
THE METHOD OF POLYPOLARIZATION: AN EXPERIMENT IN STUDYING THE ANCIENT FABRICS FROM NOYON UUL

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Preface

In 1920s, the Mongolo-Tibetan Expedition led by P.K. Kozlov dug out the numerous ancient artifacts from kurgans built over the elite tombs of the Xiongnu (the Asiatic Huns), located in the Noyon uul mountains in Northern Mongolia. Silk and wool fabrics, mainly dating from the 1st century AD, comprised the main part of the collection. Over the years, the finds became the subject of both stylistic and technical analyses (Воскресенский, Тихонов 1932; Руденко 1962; Лубо-Лесниченко 1994; Миняев 1981; Миняев 2010). The first technical analyses were done soon after the discoveries in the Laboratory of Archaeological Technology of GAIMK (today it is the Institute for the History of Material Culture of the Russian Academy of Sciences, ИМК РАН), however, an attempt to determine the species of animal the wool was obtained for making felt, fabrics, and threads led scholars to inconclusive and contradictory results (Воскресенский, Кононов 1932). In recent years, the Noyon uul textiles kept in the Oriental Section of the State Hermitage Museum have been studied with the newly created method of polypolarization.

The method

Polypolarization, a system for the optical electronic, contactless study of minerals and organic structures, was developed in the Institute for the Study of Material Culture, Russian Academy of Sciences (Куликов и др. 2008; Куликов и др. 2009); it is described in detail in a series of publications (Куликов и др. 2009; Куликов и др. 2010; Kulikov et al. 2010). The great benefit of this method, especially for archaeology, is the extremely small size of samples needed for the analysis that preserves the shape and structure of the object in study.

In order to explore the ancient fabrics by the method of polypolarization, the scholars created

the bank of standard photographs in polarization of animal hair, as well as plant and animal fibers. At first, the method was used for the analyses of the felt carpet from kurgan no. 6 from the Noyon uul cemetery (the State Hermitage inventory no. MR-1958/1959). The selected samples of felt and threads of the carpet's décor had been compared with etalon samples. Comparison of microphotographs of the etalons of wool and samples of the carpet allowed us to conclude that the fineness (the size of the cross-section of an individual thread) and configuration of the middle part of the hair (the cortex) of felt and threads of the carpet are typical for camel hair (Куликов и др. 2009).

Thus, the first experiment with the use of the polypolarization method for the study of archaeological fabrics was promising. This article introduces the results of the next stage of the research, when the samples of the "wool cover" from kurgan 6 of the Noyon uul cemetery (the State Hermitage inventory no. MR-1955) was analyzed by the method of polypolarization. Similarly to the previous study, the samples of the warp and décor threads of the "cover" were compared to the etalon samples of hair of various animals (sheep, horse, camel) and the plant fibers.

The subject of research

The "cover" is a wide cloth sewed from the pieces of different fabrics (fig. 1-3). Its initial location in the kurgan is not certain, since the "excavations" by P.K. Kozlov's expedition were limited mainly to the digging of trenches to burial chambers and taking out the finds; there were no any field drawings that would recorded the burial goods *in situ*. The expedition reports and diaries of S.A. Kondrat'ev, who supervised the excavations, indicate that the "cover" was taken in fragments from different parts of the burial pit.

The inventory list in the Acquisition Book of the GAIMK, the State Academy for the History of Ma-

