# A Man's Caftan and Leggings from the North Caucasus of the Eighth to Tenth Century: A Conservator's Report

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THE LINEN CAFTAN embellished with elaborate silk borders (Figures 1–3) and the pair of silk leggings with linen feet (Figure 4) that accompanies it are immediately recognizable as parts of a coordinated set of garments made for a horseman. Although the once brilliant colors of the silks and the whiteness of the linen have archaeologically discolored and the fur lining is mostly gone, material evidence such as the patterned silks relates the set to a large corpus of mortuary offerings excavated at Moshchevaja Balka, located in the northwestern Caucasus Mountains (between the Black and Caspian Seas), now in the collections of the State Hermitage (Saint Petersburg) and other museums in Russia.[1] It is possible that the caftan and leggings could have come from the same or a related site. If so, the wearer might have been an Alan who lived in an outlying settlement ruled by the Khazars in the vicinity sometime during the eighth to tenth century (see Elfriede R. Knauer, "A Man's Caftan and Leggings from the North Caucasus of the Eighth to Tenth Century: A Genealogical Study," pp. 125–54 below).

Our study of the caftan and leggings was aided by a hands-on comparison with the following three groups of objects—Reference Groups I, II, and III—excavated at or attributed to the Moshchevaja Balka site.

Reference Group I: A large corpus of a variety of objects in the Hermitage representing the Moshchevaja Balka group with secure excavation provenance that has been published (for selected pieces, see Knauer, Figures 5, 11–13, 30).[2] (The proportionately smaller groups in other Russian museums, for the most part, have not been published.)

Reference Group II: Three garments—the Metropolitan's caftan, the leggings, and a caftan made of Chinese Tang dynasty silk damask—attributable to the Moshchevaja Balka group, auctioned in 1994.[3] Referred to here as the Reference Silk Caftan (Figures 19, 20),[4] the silk damask caftan was in a London collection and was generously lent to the Metropolitan Museum for this study.

Reference Group III: A corpus of forty-six objects related to those in Reference Group II, similarly attributable to the Moshchevaja Balka group, was auctioned in 1996.[5] All items in the lot except three became a most welcome gift to the Metropolitan Museum in 1999 (Figures 5–18). Among the objects, an undecorated linen caftan (Figure 5; extant part consisting of an entire lower section and a small portion of the upper sections) and a pair of leggings (Figure 6; complete) were extremely helpful for this study.

The fifty-six auctioned objects of Reference Groups II and III plus seven not referenced (see note 3) and three missing from Reference Group III (see note 5) exhibit common traits indicating that they make up full or partial finds removed from burials at the same site as the objects in Reference Group I or from one nearby.[6] Of these, comprehensive and comparative visual and technical assessment was directly possible on thirteen items, enabling me to characterize the group's materials, weaving, design, cut, style, tailoring, state of preservation, and material fatigue.

When the Metropolitan Museum acquired the caftan and the pair of leggings at the recommendation of the Department of Ancient Near Eastern Art, the garments came with distinctive physical attributes we interpret as indicating they had been preserved in a burial site: their overall state; interrelated evidence of losses, creases, discolorations, organic brown staining, and encrustation penetrating through or deposited on the obverse and reverse in a somewhat dissimilar way; and masses of embedded dried-up, empty insect cocoons. The caftan and leggings have survived in reasonably fair physical condition, given their age, despite the fact that approximately 35 percent of the caftan and 10 percent of the leggings have suffered environmental deterioration associated with burial


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The notes for this article begin on page 117.

Figure 1. Linen and silk caftan. North Caucasus, 8th–10th century. After conservation in 2000. H. (reconstruction) 142 cm. The Metropolitan Museum of Art, Harris Brisbane Dick Fund, 1996 (1996.78.1)

Figure 2. Proper left side of caftan in Figure 1

Figure 3. Back of caftan in Figure 1

conditions, which are detrimental to organic materials. Most of the polychrome patterned silks on both legs of the leggings and on the proportionately sparse borders of the caftan, which constitute the visibly significant design features of the set, have miraculously survived. The examination and interpretation of these materials and design features gave us an adequate understanding of their original form as well as their surroundings during the time they were used as functional items.

At the initial stage of the burial, slightly acidic moisture must have exuded from the body, staining and damaging the buried objects. Concurrently, oxygen and acid-oriented mildew and keratin-infesting insects thrived for one or two generations in the earliest, slightly acidic burial period, as evidenced by the loss

Figure 4. A pair of silk and linen leggings. North Caucasus, 8th–10th century. After conservation in 2000. H. 81 cm. The Metropolitan Museum of Art, Harris Brisbane Dick Fund, 1996 (1996.78.2 a [right], b)

of the fur lining and countless numbers of cocoons found embedded in adjacent layers of the silks and linens. (The moth-eaten, shredded fur lining presumably remained in the burial site but must have been removed at the time of unearthing.) As the bodily substances changed into an alkaline state, the chemical reaction discolored the alkaline-sensitive safflower-dyed red color of the silk to beige and the indigotin blue to a gray-blue brown, whereas the breakdown of the acid-sensitive iron mordant in the brown was prevented. (A brown or black color commonly dyed with tannin and iron would have completely deteriorated through oxidation caused by acidification by air.) Subsequently, over the duration of a long-term burial, the presence of alkalinity fostered by the limestone reported at the site (instead of common acidic earth burial), the low humidity (the site was above ground), the severely limited fresh oxygen supply (the burying space was contained), and the low temperature (oxidation was slowed down) allowed the two contrasting media—cellulosic linens and proteinaceous silks, wool, and fur—to survive side by side. In assessing the state of the textile culture in the region, therefore, one should not interpret the general lack of items woven with proteinaceous wool yarn in the lot to indicate its paucity in the region, as it was used instead of cotton as wadding, and a thoroughly developed fiber-spinning method was known. Cotton, the same cellulose-based fiber as the linen in the burial site, however, is absent, which may indicate that it was not yet used in the region.

It is no longer possible to estimate the precise condition of the caftan and leggings at the time of their unearthing, and no doubt the rest of the caftan and leggings had deteriorated in the burial site. But it can be conjectured that there was a quantity of unavoid-

Figure 5. Back of a portion of a linen caftan, showing the join of the proper left sleeve at the waist. North Caucasus, 8th–10th century. H. 112 cm. The Metropolitan Museum of Art, Gift of Jacqueline Simcox, 1999 (1999.153.37)

Figure 6. A pair of linen and hemp leggings. North Caucasus, 8th–10th century. H. 89 cm. The Metropolitan Museum of Art, Gift of Jacqueline Simcox, 1999 (1999.153.38)

able archaeological staining, soiling, and oxidative products that had accumulated and interacted with the linen, silk, and fur/skin in the burial site over a millennium. No sooner were the garments brought out of the burial site than much of the in situ information was lost, as usually occurs with all archaeological dyes, fibers, yarns, cloth, and other items. With certain exceptions, their postexcavation treatment appears to have included rinsing in water in the same way at the same time, and then all were stored within the same length of time. Among the garments in Reference Groups II and III, the Metropolitan's caftan (Figure 1), and Reference Silk Caftan (Figure 19), both Reference Group II, and an undecorated caftan (Figure 5) from Reference Group III share nearly identical indications of loss and preserved areas as well as similar burial stains, causing one to wonder if they had been layered on the same deceased body. From the evidence of the parts of the garments that survived and that were stained, the deceased appears to have been laid in a dorsal position with the legs and proper left side of the body positioned higher than the right side, and with the right arm and torso slanting down toward the head.

The first treatment after excavation appears to have been a quick rinsing in water shortly after removal

Figure 7. A woman's tunic of linen and nettlelike fibers. The neckline and cuffs are embellished with a rural-type patterned silk (similar to our Silk A) and with loops and buttons and an appliquéd square of two kinds of mainstream-type patterned silk. North Caucasus, 8th–10th century. H. 122 cm. The Metropolitan Museum of Art, Gift of Jacqueline Simcox, 1999 (1999.153.35 [appliqué], 36 [tunic])

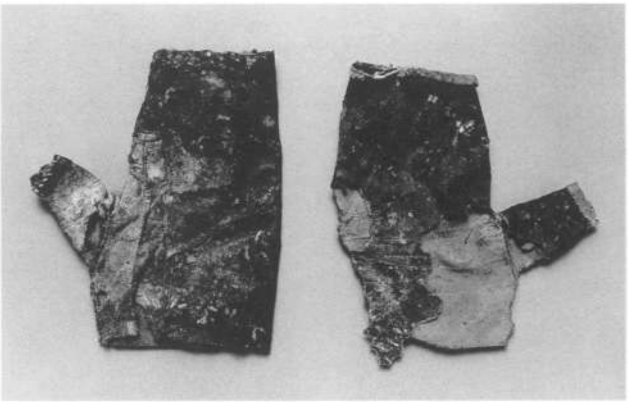


Figure 8. A pair of leather mitts. North Caucasus, 8th–10th century. H. 17 cm. The Metropolitan Museum of Art, Gift of Jacqueline Simcox, 1999 (1999.153.1a, b)

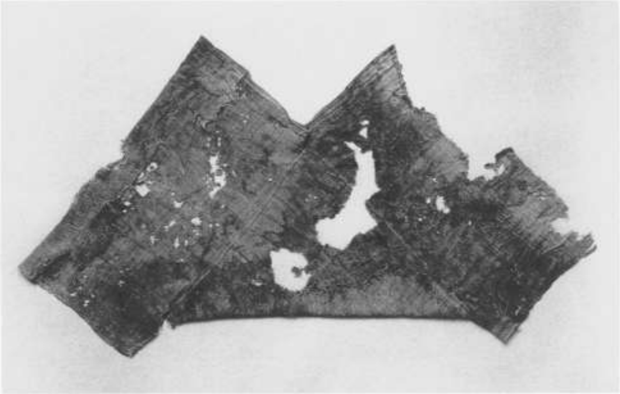


Figure 9. A pair of short linen and hemp trousers. North Caucasus, 8th–10th century. H. 58 cm. The Metropolitan Museum of Art, Gift of Jacqueline Simcox, 1999 (1999.153.40)

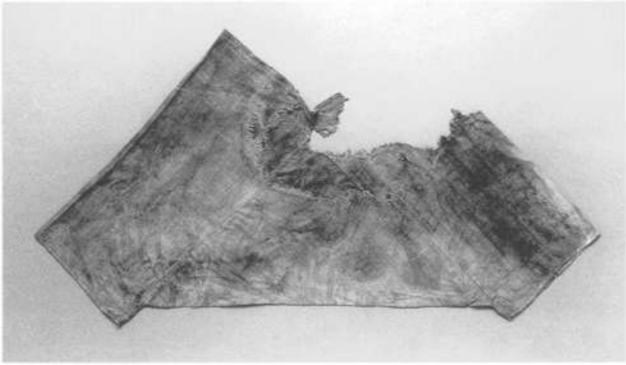


Figure 10. Portion of a pair of short trousers of nettlelike fiber. North Caucasus, 8th–10th century. H. 52 cm. The Metropolitan Museum of Art, Gift of Jacqueline Simcox, 1999 (1999.153.43)

Figure 11. A rural-type patterned silk similar to our Silk A, probably a tunic collar. North Caucasus, 8th–10th century. H. 80 cm. The Metropolitan Museum of Art, Gift of Jacqueline Simcox, 1999 (1999.153.34)

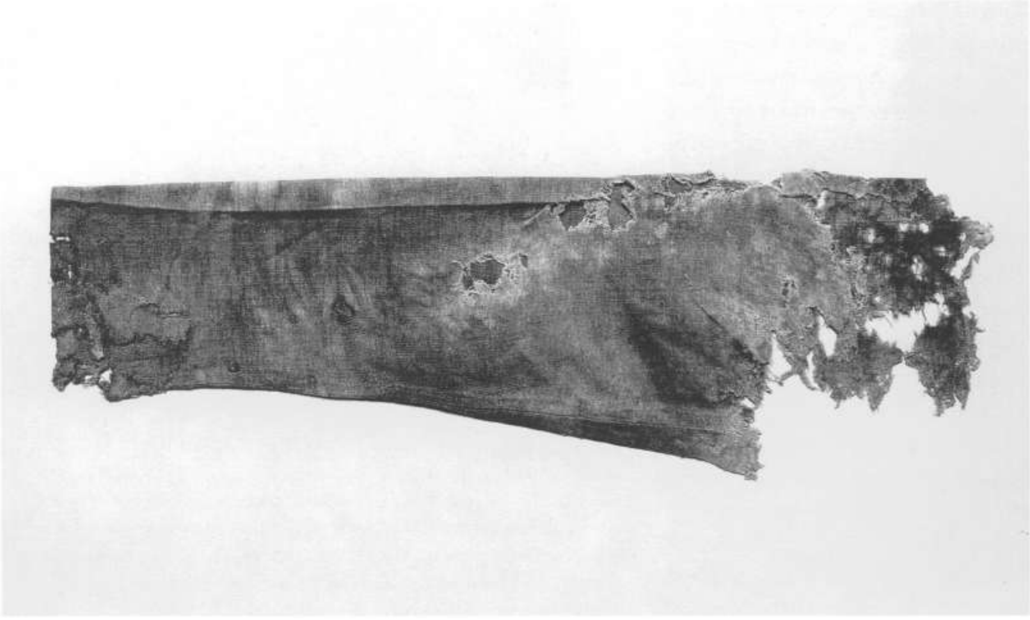


Figure 12. Portion of a linen caftan sleeve. North Caucasus, 8th–10th century. L. 57 cm. The Metropolitan Museum of Art, Gift of Jacqueline Simcox, 1999 (1999.153.41)

Figure 13. Pillow with ends (only one end extant) of a rural-type patterned silk (similar to our Silk A), stuffed for exhibition. North Caucasus, 8th–10th century. L. 54 cm. The Metropolitan Museum of Art, Gift of Jacqueline Simcox, 1999 (1999.153.39)

from the burial site. The treatment must have reduced the odor associated with burial and aging and made the set biologically cleaner while removing the visible surface soils and oxidative products. The immersion in water, however, even if it was for only one minute, not only caused a certain amount of loss but also irreversibly altered the quality of the material:[7] the weight became lighter; the sheen decreased; the texture roughened; the tactile character, or hand,[8] softened; the unraveling yarns along cut edges became matted during drying; and as for the fur, the water gelatinized the oxidized protein while contracting and stiffening the skin, thus causing it to crack under any straining. The treatment also dispersed, redeposited, and saturated the heavy gelatinized body decomposition products, soils, and stains, and thus they still remain.[9] The creases that occurred in the burial and the wrinkles created by washing appear to have been ironed out. Hundreds of empty lepidopteron cocoons are still scattered over the surface of both the interior and exterior of the linen and silk cloths as well as on the inside layers of the wool wadding. Despite the loss of portions in the burial, what remains at present of the linen and silk is in a remarkably good state of preservation for its age and material chemistry. In particular, the condition of the silk fibers is notably good—the good condition of the dark brown is unusual despite the nature of the mordant used.

The second treatment on our caftan and leggings occurred between the auction in 1994 and the Museum's acquisition. For presentation on the art market, the disassembled scattered parts of the caftan

Figure 14. Rectangular length of linen. North Caucasus, 8th–10th century. H. 36 cm. The Metropolitan Museum of Art, Gift of Jacqueline Simcox, 1999 (1999.153.42)

Figure 15. Top row: oval wooden container, side bound with twine, decorated with black, red, and white paint in a crisscross pattern (1999.153.2), L. 15.5 cm. Middle row: forked wooden twig (1999.153.13); small hollowed-out wooden container with channel for lid (1999.153.4); wooden spoon with broken handle (1999.153.18). Bottom row: hardwood knife sheath (?) (1999.153.16); curved wooden handle (1999.153.15); fruitwood comb (1999.153.14). North Caucasus, 8th–10th century. The Metropolitan Museum of Art, Gift of Jacqueline Simcox, 1999

Figure 16. Clockwise from top: circular container of burl wood with pierced handle (1999.153.5), L. 13.7 cm.; decorated rectangular wooden container with channel for lid (1999.153.3); decorated wooden lid (1999.153.9); wooden disk (1999.153.10); fruitwood comb (1999.153.8); decorated rectangular wooden container with lid (1999.153.7a, b). North Caucasus, 8th–10th century. The Metropolitan Museum of Art, Gift of Jacqueline Simcox, 1999

were reconstructed by stitch-mounting them onto conservation backing cloths (see Figure 19 for the style in which the Metropolitan Museum's caftan was reconstructed when acquired). After the Museum's acquisition in 1996, the examination of the context of the caftan and leggings in comparison to a portion of an undecorated linen caftan (Figure 5) and a pair of undecorated linen and hemp leggings (Figure 6) in Reference Group III, strengthened by field experience and Reference Group I publications, led me to conclude that the preacquisition reconstruction of the caftan and the leggings was incompatible with their original styles. In 1999–2000 they underwent a third phase of conservation in the Department of Textile Conservation, which, despite our concern at exposing them to yet another round of treatment, included disassembling the previous reconstruction, cleaning, straightening, and then reconstructing.

To assist the gallery visitors' perception of the garments in the context of an art museum's collection, the caftan and leggings were reconstructed based on our subjective but informed assumptions.[10] Even though we had the remarkable objects from Reference Groups II and III as models at our side, it was agonizing, as usual during a reconstruction, to have to choose a single way to proceed in preference to several other conceivable options while working with the minute details of the garment's cutting and tailoring.

On completion of our conservation work, the caftan and the leggings together with a pair of mitts (Figure 8) and a pillow (Figure 13) from Reference Group III were displayed in the Museum's newly reor-

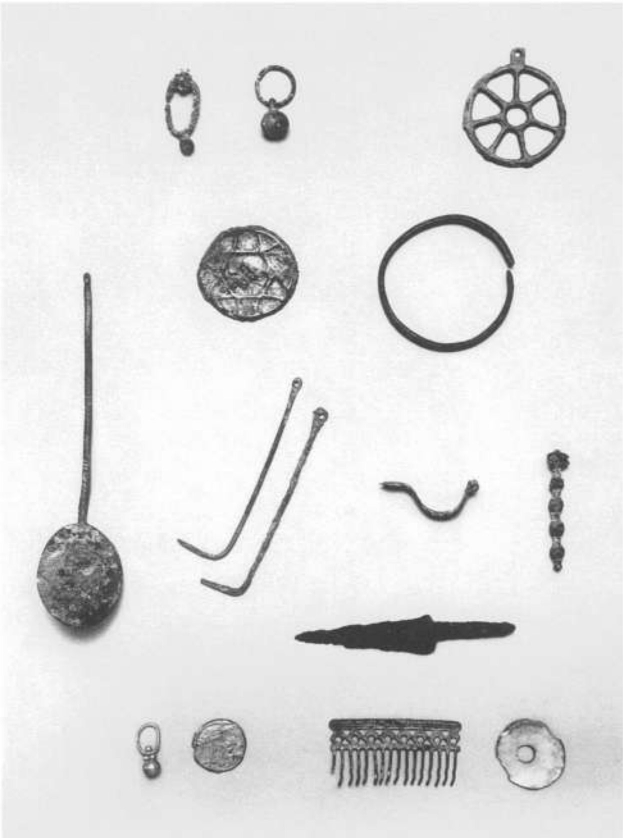


Figure 17. Top row: brass earring (1999.153.33), 3.2 x 1.3 cm; brass pendant (1999.153.31); copper disk with spoked design and suspension loop at the top (1999.153.30). Second row: tinned brass mirror with crisscross design, loop (broken) in center (1999.153.22); copper bracelet (a child's?) (1999.153.21). Third row: brass spoon with flat disk bowl (1999.153.17); two brass hooks with holes for suspension (toilet articles?) (1999.153.20a, b); bow of brass fibula (1999.153.23); brass beaded strip (1999.153.25). Fourth row: iron pointed object (1999.153.24). Bottom row: gold earring (1999.153.32); gold circular disk with repoussé pattern (imitation coin?) (1999.153.12); brass comb-shaped object (1999.153.11); pierced mother-of-pearl disk (1999.153.26). North Caucasus, 8th–10th century. The Metropolitan Museum of Art, Gift of Jacqueline Simcox, 1999

Figure 18. Top group: leather strap with iron and copper buckle in four pieces (1999.153.6a–d), portion with buckle L. 20.6 cm. Second row from bottom: tinned copper belt plaque decorated with a design of bunches of grapes (1999.153.29); tinned copper belt plaque with relief design (1999.153.19). Bottom row: notched leather strips (1999.153.28a, b); curved leather band (1999.153.27). North Caucasus, 8th–10th century. The Metropolitan Museum of Art, Gift of Jacqueline Simcox, 1999

ganized Ancient Near Eastern Art Galleries. The rest of the Reference Group III textile objects are stored in boxes made specifically for each item, for the most part with the encrustation and dried-up empty cocoons left as they were when the Museum acquired the objects, and are available for future study and conservation.

