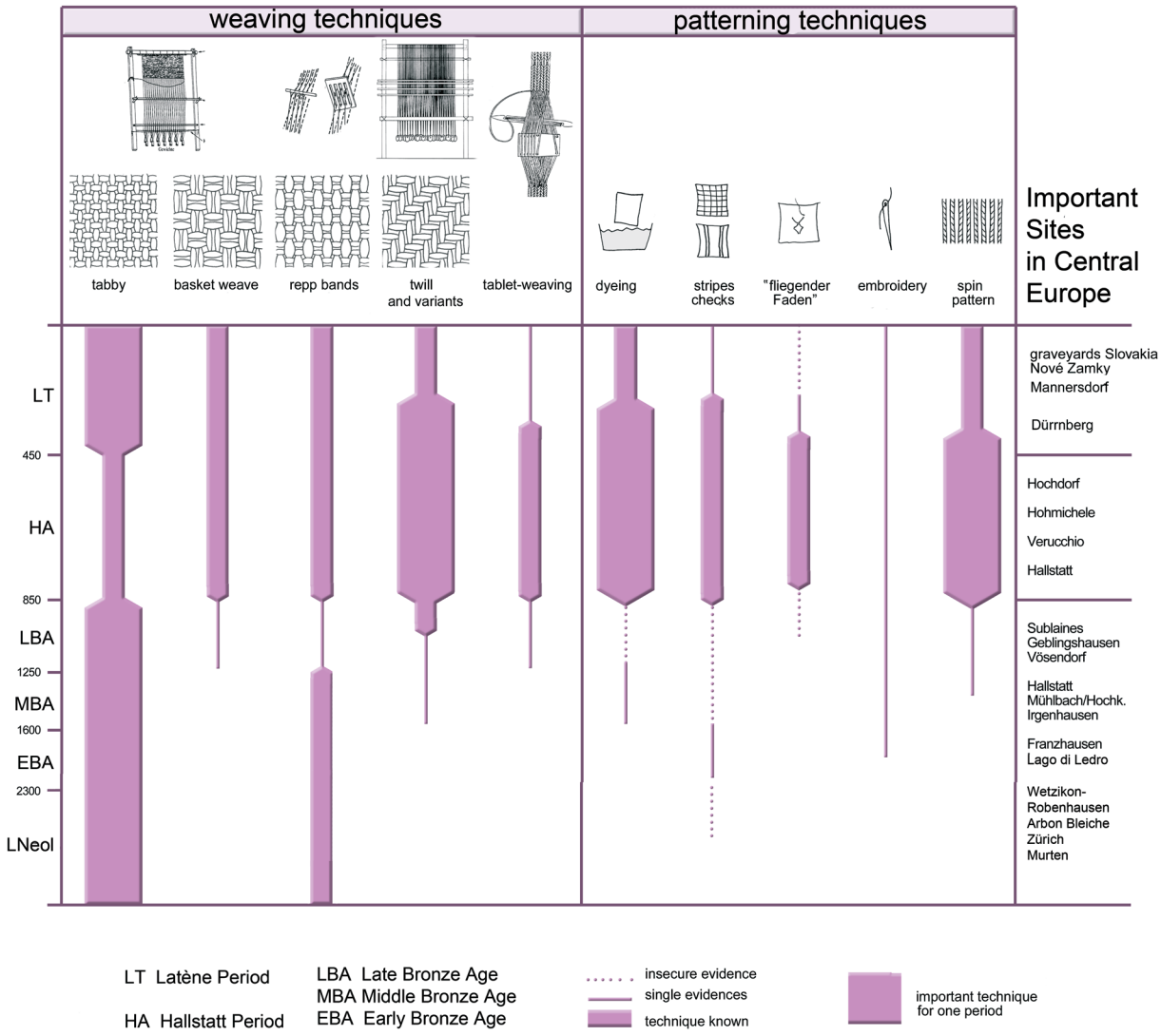
In addition, a group of richly furnished graves in Germany, France, Spain and northern Italy have supplied us with vivid glimpses of luxurious, highly decorated textiles in bright colours[31]. Two tombs from Verucchio in Italy proved to contain several complete garments that are comparable to clothing depicted in Greek and Etruscan art.[32] Twill, the new weave that was introduced in the Bronze Age, became a major feature of the Iron Age, and contributed to a proliferation of textile textures and woven patterns. Dyes became common, adding colour and colour patterns to the toolbox of Iron Age textile craftspeople. This is particularly visible in the Hallstatt Period, when the great number of variations gives the observer the impression that this was a time of experiments. No strict regimes of craft traditions seemed to have limited creativity. Later Iron Age textiles are much less diverse; while twill was the favourite weave of the Hallstatt Period, textiles of the La Tène Period are often tabby; compared with the happy deliberations of the preceding period, La Tène textiles appear almost sober (fig. 7).

Analysis of Archaeological Textiles

The data to be recorded in a basic technical analysis of a textile comprise a description of the condition of the textile, whether it is intact or deteriorating, carbonised, mineralised or perhaps only present in the form of an impression. Its dimension(s) should also be noted, as well as its colour, stains and any evidence of pigmentation or dyeing. Similarly, the type and conditions of the fibre is to be recorded, and evidence of fibre preparation such as combing or carding. The number of threads per

tena. Različitih su dimenzija i težina, što ukazuje na to da su izrađivana prediva različitih debljina (sl. 5). Tekstilne predmete iz željeznog doba pronalazimo na mnogim europskim nalazištima. Kisele močvare sjeverne Europe poznate su kao izvor dobro očuvanih tekstilnih predmeta i odjeće, poput plašteva, sukanja te raznih vrsta ogrtača.[30] U srednjoj Europi, rudnici soli u Hallstattu i Dürrnbergu važan su izvor dobro očuvanih i posve obojenih tekstilnih predmeta (sl. 6). Pronađene su rafinirane vrste tkanja, s prugama i kariranim uzorcima, uzorci s flotirajućim potkama ili osnovama, višebojne rips trake i bordure s meandrima, trokutima, rombovima i svastikama, izrađene tehnikom tkalačkih daščica.