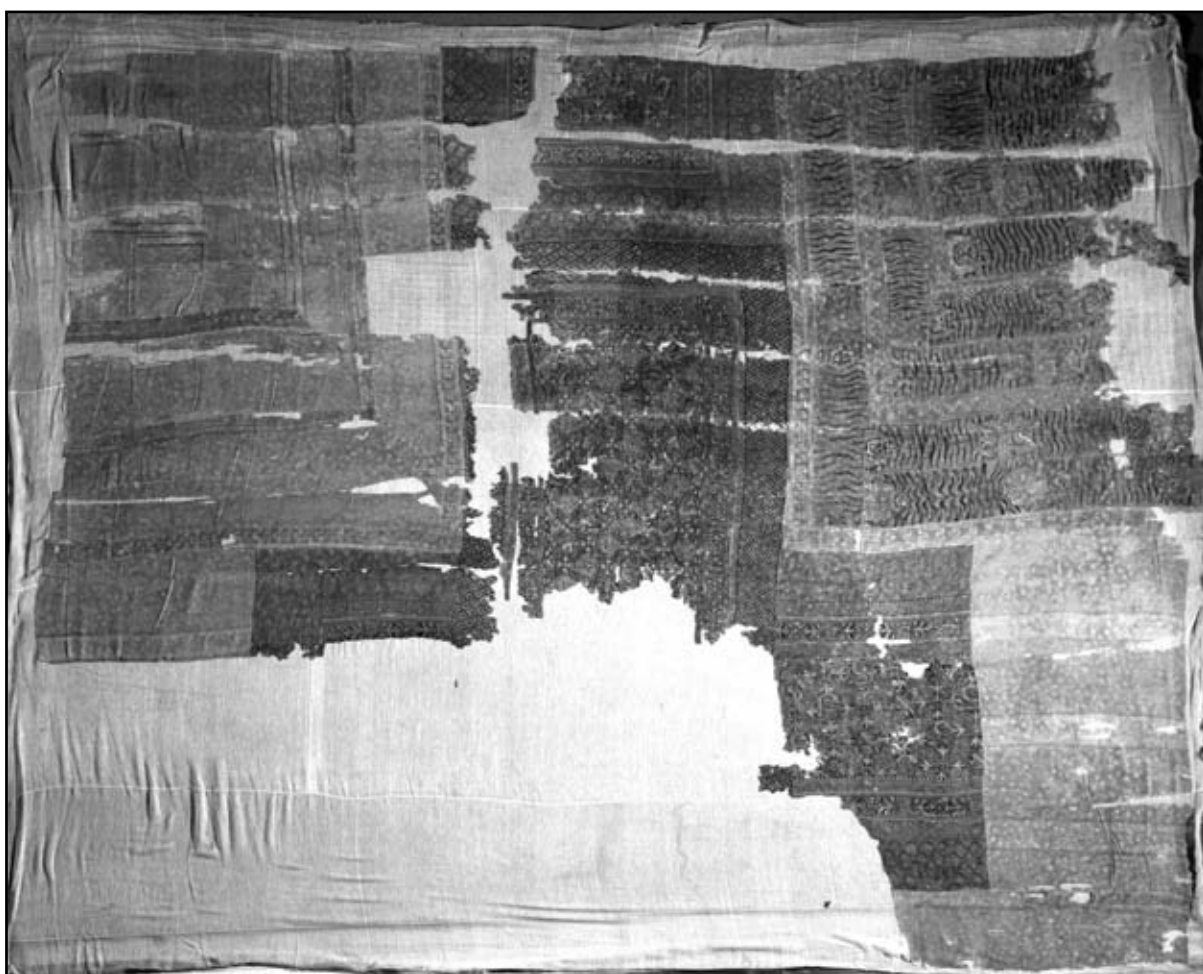


Fig. 1. The “veil” from the barrow 6 in Noin-Ula cemetery.

terial Culture (further - AB GAIMK) kept the following record:

1. AB GAIMK - 14360-14362 near the southern wall of the trench at 9,90-10 M depth;
2. AB GAIMK - 14363-14366 on the ceiling logs under the felt;
3. AB GAIMK - 14422 on the logs of the outer ceiling (here is also a handwritten note – correction – “on the logs of the inner ceiling”);
4. AB GAIMK - 14425 in the northern part of the inner chamber;
5. AB GAIMK - 14436-14438 on the logs of the outer ceiling;
6. AB GAIMK - 14442 over the crack in the wooden cover of the outside chamber;
7. AB GAIMK - 14544-14546 on the logs of the outer ceiling;
8. AB GAIMK - 14550 in the western part of the inner chamber;
9. AB GAIMK - 144562-14567 on the logs of the outer ceiling.

Schematic drawings S.A. Kondrat’ev made in his diary (fig. 4) and those published in brief expedition reports slightly clarify location of the “cover”. A scheme from the diary shows that the borders of the “cover” (the “carpet”, according to S.A. Kondrat’ev) cover the space over the coffin, as well as the inner and outer passages. A scheme in the report (likely, made by S.A. Kondrat’ev) shows the central part of the “cover” over the coffin but its separate fragments are also marked in the outer passages and the western inner passage (fig. 5). These schematic sketches and records in the AB GAIMK allow us to assume that the “cover” was initially placed over the logs of the ceiling of the outer chamber. Later, after collapse of the chamber, due to robbers and P.K. Kozlov’s expedition, some parts of the “cover”, and its borders in the first place, happened to be in the passages of the burial construction.