In the following discussion, overall features of the caftan and the pair of leggings will be described based on our reconstruction, and the many fragmentary extant original features associated with the caftan and leggings and from the three reference groups will be noted as necessary.

## The Primer of the Caftan and the Pair of Leggings

Based on representations depicting the steppe peoples of the period (e.g., Knauer, Figure 20), the caftan probably reached the mid-calf of the wearer. It could have been worn as one of several layers, with a functional, undecorated linen caftan[11] underneath and a sheer, decorated caftan, such as the Reference Silk Caftan, over it perhaps during the day, with a third layer such as our heavy, fur-lined one worn in the cold. Over this caftan, an ornate, multipurpose belt, and headgear, a pair of leather mitts,[12] and boots would

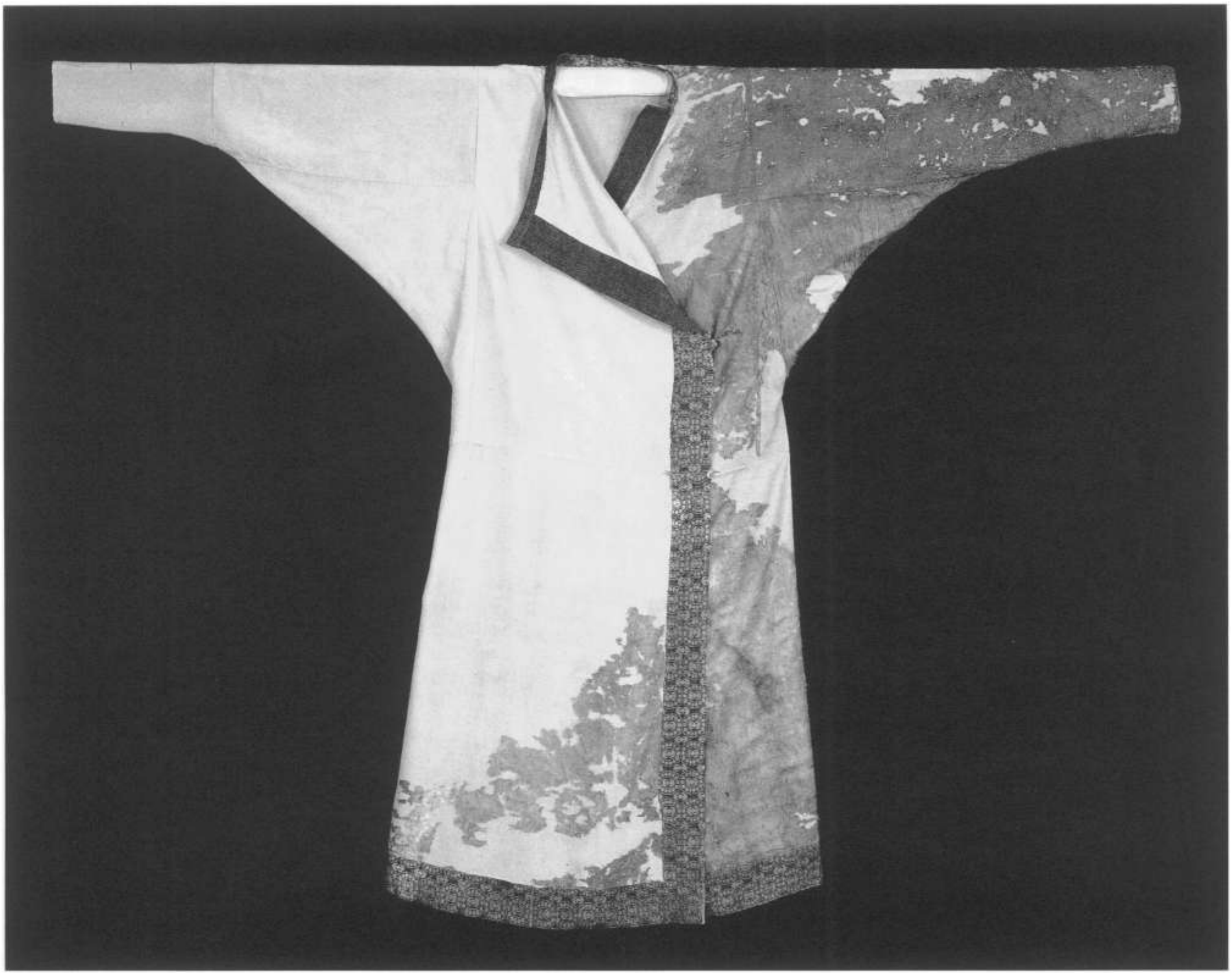
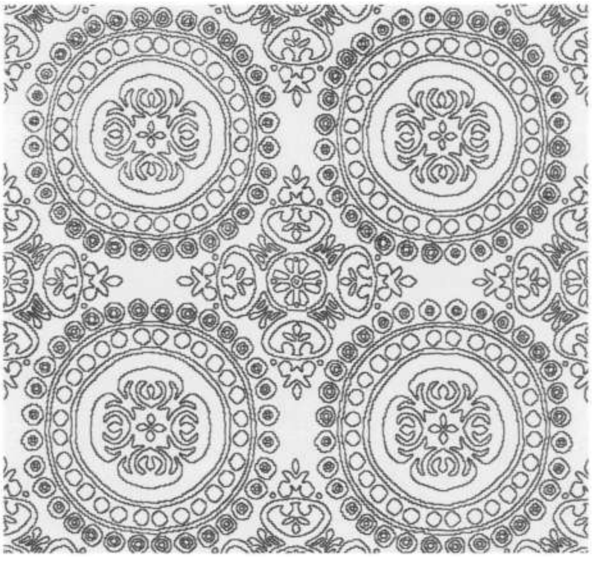


Figure 19. Reference Silk Caftan of silk damask, Chinese Tang dynasty, trimmed with rural-type patterned silk (similar to our Silk A). North Caucasus, 8th–10th century. Unlined. Reconstruction by the owner in 1995. H. 132 cm. Rossi and Rossi Ltd., London (photo: courtesy Rossi and Rossi)

Figure 20 (below). Design of the Tang dynasty silk damask of the Reference Silk Caftan in Figure 19. H. roundel 14.5 cm. (drawing: Barbara Teague)



have been part of the wearer's accoutrements. For vigorous hunting and combat, an appropriate set of protective gear must have been worn over the caftan.

The caftan was worn double-breasted style, with the proper left front closing toward the right and the right front overlapping it. Modeled according to the reference undecorated linen caftan (Figure 5), the triangular sidepieces on the front push the side seams toward the back, causing the broad-shouldered back to narrow toward the waistline (Figures 1–3, 21) and making the sleeves emerge from the back like a pair of huge wings. This style provided considerable room to accommodate the height and breadth of the mounted wearer's upper body even in full motion. The narrow wrist openings of the sleeves helped to retain the wearer's body heat. For easier movement of the lower body, two long slits, bordered with decorative silks, were left in the back below the hipline. When the wearer was in a standing position, the slits would slightly reveal the leggings, and with the wearer's knees bent in a seated position, as on a chair or in a saddle,[13] the entire elaborate leggings would be visible. At the top of the seamed part of each of the embellished slits, a rounded hump conspicuously sticks out on the narrow back waistline.[14] Three sets of button-and-loop fastenings hold the caftan closed. The garment was completely lined with fur (see Figures 1, 37), although, owing to the loss, it cannot be ascertained whether the sleeves were originally fur-lined as well.

The coordinating leggings were made of a polychrome patterned silk like those depicted in full view in pictorial representations (see Knauer, Figure 18). Each legging is composed of two standard units (Figures 4, 22; see The Construction: The Pair of Leggings, p. 98). The upper parts are a single layer of silk, soft and pliant without a lining or stiffener or any visible attachments. This characteristic suggests that the leggings were more decorative than protective and that they might have been worn over a pair of undecorated functional leggings (Figure 6).

The silks and linens used in the coat and leggings came from bolts of cloth woven as a length to be cut into required shapes and sizes (not an easy task at that time).[15] The type of pattern cutting practiced in the region was semistraight. Representing a long-established local craft convention, the semistraight pattern cutting was designed with precision to be suitable for the wearer's activities. In tailoring, the cut pieces were neatly seamed with the finest stitches using sturdy linen sewing threads and, no doubt, finely forged sharp iron needles. Overall, the high quality of the linen cloth, garment design, cutting, assembling, and sewing demonstrated remarkable professional coordination in comparison with contemporaneous examples from other cultures, attesting to this region's elevated standards in artistic and technical achievements regarding textile culture and perhaps even social decorum.

## The Construction: The Caftan

The caftan was made of a densely woven plain-weave cloth of undyed white[16] fine linen (Figure 23) with a medium hand (Figure 24). The linen's plainness was decorated effectively with broad strips of two different polychrome patterned weft-faced samit silks (Figure 26)[17] along the edges, both exterior (Silk A, Figures 28–30) and interior (Silk B, Figures 31–33). It was lined with fur. Collar, cuffs, and other elements, if any, are unknown.

The caftan was composed of the twelve standard units (Figure 21) of linen cloth (of which six units in thirteen pieces are extant) plus the embellishing silks, the three buttons made of linen cloth, and two lengths of linen double cording (bias cut) used for the three button-fastening loops. Each of the twelve standard units could be made up of a number of pieces seamed depending on the original width of the bolt or the size of the remnants or old garments that were used. Each of the triangular sidepieces (4, 5) in our caftan is composed of two pieces instead of the standard one. The lower fronts (10, 11) and the back (12) are composed of three pieces each, with narrow strips placed along the sides, mostly hidden under the border silks. The upper sleeves (6, 7) are composed of two pieces, discussed below. All the units and decorative borders are actually composites of small to large similar pieces of cloth with traces that indicate that they had been used previously.[18] This must have been the result of either the talismanic use of old clothes associated with a respected person or the reuse of precious hand-worked materials, a common practice in many cultures throughout history then and now.

The overall measurements of the caftan come to a total height of 142 centimeters (reconstruction), with the upper half to the waistline measuring 65 centimeters (reconstruction), and the lower half 77 centimeters (extant). The entire shoulder line, from wrist to wrist, is 184 centimeters (reconstruction). With the two overlapping front panels (one-half extant) closed in a double-breasted manner, the waistline is 105 centimeters (extant), and the entire fanned-out hemline 164 centimeters (extant, with actual open waistline 151 centimeters and hemline 210 centimeters). (See The Construction: The Pair of Leggings, p. 98, for measurements of the leggings.) Based on these measurements, which are an approximation of the space afforded within the garment's fur-lined interior, it can be deduced that the coat and leggings were made for a male equestrian approximately 180 centimeters tall but assuredly slender and perhaps young. The degree of wear and soiling indicates that the set had been worn only slightly before becoming mortuary items.

All the units of linen including the lower sleeves were cut with the direction of the warp consistently aligned vertically when the coat is arranged with the arms stretched out straight. There is no shoulder seam along the line from wrist to shoulder to wrist. The units were assembled for the most part by neatly stitched flat-fell seams, which were folded and finished toward the center of the units.[19]

In tailoring the coat, the units were prepared, the upper and the lower halves were each assembled and for the most part embellished, then the two halves

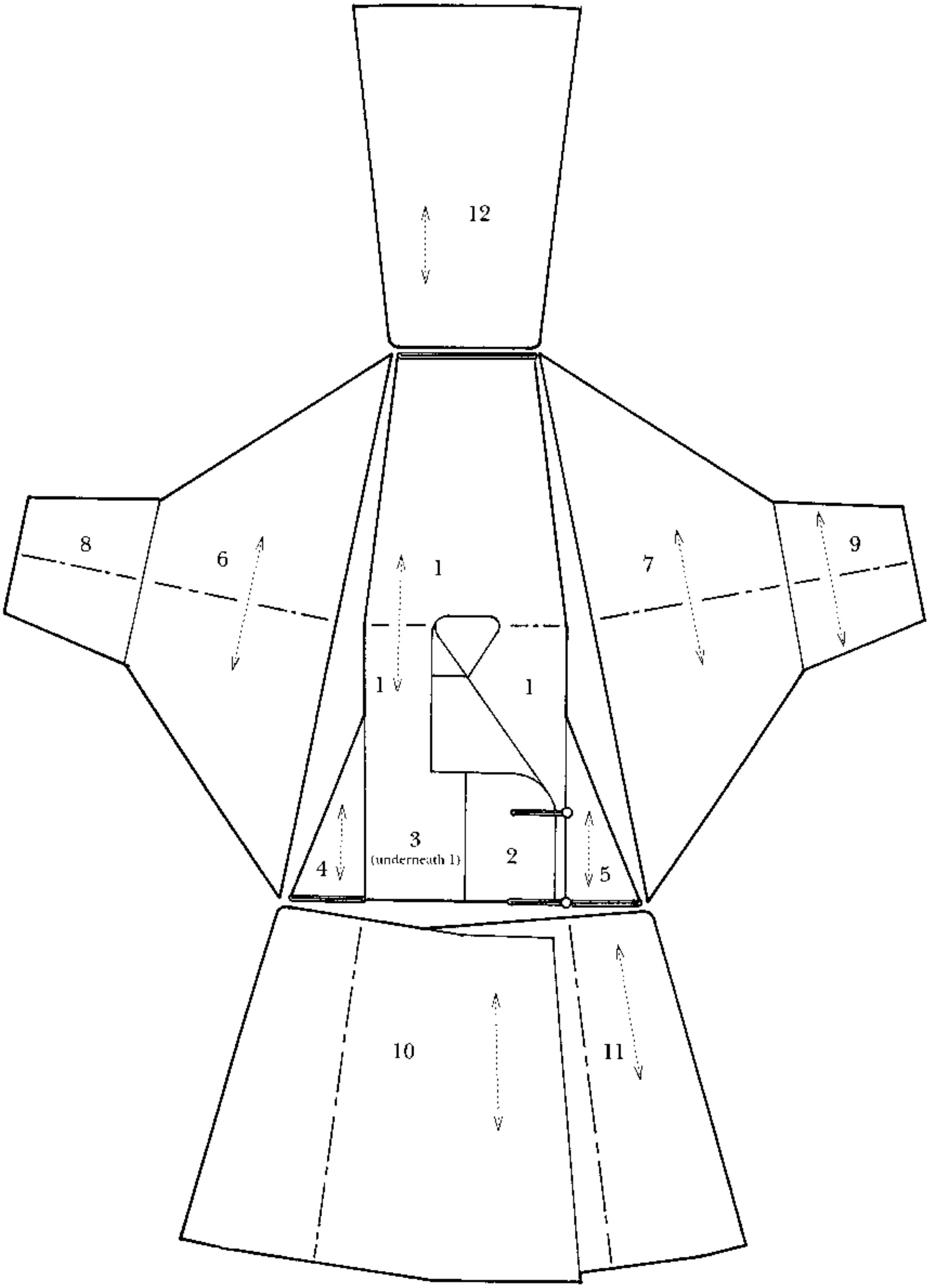



Figure 21. Diagram of the twelve standard units of a caftan like the MMA caftan (Figure 1), an undecorated linen caftan (Figure 5), and the Reference Silk Caftan (Figure 19): 1) contiguous unit of upper right front, upper left front, and back; 2) right and 3) left fronts' extended overlaps seamed to center cuts of 1); 4) right and 5) left triangular sidepieces attached to the body's front underarm areas; 6) right and 7) left upper sleeve pieces, shoulder to elbow, front and back continuous; 8) right and 9) left lower sleeve pieces, elbow to wrist, front and back continuous; 10) right and 11) left lower halves of front; and 12) lower half of back (drawing: the author and Daniel Kershaw)

were seamed together along the waistline. For the upper part of the body (1), the cloth was cut in one continuous panel for the front and back, and folded in half at the wider shoulder line. A slit was made in the center of the front half, and a neck opening (reconstruction, 15 x 6 cm) was cut out. To each side of the slit in the front, an overlap panel (2, 3; reconstruction) was sewn, creating the double-breasted front. The triangular sidepieces (4, 5; reconstruction) were seamed to the outer edges of the front; the edges of the sidepieces and the outside edges of the back would be seamed to the upper sleeves later. Adding the sidepieces pushes the side seams of the caftan toward the back, making the back narrower than the front.

To prepare the upper sleeves (6, 7; reconstruction), two rectangular panels were cut diagonally at one end. The cut-off triangular pieces were each seamed to the other straight-cut end of the panels, forming trapezoidal pieces whose bias-cut edges became the lower edges of the upper sleeve units. Then the five units making up the upper half of the caftan were seamed to each other in the direction of the warp, the sleeve units (8, 6 and 7, 9) flanking the central unit (1–5). The assembled flat upper body section was then folded in half in the direction of the weft, creating a shoulder line from wrist to wrist. The lower edges of the joined upper and lower sleeves were sewn together. Unable to verify the lost original but following the model of reference caftans, tunic, and sleeve,[20] we reconstructed the Metropolitan's caftan with a simple hem at the wrists, without embellishing borders.

The refinement and embellishment of the assembled upper body section followed. To create a lapel on the extended overlap of the outer right front (the left front was lost), a border of Silk A was first attached to the exterior extending to midway in the panel (26 cm, extant). The obverse of the border was overlaid onto the obverse of the linen and sewn. After the border was folded back to expose its obverse, the opposite edge and the top were turned under and sewn to the linen, completing the exterior border. To finish the interior, first a strip of wool wadding and then a border of Silk A (63 cm, of which 50 cm extant) were placed on the linen and stitched. Examining the remaining proper right front panel with a decorated lapel and a small part of proper left front panel, it was clear that the caftan had an asymmetrical lapel closure (see Knauer, Figure 17). The presence or absence of embellishment for the neckline is unknown, however, for those sections, as well the neckline portions of the comparable undecorated (Figure 5) and Reference Silk (Figure 19) caftans, were totally lost. We therefore stabilized the original decorated lapel on the proper right front, and we left the neckline plain.

Each of the three lower panels (10–12, all extant) is a composite of three pieces. After seaming the nine pieces into three panels, the panels were assembled for the lower half of the caftan. The two front panels, wider than the back panel, extend 7 centimeters around each side of the body toward the back (33 cm at the waistline, plus the humps). To facilitate movement of the lower body, the two front panels were seamed to the back panel (almost all extant) only down to the hipline (27 cm, extant), leaving the rest of the lower portion (49 cm, extant) as slit openings for the ease of the wearer seated on horseback. The outer edges of the three panels were embellished by stitching borders of Silk A on the exterior and Silk B on the interior. In attaching the borders (8.5 cm wide), the two-directional designs, whether Silk A or Silk B (see Figures 28–33), were meticulously oriented vertically long or horizontally wide in their proper upright position—never sideways, even when tiny pieces were used. (Under magnification, it can be seen that the direction of the weaving, not otherwise recognizable, was not respected in these borders.) The assembled and silk-trimmed upper and lower body sections were then joined at the waistline.

The final refinement was the attachment of button-and-loop fasteners. To hold the double-breasted front closed, three sets of button-and-loop fasteners were strategically placed: 1) on the waistline at the proper right interior; 2) on the waistline at the proper left exterior; and 3) at breast height on the proper left exterior. The buttons, 7 millimeters in diameter and 4 millimeters thick, were made of linen cloth covering an undetermined hard core. For the loops, cording (19 cm extant) was made of bias-cut linen, stitched, and turned inside out (3 mm diam.), with loops at both ends. It was sewn doubled onto its position around the back outside waistline of the caftan. The loop at the proper right (3 cm, extant) was pushed through a gap in the waistline seam to the inside of the caftan and securely stitched to meet the button (1; reconstruction) attached to the right side of the left front panel. The other loop (reconstruction) placed at the proper left side meets the button (2; reconstruction) attached to a short doubled cording (reconstruction) placed on the left side of the right front. Another button (3; extant) at the end of a short doubled cording (extant) attached at breast height to the right front was positioned to meet the loop (reconstruction) attached to the edge of the proper left front.

A prepared fur lining[21] (lost, not simulated in reconstruction) was stitched along the inside edge of the silk borders through the layer of linen.

A knot of heavy black thread, pierced through the layers of silks and wadding at each of the lower corners of the front panels, remains. The reason for the knots cannot be conjectured.

For our reconstruction, an unbleached muslin (cotton)[22] was selected because it is a texture close to the original linen. It was dyed with a mixture of four dyes from the Solophenyl series by Ciba-Geigy with Glauber's salts under normal pressure. A practical test for color fastness, which involved exposing the dyed muslin to simulated gallery light for a time calculated to be the equivalent of eight hours per day for three years at fifty lux, showed no visible fading.