Uz navedene, još je jedna skupina bogato opremljenih grobova iz Njemačke, Francuske, Španjolske i sjeverne Italije omogućila živ uvid u raskošne, bogato ukrašene i jarko obojene tekstilne predmete.[31] Dva groba pronađena u Verucchiu u Italiji sadržavala su nekoliko cjelovitih odjevnih predmeta, usporedivih s prikazima odjeće u grčkoj i etruščanskoj umjetnosti.[32] Tijekom brončanog doba pojavila se i nova vrsta tkanja – keper–poslije karakterističan za željezno doba, koji je pridonio širenju različitih tekstura tekstila i uzoraka tkanja. Uobičajilo se bojiti tekstil, majstori željeznog doba unijeli su boje i bojene uzorke. Sve je veći broj varijacija, osobito u halštatskom razdoblju koje nam se može doimati kao razdoblje eksperimenata. Čini se da nije bilo strogih ograničenja zanatskih tradicija koje bi sputavale kreativnost. Kod tekstilnih predmeta iz kasnijega, željeznog doba nema više te raznolikosti; dok je keper bio omiljeni tip tkanja u halštatskom razdoblju, tekstilni predmeti iz latenskoga vremena često su izrađeni tehnikom običnog tkanja; u usporedbi s razigranošću



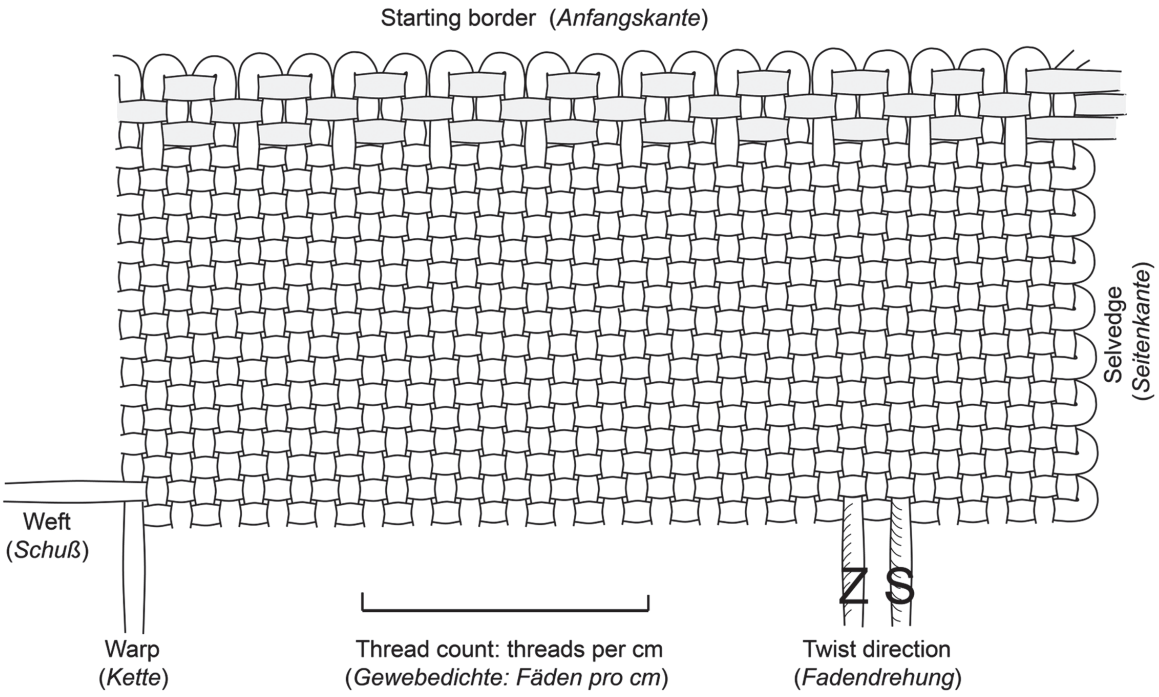
7. Rise and fall of textile techniques (© Karina Grömer).
Uspon i pad tehnika izrade tekstila (© Karina Grömer)

cm in warp and weft is to be noted. If it is not possible to identify warp and weft, system 1 and 2 is used. Description of the yarns is another important aspect. It includes twist direction, twist angle, and yarn diameter of the yarns of both systems, and whether it is single or plied yarn. Twist direction is rendered as s or z, or i if no twist can be seen (fig. 8). Plied yarn is described with a large letter designating the direction of the ply, small letters of the single yarns. The weave is the next important item of information, and should mention whether it is a simple pattern or a composite one, and any woven decoration such as pile or tapestry. Edges and their construction are also to be described, and assessed whether they might be selvedges, starting borders or finishing borders. This also applies to evidence of finishing treatment such as fulling or brushing. Any form of applied decoration, fastenings, and evidence

prethodnog razdoblja, latenski tekstil djeluje gotovo kao otrežnjenje (sl. 7).

Analize arheološkog tekstila

Osnovnom tehničkom analizom tekstila bilježe se podaci koji uključuju opis stanja tekstilnog predmeta, je li predmet intaktan ili u stanju propadanja, je li karbonizirao, mineralizirao ili pak postoji samo u obliku otiska. Valja zabilježiti dimenzije te boju, mrlje ili bilo kakve tragove pigmentacije ili bojenja. Treba zabilježiti i tip i stanje u kojem je vlakno te tragove prerade, primjerice češljanjem ili grebenjem. Treba zabilježiti broj niti po centimetru u osnovi i potki. U slučaju da nije moguće odrediti osnovu i potku, primjenjuje se sistem 1 i 2. Još jedan važan aspekt je opis prediva, što uključuje smjer i kut uvoja, promjer prediva obaju sustava te utvrđivanje jednonitnog ili višenitnog prediva. Smjer uvoja označava se kao „s“ili



8. Terms for technical data of textiles (© Karina Grömer).
Nazivi za tehničke podatke o tekstilnim predmetima (© Karina Grömer)

for use such as stitching, buttonholes, seams or hems should also be recorded.[33]