The expedition reports and S.A. Kondrat’ev’s diaries call this piece of cloth the “carpet”, for what

can be confused with the felt carpet found in the same kurgan 6 but located under the coffin. Following S.A. Kondrat'ev, K.V. Trever also used the term "carpet" (see Тревев 1931, 40). S.I. Rudenko called the central part of the cloth the "cover", and the fragments found in a space between two chambers considered as the wall coverings (Руденко 1962, 190). E.I. Lubo-Lesnichenko offered for the piece the term "hanging" ("zavesa"), since he believed that originally it decorated the main house of the chief buried in the kurgan (Лубо-Лесниченко 1994, 230). The term was accepted by other Russian scholars but the above-mentioned evidence on the location of the cloth suggest in the favor of the term "cover" though in quotes.

Fabrics that belong to the "cover" are represented by three different types:

- 1) Monochromic fabrics of the linen weave. They were used as separate parts of the "cover" as well as the textile for the fragments with embroidery. Presently, the monochromic fabrics have the beige, red-brown, and red colors; perhaps, the original coloring had different shade.
- 2) Polychromic fabrics are represented by two types. The first one has the beige background with stripes of the light beige color, with green border along the stripes. Both beige and light beige stripes are decorated with a repetitive pattern of small amorphous spots of light color. The second type of polychromic fabric has the narrowing stripes, their borders are of the lighter green color, and run not only along the outer edge of each stripe but inside it as well. It can be assumed that originally these polychromic fabrics also had the slightly different shade.
- 3) Embroideries with geometric, vegetative, or zoomorphic images. With an exception of a fragment with an embroidered image of a tiger made on beige fabric with a green woven stripe, the monochromic fabrics were used for all embroideries.

The main part of the "cover", 330×416 cm, is composed of 52 fragments of the described types of fabrics that were sewed together in a random order. Some fragments are identical by their structure and décor. Besides that, the collection of finds from kurgan 6 includes several more textile fragments analogous to the fabrics of the "cover" in both structure and décor, and likely originally belonged to it.

Several samples of each type of fabrics from the main piece of the "cover", its separate parts, and the threads of seams that connected the different parts of the main piece were chosen for the analyses with the method of polypolarization.

There are 18 fragments of fabric that differ in structure, coloring, and décor (fig. 2-3) that were selected from the main piece of the "cover". Below we provide their descriptions in sequential order.

Fragment no. 1 is a small square piece of polychromic fabric in beige with spots of a lighter shade and a narrow green band along the edge (fig. 2/1).

Fragment no. 2 is a narrow stripe with the woven geometric décor made with the red-brown and beige threads (fig. 2/2).

Fragment no. 3. A band of polychromic fabric with the beige background and spots of a lighter color over the surface of the fragment; its width is 17 cm. The band has three ornamental stripes: the middle one has the same color as the background; the side stripes are in beige of a different shade, with the green border along the stripes' edges (fig. 2/3).

Fragment no. 4 is a narrow piece of a fabric with the woven geometric décor in the shape of zigzags made with red-brown, beige, and green threads (fig. 2/4).

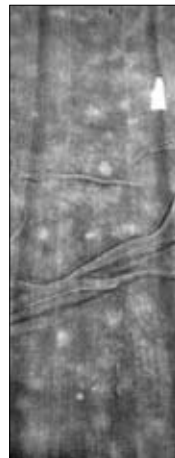
Fragment no. 5. A monochromic fabric with the brown background has a width of 17 cm. The fragment is embroidered with an image of a spread out hide of a tiger, over the back of which runs the straight brown stripe made with the brown, light-beige (originally could be white), and yellow threads. The waved stripes imitating the stripes of the tiger's hide are shown to the right and to the left from it. The tiger's heads with a pair of the fore legs are visible at the both ends of the image of hide. Some images show the animals' muzzles with open mouth. The absence of the even a pair of embroidered heads with stylistically identical manner of their representation, probably indicates that this embroidery was made by different masters. Conditionally, the types of heads can be divided into two groups: 1. The bare-toothed tiger; teeth (two on the lower jaw and one on the upper jaw) are visible only from the sides; 2. The tiger with open mouth; two jaws are seen (ten teeth on the lower jaw and two teeth on the upper jaw). The images are made in the same technique: the contour lines are made with chain stitches, and space between them is filled with satin stitches.