## The Construction: The Pair of Leggings

The major parts of the leggings were constructed of decorative Silk C for the leg section and of durable linen cloth for the foot section (Figure 4). Each legging was composed of two standard units (Figure 22). The leg section, reaching from the ankle to above the knee, is a single layer of Silk C (extant), soft and pliant without a lining or stiffener.[23] On these leggings, a separate piece was added to the ankle area, also of Silk C, perhaps because the silk length was not sufficient. Linen reinforcing strips (cut in the direction of the warp) were stitched around the interior of the leggings' tops. The foot section (partial reconstruction)—covering the foot from below the ankle to the toes—was constructed of tiny random-size bits of linen cloth ingeniously seamed with curves and darts to form three-dimensional interiors.[24] In the middle of the front edges of the tops of the leggings, small leather disks with holes (extant) were sewn through all layers of linen strips and silks. The leggings, probably worn over undecorated ones, must have been held up by means of strings (missing)[25] threaded through the leather disks and probably anchored to a belt worn inside the coat.

The dimensions of the leggings are 81 centimeters in height (extant), 59 centimeters around the knee (extant), 32 centimeters around the ankle (extant), and 24 centimeters from heel to toe (extant).

It cannot be ascertained from the silk leggings whether there were distinctions between the right and the left foot, since seams for the toe only partially remain. However, the Metropolitan's undecorated linen and hemp leggings (Figure 6) clearly do not distinguish between right and left feet. Only the creases caused by tying and dark staining from the burial suggest whether the leggings were worn on the right or left foot.

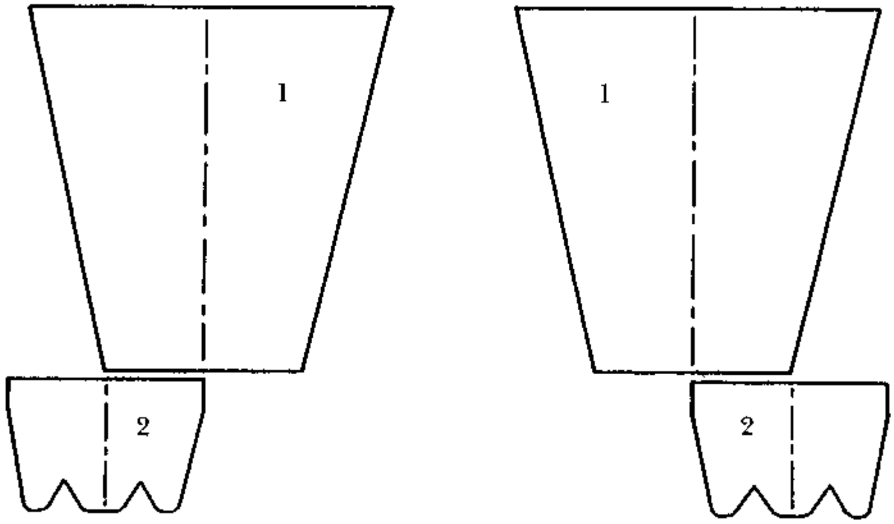
## Undecorated Linen Cloth

Structure (applicable to all the composite pieces)
Predominantly warp-faced plain weave. Structurally reversible

Materials
Warp: Undyed, bleached linen, Z (spun). Count: 27–29 per centimeter
Weft: Undyed, bleached linen, Z (spun). Count: 19 per centimeter

A close examination of the weaves reveals that the somewhat irregular thick-and-thin diameter off-white

Figure 22. Diagram of the two standard units of a pair of leggings like the ones in Figure 4: 1) leg section; 2) foot section (drawing: the author and Daniel Kershaw)



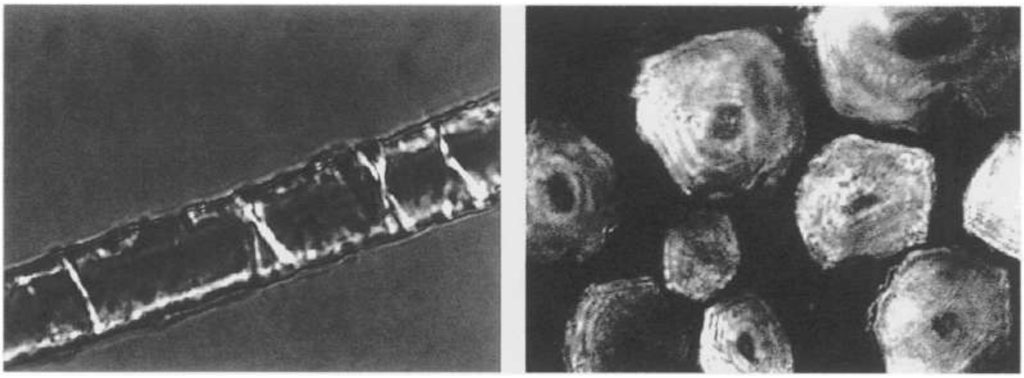


Figure 23. Flax fiber of the caftan in Figure 1, longitudinal (left) and cross-sectional views, 1000x (microscopy: Florica Zaharia)

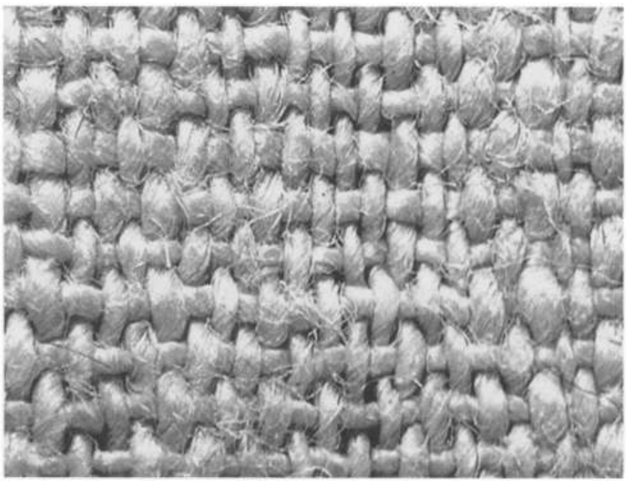


Figure 24. Surface of the linen cloth of the caftan in Figure 1, 17x (microphotograph: the author)

linen yarn is sporadically mixed with slightly darker fibers[26] running in both warp and weft directions, creating a subtle surface effect distinctive to the region (Figure 24). Unlike most linen fabrics from other cultures, there is no streaking or striped discoloration in the warp or weft or weft irregularity, attesting to the high level of quality control in the area. The hand of the cloth can be described as soft, bending, clinging, and draping but with a fairly dense, integral strength. This visual impact and hand of our linen, which was woven as a bolt of cloth, distinguish it from woven-to-shape items produced in the environs of Egypt, Syria, and Iraq in the Late Antique period.

## The Polychrome Patterned Silks

Three polychrome patterned silks, Silks A, B, and C, of related types, embellished and adorned the caftan and leggings: Silk A was used as a border on the lapels and the exterior of the lower panels of the caftan; Silk B was used as a border in the interior of the lower panels of the caftan; and Silk C was used as the leg section of the leggings.

*Patterned Silk A (same pattern from more than one bolt)*

Design
Pattern of pearled-border roundels and interstitial fillers, both filled with a double-axlike design. Pattern repeats straight horizontally and vertically without distinct top and bottom (Figures 28–30).

Structure common to Silks A, B, and C
Weft-faced samit: weft-faced 1\2 twill weave compounded with inner warps and complementary wefts. Four colors compose the design, of which two- or three-color complementary wefts interlace per passage depending on the colors called for in the design. The weft order (g is the ground weft, and a and b are the pattern wefts) is as follows: two-color weft passages, a,g/g,a/. . . ; three-color weft passages, a,b,g/a,b,g/ . . . The pattern step is one binding warp. It is not reversible.

Materials
Binding warp: Undyed silk (spun), Z. Count: 21 per centimeter
Inner warp: Undyed silk (spun), Z x 2. Count: 21 per centimeter
Weft: Dyed and undyed silk (reeled). Colors: dark brown, undyed? or red?, yellow? Count: 24–51 per centimeter

Figure 25. Silk filament of the border of the caftan in Figure 1, longitudinal (left) and cross-sectional views, 1000x (microscopy: Florica Zaharia)

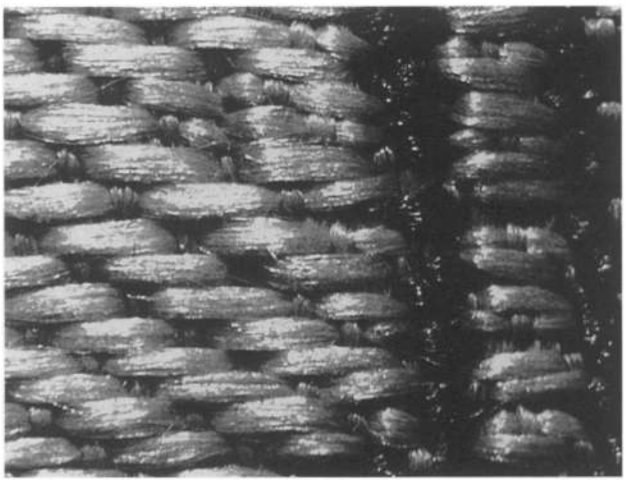


Figure 26. Weft-faced samit of Silk A, the border of the caftan in Figure 1, showing weft-faced 1\2 twill with thickness compounded by inner warps, and three-color (10th, 11th weft passages from the bottom) and two-color (the rest) weft orders; 17x (microphotograph: the author)

The pattern organization is based on the circle-and-cross repeat of Sasanian origin and is oriented in two directions along the warp, without a distinct top and bottom of the design. Across a row, roundels abut horizontally without interstices whereas between roundel rows, space accommodates interstitial patterns. Both the interstitial patterns and the roundel fillers are stylized double-axlike motifs. The border of each roundel contains fourteen pearls. An odd feature is that at the center of the loomed width, an off-white 4-millimeter stripe was woven abutting the two center roundels as if dividing the woven width of the cloth in half.[27]

One complete pattern unit, composed of two minimum units, is symmetrically repeated horizontally, with the complete units aligned vertically in columns (not offset). The interstitial patterns extend 3 millimeters into the space between the roundels' tops and bottoms. Although the roundels were supposed to be woven to a consistent size, approximately 4 by 4 centimeters, they vary greatly from row to row and somewhat from column to column. The average dimensions of the roundels woven is 4 centimeters high by 3.5 centimeters wide (Figure 28). The minimum repeat units are 4.5 by 1.8 centimeters, and the complete, maximum units are 4.5 by 3.5 centimeters. The width of the roundels overlaps 2 millimeters with the interstices.

At present, the pattern appears as an off-white color on a dark brown ground. Examination of the structure, however, reveals that the pattern was executed in polychrome. Within one pattern unit, at the center of the axlike motif in both the roundels and the interstices, aside from the dark brown ground there are four weft passages of two-color pattern wefts, while all the rest is in one color. A light yellow is faintly identifiable in one of the pieced borders.[28] Because analogous colors of yarns cannot be easily differentiated by their physical characteristics alone, in the absence of visible colors and with the reverse of the selvage inaccessible, it is not possible to ascertain whether a third or fourth color might have been present.

Selvages, about 1 centimeter wide, were continuously woven with a pattern weft on the obverse over the last regular warp in the same weft-faced 1\2 twill samit weave. The stripe in the center, the graduating widths of the roundels becoming symmetrically narrower toward the selvages, and the extant two selvages indicate that the full-loom width of the fabric was 64 centimeters, accommodating sixteen complete roundels. Since the roundels at both the right and left selvages are complete, the starting point of the pattern heddle arrangement on the loom could have been either side.[29]

*Patterned Silk B (same pattern from more than one bolt)*

Design
Repeated pattern of pearled-border roundels with interstitial fillers, both filled with a rosette. Pattern repeats straight horizontally and vertically without distinct top and bottom (Figures 31–33).

Structure—see Silk A

Materials
Binding warp: Undyed silk (spun), Z. Count: 21 per centimeter
Inner warp: Undyed silk (spun), Z x 2. Count: 21 per centimeter
Weft: Dyed and undyed silk (reeled), no twist. Colors: dark brown, undyed?, blue, yellow?, red? Count: 18–27 per centimeter

The pattern organization is based on the circle-and-cross repeat and is oriented in two directions along the warp, without a distinct top and bottom of the design. Across a row, roundels abut horizontally without interstices, whereas between the roundel rows, the space accommodates interstitial patterns. Both interstitial patterns and fillers of the roundels are rosettes. Depending on cut pieces, each roundel border contains sixteen, seventeen, or eighteen pearls, indicating that the pieces of Silk B were cut from at least three different bolts. (Full-width reconstruction of Silk B from two pieces indicates that each bolt was obviously woven with a consistent number of pearls.)

One unit of the pattern is symmetrically repeated along the horizontal axis aligned vertically in columns (not offset). The minimum repeat unit is 8.5 centimeters high by 2.5 centimeters wide, and the maximum unit 8.5 by 5 centimeters. One complete pattern unit is composed of two minimum units in a horizontal symmetrical repeat. The vertical repeat is a straightforward repeat of the maximum unit, with the rosettes in the interstices extending 1.2 centimeters into the space between the adjacent roundels' top and bottom. Greatly varying from row to row and column to column in size, the average dimensions of the roundels are 7 centimeters high by 5 centimeters wide, and the interstice filler measures 4 by 4 centimeters (Figure 32).

At present, the pattern appears to be solely an off-white color on a dark brown ground. Originally polychrome, within one repeat unit, apart from the dark

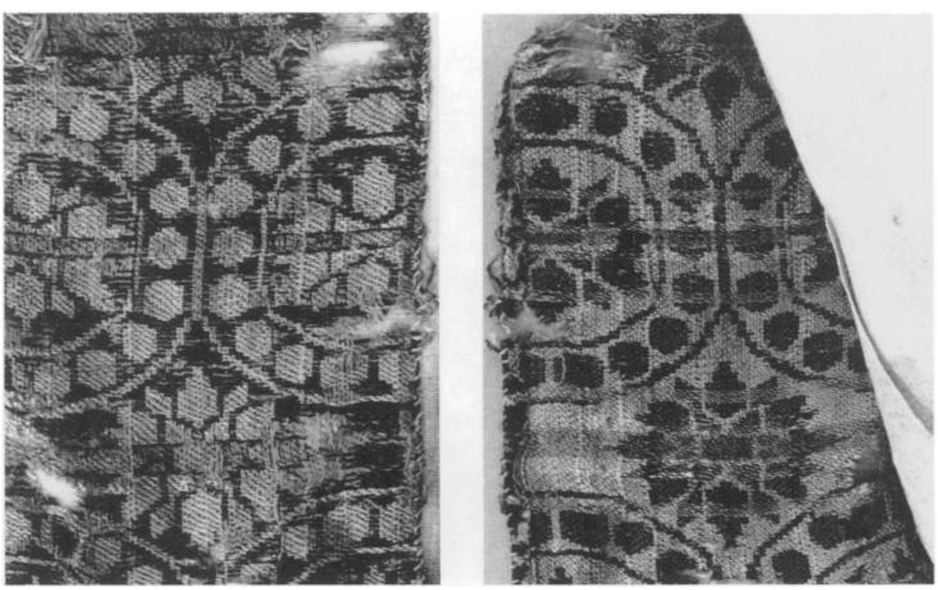


Figure 27. Obverse (left) and reverse of weft-faced samit Silk B of the interior border of the coat in Figure 1. The reverse shows three-color areas (in three bands at each rosette's center of the large petals) and two-color areas (the rest—dark and light reversal of the obverse) (photo: the author)

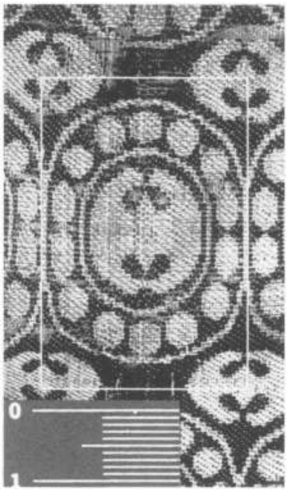



Figure 28. Silk A, showing one repeat unit (photo: the author)

Figure 29. Silk A, showing vertical repeat units. The heights of the roundels change from shorter to taller every three-roundel repeat

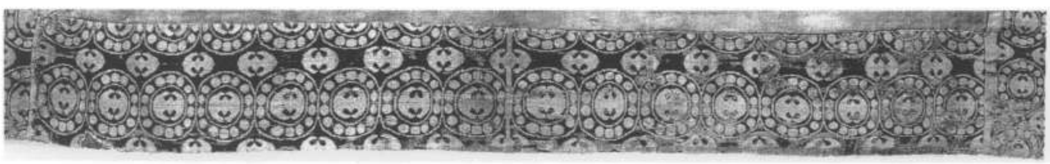


Figure 30. Silk A decorating the exterior of the coat in Figure 1, showing 16 horizontal repeat units in full loomed width (64 cm). The widths of the roundels decrease symmetrically from the stripe in the center toward the selvages

brown for the ground, one- and two-color pattern weft passages are evident, as called for by the design. One of the off-white colors shows a brownish yellow tint, and another a bluish gray, originally a blue. Other than that, for the most part, the original colors of the yarns are indistinguishable by their physical characteristics. The pearls in the border were likely red, the center of the rosettes blue, and the tips of the petals accented by yellow against a dark brown ground. Whether the one-color pattern wefts were off-white or red cannot be determined. In the pattern unit, there are ten bands of two-color pattern areas: five bands in the roundels, each with four or eight passages of weft; and five bands in the interstitial pattern, each with six or ten passages (Figures 27, 32) that alternate with one-color pattern areas.

Selvages, about 1 centimeter wide, were continuously woven with a pattern weft on the obverse over the last regular warp in the same weft-faced 1\2 twill samit weave. The graduating width of the roundel suggests the loomed width was about 64 centimeters (the maximum width with one selvage extant is 53 cm), accommodating ten roundels with the first and the last roundels complete at the selvages.

*Patterned Silk C*

As a rare example, Silk C has two different consecutively woven patterns, C1 and C2: the first pattern, C2 (Figure 36), of isolated large rosettes, was woven as a short beginning length (only present in legging 1996.78.2a; see Figure 4). Along the same length of warp, the second pattern, C1 (Figure 34), constitutes the rest of the entire cloth composing the pair of leggings.

Design

Patterned Silk C1: repeated pattern of pearled-border roundels and interstitial fillers, each filled with a confronted pair of highly stylized birds or boar's heads between stemmed dish or compotelike devices, the smaller one above and the larger one below. The pattern repeats straight horizontally and vertically with distinct top and bottom (Figures 34, 35).

Patterned Silk C2: repeated pattern of isolated large rosettes. Pattern repeat is organized offset, in vertical alignment without distinct top and bottom (Figure 36).

Figure 31. Silk B, showing vertical repeat units. The heights of the roundels change from shorter to taller every three-roundel repeat

Figure 32. Silk B, showing one repeat unit (photo: the author)

Figure 33. Silk B decorating the interior of the caftan in Figure 1, showing six horizontal repeat units with a selvage at right. The widths of the roundels decrease toward the selvage (reconstructed full loomed width is 64 cm, fitting ten roundels)

Structure—see Silk A

Materials

Binding warp of C1 and C2: Undyed silk (spun), Z. Count: 18–24 per centimeter

Inner warp of C1 and C2: Undyed silk (spun), Z. Count: 18–24 per centimeter

Weft of C1: Dyed and undyed silk (reeled). Colors: dark brown, no twist; undyed?, no twist; red?, no twist; yellow, no twist; blue (spun), Z. Count 18–30 per centimeter

Weft of C2: Dyed and undyed silk (reeled), no twist. Colors: dark brown, undyed? Count: 18–30 per centimeter

In Silk C1, the pattern organization is based on the circle-and-cross repeat and is oriented in a single direction with a distinct top and bottom of the design. The pattern is composed of horizontal rows of major pearled-border roundels connected by inset minor roundels without interstices, and of vertical columns (not offset) of major roundels connected by abutting minor roundels separated by interstices with fillers. The major roundels and interstices are filled with highly stylized, confronted pairs of birds or heads of boars[30] placed between two compotelike devices,[31] the smaller one above and the larger one below (Figure 34). Each minor roundel is filled with a single pearl. Pearls fill the borders of all roundels, eighteen in each major roundel, twelve in each inset minor roundel, and eleven in each interstitial minor roundel.

The pattern is oriented along the warp with a distinct top and bottom, unlike Silks A and B. Following the convention of draw-loom weaving applicable for this type of textile,[32] the weaving direction can be postulated as conforming to the direction of the pattern, beginning at the bottom of the design and weaving toward the top (see weft order, below). Silk C, with its conspicuous design orientation, was used in the leggings for the most part with the design upside down, suggesting that the people who used the silk were not reading the design clearly.