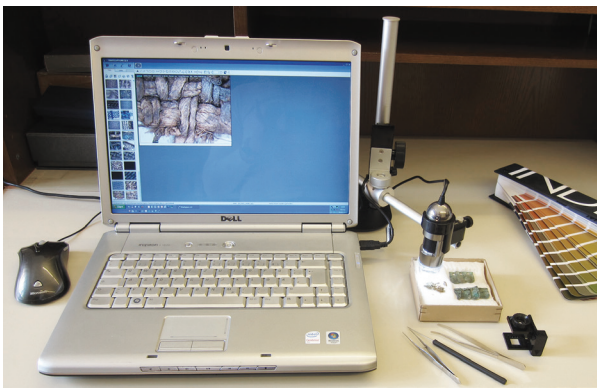
Recent years have seen a rapid development of methods of analysis that add to these basic aspects of textile analysis, facilitating it and opening new possibilities that textile scholars merely dreamt of twenty or thirty years ago. Digital microscopes are one such tool. Unlike traditional, binocular optical microscopes, Dino-Lite digital microscopes are small and easy to transport, and supply higher magnification, lighting, and tools to measure yarn diameter or twist angle (fig. 9). They also allow instant documentation of observations in the form of photography. Scanning electron microscopes (SEM) and further types of digital microscopes such as the Optilia Flexia offer magnifications higher than x400 allowing for fibre identification and measurements.[34] CT-scanning (computerised tomography), application of 3D graphics, and other advanced methods have recently opened new possibilities for the investigation of hidden structures.[35]

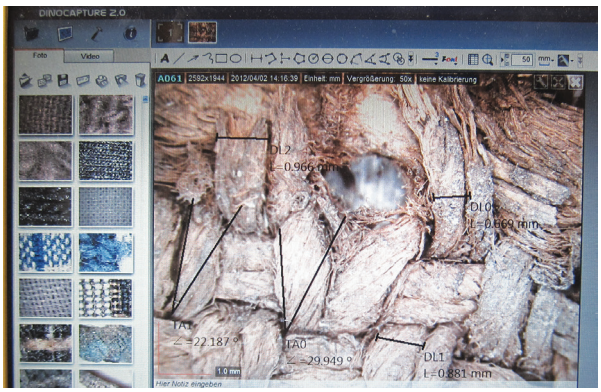
A Dino-Lite microscope was used by the Croatian Conservation Institute to document details of the Pustopolje textile. The current authors used a similar instrument for our examination of the Pustopolje textile. This proved invaluable as it made it possible to 'look through' the fine net that the textile had been covered with as part of the conservation (Fig. 10). By investigating specific points of the textile we were able to supplement the description of the textile made by the Croatian Conservation Institute, and establish how it was made by identifying the starting and finishing borders of the textile.

„z" te „i" ako uvoj nije vidljiv (sl. 8). Višenitno predivo navodi se velikim slovom koje označava smjer uvrtanja, jednonitno predivo navodi se malim slovom. Sljedeća važna stavka je tkanje, pri čemu treba navesti je li riječ o jednostavnom ili kompozitnom uzorku, te postoji li kakva utkana dekoracija poput omčice ili tapiserije. Valja opisati rubove i njihovu konstrukciju te procijeniti je li riječ o živim rubovima, početnim ili završnim obrubima. Isto se odnosi i na tragove završnih tretmana kao što su filcanje ili češljanje. Također treba zabilježiti sve vrste apliciranih ukrasa, kopči te tragove zakrpa, rupa za gumbe, šavova ili poruba.[33]

Metode analize razvijene posljednjih godina dopuna su temeljnim aspektima analize tekstila, olakšavaju posao istraživačima i pružaju im nove mogućnosti koje prije dvadeset ili trideset godina nisu mogli ni zamisliti. Jedna od novina je digitalni mikroskop. Za razliku od tradicionalnoga, binokularnog optičkog mikroskopa, digitalni Dino-LIte mikroskopi su

maleni i lako prenosivi, daju veće povećanje, osvjetljenje i više opcija za mjerenje promjera prediva i kuta uvoja (sl. 9). Također omogućuju neposredno fotografsko dokumentiranje. Skenirajući elektronski mikroskopi (SEM) te ostali tipovi digitalnih mikroskopa, kao što je Optilia Flexia, nude povećanje četiristo puta, što omogućuje identificiranje vlakana i daljnja mjerenja.[34] CT-skeniranje (kompjutorizirana tomografija), primjena 3D grafika i druge napredne metode otvorile su nove mogućnosti za istraživanje skrivenih struktura.[35]





9. Textile analysis with Dino-Lite Microscope (photo: K. Grömer).
Analiza tekstila Dino-Lite mikroskopom (snimila: K. Grömer)

Fibre analysis

Fibre analysis comprises the identification of fibres, measurement and assessment of fibre quality (fig. 11). Textile fibres from prehistoric Europe include flax, wool, hemp and nettle, but also bast of various trees, e.g. lime, willow or oak that have been used for textiles, basketry and ropes. Wool of goats, rabbits and other animals are further options. Further measurements of fibres can be used to assess how the fibre has been processed, e.g. whether vegetable fibres have been retted or not, or if they had been spliced or spun into yarns.[36]

The composition of wool fibres can inform us about the type of sheep they derive from (i.e. primitive hairy sheep or more developed ones), whether the wool was shorn or plucked, if it had been sorted or whether it had been combed. This is done by a combination of light microscopy and SEM, investigating pigmentation, scales, fibre surface, medulla and indications of dye, but requires sampling; if it is not possible to take samples, an Optilia Flexia microscope may be used.[37] A combination of Environmental Electron Scanning Microscopy (ESEM) and Fourier Transform Infrared Microspectroscopy (FTIR) has been applied to identify fibres in a non-destructive way. Although samples were removed, they were not altered. The latter method checked whether the characteristic peaks for major organic polymers were present in the spectra of the specimens.[38]