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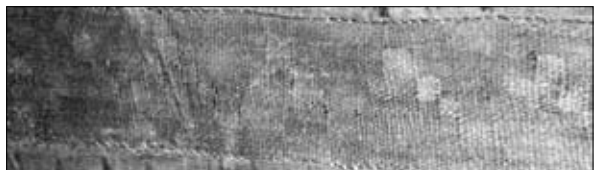
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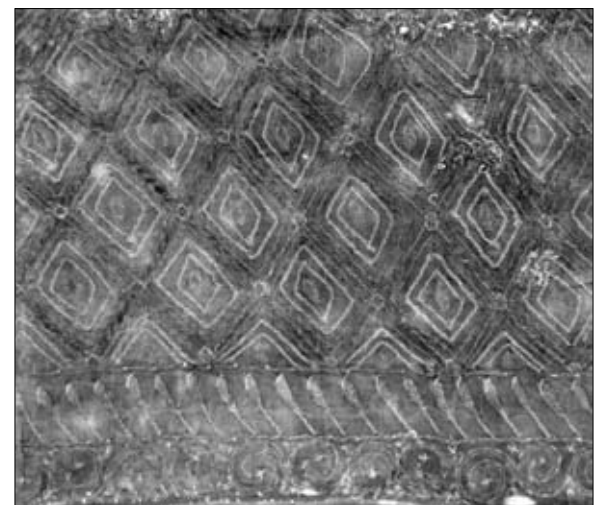
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9-10

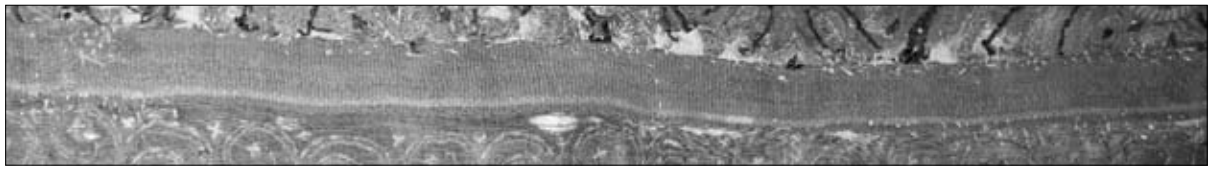


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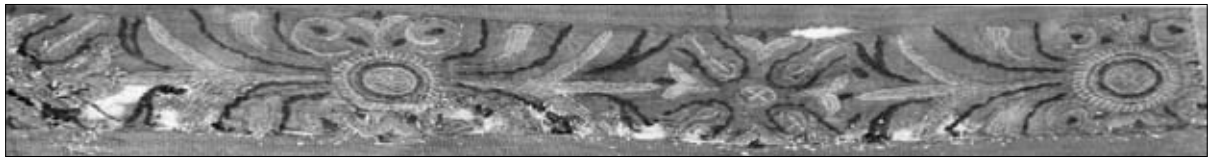


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Fig. 2. Fragments of the "veil" 1-7, 9-11.



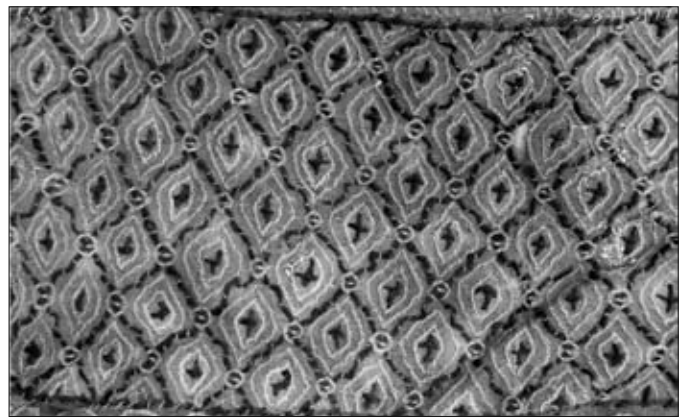
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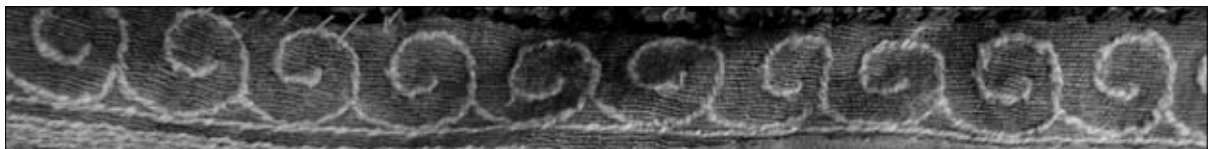
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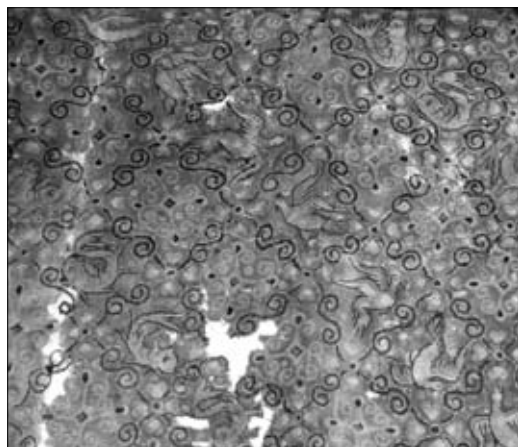
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18