At present, the pattern appears to be an off-white color on a dark brown ground. Examination of the structure, however, reveals that although the colors are no longer present, the pattern had originally been polychrome. Within one repeat unit, besides the dark

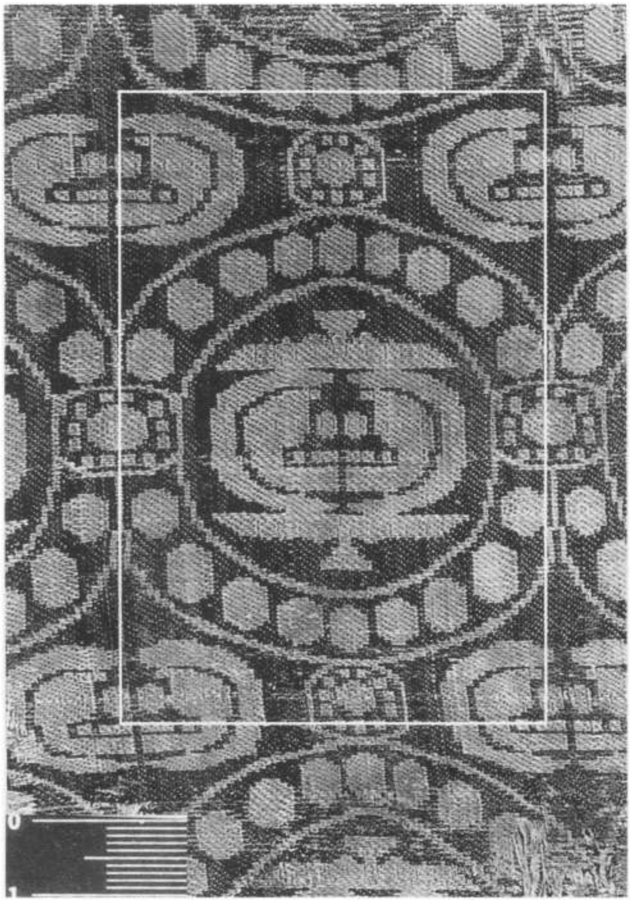


Figure 34. Silk C1, showing one repeat unit (photo: the author)

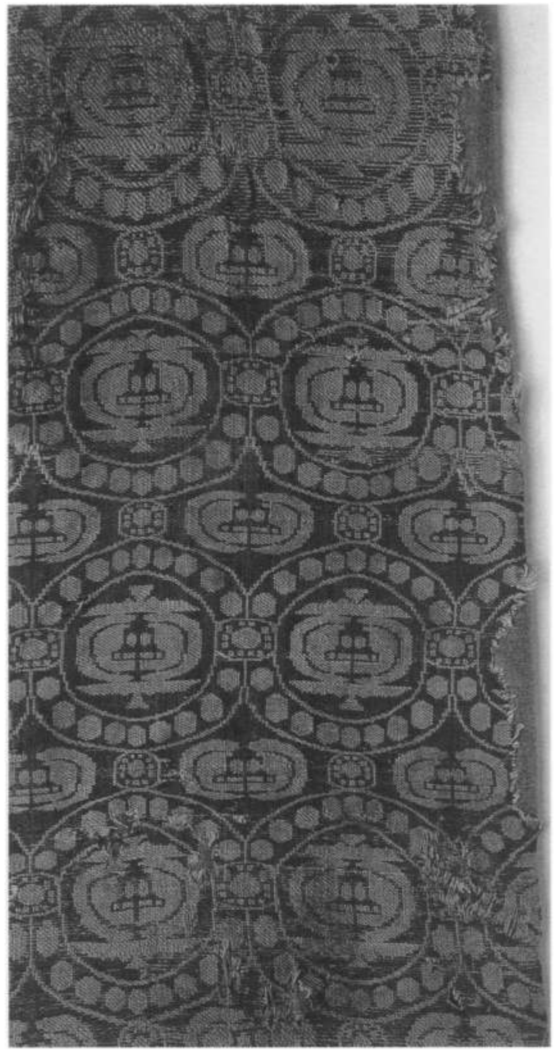


Figure 35. Silk C1 of the legging at right in Figure 4. Used upside down in the legging. The widths of the roundels decrease toward the selvage at right. The heights of the roundels change from shorter to taller per every three-roundel repeat (reconstructed full loomed width is 64 cm, fitting nine roundels)

brown for the ground, one- and two-color pattern weft passages appear as called for by the design. In one area, one of the off-white colors shows a discolored yellow and another a light greenish brown reduced from the original blue. Beyond these two, other colors, if any were used, are indistinguishable because the physical characteristics of the yarns are visually similar. While the off-white may have been the original color of the pearls, the other colors cannot be determined. It is likely that yellow and/or red were used in combination in the two-color pattern areas (besides the dark brown ground color). Within the height of the minimum pattern repeat unit, and alternating with single-color areas, there are eight two-color pattern areas: five in the roundels, each with two, four, or six passages of weft; and three in the interstices, each with two or four passages.

Although actual woven dimensions of the pattern vary greatly from row to row and somewhat from column to column, the major roundels were intended to be 7.5 centimeters high by 7.5 centimeters wide; the minor roundels 1.5 by 1.5 centimeters; and the design in the interstices 2.3 by 4.5 centimeters. In the horizontal organization of the pattern, one complete unit is composed of two symmetrical minimum units; the vertical organization consists of one complete unit in straight repeat, with the interstitial pattern overlapping each roundel's top and bottom by 3 millimeters (Figure 34). The minimum unit is 9 centimeters high by 3.8 centimeters wide, and the maximum unit is 9 by 7 centimeters.

Selvages, about 1 centimeter wide, were continuously woven with a pattern weft on the obverse over the last regular warp in the same weft-faced 1\2 twill samit weave. The maximum width extant is 43 centimeters with one selvage present. The graduating

Figure 36. The two different continuously woven patterns of Silk C on the rim of the right legging in Figure 4, showing half of a pattern unit of C2 at the beginning of weaving followed by C1. Used upside down in the legging. (photo: the author)

width of the roundels suggests the full loomed width was about 64 centimeters, which would accommodate nine complete major roundels.

In Silk C2, the weaving begins with an undecorated dark brown section (3 mm extant). After that, a pattern oriented in two directions, without a distinct top and bottom, was woven with only one-half of a complete repeat unit (3.5 cm), perhaps as an experimental run on the new warp or section. Not enough fabric was woven for us to estimate the size of a complete repeat unit, but it appears that the pattern was intended as a two-directional, straight repeat, with one complete unit composed of two symmetrical minimum units arranged horizontally and offset in columns vertically. This type of pattern repeat with a singular design in offset columns is unusual in the eighth to tenth century, but it becomes increasingly common in later periods. Even though the patterns in C1 and C2 were set up with the same repeat-unit organization on the same warps,[33] the pattern in C2, being too large to fit into either the roundels or interstices of C1, can be considered an independent design. The shift in pattern from Silks C2 to C1 is evidence that the loom in use in this weaving locality was devised for interchangeable sets of patterning cords.[34]

The pattern against the dark brown ground is in two colors, off-white with tiny dots in four of the petals that are the same dark brown color as the ground. As with Silk C1, the rosette is 7 centimeters high by 7.5 centimeters wide and the space between the rosettes is 5 by 2 centimeters. The minimum repeat unit is 6 centimeters high, and the design overlaps 1 centimeter with the next row. The minimum unit is 3.8 centimeters wide, and the design overlaps 5 millimeters with the design in the next column.

## The Wool Wadding

When the caftan was worn, the interior silk borders were meant to be visible. The fur lining, therefore, extends only to the inside edge of the silk borders. To replicate the thickness of fur, a wadding of loose, hairy wool fibers (not felted) was placed between the linen and the exterior and interior silk borders at the lapels and around all the panels of the lower section. The use of hairy wool fibers as wadding suggests that wool was less precious than cotton. Perhaps cotton was not raised as an agricultural product, and it may have been imported to the area only as yarn and cloth, not as fibers.

## The Fur Lining

The fur lining is now totally lost and indicated only by several tiny remnants left sewn at the edge of the interior border (Figure 37). The fur consists of yellow, long curly hair (ca. 2.5 cm) still on the skin or hide, which is now stiff, dark brown, and cracking. The fur lining was probably removed at the time of unearthing owing to its state of decomposition. It had likely been far too infested and shredded by keratin-starved insects, a common fate for this type of animal sub-

Figure 37. Remnant of the fur lining in the coat in Figure 1; see the inside edge of the opened lapel in that photograph (photo: Emilia Cortes)

stance in a burial site. The type of animal and method of tanning have not been investigated.

## Early Linens and Their Inherent Qualities in Historical Perspective

The entire caftan and the foot section of the leggings, as well as the majority of the other items in the reference groups, were constructed of cloth woven with flax fiber yarn,[35] indicating that linen was historically the most common textile fiber in the region. The softer and pliable fine fibers for the caftan were taken from the source plant in the middle of its growth cycle, while the stiff and sturdy fibers for the items that required strength to withstand abrasive use, such as the foot sections of the leggings, were from an overmatured stage of growth. Although linen constitutes the major component among the bast fiber-made items in Reference Group III, a smaller quantity of hemp and nettlelike fibers was also found making up all or part of those items that were expected to withstand vigorous, abrasive use.[36]

The degree of uniformity and fineness of all bast fiber yarn in the garments under discussion here shows that fiber preparation and spinning in the region were expertly practiced. As is common in professional weaving, the warp yarns were slightly finer and more consistent than the weft. Effects observable in the yarns include the Z-twist spinning direction,[37] degree of twist, amount of fiber fed into the yarn while twisting, constancy of diameter, full rotation through the innermost fibers, and others. These features indicate that the spinning practice in the region during the eighth to tenth century likely consisted of using a spinning shaft with fibers fed to its end in a clockwise motion.[38]

Variations among cloths woven in different regions can be largely attributed to different source plants (or animals) and processing methods. Contributing factors include the stage of growth of the plant at the time of harvest and the method of fiber extraction (influenced by the quality of the local water and the variability of the weather). The linen and other bast fiber yarns associated with the caftan, leggings, and other garments from the Moshchevaja Balka group were spun, not spliced or knotted. This allows speculation that the linen cloths were local or Middle Eastern products[39] and not imported either from Central Asia (where in this period, a bolt of cloth would have been woven with ramie and hemp yarns[40] that were spliced, probably up to the time of Muslim influence) or from Egypt.[41]

The regional convention for weaving a long length or bolt of undecorated utilitarian linen cloth was to produce a predominantly but not highly warp-faced,[42] not weft-faced, weave.[43] All the cloths used to make garments, whether cut from new bolts or from already used garments or remnants, were flawless products. This indicates that the tension of the warp was kept constant throughout its length except for the negligible shortening caused by the take-up of the weave, which enabled the weft to be inserted uniformly. When the weaving was completed, any variation in the compactness of the weft was gradual and, if uneven, scattered in random areas. The total absence of sudden increases and decreases in the density of the wefts, in contrast to the patterned silks discussed below, allows us to conjecture that the type of loom used to weave this linen maintained an open warp, fully extended for its entire length, and rules out the loom types that required rolling and unrolling of stored lengths of warps during weaving. A bolt of plain-weave linen in this region in this period was most likely woven on a staked-out loom, the type traditionally set up outdoors in the Middle East.[44] The two warp sheds were created by a counter-shed arrangement, and the weft was beaten with a sword,[45] not a reed. Indeed, examination of the fabric in microscale (Figure 24) supports this hypothesis: alternate warps are considerably straighter or tighter than the intervening ones,[46] and the fabric's density is irregular from warp to warp and area to area across the width, since thick and thin yarn contours are made to accommodate or adjust to each other. The overall uniform compactness of all the cloths also indicates that the warps and wefts had been wetted during weaving,[47] a process that was more conveniently done if the loom was set up in houses with mud floors or outdoors.

Selvages were present in some of the pieces that were simply woven with the one-shuttle weft returning over the last regular warp. Since none of the cloth in our caftan is a selvage-to-selvage width, the original loomed width cannot be determined. The widest width extant in the Metropolitan's caftan is 48 centimeters with one selvage present.[48]

Linen can be dyed only with a limited variety of natural dyes since most natural dyes are not chemically compatible with cellulosic bast fiber. In this region, we can postulate that linen was dyed in brown from a combination of tannin coming from a variety of trees and from water that contained iron and blue from a plant containing indigotin. Faint yellow from a variety of plants and perhaps a light pink from safflower, madder, and/or henna might have been used, but since each of these dyes has a short duration, we do not expect to see these colors today.[49] In the Museum's caftan, leggings, and all other linen items in Reference Group III, no dyed colors, if there were any originally, remain visible today.

No finishing treatment on the linen cloths composing the caftan, such as flattening or glazing, is detectable, if it had ever been applied to the cloth after weaving was completed.[50]

## Early Silks and Their Inherent Qualities in Historical Perspective

The world's different textile cultures developed various looms in response to regional requirements for transforming specific types of yarn into cloth.[51] In broad terms, two types of looms evolved: warp- and weft-oriented. The regions in which long, smooth silk or spliced bast fiber (linen, ramie) were the major textile materials—primarily China and Egypt—developed the warp-oriented weaving technology, in which warps were set close together. Looms could be used either indoors or outdoors, depending on the environment. Nomadic and pastoral weavers who used spun wool and bast fiber yarn also developed a warp-oriented weaving technology that required the warps to be highly twisted. Their looms were used outdoors, fitting their lifestyle. The sedentary people in the regions where short, resilient wool and cotton as well as spun bast fibers were the major textile materials, most of the regions west of China, developed a weft-oriented weaving technology, in which warps were set with spaces between them. Their looms were made for working indoors.

Over time, motivated by the desire to wear decorated textiles, weavers succeeded in weaving patterned fabrics, regardless of the primary orientation of warp or weft. At the outset, monochromatic warp- and/or weft-float patterns were created, and colored yarns were used as stripes (vertically, in warps) and bands (horizontally, in wefts) or added as supplementary sets of patterning warp and/or weft.

The development of fiber-dyeing technology, an application of practical organic and inorganic chemistry, paralleled the development of weaving and enabled weavers to create polychrome patterns on the loom. Because of the chemistry between the two types of available fibers (proteinaceous silk and wool, and cellulosic cotton and bast fibers) and the restrictive coloring matter or dye sources at hand (which need to bond chemically with the two types of fibers), dyeing technology supported the production and defined the regional character of the textiles produced. In the regions where proteinaceous fibers were available, particularly silk in China and wool in other temperate-to-cold regions, weavers were able to work with a variety of colors because dyes bond with proteinaceous fibers more readily than with cellulosic fibers such as linen and cotton. It is understandable that by the eighth to tenth century in the Moshchevaja Balka region only the colorful imported silk textiles were available to ornament the locally produced bleached white linen garments.

As weaving technology matured worldwide, weavers in both warp- and weft-oriented cultures developed loom mechanisms that created patterns in an interlacing principle that would today be called warp-faced (Figure 38) and weft-faced (Figure 40) taquete (binding in a plain-weave sequence) and warp-faced (Figure 39) and weft-faced (Figure 41) samit (binding in a twill-weave sequence) structures.[52] The selective manipulation of the sets of polychrome patterning warps or wefts to create the pattern in warp- or weft-faced plain or twill weave was initially done manually with simple tools in narrow widths. Eventually, as loom engineering developed,

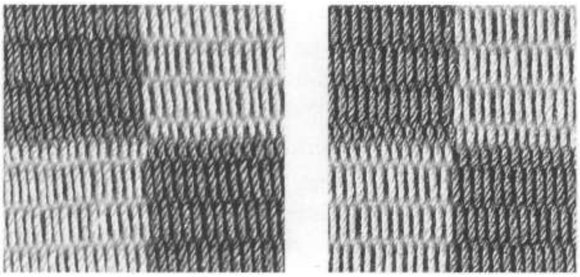


Figure 38. Warp-faced taquete, two-color warps alternated, obverse (left) and reverse (weaving: the author and Sandra Sardjono)

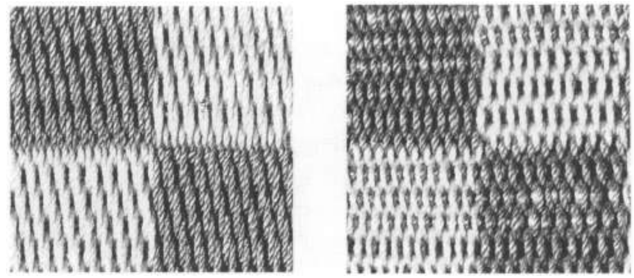


Figure 39. Warp-faced samit (2\1 twill), in two-color warps alternated, obverse (left) and reverse (weaving: the author and Sandra Sardjono)

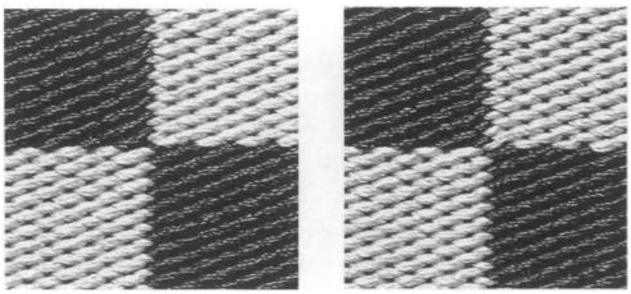


Figure 40. Weft-faced taquete, in two-color wefts alternated, obverse (left) and reverse (weaving: the author and Sandra Sardjono)

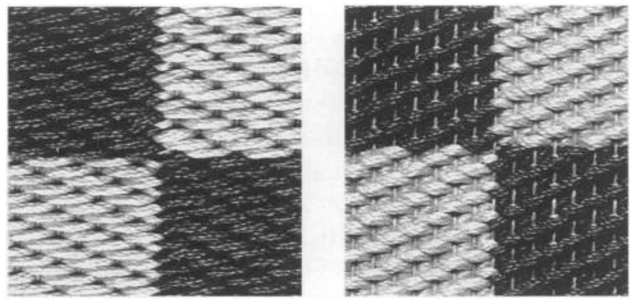


Figure 41. Weft-faced samit (1\2 twill), in two-color wefts alternated, obverse (left) and reverse (weaving: the author and Sandra Sardjono)

greater widths of fabric could be woven mechanically, which had the advantages of reducing the breakage of warps, increasing productivity, and allowing a variety of design units to be repeated—motivated first by the desire to weave a better-quality product and later to make the task less labor-intensive.

In warp-faced taquete or samit structure (Figures 38, 39), three sets of elements are used: 1) one set of complementary warps composed of two or more colors to create the pattern and form the structure; and two sets of wefts, 2a) one set that functions as structural binding (in a plain- or twill-weave binding sequence); and 2b) a second set of wefts, referred to as inner wefts, that functions as a color separator for the complementary warps. The inner weft allows the selected warp color making the pattern to be visible on the obverse of the cloth, while the other elements remain on the reverse, thereby creating an obvious distinction between obverse and reverse of the cloth. Depending on the colors called for in the design in vertical relationship, at least two, generally three, and up to six complementary warps or colors in varying combinations from area to area have been used in warp-faced taquet or samit textiles. Unlike a weft-faced structure, colors in warps, once set on the loom, cannot be changed.

In weft-faced taquete or samit structure (Figures 40, 41)—such as the fabrics associated with the Moshchevaja Balka group finds—three sets of elements are used: two sets of warps, 1a) one set that functions as structural binding (in plain- or twill-weave binding sequence), and 1b) the second set of warps, referred to as inner warps, that functions as a color separator for 2); and 2) one set of complementary wefts composed of two or more colors to create the pattern and form the structure. The inner weft allows the selected weft color making the pattern to be visible on the obverse of the cloth, while the other colors remain on the reverse, making an obvious difference between obverse and reverse. Depending on the colors called for in the design in horizontal relationship, at least two, generally three, and up to six complementary wefts or colors in varying combinations from row to row or area to area have been used in weft-faced taquete or samit textiles. Of the complementary sets, at least two wefts must traverse selvage to selvage. Otherwise, any number of complementary wefts in different color combinations, continuous or, unlike warp-faced taquete and samit, discontinuous,[53] were used per passage of weft from one horizontal repeat of design to the next. Each additional complementary weft increases the fabric's thickness, and in some weft-faced samit textiles, in order to accommodate them as substitutions, the unused wefts floated on the back, unbound in the structure (not discontinuously brocading). Silks A, B, and C from the Moshchevaja Balka group were woven during a four-hundred-year period, from the seventh to the eleventh century, in which weft-faced taquete and samit developed, improved, matured, and eventually were replaced by another type of pattern-weave principle, lampas.[54]

As with the process of yarn twisting, looms are made to work efficiently by exploiting human physical capacities and the earth's gravity. To insert a weft that creates a pattern on a common bolt-weaving pattern-weaving loom, a shed is opened by mechanically raising[55] the selected warps from the stationary straight web plane. Only the warps raised from the web plane are thus strained, crucially distinguishing the two faces of freshly woven cloth: the face on the underside, which remained unmoved, comes out as a flatter surface and is considered the obverse side of the finished cloth; the upper side, because it was disturbed by the raising of warps for structure and pattern as randomly and frequently as needed, is bumpy and is considered the reverse side of the finished cloth. The weaver must deal frequently with many loose pieces of yarn—ends of broken warps, joins of overlapping ends of weft yarns, and unused carryover brocading wefts—and leaves them on the easier-to-work-on upper side. In addition, the upper side can easily be soiled by the many small tools and shuttles placed there until they are next needed (they cannot hang between and down below the warps because they would drop to the floor).[56]

In warp-oriented weaving, to weave, for example, warp-faced 2-1 twill samit in four colors (using a complementary set of warps) with the reverse (weft-faced) shown at the upper side on the loom, each shed for one twill binding weft of three threaded in three shafts in the twill-weave system unit is facilitated by raising one shaft. To create the pattern, while the single selected color warp stays on the web plane as the obverse (underside), the remaining two warps are raised and the inner weft is inserted—only once—to keep them separated as the reverse. Since the weave is warp-faced, the insertion of the weft can be tighter, thus easier and more evenly spaced, and allows faster weaving than weft insertion in the weft-faced weaves.