Samples of the Pustopolje textile have been subjected to fibre analysis by Dr Antoinette Rast-Eicher, ArcheoTex.[39] Light microscopy and SEM showed that although the fibres are very brittle, broken and partly without scales it could still be ascertained that they represent 'typical' Bronze Age wool with very fine fibres combined with very coarse ones (kemp). This type of wool is little removed from the wool of the wild ancestor of domesticated sheep; it resembles that of the European muflon (*ovis ammon musimon*), a wild remnant of early domesticated sheep. It proved possible to describe details of the fibres, such as pigmentation and medulla: the fine fibres are slightly pigmented; the kemp fibres are light with a large medulla. The net-like structure

Hrvatski restauratorski zavod koristio se Dino-Lite mikroskopom prilikom dokumentiranja tekstilnog predmeta iz Pustopolja. Autorice ovoga članka služile su se sličnim instrumentom u istraživanju tekstila iz Pustopolja, što se pokazalo neprocjenjivim jer je omogućilo „pogled kroz" finu mrežu kojom je tekstilni predmet bio prekriven, kao dio konzervatorskog postupka (**sl. 10**). Istraživanjem određenih aspekata predmeta dopunjen je opis koji je sastavio Hrvatski restauratorski zavod, a nakon određivanja početnih i završnih obruba, utvrđeno je na koji je način predmet bio izrađen.

Analiza vlakana

Analiza vlakana sastoji se od prepoznavanja vlakana, mjerenja i procjene kvalitete (**sl. 11**). Tekstilna vlakna prapovijesne Europe uključuju lan, vunu, kudjelju i koprivina vlakna te liko različitih vrsta stabala, npr. limete, vrbe ili hrasta. Služila su za izradu tekstila, u košaraštvu te u izradi užeta, a koristila se i dlaka koze, zeca i drugih životinja. Dodatnim mjerenjima saznajemo na koji je način vlakno prerađivano, npr. jesu li biljna vlakna bila močena ili nisu, jesu li bila rezana ili predena.[36] Prema sastavu vunenih vlakana možemo saznati od koje vrste ovce potječu (od primitivne ovce ili plemenitije pasmine), je li vuna bila strižena ili čupana, sortirana ili češljana. Analize se provode kombinacijom svjetlosne mikroskopije i SEM-a, ispitivanjem pigmentacije, ljusaka, površine vlakna, medule i tragova boje, ali se pritom moraju uzimati uzorci. Ako uzorkovanje nije moguće, može se koristiti mikroskop Optilia Flexia.[37] Za identificiranje vlakana na nedestruktivan način kombiniran je pristup elektronskim mikroskopom za ispitivanje okoliša (ESEM) i transformacijskim infracrvenim spektroskopom Furier (FTIR). Ispitivanje nije ostavilo traga na uzetim uzorcima. FTIR metodom provjeravano je jesu li karakteristične tjemene vrijednosti za važnije organske polimere prisutne u spektru uzoraka.[38]

Analizu vlakana tekstilnog predmeta iz Pustopolja obavila je dr. Antoinette Rast-Eicher iz tvrtke ArcheoTex.[39]

10. Analyzing the Pustopolje textile with Dino-Lite Microscope; looking through the net (photo: Jo Sofaer, K. Grömer).
Analiza tekstilnog predmeta iz Pustopolja pomoću Dino-Lite mikroskopa; pogled kroz mrežu (snimile: Jo Sofaer, K. Grömer)

of the medulla is clearly visible. The coarse kemp fibres are on average 100µ in diameter, with polygonal-net-like scales or horizontal lines. Longitudinal pleats and breaks indicate shrinkage, and microorganisms can be observed as little balls on the surface. These features show that the textile has been subjected to humidity (fig 12a). Photos made by the Croatian Conservation Institute shows coarse fibres sticking out from the textile's surface (fig 12b). This suggests that although one of the four samples did not contain any coarse fibres, the wool was used more or less directly from the staple, without sorting or removal of the kemp and other coarse hairs.

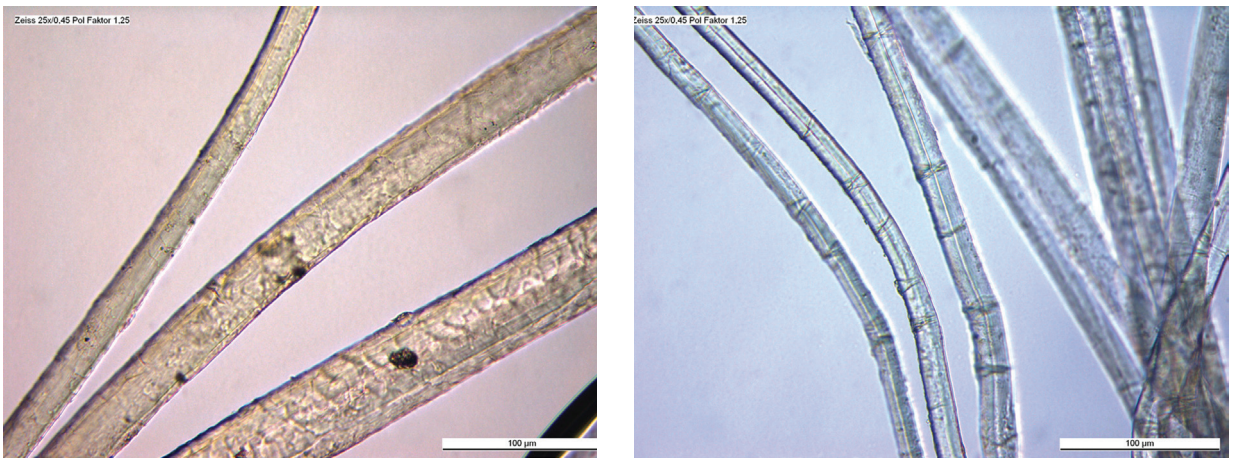
Dyestuff analyses

Methods for identifying dyes in archaeological textiles have advanced greatly in recent years, to a great extent due to the *Dyes in History and Archaeology* meetings that started 1982 as a workshop of British scholars. The DHA meetings are held annually and have grown into an international forum investigating dyes and dyeing from all parts of the world. The most common dyes to be found in archaeological textiles from Prehistoric Europe and the Ancient Mediterranean are woad (*Isatis tinctoria* L.) for blue, various types of madder for red (*Rubia tinctorum* L., and related wild species such as *Rubia peregrina* L., *Galuim verum* L., *Galium boreale* L. etc), for yellow weld (*Reseda luteola* L.), saffron (*Crocus sativus* L.), safflower (*Carthamus tinctorius* L.) or dyer's greenweed (*Genista tinctoria* L.), while insect dyes like Kermes (*Kermes vermilio*), Armenian cochineal (*Porphyrophora hamelii*) or Polish cochineal (*Porphyrophora polonica*) give scarlet reds. Marine molluscs of the Muricidae family (*Hexaplex trunculus, Bolinus brandaris* and *Stramonita haemastoma*) were used to obtain purple. In addition, a range of other, less easily identifiable sources were used.[40] Several of the latter have been found in Bronze Age textiles, presumably representing an experimental