Fig. 3. Fragments of the "veil" 12-18.



Fig. 4. Drawing from S. A. Kondratyev's diary with the scheme of an arrangement of the "veil".

It should be noted that similar décor displaying the tiger hide is known on a wool fabric found in the Zanguluk cemetery located in the Xinjiang Province (the Urumqi Museum). It is also present on the Tibetan carpets of the later period. Some

images depict the whole tiger hide, while the others show only two fore legs of the tiger hide joined together (Casey 2008, 41) (fig. 2/5).

Fragment no. 6. This sample includes warp threads and various threads from embroidery of the first type of tiger head's representation (the threads of the foot, claw, the border of the animal's muzzle etc.) (fig. 2/6).

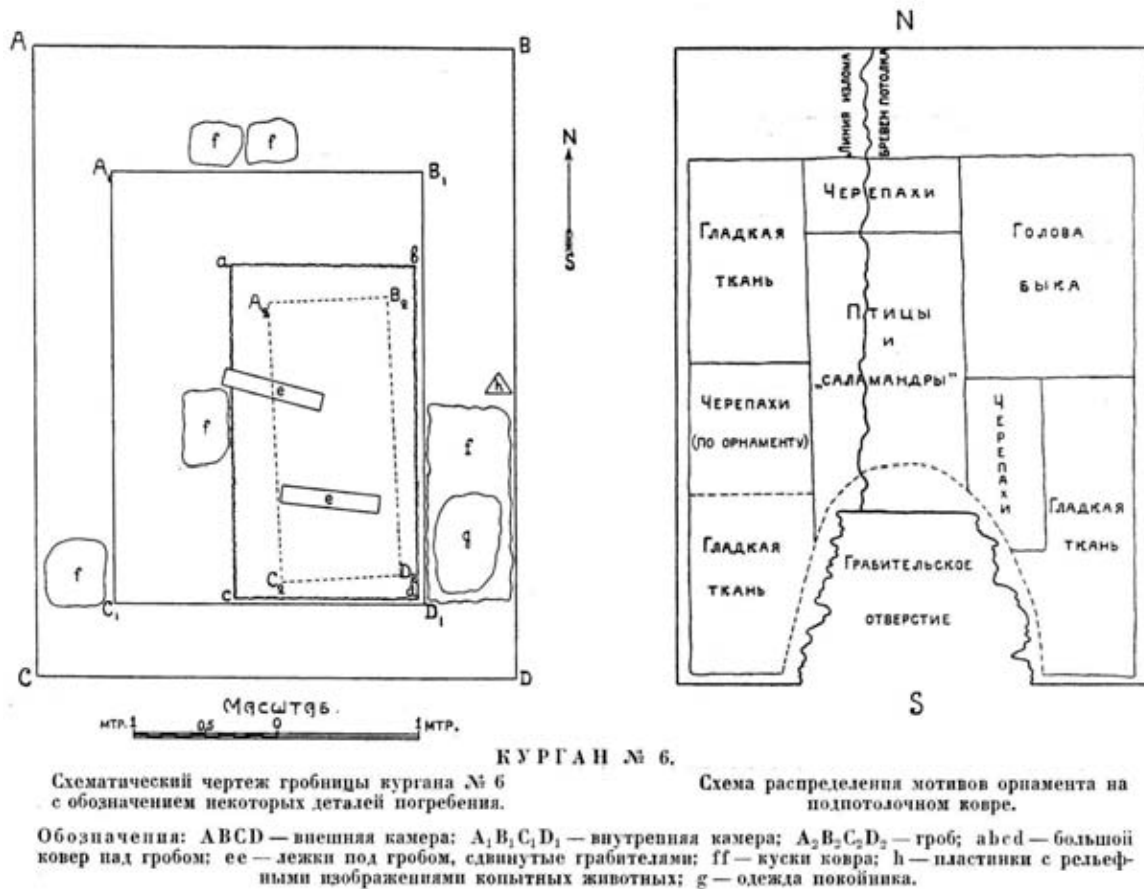
Fragment no. 7 is a polychromic fabric with the woven zigzag pattern made with red-brown, beige, and green threads (fig. 2/7).