In weft-oriented weaving, to weave, for example, weft-faced 1\2 twill samit—the structure of Silks A, B, and C—using a complementary set of weft with the reverse (warp-faced) shown at the upper side on the loom, in the twill unit each shed for one twill-weave binding warp of three threaded in three shafts is made by raising two shafts. To create the pattern, selected inner warps are also raised: the single selected color weft for the pattern is laid on the web plane to appear on the obverse (underside), separated from the other two yarns laid above the inner warp. Thus, for example, to weave a pattern that requires three colors per passage, shuttles each with a different color must be thrown three times to complete one weft passage.

Another crucial and time-consuming skill required in loom weaving is the laying of the weft in the opened shed. For a warp-faced weave, the tighter the weft tension, the easier, and therefore the faster, it is to lay the wefts in the shed evenly as required. For a weft-faced weave, the looser the weft tension, the more difficult it is to lay the wefts in the shed as required. In creating weft-faced weaves, as in the weft-faced samit of Silks A, B, and C, while maintaining the warp tension taut, the tension of the weft inserted must be loose and even to allow the weft to meander compactly around the warp. The weft tension can differ from weaver to weaver and from insertion to insertion by the same weaver. A bobbin winder's skill in smoothly unwinding the weft yarn from a shuttle also contributes to the evenness and looseness of the inserted weft. In addition, if the wefts are inserted taut, selvages will be pulled inward, narrowing the width of the cloth—a common problem faced by weavers—as exemplified by Silks A, B, and C. Hence, weft-faced samit is the type of weave that is the most time-consuming to produce, and even when done by a skilled weaver, the faults that require post-weaving correction are disproportionately greater than when producing a warp-faced weave.

During the international trade and thus communication among nations of the fifth through the eleventh century, weaving technology was one of the major exchanges. By the seventh century, using available materials of each region to participate in this lucrative exchange, weavers competed to produce patterned silks solely in the unprecedented weft-faced samit structure. As the world reached the stage of early medieval "fancy silk" consumerism in approximately the tenth and eleventh centuries, the demand increased. As a result, time-consuming production of weft-faced samit-weave silks was replaced by more elaborate and colorful patterned lampas-weave silks that were easier to weave. While lampas-weave structures allowed more efficient production compared to the superb weft-faced taquete and samit weaves, the quality was inferior. Consumers, however, were unaware of the differences.

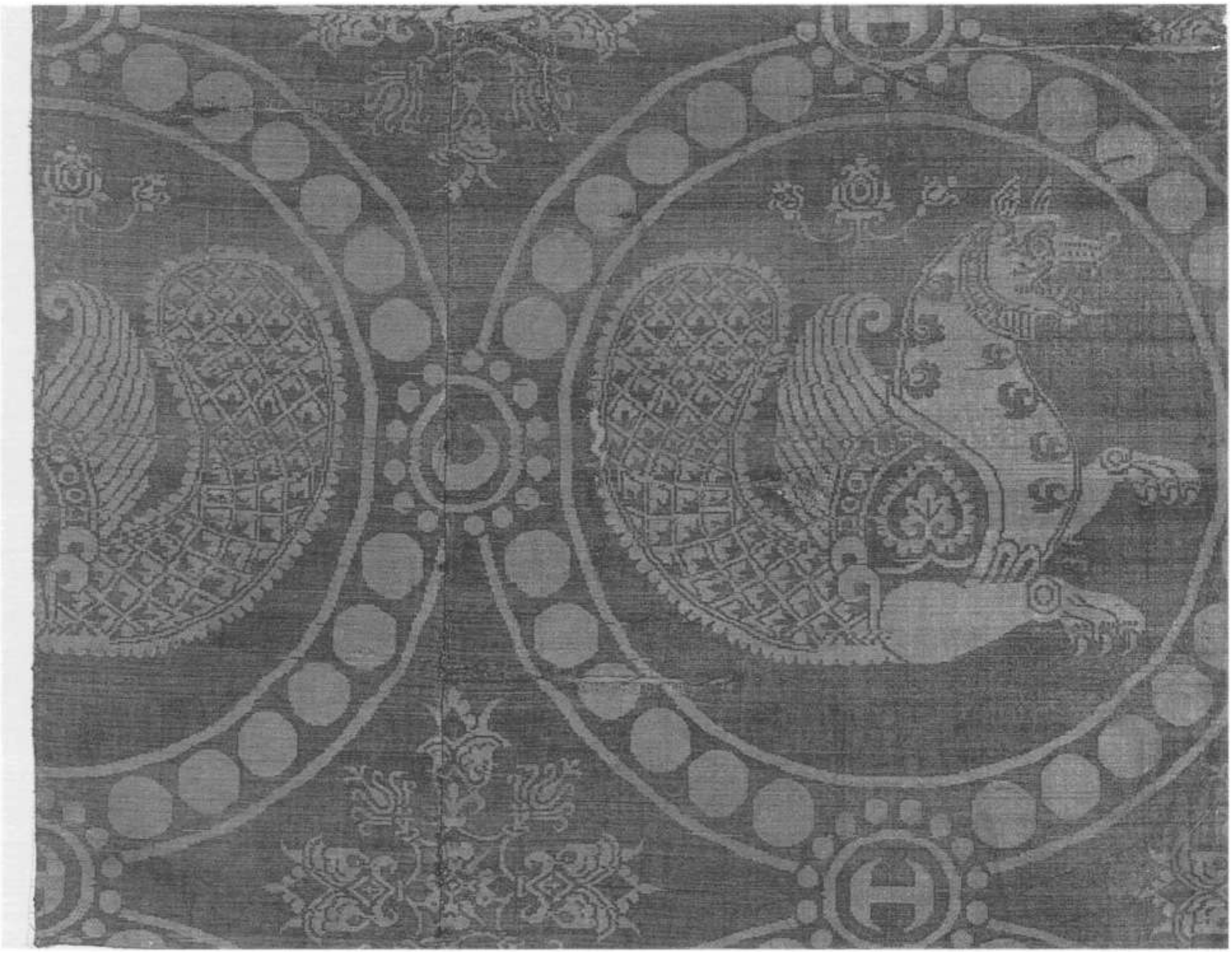


Figure 42. Silk, weft-faced samit (1-2 twill), from the Church of Saint-Leu-Saint-Gilles, Paris. Woven in a Byzantine dominion, ca. A.D. 600–800. Musée de la Mode et du Textile, Paris, 16364 (photo: Laurent-Sully Jaulmes)

By the eighth- to tenth-century period in which the Metropolitan's caftan was made, contacts between East and West through trade on the Silk Routes had already existed for over a millennium.[57] While the routes shifted from place to place and from time to time because of political and territorial conflicts, bandits, and geological changes, the extant archaeological objects are evidence that trade, even if interrupted, never ceased completely. From the earliest times, among the most sought-after trade goods were particularly colorful patterned cloths. Those woven of silk were cherished by wool cultures,[58] those made of cotton were desired by bast fiber, wool, and silk cultures,[59] and vice versa.[60] Increased encounters with exotic and refined foreign goods not only aroused awe and curiosity at each destination but also encouraged rural weavers to imitate new products through trial and error. That, in turn, created competition among the weaving centers. In due course, various technologies developed for the efficient production of salable products, the result of which was a decline in quality.

Initially, craftsmen must have used local materials, but to achieve better or new products, they chose the best of the portable trade goods—fibers, yarns, dyed yarns, dyes, auxiliary agents, seeds, tools, and other essentials—produced in different parts of the world. At the same time, they were dependent on their local water, environment, and climate. Increased production due to commerce led to the migration of textile professionals. The skills of craftsmen[61] had expanded and become specialized to such an extent that traders and suppliers of basic materials responded to the specific demands of their clients, sometimes unaware of the end purpose of their goods. The desire for elaborate textiles, on both the supply side as an achievement and the demand side as a luxury—from the courts of Byzantium to Sasanian Iran, and from the Tang dynasty in China to the Nara court in Japan—accelerated regardless of cost, with the result that between the eighth and the twelfth century, textile culture reached an unparalleled height. The patterned silks found in the Moshchevaja Balka group were woven in the first half of this epoch of textile achievement. Later, as demand decreased or ceased—whether because of a patron's whim or tribal conflict, or as supply was reduced or interrupted by natural disasters[62]—the quality of textile production declined and shifted to such an extent that the once high material-technological level was never achieved again.

To weave a patterned cloth in a weft-faced structure on a loom, a mechanical device to control the pattern and increase production was developed. A design to be woven is normally drawn in a small unit. To transpose it efficiently to a large surface, weavers in both the East and the West, perhaps concurrently (present evidence favors a date about the fourth to fifth century), laid out the design following a basic repeat system, while devising a mechanism to convert it into a woven structure. In the East, with its predisposition for warp-faced taquete and samit silk weaving,[63] the pattern was laid out vertically, a technique that remained common until the eighth century.[64] In the Western, Roman world, with weft-faced taquete/samit weaving, the horizontally organized pattern was repeated vertically up to the sixth century.[65] Silks woven with this type of pattern repeat with roundels and interstices are, coinciding with the overall development in many facets of technology, far more elaborate, detailed, and colorful than their warp-faced counterparts. They became common from the seventh century and evolved with the technical development associated with the structure of weft-faced samit and the pattern-loom mechanism.

Coincidentally, at the outset, both East and West employed a similarly organized one-directional pattern repeat system, attesting to similar solutions when working with manually operated looms. In the seventh century, along with the gradual disintegration of the Chinese sericulture monopoly, the repeat system changed to one that is symmetrically organized, using the Sasanian pearled-border roundel design,[66] indicative of the power and expansion of both the Sasanian and Byzantine Empires. As history moved forward, so did design and the loom mechanism.

Contact through trade between East and West is apparent in extant contemporaneous textiles fortuitously preserved in burial sites in Egypt and in a documented repository of the imperial house of Japan. In China, this epoch coincided with the transitional period in which loom technology shifted from warp- to weft-oriented weaving with the advent of pattern weaving. Such a shift was a fundamental technological breakthrough, but in China it was an adaptation

Figure 43. Silk, weft-faced samit (1/2 twill), probably from a site in the Taklimakan desert, Xinjiang. Woven in a Sasanian dominion in Central Asia, ca. A.D. 700–800. Private collection (photo: Bruce Schwarz)

rather than an invention. Warp-faced samit for bolt weaving had already been used in the warp-oriented weaving culture in China in ancient times, from the Warring States period to the Sui and Tang dynasties. The warp-faced structure that was conventionalized over a millennium under China's silk monopoly was cumbersome and restrictive. In contrast, the weft-faced taquete/samit weave system,[67] which was based on the weft-oriented looms that had developed in the culture of the regions from Persia/Iran westward using short-fiber wool, was less cumbersome, more versatile, and material-saving.[68]

In the West, wool cultures had already developed the taquete/samit system for both warp-faced (for narrow-band weaving)[69] and weft-faced (for wide-width weaving)[70] cloth. Recently reported archaeological evidence has added documentation for the concurrent or even earlier occurrence of weft-faced wool taquete (estimated as a wide-width bolt weaving) from a wool-based textile culture in the Roman world.[71] To produce traditional samit in highly sought-after silk,[72] the wool, linen, and wild silk[73] weavers of the West had only to learn how to handle the traded silk yarn—most likely with its colors already dyed. They did not have to change the orientation of weaving, the loom mechanisms, or the weave structure, nor did they need to learn the labor-intensive and costly cultivation of mulberry trees, silkworms, yarn-making processes, and dyeing chemistry.

In the East, in the Sasanian domain, a weft-faced samit in red wool and white cotton (initially two, later three colors per passage of weft) of superb quality with the pattern of Sasanian pearled-border roundels had been woven.[74] A rare example in silk with a similar design but in one-quarter scale is extant.[75] Sometime in the seventh century, at a weaving workshop within the Sasanian Empire, local and Chinese weavers seem to have collaborated on a different version of the samit in polychrome and with silk for Sasanian patrons. Extrapolating from the Chinese polychrome warp-faced samit technology (more than three colors per passage of weft), the weavers interpreted the Sasanian design from a Chinese perspective.[76]

The convention of the repeat pattern of a combination of roundels and interstices (Figures 42, 43; Knauer, Figure 5) began at this time.[77] Soon, all textile cultures were producing the elaborate polychrome samit silks, copying the Sasanian roundels with pearled borders in a circle-and-cross repeat. In this patterning system in the mainstream, the large major roundels, sometimes with connecting roundels, are filled with senmurv, elephants, winged horses, or horsemen. These designs, favored by Sasanian and Byzantine patrons, were placed in the roundels oriented in an upright direction. In each roundel a single design faces in the same direction, alternating direction row by row or column by column. If two motifs appear within a single roundel, they confront or oppose each other symmetrically. Fillers in the interstices are, for the most part, oriented in four directions but in exceptional cases in only one direction. With diameters commonly measuring about 20 centimeters or as much as 50 centimeters,[78] these mainstream silks' perfectly circular roundels required a weaver of remarkable skill and aesthetic sensibility, and provided viewers a magnificent object to look at.

To produce warp- and weft-faced taquete and samit, technologies integrally related to the structure, the pattern repeat, and the mechanical organization of the loom were developed at silk-weaving centers in the East and West at various times. In brief, the development of warp- and weft-faced taquete and samit structures can be postulated to have evolved progressively through stages of an experimental period.

- In China, as a long-fiber culture (silk and spliced ramie/hemp), weaving of a vertically oriented warp design for a warp-faced taquete and samit was done on a back-tensioned loom with closely set warps without a reed. The weft was beaten with a wooden sword, thereby creating a textile that becomes warp-faced. A bolt width of cloth was produced.[79] In the seventh-century adaptation of the Sasanian circle-and-cross design, the orientation allowed half-inverted patterning to appear.
- In the regions west of China or in the spun short-fiber cultures (wool and cotton), weaving of a horizontally oriented weft design for weft-faced taquete and samit weaves (developed in a region under the Sasanian Empire or some earlier patronage) was done on an upright or high loom. The looms were equipped with or without a spacer/reed, and the weft was inserted into moderately spaced warps loosely in tension and compactly in space (the time-consuming characteristic of weft-oriented weaving) by beating with a pointed stick or reed. A bolt width of cloth was produced.
- In the regions farther west in spun-fiber cultures (spun linen and wool), weaving of a horizontally oriented weft design for a weft-faced taquete weave (a structure that originated in the region) was done on an upright loom with moderately spaced warps and wefts inserted loosely and compactly by beating with a pointed stick. A short, garment-shaped cloth was produced.

Contacts between the East and West eventually caused evolutionary modifications to traditional Chinese silk weaving technology.

- Weaving of a design for a weft-faced samit weave was done on a back-tensioned loom. The weft was compacted with a sword beater while a bolt-width weft-faced samit was being woven. (This was not a successful method for creating weft-faced weaves, as the setup, in principle, tends to create warp-faced weaves.)
- Weaving on the back-tensioned loom continued, but the sword beater was changed to a reed as the warp-separator/weft-beater. This involved the creation of specialized professions, including bamboo splitter and reed maker. With less effort, weft-faced weaves can be created with this method.
- An innovative cloth beam tensioner—a rope wrapped around the cloth beam and tied to the loom structure—was invented. This enabled the weaver to adjust the tension of the warps at any point during weaving with or without a back beam (for example, bundled warps can be tied to a post). Its introduction terminated the use of back-strap tensioning and made weft-faced weaves possible, if the weft was laid loosely enough to meander around the taut warps, and allowed weavers to perfect the technique of weaving weft-faced taquete and samit.
- To achieve the clearest design on the obverse, weaving workshops further developed a mechanical system of double back beams on the loom. This system enabled the two independently functioning warps to be taken up each according to its own require-

ments as weaving proceeded, one for the binding warps (which loosely meander between multiple wefts) and the other for the inner warps (which lie tautly between the two groups of separated wefts, the single weft for the obverse and the rest of the multiple wefts for the reverse).

- Beginning about the tenth century, the time-consuming weft-faced taquete and samit weaving were gradually replaced, first by double-faced weft-faced samit[80] (pseudo–weft-faced) for a short while in the East, and by lampas. Weft-faced taquete and samit were continued only in isolated regions[81] that are far removed from the original places of manufacture of weft-faced taquete and samit weaving.

Over time, along with the dissemination of lampas weave,[82] weft-faced samit from the early medieval period that is structurally associated with the circle-and-cross repeat pattern stopped being produced owing to cultural shifts that were occurring at an even faster pace than the transition of lampas loom technology. Against this background, the Moshchevaja Balka group of weft-faced samit silks represents the product of a rural technology of the eighth to tenth century, imitating the mainstream circle-and-cross repeat pattern.

## The Moshchevaja Balka Group of Patterned Silks

The homogeneity of Silks A, B, and C and all others of the same type in the three reference groups allows us to identify the group as a specific rural type. They share the same traits in fibers, yarns, dyes/colors, method of fabrication, structure, pattern repeat organization, and finishing. Whether the similarity stems from demand (for example, the cloth could have been restricted to designated wearers as in military ranks) or limited supply (possibly through the lack of designers or pattern cord plotters), each piece was evidently woven in the same rural weaving center. Nonetheless, details vary from piece to piece. Silk A, for example, is represented in all three reference groups in many dissimilar versions, and Silk B, which appears in the strips used as the border in the interior of the Metropolitan's coat, can be identified in at least three versions in the reference groups. Further details, such as the common state of soiling, fading, physical condition, and material fatigue, support the conclusion that the silks come from a group with the same provenance. All the patterned silks are more pliable than mainstream weft-faced samit[83] even from later periods, being soft to the touch and able to drape in all directions despite the fact that the weave was compounded with two sets of warps and frequently three complementary wefts (Figures 25, 26). These silks are not only more numerous than the mainstream high-quality weft-faced samit[84] among the Moshchevaja Balka group finds but are also unique to this site. Since not even a single piece of this type from the same period has so far been associated with any other sites where similar mainstream-type silks were also found, we can conjecture that they were manufactured in a region west of the Caspian Sea, not far from Moshchevaja Balka.[85]

The production of polychrome patterned silks, whether by a large- or small-scale mainstream or rural workshop, requires the well-coordinated and time-consuming labor of craftsmen responsible for material, tools, and equipment. Silks A, B, and C, individually and collectively, evince the standards of craftsmen using a minimally equipped loom to weave a samit structure and whose goal seems to have been only to finish the task, with little concern for the quality of the finished product.

In early times, each warp or weft yarn was individually and collectively handled after being made into yarn until it was transformed into cloth. Adding twist,[86] therefore, to individual reeled yarn for ease of dyeing, warping, threading, beaming, and weaving was an essential part of the process, even though it is arduous and time-consuming. In the silks under consideration, the wefts are dyed reeled silk yarns[87] without additional twist,[88] whereas the warps are tightly twisted undyed spun yarns (Figure 26). For weavers in rural workshops, inexperienced in handling reeled-out silks that catch on anything they come into contact with, such as other yarns, hands, and surroundings, spun silk yarns and twisted reeled silk yarns were easier to handle. Weavers outside the mainstream used the less-costly, easier-to-handle spun silks. The choice of yarn was also dictated by cultural or religious beliefs. For instance, followers of Buddhism and Islam produced only spun yarns from moth-hatched cocoons, so that they did not have to kill the pupae, which occurs when reeling out the filaments. Whether motivated by religious beliefs or for other reasons, the makers of these silks' spun yarns came from outside the mainstream of silk producers. At this time, it is not possible to identify where the two types of yarns were processed and where the entire cycle of raising the silkworms, harvesting the cocoons, reeling out or preparing floss, spinning from the floss, and adding the additional twist took place.