Ispitivanje svjetlosnom mikroskopijom i SEM-om pokazalo je da se unatoč krhkosti, izlomljenosti i djelomičnom gubitku ljusaka još može utvrditi da vlakna predstavljaju „tipičnu" brončanodobnu vunu te da su kombinirana vrlo fina s vrlo grubim (osjastim) vlaknima. Takav tip vune ne razlikuje se mnogo od vune divljeg pretka domaće ovce; sličan je vuni europskog muflona (*ovis ammon musimon*), divljeg praostatka prve udomaćene ovce. Bilo je moguće opisati detalje vlakana poput pigmentacije i medule: fina vlakna su blago pigmentirana; osjasta vlakna su svijetle boje i imaju široku medulu. Mrežasta struktura medule jasno je vidljiva. Gruba osjasta vlakna u prosjeku imaju promjer od 100µ te poligonalne ljuske ili horizontalne linije na površini. Uzdužni nabori i puknuća ukazuju na stezanje, a vidljivi su i mikroorganizmi na površini u obliku sitnih grudica. Sve upućuje na to da je tekstilni predmet bio izložen djelovanju vlage (**sl. 12a**). Na fotografijama snimljenim u Hrvatskom restauratorskom zavodu vide se gruba vlakna koja strše s površine tekstila (**sl. 12b**). Iz toga možemo zaključiti da je, unatoč tome što jedan od četiri uzorka nije sadržavao gruba vlakna, vuna bila uzimana više ili manje izravno iz runa, bez prethodnog sortiranja ili uklanjanja osjastih ili drugih grubih dlaka.

Analize bojila

Posljednjih su godina znatno uznapredovale metode prepoznavanja boja u arheološkom tekstilu, u velikoj mjeri zahvaljujući susretima *Dyes in History and Archaeology* (Boje u povijesti i arheologiji), koji su pokrenuti 1982. kao radionica za britanske istraživače. Susreti se održavaju svake godine i prerasli su u međunarodni forum koji istražuje boje i bojenja iz svih krajeva svijeta. Boje na koje najčešće nailazimo u radu s arheološkim tekstilom iz prapovijesne Europe i antičkog Sredozemlja su sač (*Isatis tinctoria* L.) za modru, razne vrste broća (*Rubia tinctorum* i s njom povezane vrste kao što su *Rubia peregrina, Galuim verum, Galium boreale* itd.) za crvenu, za žutu



11. Transmitted light microscopy: left: sheep wool; right: flax. Samples from the salt-mine Hallstatt (photo: K. Grömer, © Natural History Museum Vienna).
Transmisijska svjetlosna mikroskopija: lijevo: ovčja vuna; desno: lan. Uzorci iz rudnika soli u Hallstattu (snimila: K. Grömer, © Prirodoslovni muzej, Beč)

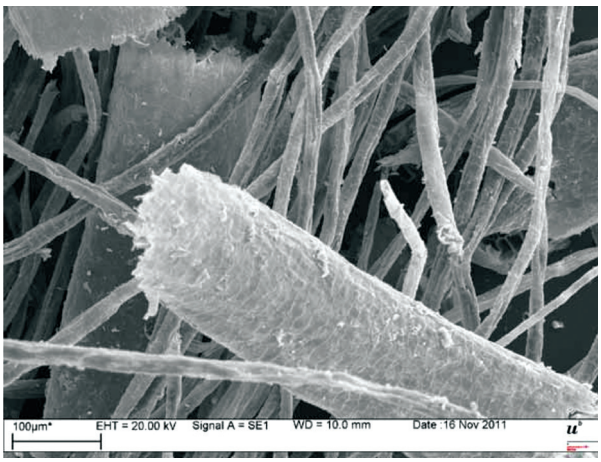
stage where the dyestuffs that were to prove best and fastest were not yet identified/available.

Several methods may be employed to identify dyes in textiles. UV/Visible absorption spectrometry and thin layer chromatography (TLC) was introduced in the 1980s[41], and are still used; they do however only detect relatively well-preserved traces of dyestuffs. In the 1990s, high performance liquid chromatography coupled with the spectroscopic technique photo diode array detection (HPLC-PDA), was introduced.[42] The latter methods were used to investigate two samples of the Pustopolje textile, resulting in the detection of yellow and red components that cannot (yet) be closer identified.[43] In the future ultra performance liquid chromatography (UPLC) will allow the detection of dyes in even lower concentrations and therefore in smaller sample sizes. Additionally transmission light microscopy (TLM) is used to examine the colouring respectively dyeing of the fibres. Scanning electron microscopy with energy-dispersive X-ray analysis was introduced to detect chemical elements which could have plaid a roll in dyeing processes as aluminium, copper and iron or cause colour change in the fibres as copper and iron.