Fragment no. 8 by its structure, décor and coloring is similar to the fragment no. 3m; its samples were not taken for the polypolarization analysis.

Fragment no. 9. Brown fabric with embroidered figures of tigers; analogous to the fabric of fragment no. 5 (fig. 2/9-10).

Fragment no. 10. The woven stripe in the center of fragment no. 9, the green along the edge and beige in the center (fig. 2/9-10).

Fragment no. 11. The fragment's background is red-brown, with spots of a lighter color. Against



КУРГАН № 6.
 Схематический чертеж гробницы кургана № 6 с обозначением некоторых деталей погребения.
 Схема распределения мотивов орнамента на подпотолочном ковре.
 Обозначения: ABCD — внешняя камера; A₁B₁C₁D₁ — внутренняя камера; A₂B₂C₂D₂ — гроб; abcd — большой ковер над гробом; ee — лежки под гробом, сдвинутые грабителями; ff — куски ковра; h — пластинки с рельефными изображениями копытных животных; g — одежда покойника.

Fig. 5. The scheme of an intraburial construction of barrow 6 and the scheme of an arrangement of details of the "veil".

the background, the images of geometric and vegetative décor are embroidered with yellow, beige, green, and red threads. The main part of the fragment compile the four lines of the concentric diamonds embroidered with one green (used for the border), one red, and two beige threads; the oval figures embroidered with satin stitches with green threads are placed in the centre of diamonds. Outside the area of the diamond pattern runs one row of the feather-shaped figures (leaves?); the two-thread stripe separates it from the décor of the continuous raw of spirals, with crosses in the centre of the spirals and between them. The embroidery is 5 cm width (fig. 2/11).

Fragment no. 12. The narrow piece of polychromic fabric has a width of 2,2 cm; it is dyed in two stripes of the red-brown and green-beige color. The band is woven in twill structure, where ratio of the weft and warp treads is 13×33 per square cm (fig. 3/12).

Fragment no. 13. A red-brown fabric, it has a width of 8 cm. The complex geometric décor comprised out of two interchanging figures is embroidered with brown, beige, and red threads. One figure is a four-petal ray rosette; a circle with a cross inside it is in the center of each rosette; the ends of the rosettes' petals are forked. The second figure can be conditionally called the "palmetto" comprised out of concentric circles in the center, four volutes adjoined to the centre of the volutes, and two trefoils, the bases of which are located between the volutes (fig. 3/13).

Fragment no. 14. A monochromic fabric of the light-brown color, its width is 47 cm. The complex décor is embroidered with brown, green, and red threads created. The pattern include a central, heart-shaped figure with a line and a cross at the end of the line, and four trefoils with stamens and grape tendrils outside of the central figure arranged in the cross-like manner. The images of turtles and stylized fish are embroidered inside the squares created by these flowers and tendrils. These images are arranged in such way that the continuous rows of turtles and fish go in one diagonal direction, and the images of turtles interchanging with the images of fish in other direction. The turtles are shown in the same, the bird's-eye view angle. Each turtle holds in its mouth a blade of grass. With the same stylistic design, there are five different variants in the representation of the turtle shells, and two variations in the representation of fish (fig. 3/14).

Fragment no. 15. A piece of a brown fabric, with concentric diamonds embroidered on it. The borders of diamonds and a cross in the center are made with the dark-brown thread, and the lines of diamonds in the center – with the beige thread; the same threads were used for the embroidered circles at the spot where the diamonds were connected, and the brown border of the diamonds attached to the fabric (fig. 3/15).