All the reeled silk weft yarns without twist are the same off-white and brown colors. As these silks are obviously expensive and luxury goods, such unpretentious colors cannot be taken as original. From the well-preserved colors of the Sasanian woolen textiles excavated in Iran and Egypt,[89] we are able to conjecture that colors conventionally used by the Sasanians, besides undyed cotton for white, were intense red, blue, yellow, brown, and, in a later period, green.[90] No colors were in pastel tones. The sources of dyes for these colors are as follows: red, the root of madder[91] with alum mordant or an insect with alum mordant; blue, an indigo-containing plant; yellow, a plant source with or without alum mordant; and brown-black, a tannin-containing wood with iron mordant. Since silk and wool are both proteinaceous, the dyes used for these materials can generally be the same. For silk, an additional dye used was a red color from safflower, popular for its intensity. Since ancient times, in many parts of the Old World, the safflower plant was cultivated for its seeds that produced oil and its flower petals that were used in infusions to cure ailments and from which a pigment/dye was extracted as a cosmetic to color lips as well as a dye to color cotton, linen, and, most commonly, silk (though not wool). Since the annual plant grows everywhere and is thus inexpensive, the colorant was used ubiquitously and abundantly. To dye silks red in the most coveted intensity, dried safflower petals were traded to dyers living in specific regions where water was relatively uncontaminated. The bright red is, however, acutely unstable and extremely reactive to light and acidity/oxidation and alkalinity that come from common household sources—air, water, food, or discharges. The colorant degrades, appearing faded faster than any other colorant through inevitable exposure to destructive elements during use and over time, even in storage, frequently disguising the once strong visual impact of the red color.[92] The burial conditions of the Moshchevaja Balka group site, with a decaying body and limestone enclosure, accelerated the garments' color loss from brilliant red to light beige to off-white with a yellowish orange hue.

That the dyes used in the yarns of Silks A, B, and C were from inferior sources is proved by the even fading of the cloth in its entirety, regardless of whether the areas were with or without burial stains or in good or bad condition. Good craftsmen generally choose those dye colors that will last as long as their products. It is, therefore, possible that the weft yarns in these silks reached the weavers already dyed brilliant red. The weavers chose them for their weaving unaware of the source of the dye or its rapid fading quality. For example, if the equally pervasive but more fast madder red (since its hue is a brownish subdued tone and more costly, the weavers must have opted for the more brilliant but cheaper safflower red)[93] had been used, Silks A, B, and C would still be red today, even after having been buried. Alternatively, if the weavers knew that safflower's brilliant red had a short life, they may have intended to weave the silks for sale.

The color that was originally blue, being indigotin, became gray through chemical reduction in the burial site. The yarn that had the traces of blue was the only weft composed of spun yarn (in Silk B); as the dye was common and used for cellulosic fibers, the regional specialty, the yarn could have been dyed locally to save money in preference to the purchase of already dyed yarn. The loss of colors made from safflower and indigo as well as the unusually good state of the dark brown dye and its substrate silk yarn (which normally we would expect to have deteriorated by accelerated oxidation of iron mordant) indicate that the burial environment acted as an alkaline buffer.

At a glance, the pattern repeat in these silks looks the same as those of refined, mainstream weft-faced samit silks following the circle-and-cross repeat pattern. There are, however, differences. Far smaller in scale (4–7 cm high), these are simplified versions. In terms of pattern layout in a repeat unit, the roundels abut horizontally repeating row by row, and vertically with interstices between the roundel rows. The interstices are filled with a design. In Silks A and B, the design is oriented in two directions without distinct top and bottom, whereas in Silk C1 the design is oriented in one direction with distinct top and bottom and with additional small connecting roundels located at each juncture, horizontally inset and vertically abutted. The major designs contained in the roundels, unlike their mainstream counterparts, are identically repeated in the interstices in almost the same scale. Further, the design was taken from the minor connecting roundels sometimes associated with a type of larger-scale mainstream silk (e.g., Figure 42). For the adapted pattern, we see evidence of simplification, a clever accommodation by rural weavers working on a loom equipped with a basic pattern-control mechanism and operated by the simplest technology. This pattern organization was based on a timesaving preparation common to Silks A, B, and C.

The numbers of weft passages in each pattern repeat unit are: Silk A, 138; Silk B, 174; and Silk C1, 230. The reduced size of the pattern, the repeat type, and the restrictive use of one- (Silk C2) and two-color design wefts (in several rows of Silks A, B, and C1) besides the ground color made production less time-consuming and labor-intensive. The count of warps per centimeter is irregular, averaging 21, with the center of the width of cloth having fewer than the areas toward the selvages. The count of wefts varies from 18 to 30 per centimeter, with Silk A, the finest in count, having up to 54 wefts per centimeter.

To repeat the pattern unit that runs upward as the weaving progresses, a set of pattern-controlling heddles was used in rotation. In Silk C and portions of Silks A and B (coming from different bolts), the pattern repeats vertically in one straight unit, in a one-directional rotation. In some of Silks A and B (but not in all of them), four dark and light wefts alternate in the center of the roundels. In Silk B, the relationship of the pearled-border roundels and the palmette design contained within the roundels is inconsistent roundel to roundel.

In Silk A, because of the change in density of the warps, the sixteen roundels gradually decrease in width, the ones in the center being 4.5 centimeters wide and the ones closest to the selvages, the smallest, 3.2 centimeters wide. An even slightly tight weft can cause an excessive narrowing of the loom width, especially with this weft-faced samit when the weaver hastily throws a shuttle without taking the time to lay the weft loosely at each insertion into a shed.

All the Metropolitan's silks are in weft-faced samit weave structure with the binding system of 1\2 twill weave. Binding warps were threaded in three shafts in sequence, and inner warps were threaded in the pattern-controlling device. From various features inherent in these silks, we can deduce that the looms, beginning from the weaver's end, must have been equipped with a front cloth beam, a tenter stretching over the freshly woven cloth, a reed, three shafts, and a set of pattern-controlling devices, and that without a back warp beam, the binding and inner warps were held in two separate bundles. The pattern-controlling device for inner warps was probably the type in which a series of draw cords selectively raises the warps in sequence, separating above at least two- and sometimes three-color complementary wefts (that were not patterning) for the reverse, and leaving one for the obverse, which faces downward on the loom. Seated at the loom, the first weaver treadled the shafts to create the structure, raising the first set of warps in a twill binding sequence that did not bind pattern wefts on the obverse. After the second weaver manipulated the draw cords of the patterning device to lower the warps not patterning for a color, the first weaver threw a shuttle. This procedure was arduously repeated for each of the multiple colors that composed one of three passages of weft within a unit of 1-2 twill weave structure. The team moved on to the next two twill binding sequences using the same procedure. For example, in a three-color per weft, 1-2 weft-faced samit, to complete the weaving of one three-weft unit of twill structure (1–2 mm of cloth is woven), the shed opening for twill structure was required three times. At each opening an additional three were needed, for a total of nine pattern shed openings that alternated with nine shuttle throwings (as opposed to a monochrome standard weft-faced 1-2 twill weave, which required only three sequences). To smoothly roll out the weft from the shuttle, a professional bobbin winder wound the bobbins, and an assistant did chores around the loom.

All the roundels in a circle-and-cross pattern should have been woven in perfect circles throughout a bolt. Instead, in Silks A, B, and C, the height of the roundels gradually row by row became elongated from circles to ovals. This is not intentional to achieve a particular design but rather results from the change in compactness of the weft caused by the weaver's lack of sensitivity toward his goal.

In the rural regions of the Middle East and as far east as Central Asia, the length of warps prepared for weaving a length of bolt was conventionally chained and/or bundled, not wound on a roller.[94] This method not only saved manpower during the setting up of warps on the loom but also avoided their becoming tangled since they were handled only once after warp preparation was completed on a warping board. (In later centuries, engineering improvements produced an efficient, uniform rolling system on a warp beam, eliminating tangling and obvious traces of tension or beam unit renewal in the resultant cloth.)[95] After the rest of the warping procedures were done—arduous threading into heddles and reed, and setting onto the front beam to create the weaving plane under the tension necessary for weaving—the chained warp was placed at the back of the loom and weighted down to keep it dangling or stretched out.[96] As the weaving progressed, in order to advance weaving approximately 5 centimeters further, the warps had to be forwarded. The bundled warps would first be released from the tension, and then only the required length of the warps would be unchained. The remainder of the warps would be repositioned at the back, while the subtle tension of the beam would be simultaneously adjusted and the weaving could then be resumed.[97] In order to weave on a loom equipped with this type of warp storage, the weaver would have been required to spend a considerable amount of time whenever the warp was forwarded. The weavers of our silks were obviously in haste and so unrolled the bundled warps less frequently than necessary.

What is more, our silks indicate that the force used to beat in the weft at each insertion in weaving was less than adequate. On the loom, the reed/beater frame hangs (or, later, stands) in the area where weft beating takes place. A straight and narrow rigid beater swinging from a fixed point can function properly only when the just inserted weft is beaten within a 10- to at most 15-centimeter space against the already woven section near the front or cloth beam. Although the position of the beater can be adjusted on an advanced loom, on the loom on which our silks were woven it was apparently not moved toward the back as the weaving progressed. As our silks indicate extra-long beam units, the weaver must have beaten in the wefts for the entire 30- to 50-centimeter length of beam unit while the beater was hanging pivoted in one position. (One "beam unit" constitutes the weaving space possible between the last weft in the woven portion that is rolled up onto the cloth beam and the front of the reed/beater when it is pushed against the foremost shaft.) At the beginning of weaving, with the warps under proper tension and the beater in a proper relationship to the area being woven, the wefts were correctly compacted by the beater in a standard position creating the first row of roundels in circles, as intended in the design. As weaving progresses, each insertion incorporates a certain length of warp into the weave, thereby shortening the length of the remaining warps on the beam unit and increasing their tension. In weft-faced weaves, the looser the warp tension, the less compact the weave becomes; conversely, the tighter the warp tension, the more compact the weave becomes.[98] In our silks, as the weaving continued without renewing the warps and the wefts were beaten in by the beater beyond its functional capacity and so not able to compact the wefts, the spaces between the wefts began to increase, resulting in an elongated height of a row of roundels. Only after weft insertion reached the far end of the maximum length of the beam unit—in Silk C an astonishing 51 centimeters—where there was no more space for the inserting weft, was the warp tension released and the woven area rolled onto the cloth beam. As a result, in our silks, the roundels are circular at the outset of the beam unit but gradually—not abruptly—become elongated and finally become ovals. The next row of roundels is suddenly circular again, indicating the boundary line at which as yet unwoven warps were unrolled and the woven portion was rolled onto the cloth beam. The indicated direction of weaving conforms to the conventional order of weft insertion (see note 32). Even in the better-executed Silk A, the length of the beam unit that contains three or four rows of graduated roundels is 20 to 25 centimeters. In the worst executed Silk C, the length of the beam unit containing four rows of graduated roundels is an astonishing 40 to 50 centimeters: the tallest row of 9.7 centimeters with a loose weft count of only 15 per centimeter gradually changes to the shortest row of 7.5 centimeters with a weft count appropriately compacted to 27 per centimeter.

Although these technical matters required concerted planning for the type of yarns and densities of the warp and weft, ultimately the all-important adjustment of tension at the time of weaving is solely dependent on the attentiveness of the weaver. Had the weaver of Silks A, B, and C kept the proper warp tension throughout by adjusting it each time three to five centimeters of the bolt's length was woven, releasing a length of warp from the bundled warp (or moving the positions of the weights, an advanced mechanism), and inserting each weft loosely (which requires considerable skill and takes time), the roundels would have come out the perfect circles the designer intended.

The weaving of Silks A, B, and C was done hastily, perhaps for export and, because of its unrefined character, presumably was not made for someone in the community. No weaver would let such inferior products be sold locally, in particular, such a laboriously fashioned polychrome patterned cloth of expensive silk. The irregularities in weaving, which could have been better regulated, suggest that the weaver was pressured to finish the bolts, perhaps for a waiting merchant or a unknown client.

After being woven, the cloth was mechanically flattened to add glossiness. Silk cloths were laid on a hard surface, moistened with water with or without additives such as sizing or an alkaline agent, and beaten with a wooden beater. The sheen[99] that was present at the time of burial is slightly noticeable even now, though the postexcavation washing reduced it to a degree.

Throughout history, the development of a textile culture has been a fruitful outcome of concerted responses to the disposition of natural materials in the environment by craftsmen, each pursuing various specialties in search of the ultimate achievement through ingenuity and tenacity. By their efforts, the foundation for today's aesthetics, arithmetic, chemistry, and engineering was formed. Whether motivated by simple awe, genuine joy, critical needs, or impossible demands, the same search continues today by individuals in the field of preservation. Art historians and conservators cooperate in interpreting the material and technological context of items from the remote northwestern Caucasus Mountains, just as those who directly and indirectly made the coat and leggings pursued it a millennium ago. By studying their material nature, ethnographic features, and the particular environment that contributed to their survival today, our integrated technical and scientific perception and knowledge have been broadened. The Museum's collection will assist us to elucidate, if only fractionally, the knowledge of a distant culture of the past and to formulate a preservation strategy for future generations.

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## NOTES

1. Moshchevaja Balka is in the southern part of the Russian Soviet Federated Socialist Republic. The first recorded academic fieldwork was conducted in 1900–1901. Alternating with postexcavation research and publication, intermittent fieldwork continued most actively in the 1960s–1970s and is still ongoing by Russian museums. For publications, see note 2.
2. See Anna A. Ierusalimskaja, *Die Gräber der Moščevaja Balka: Frühmittelalterliche Funde an der nordkaukasischen Seidenstrasse* (Munich, 1996); Anna A. Ierusalimskaja and Birgitt Borkopp, *Von China nach Byzanz*, exh. cat. (Munich, 1996); Valery Golikov et al., "Experimental Research of Polychrome Sogdian Silk of the VIIIth–IXth Centuries from the Tcherkessk Museum Collection," in *Interdisciplinary Approach about Studies and Conservation of Medieval Textiles*, preprints for the Interim Meeting, ICOM Conservation Committee, Palermo, October 22–24, 1998, ed. Rosalia Varoli-Piazza (Rome, 1998), pp. 133–39.
3. The first of three lots of the Moshchevaja Balka group of objects was sold at the Kunst-Auktionshaus Dr. Fritz Nagel, Stuttgart, May 7, 1994, lot 18; it consisted of the Metropolitan's leggings and the fragments that were reconstructed as the Metropolitan's caftan and the Reference Silk Caftan. The second lot, seven textile fragments, was sold at Kunst-Auktionshaus Dr. Fritz Nagel, May 6, 1995, lot 1; the present whereabouts are unknown. For the third group, see note 5.
4. The Reference Silk Caftan warrants further research. It is conceivable that this lightweight silk caftan embellished with polychrome silk borders similar to those on the Metropolitan's caftan was one of the garments in a set that was worn interchangeably with the MMA caftan. The silk composing the entire caftan is a late Tang dynasty 2-1 twill damask (in two opposing twill alignments: warp-faced for ground and weft-faced for pattern, which reverse at a point) dyed in golden yellow. It is one of the securely identifiable Chinese silks among the other silks in the Moshchevaja Balka finds, which came from an area reaching as far west as the northern Caucasus in the 8th–10th centuries. See note 58.
5. The third lot of material from the Moschevaja Balka group, 46 objects, was auctioned at Kunst-Auktionshaus Dr. Fritz Nagel, November 15, 1996, lot 262. Of these, three textile fragments are purported to have been in a Paris collection, but their whereabouts are uncertain in 2001, and 43 crafted objects of wood, metal, shell, leather, and textiles were given to the Metropolitan Museum by Jacqueline Simcox (Figures 5–18).
6. A silk illustrated in Ierusalimskaja, *Gräber*, pl. 11, fig. 25 (Reference Group I), Reference Silk Caftan (Figures 19, 20; Reference Group II), and MMA 1999.153.43, worn-out pants (Figure 10; Reference Group III), all show unusually large holes of embroidery stitches made with a blunt needle or heavy threads, indicating that the three groups previously shared a common use before they were reused and made into these items.
7. Post-unearthing contamination (primarily from touching, washing, and X-raying) prevents an accurate measurement by the radiocarbon-dating method without applying still inconclusive adjustments.
8. *Hand* is professional jargon to describe subjectively a tactile physical quality of fabrics, e.g., stiff, sturdy, soft, pliable, etc.
9. A sufficient amount of body decomposition remains to allow for future DNA analysis that could confirm association between the burial lots and the past and present people of the region.
10. I propose that excavated objects should be preserved intact in museums in a condition as close as possible to their state at the time of burial, including food stains, sweat marks, and, in some cases, earth (but not postexcavation dust). Since these alien substances present, singly and in combination, valuable intrinsic information about the objects' past and excavation, they should not be thoughtlessly removed (these alien materials would no longer be harmful, and some substances have protected the fibers throughout the burial period). The level of cleanliness we demand for a facial towel today is not appropriate to museological preservation and conservation. Essentially, an archaeological object must be preserved in an environmental condition identical to or approximating its findspot, provided with physical/mechanical support while shielded from exposure to air, incompatible pH conditions, all types of light, and mechanical movements. All invasive treatments including washing and attachment of conservation materials should best be avoided; these are frequently, and paradoxically, the causes of additional damage in the long run.
11. For example, an undecorated lower half of a caftan (Figure 5).
12. For example, a pair of leather mitts (Figure 8).
13. When seated, the wearer sits on the back panel. The 27-cm side seams between the waistline and rider's panels do not allow the lower back panel to flip out backward.
14. A pair of humps on the back at the waistline recurs in all three subject and reference caftans under discussion: the Metropolitan Museum's caftan (one extant, decorated with silk border, Figure 2), Reference Silk Caftan (one extant, decorated with silk border), and the undecorated lower half of a caftan (a pair extant, Figure 5).

15. As opposed to extant contemporaneous garments that were woven, from Mesopotamia to the Mediterranean coastal regions as well as in some other parts of the world, in the specific shape of a straight-seamed garment that required little sewing. See notes 65 and 72 for fancy versions.
16. The original whiteness remains in the lower half of the left front (hidden under the right front panel; Figure 2) and in sections of the back panels (Figure 3) of the caftan.
17. See note 52 for terminology use in this article.
18. For example, a tunic for a woman (Figure 7) is also a composite of several different used linen and hemp cloths.
19. In seaming the Reference Silk Caftan (Figure 19), the last warps in the full 1-cm-wide plain-weave selvages were butted and stitched. At the edges of the wrist openings, raw selvages were used.
20. A portion of a linen tunic sleeve (Figure 12). The wrist opening was finished with straightforward hemming without a border. Since the Metropolitan's caftan is also of linen, its sleeves would have been finished the same way. The original wrist openings of the Reference Silk Caftan (Figure 19) had no patterned silk borders, whereas a woman's tunic (Figure 7) was embellished at the wrists with silk borders.
21. Many tiny remnants, mostly without hair, are extant in the interior along the seams of the border silks.
22. Modern linen fibers are extracted from flax stalks by the use of strong chemicals to speed up the process. The chemicals' residues and/or overprocessing affect the bast fiber's ability (see note 26) to withstand oxidation/acidification or longevity in our environment, much less than the fibers processed in the natural environment of the archaeological period. For our conservation work, cotton cloth was used for the coat for easy identification of the original and the conservation materials. The 8th–10th-century linen could have greater longevity than the industrially hybridized 20th-century cotton grown in a polluted environment.
23. The Reference Silk Caftan made of very sheer silk damask is, with borders altogether, also unlined.
24. The foot parts of all other leggings in the reference groups were composed of a single piece with the seam in the heel. Each foot part of the undecorated leggings (Figure 6) and, according to the photograph, Ierusalimskaja, *Gräber,* pl. 25, fig. 55 (Reference Group I), was of a nettlelike fiber cloth, coarser and darker in color than the linen cloth used for their leg sections.
25. Leather disks (triangle, 1.5 cm) attached at the front rim of a pair of linen leggings (Figure 6) retain the leather strings (6 cm).
26. Dark streaks in bast fibers are commonly interpreted as evidence of the presence of lignin (an acidic compound inherent in the source plant) that turns brown as it oxidizes over time. The presence and amount of lignin differ not only by plant species but also according to when and where the plants were harvested. Since the acidic lignin accelerates oxidation of cellulose, bast fibers weaken and break faster than those with less or no lignin. Flax contains much less lignin than other bast fiber plants. Since the linen fibers in our objects are still in good condition for their age, our caftan, from the time the thread was spun and to the burial, must have been evenly off-white (see note 16).
27. This recurs with the pillow (Figure 13). Also Reference Group I; see Ierusalimskaja, *Gräber,* pl. 94, fig. 156 II.
28. Also a tunic collar (Figure 11) of the same type of silk but from a different bolt, retains high-value yellow wefts in the center of the axlike pattern.
29. In executing a repeated design oriented either upright or sideways in the weft direction across the full width of cloth on the loom, the beginning and end of a repeat unit are, for the most part, regionally conventionalized. In the Eastern tradition, in medieval silks, almost all units were completed at both right and left selvages—as ours is—whereas in areas west of China, a unit would be complete at the left but frequently remained incomplete at the right selvage. Since weaving had to be done with the reverse side up on the loom, the incomplete pattern units indicate that the pattern heddle threading of warps started at the right side of the loom.
30. In earlier and contemporaneous textiles of all types and provenances, the design of a boar's head—never the whole animal—is consistently depicted alone in a roundel. See, for example, a Sui dynasty samit silk in a private collection (Figure 43); a Tang dynasty samit silk (Xinjiang Uygur Autonomous Regional Museum), *Archaeological Treasures of the Silk Road in Xinjiang Uygur Autonomous Region,* exh. cat. (Shanghai: Shanghai Translation Publishing House, 1998), cat. no. 47; a wool embroidery attributed to the 7th century, Textile Museum, Washington, D.C., inv. no. 3.304, Carol M. Bier, "Textiles," in Prudence Oliver Harper, *The Royal Hunter: Art of the Sasanian Empire* (New York: Asia Society in association with John Weatherhill, 1978), cat. no. 53; and a wool tapestry attributed to the 7th century, Cleveland Museum of Art, inv. no. 50.509, *Woven Treasures of Persian Art,* exh. cat. (Los Angeles: Los Angeles County Museum of Art), cat. no. 4. If the design in Silk C1 can be interpreted as a pair of confronted boar's heads, the heads are considerably stylized (see Knauer, Figures 11–13), perhaps because the motif was not in the convention of their locality. The lack of clarity in the motif is another reason to think that this rural group of weft-faced samit silks was woven after the 7th century by copying a copy of a copy, in a weaving center remote from the mainstream.
31. This motif is derived from the tree of life that was naturalistically rendered in the 7th century and gradually became stylized. See, for example, a wool and cotton samit, Textile Museum, inv. no. 73.623, Bier, "Textiles," cat. no. 57; a silk samit, Musée National du Moyen Âge (Cluny), Paris, inv. no. Cl. 22513 (see note 75).
32. The direction of the weaving is established following the conventional order of three-color wefts, the two design wefts first, followed by the ground weft.
33. To weave a cloth on a mechanical loom, for example a polychrome samit on a draw-loom, each warp in the set(s) of the massive number of warps has to be threaded in strict order through each dent of the reed, each hole in a heddle in the shaft, and, with a draw-loom, each hole in a pattern lash according to the complex sequence required by the structure. As such, the threading of the warp in dressing a loom requires a greater understanding of loom technology and weave structure than skill at simply tying the ends of two fine warp threads. Thus weavers saved a length of already threaded leftover warps on the loom and tied them with the new warps one by one. Once the warps were arranged in a particular structure, the arrangement would be continuously used to weave many bolts in the same structure; the pattern could be changed by choosing from a variety of patterning cord arrangements that were coordinated with the type of structure.
34. For an example of the use of interchangeable patterning cords, see Museum of Fine Arts, Boston, inv. no. 40.45; Dorothy G. Shepherd, "Medieval Persian Silks in Fact and Fancy," *Bulletin*