Radiocarbon dating

Textiles usually have a short 'lifetime', i.e. period of use. That makes them well suited as material for dating by radiocarbon, especially after the development of accelerator mass spectrometry (AMS) has made it possible to date small samples, requiring only about 20mg. Several projects have carried out systematic radiocarbon dating of archaeological textiles and are beginning to establish firm chronological frameworks for important textile collections, and as a result of this an online database of dated textiles has been established.[44] This has proved particularly important for the study of textiles from the Late Antiquity, so-called 'Coptic textiles', and for textiles deposited in

jatanac (*Reseda luteola*), šafran (*Crocus sativus*), šafranik (*Carthamus tinctorius*) ili žutilovka (*Genista tinctoria*), dok boje koje dobivamo od kukaca kao što su kermes uši (*Kermes vermilio*), armenski košenil (*Porphyrophora hamelii*) ili poljski košenil (*Porphyrophora polonica*) daju skrletnu crvenu. Morski mekušci iz porodice Muricidae (*Hexaplex trunculus, Bolinus brandaris* i *Stramonita haemastoma*) koristili su se za dobivanje grimizne. Uz spomenute, koristio se i niz drugih izvora boje koje je teže utvrditi.[40] Nekoliko takvih boja pronađeno je u tekstilnim predmetima iz brončanog doba pa se pretpostavlja da označavaju eksperimentalni stadij u kojemu bojila koja su se poslije pokazala najboljima i najbržima još nisu bila pronađena ili nisu bila dostupna. Za određivanje boje u tekstilu može se koristiti nekoliko metoda. Osamdesetih godina prošloga stoljeća uvedene su UV vidljiva apsorpcijska spektrometrija te tankoslojna kromatografija (TLC)[41] koje se još uvijek koriste; one međutim detektiraju tek razmjerno dobro sačuvane tragove bojila. Devedesetih je uvedena tekućinska kromatografija visokog učinka u kombinaciji sa spektroskopskom tehnikom fotodiodne detekcije (HPLC-PDA).[42] Te dvije metode primjenjivane su u istraživanju dvaju uzoraka tekstila iz Pustopolja, pri čemu su otkrivene žute i crvene komponente koje se (zasad) ne mogu pobliže odrediti.[43] U budućnosti će tekućinskom kromatografijom ultravisokog učinka (UPLC) biti moguće odrediti boje čak i u nižim koncentracijama, a time i iz manjih uzoraka. Uz navedene se metode koristi i transmisijska svjetlosna mikroskopija (TLM) da bi se ispitala obojenost vlakana. Uvedena je i skenirajuća elektronska mikroskopija (SEM) s analizom energijski disperzivnih x-zraka da bi se detektirali kemijski elementi koji mogu imati ulogu u postupku bojenja, kao što su aluminij, bakar ili željezo ili koji mogu izazvati promjenu boje vlakana, kao bakar i željezo.



12. Pustopolje. A) preservation of the wool fibres (photo: Antoinette Rast-Eicher); B) Coarse kemp fibres on the surface of the fabric (photo: Croatian Conservation Institute Photo Archive).
Pustopolje. A) očuvanost vunenih vlakana (snimila: Antoinette Rast-Eicher); B) gruba osjasta vlakna na površini tkanine (fototeka HRZ-a)

the bogs of northern Europe.[45] According to international convention, radiocarbon dates are given in conventional radiocarbon years BP (Before Present = 1950). They are then calibrated by the Oxcal v4.0 calibration programme which makes it possible to calculate the age of the sample with probabilities of 68.2% (1 sigma) and 95.4% (2 sigma). It is important to record anything that may have contaminated the item that is to be dated, like organic solvents used for cleaning or conservation purposes.

Strontium Isotope Tracing and the Provenancing of Textiles

Until recently, discussions on the provenance of textiles have been based on comparisons with similar fabrics and maps of their distribution.[46] Identifications with textile types mentioned in historical sources combined with perceptions of professionalization of textile crafts and modes of production have also been used as arguments.[47] In recent years, strontium isotope tracing seems to offer a way of identifying areas where the raw materials of archaeological textiles derive from. This has been used for some time to chart prehistoric migration by investigating human and animal bones; it has now proved possible to apply the method to textile fibres such as wool and nettle. An Iron Age textile found in Denmark proved to be made of wool both of local and non-local origin;[48] recently, another prehistoric textile from Denmark, nettle cloth of the Late Bronze Age, was shown to derive from areas with Precambrian rocks, and argued to come from the Kärnten-Steiermark area in Austria.[49]

Experimental Archaeology and Textiles

Experimental archaeology is almost as old as the discipline of Archaeology. Professor Sven Nilsson of the University of Lund in Sweden (1787–1883) was the first archaeologist to use experiments with flint knapping to interpret prehistoric

Datiranje radioaktivnim ugljikom

Tekstil obično ima kratak „životni vijek", tj. razdoblje korištenja. To ga čini materijalom pogodnim za datiranje radioaktivnim ugljikom, osobito otkako je razvijen ubrzavajući maseni spektrometar (AMS) koji je omogućio datiranje malih uzoraka, mase od tek 20 mg. Sustavno datiranje arheološkog tekstila radioaktivnim ugljikom provedeno je u sklopu nekoliko projekata kojima su postavljeni čvrsti kronološki okviri za nekoliko važnih zbirki tekstila. To je rezultiralo uspostavom internetske baze tekstila.[44] Metoda se pokazala osobito važnom i u istraživanju kasnoantičkog, tzv. „koptskog tekstila" te tekstila pronađenog u močvarama sjeverne Europe.[45] Radiokarbonske datacije konvencionalno se prikazuju u radiokarbonskim godinama BP (*before present*), odnosno prije 1950. godine. Za kalibriranje se potom koristi kalibracijski program Oxcal v4.0 koji omogućuje računanje starosti uzorka s postotkom vjerojatnosti od 68,2% (1 sigma) i 95,4% (2 sigma). Važno je zabilježiti sve što je moglo dovesti do kontaminacije predmeta koji se datira, primjerice organska otapala za čišćenje ili konzerviranje.

Praćenje izotopa stroncija i određivanje provenijencije tekstila

Donedavno su se rasprave o podrijetlu tekstilnih predmeta temeljile na usporedbama sa sličnim tkaninama i na mapiranju njihove rasprostranjenosti.[46] Predmeti su se dovodili u vezu s tipovima tekstila kakve spominju povijesni izvori, procjenjivale su se profesionalizacije u izradi tekstila i sredstvima za proizvodnju.[47] Posljednjih godina, metoda praćenja izotopa stroncija omogućuje da odredimo s kojih područja potječu sirovine za izradu tekstilnih predmeta. Već se neko vrijeme ta metoda koristi za mapiranje prapovijesnih migracija uz pomoć ostataka ljudskih i životinjskih kostiju; sada se pokazalo da je moguće primijeniti je i na tekstilna vlakna kao što

13. Hallstattfarben, Textile Verbindungen zwischen Forschung und Kunst, exhibition on ancient dyes, Natural History Museum Vienna, 1 Feb. 2012–30 Dec. 2013 (photo: A. Schumacher, © Natural History Museum Vienna).
Hallstatt, Tekstilne poveznice između istraživanja i umjetnosti, izložba o prapovijesnim bojama, Prirodoslovni muzej Beč, 1. veljače 2012. – 30. prosinca 2013. (snimila: A. Schumacher, © Prirodoslovni muzej, Beč)

artefacts;[50] another Scandinavian pioneer, N.F.B. Sehested, built a log cabin with Stone Age implements,[51] and the prominent British archaeologist Pitt-Rivers reconstructed antler picks found at the site of a hillfort he was excavating and used them to construct replicas of the ditches surrounding the site.[52] The reconstruction of archaeological textiles goes back to Jakob Messikommer and Ferdinand Keller of Switzerland; in the 1850s textiles started to turn up in their excavations of what proved to be Neolithic pile dwellings. A textile manufacturer from Zürich, Mr Paur, made a simple loom and recreated the textiles.[53] Experiments and reconstructions continued to be an important aspect of the study of archaeological textiles. In the 1930s, textile scholars Karl Schlabow of the Textilmuseum Neumünster in Germany and Margrethe Hald of the National Museum of Denmark carried out reconstructions of the Bronze Age costumes from Denmark; when research centres of experimental archaeology were established in the 1960s and 1970s, textile workshops became important aspects. Visitors were fascinated by watching spinning on hand spindles and the weaving of fine fabrics on warp-weighted looms and to try it out themselves. Craftspeople from textile workshops of e.g. the Museumsdorf Düppel in Berlin, Butser Ancient Farm in the United Kingdom, or the Archaeological Research Centre in Lejre, Denmark have carried out research projects and contributed to conferences and publications on archaeological textiles.[54] Ethnographic studies documenting methods of hand spinning and weaving on warp-weighted looms and two-beam looms have provided important data that are used by textile scholars and craftspeople alike to understand how prehistoric textiles were made.

su vuna i kopriva. Za jedan je željeznodobni tekstilni predmet pronađen u Danskoj otkriveno da je izrađen od vune lokalnog ali i nelokalnog podrijetla;[48] nedavno je za drugi prapovijesni tekstilni predmet iz Danske – platno koprive iz kasne bronce – utvrđeno da potječe s područja prekambrijskih stijena, pretpostavlja se s područja Koruške ili Štajerske u Austriji.[49]

Eksperimentalna arheologija i tekstil

Eksperimentalna arheologija stara je gotovo koliko i sama disciplina arheologije. Profesor Sven Nilsson (1787.–1883.) sa Sveučilišta u Lundu u Švedskoj bio je prvi arheolog koji se poslužio eksperimentima s okresivanjem kremena kako bi interpretirao prapovijesne artefakte.[50] Drugi skandinavski pionir, N.F.B. Sehested sagradio je brvnaru koristeći se oruđem iz kamenog doba,[51] dok je istaknuti britanski arheolog Pitt Rivers rekonstruirao alatke od rogova pronađene na nalazištu gradine koju je iskapao, a zatim se njima poslužio za gradnju replika opkopa oko lokaliteta.[52] Rekonstrukcije arheoloških tekstila datiraju još iz vremena Jakoba Messikommera i Ferdinanda Kellera iz Švicarske; 1850-ih provodili su iskapanja i pronalazili tekstilne predmete u naseljima sojenica. Jedan proizvođač tekstila iz Züricha, stanoviti g. Paur, dao je izraditi jednostavan tkalački stan te je rekonstruirao pronađene tekstilne predmete.[53] Eksperimenti i rekonstrukcije i dalje su bili važan aspekt istraživanja arheoloških tekstila. Tridesetih godina dvadesetoga stoljeća stručnjaci za tekstile Karl Schlabow iz Tekstilnog muzeja Neumünster u Njemačkoj i Margarethe Hald iz Nacionalnog muzeja Danske rekonstruirali su brončanodobne odore iz Dan-

tiles were made.[55] Nowadays, experimental archaeology is an integrated aspect in major projects investigating archaeological textiles.[56] Experimental archaeology, including spinning and weaving, is part of scholarly education for archaeologists at several universities, e.g. the University of Vienna. A summer school at the open air museum Asparn is an integrated part of the Master Studies.[57]

Research carried out within the framework of ethnography and experimental archaeology has made it possible to establish criteria that can be used in discussing the tools and techniques that were used to make specific prehistoric textiles.[58] In the case of the textile from Pustopolje, it was possible to identify the narrow repp border at one end of the fabric as a starting border, a type of transverse border that is usually associated with the warp-weighted loom; as loom weights have been found in contemporary settlements in the region we are able to argue that the textile had been produced on this type of loom. Loom weights are a common feature of Neolithic and Bronze Age settlements in Central Europe and the Eastern Mediterranean[59] and indicate that this loom was well-established in the area that is now Bosnia-Herzegovina. It was, however, not the only loom of the Bronze Age; in Egypt, the ground loom was the standard loom since the beginnings of the Pharaohs, and is indeed still used by nomads in North Africa and parts of the Middle East.[60] In Northern Europe, loom weights are very rare in Bronze Age settlements; constructional details of many of the well-preserved textiles from Denmark comprise starting borders as well as borders with closed warp loops. The latter suggest a loom with a tubular warp, something that became common by the beginning of the Iron Age in that region; the loom of the early Bronze Age of Scandinavia is not yet properly understood.[61]