*du CIETA*, nos. 39–40 (1974), pts. 1 and 2, figs. 49a, b. Also see Biblioteca Apostolica Vaticana, Museo Sacro, inv. no. 6953a–g; Odile Valansot, "Un tissue islamique de la Bibliothèque Apostolique Vaticane: Étude technique," *Bulletin du CIETA*, no. 70, (1992), fig. 3.

35. At present, reports on archaeological finds of the Linum family plant's seeds (for oil) and fibers (including yarns and fabrics) that indicate the early cultivation in the regions closer to the Moshchevaja Balka include Çatal Hûyûk, Turkey, 6000 B.C., and Jordan, 4000 B.C. *Linum bienne*, a wild perennial, grows today in steppes such as the southern slope of the Caucasus Mountains. The manufacture date of our coat suggests that its linen was likely by then a widely cultivated annual, *Linum usitatissimum L.*, which must have been grown in the alluvial soil plains in the greater Caucasus region. Under the Soviet system, flax cultivation was terminated in present-day Georgia and Armenia.

    In textile jargon, the word *flax* connotes the plant, whereas *linen* refers to both the fiber that was extracted from the stalk of the plant and the cloth that was made of it.

36. Hemp was identified in the foot parts of a pair of undecorated linen leggings (Figure 6) and a pair of short trousers (Figure 9). Nettlelike fiber was used in a pair of short trousers (Figure 10) that were severely battered by use, even after being patched in many places.

37. To obtain a yarn in the large quantity required for weaving (as opposed to a limited-length twine for tying or a single thread for stitching, for example), time-consuming, labor-intensive yarn-making procedures evolved into regionally specific methods.

    To transform short fibers into a single yarn and, further, to form more than two single yarns into plied yarn or re-plied yarn for strength and thickness, the fibers must be spun. Spinning is a technology for making a continuous yarn in which short fibers of all kinds and types (including shortened and/or bundled long fibers such as flax and silk) are prepared into a loose mass from which a portion is pulled out while in a rotation. The process can be done with the fingers (the slowest), sticks, spindles, a wheeled apparatus, or a flyer-attached spinning wheel (the fastest). A draw of even quantity (dictated by the degree of fiber preparation) and a steadiness in speed and force (dictated by the spinner's dexterity and apparatus) are the essential factors in making a yarn of infinite length with even diameter, twist, and strength that results in good cloth. See Allen Fannin, *Handspinning: Art and Technique* (New York: Van Nostrand Reinhold, 1970). Spinning requires a few seconds of ceaseless repeated motion with hands or tools to continuously draw and twist the fibers and yarns. (In describing yarn-making, "spinning" implies only fibers that are actually spun, whereas long fibers, e.g., silk and bast fibers that undergo each specific process in the first stage of transforming fibers into yarn, are reeled or spliced/knotted and then plied.)

    The physiology of the human hand determines the way in which something is twisted, rolled, or rotated—as in this case, a shaft of a hand spindle or a spinning wheel. For the right-handed majority of people, it is natural to hold the shaft of a spindle with the right palm facing the body. To roll the shaft while holding it between the thumb and the rest of the fingers, one moves the thumb to the left (toward the right requires an unnatural effort), pushing against the other fingers; then the thumb returns to its original position and repeats the action. If viewed from the upper end of the rolling shaft, the rotation is in a clockwise direction that imparts what is called a Z-twist to the yarn being spun. The same rotation if seen from the bottom up is in a counterclockwise direction. If the fiber is tied from the bottom of the shaft, an S-twist results.

    To make yarns, while continuously rotating a spindle with the right hand, fibers must be constantly fed to the end of the spindle shaft by the left hand. If the spindle is held vertically, the only direction fibers can be supplied is from above downward, resulting in a Z-twist yarn. If the spindle is held horizontally (with the palm upward), the only direction the left hand can supply the fibers is from the left, resulting in as S-twist yarn. Likewise, if working on the lap or on the proper right thigh (for right-handed people), it is more natural for the right hand, palm down, to roll the hand away from the body. If two ends to be spliced are laid horizontally on the lap or a vertically held spindle shaft is placed against the outside of the right thigh and rolled, with the fibers being supplied from the left side, the splicing area or the spun yarn twists in an S direction. With a so-called spinning wheel equipped with a belt, S- or Z-twist directions can be chosen by the way the belt goes around the wheel (in a circle as a figure 0 or with a twist as a figure 8) without changing the right-handed person's clockwise rotation.

    Since such spinning actions force resilient fibers to change from their natural state into an unnatural twisted state, the fibers try to return to their original state. Plying, which combines two or more yarns twisted in the same direction by retwisting them together in the opposite direction, adds stability and strength to the yarn by exploiting the opposing inherent forces, as 2 Z-spun yarns plied in an S twist, 3 S-spun yarns plied in a Z twist, and so forth.

    Following the initial yarn making, the plying process forces all spinners to perform a physically unnatural, tiresome reverse twisting motion. Or were left-handed people specifically brought into the process? In some regions, spinners have come up with solutions to lessen the work of plying by adapting different methods (first, working with a drop spindle, then rolling on the thigh) or have avoided plying altogether (doubling the yarn but not twisting it). The application of two opposite directions of twist applies only to resilient wool, cotton, bast, and prepared natural and synthetic fibers. Less or nonresilient materials of long to infinite length, such as plant stem, hard leaf, sheath, some synthetic, and metal (e.g., steel cables), are twisted and plied in the same direction.

    As a result, depending on the type of fibers available at the early stage of technological development, a regionally distinctive convention of fiber preparation (one of the most time-consuming processes in spinning) and of spinning methods was established. Such conventions may or may not have been modified by the introduction of unfamiliar fibers or of unfamiliar yarns through trade.

38. The options for spinning apparatus used include a spindle that rotates on the ground or in the air, a team of a fixed rotator and a mobile fiber-feeder, or a wheel-operated apparatus. Four spindle whorls were included in the report of Reference Group I (Ierusalimskaja, *Gräber*, pl. XLVII, figs. 111 and 112; those with a single hole in the center were captioned "ornaments" together with those with two holes), but that does not exclude the possibility of a wheel-operated apparatus in this context.

39. The paucity of surviving archaeological textiles from the Caucasus and neighboring regions in the Middle East makes such assessment somewhat insecure.

40. See, for example, Tomoyuki Yamanobe, *Shiruku-rōdo no Sen-*

*shoku: Sutain Korekushon, Nyūderī Kokuritsu Hakubutsukan-zō* (Kyōto: Shikō-sha, 1979), pl. 100. The detail of a bolt illustrated is captioned as "hemp," a common questionable translation from Japanese. Although it could be hemp, the original Japanese *asa* connotes "a bast fiber" that includes ramie as well as all other visually similar plant fibers.

41. In Egypt, during the period of colonization by the Romans (30 B.C. through A.D. 395), in making yarns from linen fibers, the conventional Dynastic splicing method, in which two or more single plies were twisted together in the same direction, changed completely into the spinning method traditional to the regions north of the Mediterranean Sea, at the same time that the Dynastic wraparound garment style changed to the Roman tunic. Woven of spun yarns, 4th–12th century linens excavated in Egypt (so-called Coptic group), Syria (Palmyra, Dura Europos), and Iraq (At-tar) resemble each other but do not resemble those found at Moshchevaja Balka. Rather, the linens used in the Metropolitan's caftan are closer to the medium-hand, high-quality linens woven of spun yarns by the Tiraz of Arabs who adopted the mode of Late Antique linen culture in the period following their invasion of Egypt (A.D. 750). Excavation of contemporaneous counterparts from Middle Eastern regions has scarcely been reported.

42. It is in every weaver's interest to weave as fast as possible, and warp-faced weaving can be done faster than weft-faced weaving. The technical issues involved include the relationship of diameter, elasticity (largely dependent on the degree of twist), and tension of the warp yarns in one direction and the weft yarns in another, how the yarns withstand the weaving process, which is a function of the locality or the type of fibers used, and how they were put together as individual yarns.

    In the web plane on the loom, a warp-faced weave results when closely set warps are maintained at a loose tension (enhanced if the loom has an adjustable warp tension setup), and the inserted weft yarns lie taut or straight with spaces between them (a natural phenomenon). In particular, in the initial period, when a wooden sword was used to beat in the weft (without a reed), the closely set warps meander over the taut, straight wefts, creating warp-faced weaves, including warp-faced taquete and samit in bolt-length, wide-width weaving. Once the custom of warp-faced weaves is established, looms and techniques conform to it. Today, a handweaver in China, for example, can no longer weave a weft-faced samit as true weft-faced, since no weavers allow loosely inserted uneven wefts in their products, and the space available on the loom (ca. 30 cm as opposed to the required 50 cm) does not permit a weft to lie diagonally. The time-consuming insertion of wefts in scallops as in the manner of tapestry weavers was beyond the concept of a handweaver mechanically weaving a pseudo–weft-faced satin samit on a draw loom that was constructed for warp-faced weaves.

43. In the web plane on the loom, a weft-faced weave results when spaced warps (with a reed) are kept under taut tension, and the inserted weft yarns meander around the warps compactly, an effect that is obtained only with effort. Inserting a weft loosely so that it successfully meanders around the warp to achieve a weft-faced weave consumes more time and skill than simply throwing straight and taut weft into an open shed.

    In producing polychrome-patterned cloth such as weft-faced taquete and samit, although the warp preparation for the warp-faced Chinese counterpart (or narrow-band weaving in many cultures) was cumbersome, the ability to use any number of colors called for in the design was achieved by exchanging the roles of warp and weft. This was also time-consuming even though the slowness might not have been a serious concern in the production of luxurious textiles. By the 13th century the weft-faced taquete/samit weave system was virtually replaced by the lampas-weave system (see note 54). Weft-faced taquete/samit weaves were continued in Iran (see Nancy Andrews Reath and Eleanor B. Sachs, *Persian Textiles and Their Technique from the Sixth to the Eighteenth Centuries Including a System for General Textile Classification* [New Haven: Pub. for Pennsylvania Museum of Art by Yale University Press; London: H. Milford, Oxford University Press, 1937], figs. 9, 10; Jon Thompson and Hero Granger-Taylor, "The Persian Zilu Loom of Meybod," *Bulletin du CIETA*, no. 73 [1995–96], pp. 27–53), Egypt (see M. M. El-Homossani, "Double-Harness Techniques Employed in Egypt," *Ars Textrina* 3 [May 1985], pp. 229–68), and perhaps a few other areas. The development of the lampas-weave system—for the most part, satin weave as a warp-faced weave foundation—eventually brought about the invention of a sectional warping method, which totally eliminated the time-consuming twisting of warp yarns.

44. See examples of outdoor weaving in Ann Hecht, *The Art of the Loom: Weaving, Spinning, and Dyeing across the World* (New York: Rizzoli, 1990), pl. 56, pp. 62–63; Shelagh Weir, *Spinning and Weaving in Palestine* (London: British Museum, 1970), pls. 8–11; Eric Broudy, *The Book of Looms: A History of the Handloom from the Ancient Times to the Present* (New York: Van Nostrand Reinhold, 1979), pls. 3–22, 27. For the contrasting warp arrangement for an indoor loom, see El-Homossani, "Double-Harness Techniques Employed in Egypt," pp. 229–68.

45. If wool yarn was used, which needs to be tightly twisted, a pointed stick could have aided in beating in the weft.

46. Other types of two-shaft loom could cause the same phenomenon, but are more likely to be inconsistent within the width of the loom.

47. During the yarn-making and weaving processes of bast and leaf fibers, the fibers are kept considerably moist or wet. This is because, unlike resilient wool and cotton fibers that inherently cling to each other when transformed into yarn, nonresilient smooth bast and leaf fibers stretch when moistened and shrink back after drying. Thus, the physical manipulation of bast fibers, yarns, or cloth—splicing, spinning, plying, weaving, tying, knotting, and stretching—is traditionally done by moistening the fibers. Because these fibers lack resiliency when dry, if processed in that state, the spun or spliced yarn would come apart, a tied knot would slip, weaving would produce a cloth with a loose weave that would shrink over 30% when wet later, and a stretched painting canvas would get wrinkles.

48. A width of 56 cm was measured in the panels (edges are folded inside seams, so the selvages are not determinable) making up the lower half of a coat (Figure 5).

49. In isolated regions of the world, a shellfish secretion was used to dye cellulosic and proteinaceous fibers purple (also brown and dark green). The dyeing of pink to red shades of madder on cotton in India by an extraordinarily complex method was uncommon in other parts of the world in early times.

50. In contrast, the excavated contemporaneous Egyptian linens used by the Muslim culture attest to the practice of a glazed finish for a new bolt as well as at each laundering.

51. For looms, see, for example, Broudy, *The Book of Looms*; Cheng

Weiji, chief compiler, *History of Textile Technology of Ancient China* (Rego Park, N.Y.: Science Press, 1992).

52. In this paper, the following four terms are used: warp-faced taquete (Figure 38), warp-faced samit (Figure 39), weft-faced taquete (Figure 40), weft-faced samit (Figure 41). These patterning structures involves a set of binding elements and a complementary set of patterning elements in opposing directions interlacing either warp-faced or weft-faced in plain weave (taquete) or twill weave (samit, most commonly 1/2, 1\2, 2/1, or 2\1 twill). Another set of elements, an inner set in the direction of the first set, separates one or the other of the complementary sets on the obverse for the pattern and on the reverse for the rest within the structure. For a discussion of warp- and weft-faced samit, see p. 108. For further reading, see Irene Emery, *The Primary Structures of Fabrics: An Illustrated Classification* (Washington, D.C.: Textile Museum, 1966), pp. 150–53; Shinzaburō Sasaki, *Nihon Jōdai Shokugi no Kenkyū* (Kyōto, 1976); Milton Sonday Jr. and Nobuko Kajitani, "A Second Type of Mughal Sash," *Textile Museum Journal* 3, no. 2 (1970), pp. 6–12.

    Although warp-faced and weft-faced taquete/samit textiles are structurally different, the general appearance of the two is indistinguishable to laymen.

53. For example, for one of the earliest discontinuous wefts in the set of complementary wefts in 9th-century weft-faced samit silk, see Biblioteca Apostolica Vaticana, Museo Sacro, inv. nos. 1231 and 1258, in Maria Teresa Lucidi, *La seta e la sua via*, exh. cat. (Rome: De Luca, 1994), nos. 68, 69. The varied uses of discontinuous wefts in silk, wool, and cotton in weft-faced taquete/samit are the subject of a future research paper.

54. *Lampas* is broad terminology for a loom-controlled pattern-weave system (after the 10th century) and also connotes textiles woven using this method. It is a compound structure in which a compact warp-faced weave such as satin weave (after the 13th century) is used for the ground, and a spaced-warp, weft-faced weave such as plain or twill weave is used for the pattern; they are fully or partially interconnected. The pattern stands out against the background not only because of the colors used but also because the warp-faced surface reflects and the weft-faced surface absorbs light, showing the pattern distinctly, as in damask weave. It is essential for a description of lampas to include the visual impact of the two structures, their structural relationship, and the varied types of yarns used. Because the ground weave of a lampas structure is warp-faced, which is much less time-consuming to weave than the weft-faced samit, it resulted in greater productivity and replaced weft-faced samit systems relatively quickly. The lampas system began to appear in the 10th–11th century and matured by the 12th century in weaving centers. Whether the lampas system originated in the Arab or Chinese cultures, or both, cannot be determined.

55. Sinking and counterbalanced shafts are outside the scope of this discussion. Upright looms that share the same principles of interlacing weft-faced taquete/samit but developed in the regions weaving with spun yarn must also be left out of this discussion.

56. The underside, obverse of cloth inevitably displays many weaving faults. After removal from the loom, a freshly finished bolt of patterned silk and the extra yarns used for it are taken to a craftsman who specializes in structural and material refinement for time-consuming correction by needlework, and a finisher for steaming, pounding, rolling, and stretching.

57. See Ernest Pariset, *Histoire de la soie*, 2 vols. (Paris: A. Durand, 1862–65); Luce Boulnois, *La Route de la soie* (Paris: Arthaud, 1963). The essays in these books are informative, but readers must trace the sources of references and make their own interpretations.

58. For evidence of trade from the East to West in the earliest periods, see, for example, R. Pfister, *Textiles de Palmyre*, 3 vols. (Paris: Les Éditions d'art et d'histoire, 1934–40); R. Pfister and Louisa Bellinger, *The Excavations at Dura-Europos: The Final Report*, vol. 4, pt. 2, *The Textiles* (New Haven: Yale University Press, 1945); Hero Granger-Taylor and John Peter Wild, "Sóme Ancient Silk from the Crimea in the British Museum," *Antiquaries Journal* 61, pt. 2 (1981), pp. 302–6.

59. For evidence of trade from cotton culture to linen culture, see Carl Johan Lamm, *Cotton in Mediaeval Textiles of the Near East* (Paris: Librairie orientaliste P. Geuthner, 1937).

60. For evidence of trade from the West to East, see, for example, *Archaeological Treasures of the Silk Road in Xinjiang Uygur Autonomous Region*; Yue Feng et al., "Special Issue of the Achievements of Archaeological Work in Xinjiang," *Chien Shang Chia* (Connoisseur), no. 8 (April 1998), pp. 62–85; Feng Zhao and Zhiyong Yu, eds., *Legacy of the Desert King* (Hong Kong: ISAT, 2000); Kaneo Matsumoto, *Jōdai-gire: 7th and 8th Century Textiles in Japan from the Shōsō-in and Hōryū-ji* (Kyōto: Shikōsha, 1984).

61. These included the mulberry farmer, silkworm grower, basketry worker, boiling pot maker, cocoon reeler, unreeling tool maker, floss spinner, silk winder, warper, weft winder, reed maker, bobbin maker, shuttle maker, bamboo craftsman, carpenter, metalsmith, rope maker, structural finisher, wet finisher, and so on. The Industrial Revolution, particularly since the mid-19th century, destroyed the professions that had sustained the culture for three millennia.