Textiles, Prehistoric Society, and Archaeology

The study of archaeological textiles and textile crafts holds great potential for new perspectives on all aspects of life in prehistoric Europe. The production of textiles was deeply embedded in society and economy. Textile production involved land management and consumption of labour. Sheep need different types and amounts of land that the growing of flax or hemp; tending the land and animals, and the harvesting and processing of fibres require time and manpower. Recent work on the *châine opératoire* of textile production has begun to give us some ideas on the amounts of land and labour involved in textile production.[62] The making of a sail of c. 90 m2 for a Viking ship would e.g. require 90 kg of raw materials and 8,000 hours of work; to equip a crew of 6–8 men with clothing another 40–53 kg raw materials and between 2500 and 3300 hours of labour.[63] Numbers like these add entirely new dimensions to the study of prehistoric economics, and to other aspects of prehistoric societies. Largely overlooked in Archaeology, textile studies have tended to be perceived as a specialske. Kada su se šezdesetih i sedamdesetih godina osnivali istraživački centri za eksperimentalnu arheologiju, i radionice za tekstil dobile su na važnosti. Predenje na ručnim vretenima ili tkanje finih tkanina na okomitom tkalačkom stanu fascinirali su posjetitelje, kao i mogućnost da se sami okušaju u tome. U istraživačke projekte bili su uključeni i obrtnici iz tekstilnih radionica kao što je npr. Muzejsko selo Düppel u Berlinu, Prapovijesna farma Butser iz Velike Britanije ili Arheološki istraživački centar u Lejreu u Danskoj. Sudjelovali su na skupovima i objavljivali u publikacijama o arheološkom tekstilu.[54] Etnografske studije koje dokumentiraju metode ručnog predenja i tkanja na okomitim i vodoravnim tkalačkim razbojima pružile su stručnjacima za tekstil, ali i obrtnicima, važne podatke o načinima izrade prapovijesnog tekstila.[55] U današnje je vrijeme eksperimentalna arheologija dio velikih projekata istraživanja arheološkog tekstila.[56] Eksperimentalna arheologija – a to uključuje i predenje i tkanje – dio je programa školovanja arheologa na nekoliko sveučilišta, npr. na Sveučilištu u Beču. Ljetna škola u sklopu muzeja na otvorenom u Asparnu integralni je dio magistarskog studija.[57]

Istraživanja koja se provode u sklopu etnografije i eksperimentalne arheologije omogućila su uspostavljanje kriterija za raspravu o oruđima i tehnikama koje su korištene za izradu prapovijesnih tekstilnih predmeta.[58] U slučaju tekstilnog predmeta iz Pustopolja, bilo je moguće identificirati uski ripsani obrub na jednom kraju tkanine kao početni rub, odnosno tip poprečnog obruba koji se obično povezuje s okomitim tkalačkim stanom s utezima. Budući da su u drugim onovremenim naseljima u regiji pronađeni tkalački utezi, možemo pretpostaviti da su tekstilni predmeti bili izrađivani na takvom tipu tkalačkog stana. Tkalački utezi tipičan su nalaz u neolitičkim i brončanodobnim naseljima srednje Europe i istočnog Sredozemlja[59] te ukazuju na to da je spomenuti tip razboja bio uobičajen na području današnje Bosne i Hercegovine. No nije bio jedini tip tkalačkog stana poznat u brončanom dobu; u Egiptu je još od vremena prvih faraona uobičajen podni tkalački stan, štoviše i danas se njime koriste nomadi u sjevernoj Africi i na Bliskom istoku.[60] U sjevernoj su Europi nalazi tkalačkih utega u brončanodobnim naseljima rijetki; detalji konstrukcije mnogih dobro sačuvanih tekstilnih predmeta u Danskoj sastoje se od početnih obruba i obruba sa zatvorenim završnim petljama. Takvi nalazi mogli bi upućivati na tkalački stan sa cjevastom osnovom kakav je postao uobičajen početkom željeznog doba; razvoj tkalačkog stana tijekom brončanog doba u Skandinaviji još nije dovoljno objašnjen.[61]

Tekstil, prapovijesno društvo, arheologija

Istraživanje arheološkog tekstila i njegove izrade nudi izuzetnu mogućnost novih uvida u sve aspekte života u prapovijesnoj Europi, jer je proizvodnja tekstila bila dio

ist field, of little importance to mainstream scholarship. While flint knapping techniques and the workings of metal production are normal elements in the teachings of Archaeology Departments, the basics of textiles production are rarely so, except within the framework of experimental archaeology. The recent advances in textile studies reviewed above are however rapidly changing these attitudes. Textiles are becoming accepted as an important approach to the understanding of Prehistoric and preindustrial societies in Europe and indeed in the world. ■

društva i ekonomije. Proizvodnja tekstila povezana je s upravljanjem zemljištem i potrošnjom rada. Ovčarstvo zahtijeva drukčiju vrstu i veličinu zemljišta nego uzgoj lana ili konoplje; za brigu o zemljištu i životinjama, berbu i preradu vlakana potrebni su vrijeme i radna snaga. Recentna istraživanja lanca operacija (*châine opératoire*) daju nam okvirni uvid u veličine zemljišta i količine rada za proizvodnju tekstila.[62] Primjerice, za izradu jedra površine oko 90 m2 za jedan vikinški brod, bilo bi potrebno 90 kg sirovina te 8000 radnih sati, a za odijevanje posade od šest do osam članova dodatnih 40–53 kg sirovog materijala te između 2500 i 3300 sati rada.[63] Takve brojke daju posve novu dimenziju istraživanju prapovijesne ekonomije, kao i ostalim aspektima prapovijesnog društva. Dosad je arheologija većim dijelom zanemarivala istraživanje tekstila, smatrajući ga specijalističkim područjem od male važnosti za konvencionalnu disciplinu. Dok se tehnike okresivanja kremena ili načini proizvodnje metala redovito podučavaju na odsjecima za arheologiju, s osnovama proizvodnje tekstila to je rijetko slučaj, osim u sklopu eksperimentalne arheologije. No novija dostignuća u istraživanju tekstila prikazana u članku pridonose mijenjanju takvih stajališta. Istraživanje tekstila počinje se prihvaćati kao važan pristup u razumijevanju prapovijesnih i predindustrijskih društava u Europi, kao i u ostatku svijeta. ■

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