62. It is known that beginning at the turn of the 10th century, previously warmer global temperatures gradually began to drop, finally reaching their lowest average point in the 12th century, at approximately 3° C. The paucity and poor quality of extant silks produced in the mid-10th to mid-11th century that coincides with these low temperatures suggest that this natural phenomenon may have affected the entire chain of sericulture, yielding inferior mulberry leaves, which, when fed to silkworms, resulted in thin and weak silk. See R. W. Fairbridge, "Eustatic Changes in Sea Level," *Physics and Chemistry of the Earth* 4 (1961), pp. 99–185; Zu Kezhen, "Zhongguo Jin-wuqiannianlai Qihou Bianqian de Chubu Yanjia," *Kaogu Xuebao*, no. 1 (1972), pp. 15–38.

63. Thought at this time to be the earliest examples of warp-faced taquete extant are a series of silks excavated as garments from the Mashan site, Jiangling, attributed to 3rd–2nd century B.C., Middle Warring States period. See Jingzhou diqu bowuguan, *Jiangling Mashan Yihao Chumu* (Beijing: Wenwu Chubanshe, 1985). See also Calvin S. Hathaway and Jean E. Mailey, "A Bonnet and a Pair of Mitts from Ch'ang-Sha," *Chronicle of the Museum for the Arts of Decoration of the Cooper Union* 2, no. 10 (1958), pp. 315–46.

64. See, for example, *Archaeological Treasures of the Silk Road in Xinjiang Uygur Autonomous Region*, cat. nos. 32–41, 43. The layout in silk cat. no. 44 demonstrates a transition.

65. See, for example, weft-faced taquete fragments from: Iraq, Dura-Europos, Yale University Art Gallery, New Haven, inv. no. 1933.486, spun silk, 3rd century (Pfister and Bellinger, *The Textiles*, no. 263); Iran, Shar-i-Qumis, MMA 69.24.35, wool and cotton, 6th century; Egypt, woven in tunic shapes with the design in weft direction, MMA 09.50.2304 (stitched on a later

tunic); and Victoria and Albert Museum, London, inv. nos. 1264-1888, 1286-1888, T188-1976, linen/wool, and many wool tunics and blankets, 4th–5th century (A. F. Kendrick, *Catalogue of Textiles from Burying-Grounds in Egypt* [London: V&A, 1920–21], vol. 2). For succeeding weft-faced samit, see note 72.

66. A single or double row of solid circles as decorative borders, particularly of roundels, is already observable on 4th-century Sasanian monochromatic architectural, metal, and wood objects. See, for example, Harper, *Royal Hunter*. Whether the circles can be attributed to "pearls" or should be described differently, the extant polychrome wool or silk textiles from and attributed to Iran from the 6th to 8th century were consistently woven in white. For example, the earliest dated two-weft weft-faced taquete is MMA 69.34.8, wool and cotton, excavated with a coin dated A.D. 587–88 at Shar-i-Qumis (Iran). Attributed to the 7th–8th century is MMA 48.43, wool and cotton, and to the 9th century, Musée du Louvre, Paris, inv. no. E 29187, silk sewn on wool tunic sleeves. Also, for example, see Bier, "Textiles," pp. 119–40, and Matsumoto, *Jōdai-gire*. As the design and the weft-faced samit loom technology spread internationally from the Sasanian weaving centers, pearls began to appear partially in white and later totally in other colors. For example, Abegg-Stiftung, Riggisberg, inv. no. 9, wool weft-faced samit, 9th century, in blue and red; Cooper-Hewitt National Design Museum, Smithsonian Institution, New York, inv. no. 1902-1-222, silk weft-faced samit, 11th century, in blue.

67. See Krishna Riboud and M. Gabriel Vial, *Tissus de Touen-Houang* (Paris, 1970); Matsumoto, *Jōdai-gire*.

68. The dissemination of the weft-faced samit weave system—the first polychrome loom-patterning technology—was swift in the 7th century. Since the compound structure was based on plain- and twill-weave binding systems to which weavers were accustomed, they were able to participate in the international market by adopting only the patterning apparatus with no need to change the basic mechanism of their looms. Since the weft-faced samit silks that were woven at the various workshops in widespread regions of manufacture throughout the 7th to 12th century appear, for the most part, to resemble each other visually, attribution of provenances remains so (as opposed to the succeeding lampas-weave system [see note 54] for which the loom, but not the patterning apparatus, had to be changed). This is because weft-faced samit was woven in the identical structure, with similar pattern repeat (as opposed to the lampas-weave system that produced a variety of weaves, pattern organizations, and designs), even though materials—particularly colors—and technical details differed.

69. Fragments of two narrow bands of superb quality, Byzantium, 5th century, wool and silk warp, and linen weft, excavated in Egypt, are known: MMA 90.5.11a–e (width 10 cm); see Nobuko Kajitani, "Koputo-gire," *Senshoku-no-Bi*, no. 13 [Early Autumn 1981], pl. 49, and *Textiles of Late Antiquity*, exh. cat. [New York: MMA, 1995], cat. no. 26, p. 38. The second band is in two pieces, the larger portion (width 6 cm) in the Städtische Kunstsammlungen, Düsseldorf, inv. no. 13095 (see Leonie von Wilckens, *Die textilen Künste: Von der Spätantike bis um 1500* [Munich, 1991], fig. 14), and the smaller fragment, MMA 90.5.9, unpublished.

70. For weft-faced taquete in wool/linen or wool, see note 65, and weft-faced samit (silk), note 72.

71. See *Archaeological Treasures of the Silk Road in Xinjiang Uygur Autonomous Region*, pp. 228–29, "VIII. Male Mummy of Yingpan"; Li Wanying and Zhou Jinling, "Fine Woolen Robe Unearthed from an Ancient Tomb of Yingpan," *Chien Shang Chia* (Connoisseur), no. 8 (April 1998), pp. 62–67. The excavation context is dated to Han 206 B.C.–A.D. 8 through Jin A.D. 265–420, from a site in Yingpan, Yuli (north of Khara-khoto), Xinjiang Uygur Autonomous Region, People's Republic of China (excavated in 1995).

The plate on p. 66 in the latter publication shows a close-up of the lower part of the overlapping proper left front of the superbly preserved man's coat made of wool double cloth (slightly weft-faced). At its edge (seen in the center of the plate) is a triangular piece of wool cloth in weft-faced taquete most likely cut from a bolt. As illustrated, the warp runs horizontally. Wefts are in two sets, one a solid red and the other graduated blue to pink and pink to white, a typical feature in the attributed context. The narrow solid blue area is the heading of the cloth. Exquisitely executed, all yarns are of the finest wool. The graduated-color yarns were first fleece-dyed, then mixed and carded before being spun. On the underside of the front panel, not shown, is a second small weft-faced taquete cloth in another design similarly organized. I would also note that these three loom-patterned textiles do not incorporate the circle-and-cross format, even though the pattern organization in symmetrical and offset row arrangements (like the Roman weft-faced samit in silk in note 72) was capable of creating such a design (see note 77). The entire corpus of textiles associated with the Yingpan mummy would rewrite textile history. It again demonstrates how little we know about human potential and ingenuity in history. On the other hand, it is gratifying that even a tiny example survived and that we are afforded a glimpse into the ancient world. I am most grateful for having been given the opportunity in 1997 by the Archaeological Institute of Xinjiang to study the garment closely firsthand.

72. The following silk weft-faced samit examples in fragments with a profusely repeated pattern of Roman origin, none related to Sasanian pearl roundels, are estimated to have been woven in tunic shape (with the direction of the design oriented in the weft direction), attributed to the 4th–6th century. In two-color wefts: Cathedral Treasury, Sens, inv. no. AB (*Age of Spirituality*, ed. Kurt Weitzman [New York: MMA, 1979], cat. no. 413); Mechthild Flury-Lemberg, *Textile Conservation and Research*, Schriften der Abegg-Stiftung Bern 7 (Riggisberg: Abegg-Stiftung Bern, 1988), no. 72, pp. 412–22, and no. 94, pp. 367–69, 381–83; Museum of Fine Arts, Boston, inv. no. 11.90 (Adèle Coulin Weibel, *Two Thousand Years of Textiles: The Figured Textiles of Europe and the Near East* [reprint, New York: Hacker, 1972], pl. 50); Monique King and Donald King, *European Textiles in the Kier Collection, 400 B.C. to 1800 A.D.* (London: Faber, 1990), cat. no. 7; Cooper-Hewitt National Design Museum, inv. no. 1902-1-210 (Weibel, *Two Thousand Years of Textiles*, pl. 48); MMA 2000.374; from the same tunic, Royal Museum of Scotland, Edinburgh, inv. no. 1975.299; King and King, *European Textiles in the Kier Collection*, cat. no. 6; a private collection, Antwerp, no. 795; Newark Museum, inv. no. 77.29, 39. In three-color wefts: Cleveland Museum of Art, inv. no. 50.520. For an earlier-period linen/wool weft-faced taquete, see note 65.

73. In the technological history of weaving with silklike filaments in the West, for a considerably long period, local wild silks (see King and King, *European Textiles in the Kier Collection*, cat. no. 149, which may be one of them) were used. Then, with the advent of international contact, traded silk yarns (from *Bombyx mori*) were used by weavers already familiar with weaving with wild silk.

From China reaching westward as far as Western Europe, probably as early as 100 B.C., the use of traded silk yarns—including dyed yarns—long preceded the introduction of sericulture. This extremely complex, time-consuming, labor-intensive undertaking involved raising sensitive silkworms and mulberry trees, compatible climate, soil, and water, as well as cultivating the knowledge and skill of workers. The 6th-century myths apparently fantasized by C. H. Yule in 1898, based on an anecdote in *De bello gothico* (ca. A.D. 550) by Procopius, that sericulture began in the West after silkworm eggs were smuggled out of China could be a factor, but that alone, without the lead time of the use of local wild silk and then traded silk yarns, cannot initiate and support the system of sericulture. See R. J. Forbes, *Studies in Ancient Technology*, vol. 4 (Leiden and New York: E. J. Brill, 1987), pp. 50–53. For example, the following two textiles, unearthed in Egypt, contain filaments that appear not to be from *Bombyx mori:* yellowish filaments in wool and linen tapestry-weave design, a 3–4th-century belt, MMA 33.10.36, from the Kharga Oasis (unpublished; the author is preparing a manuscript for publication); beige color filaments in a polychrome silk tapestry-weave in a 4–5th-century polychrome silk tunic decoration, MMA 90.5.154, (*Textiles of Late Antiquity*, cat. no. 14, p. 35), and from the same piece, Victoria and Albert Museum, inv. nos. 334-1887, 335-1887 (Kendrick, *Catalogue of Textiles from Burying-Grounds in Egypt*, vol. 1, no. 62, pl. XIV), and Museum of Fine Arts, Boston, inv. no. 35.87 (Weibel, *Two Thousand Years of Textiles*, cat. no. 7).

74. See, for example, MMA 1974.113.11, 12; Textile Museum, inv. nos. 73.623, 73.34, in Bier, "Textiles," cat. nos. 57–59. For others, see Lamm, *Cotton in Mediaeval Textiles*, pp. 17–52. Also blue and white, and green and white examples have been reported.

75. Musée National du Moyen Âge (Cluny), inv. no. Cl. 22513 (see note 31).

76. See, for example, Matsumoto, *Jōdai-gire*, pl. 38, with the pattern of four horsemen each aiming at a lion under the Tree of Life within Sasanian roundels with pearled borders, which was documented to have belonged to a prince in the court of Nara in the last half of the 7th century. Others of the exact type have been excavated in China and Egypt; for example, see Bier, "Textiles," cat. no. 56; Lamm, *Cotton in Mediaeval Textiles*, pp. 17–52. The sudden appearance of this type in superb quality among other experimental, rural types as well as its distribution seen in extant examples as far west as Egypt and as far east as Japan is a marvel in the history of textiles.

77. For the earliest Western counterpart of circle-and-cross repeat pattern—not yet including the Sasanian pearled roundels and before the invention of symmetrical organization of filler designs—of the 4th century or earlier, see a Roman silk weft-faced samit in fragments: Royal Museum of Scotland, Edinburgh, inv. no. 1975.299; King and King, *European Textiles of the Kier Collection*, cat. no. 6. For further development in loom technology, see MMA 2000.374, not yet published.

78. Matsumoto, *Jōdai-gire*, pl. 44.

79. Preceding bolt-width weaving, narrow belt-width weaving must have been practiced using highly twisted yarns of all types of fibers with the loom with or without string heddles and patterning shed sticks, a sword beater (seldom a reed), and sticks to hold bundled warps up at working position. The setup of the loom created a variety of warp-faced structures, including warp-faced taquete (note 69) and samit. The weavers of the world also initially wove narrow belt-width warp-faced weaving that endures today.

80. At a glance, the surface of double-faced, weft-faced samit, or Liao samit, looks like a basic weft-faced samit of the later period. Extra fine yarns for binding and inner warps alternate, and extra thick yarns for complementary wefts form the body of the fabric with weft colors mixed on the reverse. Unlike the basic weft-faced samit, the reverse is not warp-faced but weft-faced, thus double-faced—both faces structurally the same. In the structure, one of the complementary wefts patterns the obverse in 1-2 weft-faced twill, or interlaces over two binding and three inner warps and under one binding warp. The rest of the mixed color weft interlaces, with their binding points offset one binding warp, over one binding warp and under two binding and three inner warps, in effect becoming warp-faced. In this structure, however, both the obverse and the reverse have the appearance of being weft-faced since the sole weft-faced-patterning weft slides or expands over to the other warp-faced area. Hence it is a pseudo–weft-faced twill surface. To weave this patterning structure, different from the original weft-faced samit in which patterning is achieved by manipulation of inner warps, the advanced heddle threading mechanism that had earlier been developed for damask weaving must be incorporated in the loom. Since the warps and wefts do not fully interlace as in true weft-faced samit, all double-faced, weft-faced samit weave silks lack structural integrity, compromising rigidity and longevity. Still a time-consuming weft-faced weave, double-faced, weft-faced samit twill advanced next to be woven in a satin-weave based structure leading the technology into a much less time-consuming warp-faced weave, and finally arrived at a lampas weave. It is understandable that the historically short-lived double-faced, weft-faced twill and satin samit weave structure emerged and disappeared quickly and was replaced by lampas. See, for example, MMA 1996.103.1 (in 1\2 twill binding), in "Recent Acquisitions, a Selection: 1995–1996," *MMAB* 54, no. 2 (Fall 1996), p. 77. See Sasaki, *Nihon Jōdai Shokugi no Kenkyū*, pp. 91–93 (in 1\2 twill binding); Zhao Feng, "Satin Samite: A Bridge from Samite to Satin," *Bulletin du CIETA*, no. 76 (1999), pp. 46–63 (in 1-2 twill and 1-4 satin bindings).

81. For example, Persia/Iran, Egypt, and others. See El-Homossani, "Double-Harness Techniques Employed in Egypt," pp. 229–68.

82. There are no lampas silks in the Moshchevaja Balka group finds.

83. There are several small pieces of two types of mainstream-type patterned silk in Reference Group III. They are heavily grave-stained but retain yellow, dark green, and faded beige colors with dark brown pattern outlining, and are in fair condition.

84. For example, in Reference Groups II and III, only a woman's linen tunic (Figure 7) was embellished with mainstream- as well as rural-type weft-faced samit silks. All the rest—the subject caftan, leggings, Reference Silk Caftan (Figure 19), tunic collar (Figure 11), and an extant end of a pillow (Figure 13)—are decorated with rural-type weft-faced samit silks.

85. At present, several regions can be considered locations for the sericulture that could have included the production of the rural-type weft-faced samit silks associated exclusively with the Moshchevaja Balka group textiles. The most likely is the area of fertile valleys along the south side of the Caucasus Mountains in today's Georgia and Azerbaijan, where silk weaving was said to have been in practice by the 4th century, but whether it was full sericulture then is uncertain. Silkworms are no longer raised, but the endless lines of mulberry trees, for the most part still

trimmed in the style peculiar to leaf harvesting, and the old houses that are windowless on two sides of the ground floor strongly indicate the practice in the region perhaps until the advent of the Soviet system. Other regions that can be considered are in Armenia, Turkey, northwestern Iran, Syria, and Iraq. The author has not been able to survey the regions located on the north side of the Caucasus Mountains.

86. Twisting a yarn, particularly reeled-out silk yarn, not only strengthens it but also makes it possible to manipulate the yarns without tangling—as when weaving, stitching, and doing all other craftwork. Warp yarns, which are under tension and exposed to friction during weaving, require stronger yarns and time-consuming twisting. If warp yarns are not twisted, filaments catch on each other and disturb the order of thousands of warps during the process of warping and transferring them from the warping pegs and threading them into different parts of the loom.

Weft yarns—which are simply laid between warps in opened sheds without tension and friction—do not require twist and can consist of any type of lesser-quality fibers.

Paradoxically, yarn with a twisted surface, which does not reflect light, dulls the surface of an otherwise highly desired glossy silk fabric. Sometime in the 14th–15th century, because of consumers' preference and weavers' increased skill, a warp-faced satin weave (prior to its development about the 13th century, a warp-faced four-shaft broken twill weave had been the major warp-faced weave) became prevalent, though the use of twisted warps prevented a highly glossy surface. By the 15th century, the introduction of the sectional warping method allowed all warps to be prepared without twist. This development made it possible for all silk cloths to be lustrous, but weak. The diffusion of both this method and the satin weave was similar to the diffusion and disappearance of weft-faced samit in both the East and the West.

87. Reelable silk filament is a little more than half the full length of silk (ca. 1,500 m) that forms a cocoon. The remaining filaments and deformed cocoons (ca. 40% of the harvest) are unreelable. They are transformed into floss pads, which can be used as wadding or from which yarns are spun. Reeled-out silks are often overly degummed for easier dye penetration and a glossy effect in bolts. Consequently, they are expensive and used by selective weavers, although the resulting products often lack the strength and longevity of spun silks. Because the fiber source of spun-silk products was considered "waste" and because the simpler yarn-making process resulted in a heavier yarn with better durability that was more easily handled by novices, spun-silk products were always marketed more cheaply and thus as "inferior" quality goods.

88. Except for a blue weft in Silk C1, which is the same spun yarn as the undyed warps.

89. For example, MMA 69.24.35, 5th-century wool/cotton fragments, excavated in Iran; MMA 48.43, 51.85.3b, 1974.113.11, 1974.113.12, 6th–8th-century wool/cotton fragments, believed to have been excavated in Egypt. There are no known Sasanian weft-faced samit silks excavated in the heartland of the Sasanian Empire.

90. Colors that were selectively applied to ethnographic objects are always associated with cultural significance. With textiles, however, the manifestation of a particular color was not initially possible simply by the whim of an individual. The development—often accidental—of dyes and dyeing technology necessarily precedes such selection of a color. A dye compound in nature must be discovered, then a time-consuming complex treatment must be developed to cause the dye (impurities included) to chemically bond with the fibers. The establishment of cultural significance comes afterward.

91. See Robert Chenciner, *Madder Red: A History of Luxury and Trade* (Richmond, Surrey: Curzon, 2000).

92. The earliest safflower red identifiable from its visual appearance would be, generally speaking, in 15th-century textiles that have not been exposed to air and light. In daily conservation routines, the criteria can be applied in estimating the date of textiles as "before the 15th century" if there is a suspected beige in an unexposed area or "after the 15th century" if a UV-exposure fluoresces a reddish beige to pink shade in an exposed area in silks. If already faded, the textile can be exhibited, whereas unfaded, particularly light shades of pink should, in principle, never be allowed to be on view, exposed to air and light.

93. The madder plant is a perennial, and several years must pass before the best dye can be harvested.

94. The use of a roller on the loom required the invention of a device that would prevent the roller from unrolling when under tension.

95. Being extremely sensitive to climatic changes, silk has to be woven indoors so that throughout the weaving, the length of warps have to be accommodated in a limited space. Hence, in some parts of the world, warps were chained and dangled at the back of the loom. See, for example, Broudy, *Book of Looms*, pls. 6–12.

96. On a back-strap loom, tension can be adjusted at will. To weave on a high loom emancipated from the back-strap system, commonly a roller (infrequently a thick, flat board) was used to wind and release warps to be woven at the back of the loom (thus eliminating the bundling system) and another was used to roll the cloth just woven in the front. Since the roller system unrolls the wound item(s) too easily when tensioned, a device had to be invented to secure the roller(s) in a desired position for the necessary tension of the warp plane. The invention and introduction of the rope-and-lever or ratchet-and-wheel system in high looms made the subtle adjustment of tension in the warp plane possible.

97. See El-Homossani, "Double-Harness Techniques Employed in Egypt," pp. 229–68.

98. In warp-faced weaves, the phenomenon reverses.

99. Yarns and washable types of silk cloth (frequently plain or monochrome patterned cloths) to be dyed were degummed in the same way.