Fragment no. 16. A light-brown fabric with embroidered with the spiral décor made with the light-beige thread (fig. 3/16).

Fragment no. 17. A red-brown fabric has a width of 8 cm. It has the complex geometric décor embroidered with the beige and red threads is formed by the two interchanging figures, the four-petal rosettes and "palmettos" repeating the pattern on fragment no. 13 (fig. 3/17).

Fragment no. 18. A piece of a brown fabric with the diamond-like figures embroidered with brown threads. Each outer sides of a diamond are made with the S-like figures. The four-petal rosettes with the volute-shaped endings and a small cross in the middle against the background of a brown diamond, or the images of birds and fish, are embroidered in the centers of the diamonds. The rows of the cross-like figures, birds or fish are embroidered in one of the diagonal directions, while the opposite direction bear the cross-like figures that interchange with the images of birds and fish (fig. 3/18).

The central area of this embroidery is contoured with a row of the oval figures.

Besides the fragments of the main part of the "cover", several other fragments were analyzed. Found separately, these fragments by both their structure and décor are analogues to the fabrics of the "cover" and, very likely, originally formed a single piece. Theses fragments of the "cover" include:

MR-930 – embroidery with décor similar to the fragment 14;

MR-1676 – embroidery with décor similar to the fragment 15;

MR-1677 – embroidery with décor similar to the fragment 15;

MR-1678 – embroidery with décor similar to the fragment 15;

MR-1679 – embroidery with décor similar to the fragment 15;

MR-1768 – a monochromic fabric;

MR-2515 – embroidery with décor similar to the fragments 15 și 16;

MR-2534 – embroidery with décor similar to the fragment 6;

MR-2536 – polychromic fabric with décor similar to the fragment 4.

Results of the analysis

Results of the polipolarization analysis of the thread taken from the fragments of the main piece of the “cover” and its separate parts are presented in Table 1 and Table 2.

Table 1

Foundation of the “hanging” (inventory N^o MP-1955)

Test number	Number of a fragment	Sample	Color of thread	Identification of a thread
01	1	monochromic fabric	beige	camel + cotton thread
02	2	polychromic fabric	brown	camel
02a	2	polychromic fabric	beige	camel
03	2-3	a thread seaming the fragments 2 and 3	beige	camel
04	3	polychromic fabric	brown	camel + cotton thread
05	3	polychromic fabric	brown	camel + cotton thread
06	3	polychromic fabric	green	camel + cotton thread
07	3	polychromic fabric	khaki	flax
08	3	polychromic fabric	brown	camel + flax fiber
09	4	polychromic fabric	beige	camel + cotton thread + flax fiber
10	4	polychromic fabric	brown	camel + flax fiber
11	5	embroidery foundation	brown	camel + flax fiber
12	5	tiger paw	brown	camel + flax fiber + cotton thread
13	5	tiger claw	beige	camel + flax fiber
14	5	border of tiger's head	brown	camel + flax fiber
15	5	tiger's head	beige	camel
16	6	base of embroidery	brown	camel + flax fiber
17	6	tiger's hide	brown	flax + camel wool
18	6	tiger paw	brown	camel + flax fiber
19	6	tiger claw	beige	camel + flax fiber
20	6	border of tiger's head	brown	camel + flax fiber
21	6	base of tiger's head	beige	camel + flax fiber
22	7	polychromic fabric	beige	camel + flax fiber
23	7	polychromic fabric	red-brown	camel + flax fiber
24	7	polychromic fabric	green	flax + camel wool
25	9	tiger's hide	Beige	flax
26	10	polychromic insert	red-brown	flax
27	10	polychromic insert	green	camel + flax fiber
28	11	diamond-shaped décor, warp	reddish-brown	camel
29	11	a border of a diamond	green	camel + flax fiber + cotton thread
30	11	the 2nd row of a border of a diamond	dark brown	camel
31	11	the 3rd row of a border of a diamond	beige	camel
32	11	the 4th row of a border of a diamond	beige	camel
33	11	center of a diamond	green	camel
34	11	a spiral joining the diamonds	beige	camel
35	11	frieze	green	camel
36	11	décor “leaf”	beige	camel
37	11	a volute of a spiral	green	camel
38	11	a volute	beige	camel
39	12	band's seam	red	camel
40	12	band	red-brown	camel + cotton thread
41	12	band	brown	camel
42	13	a branch of a palmette	brown	camel + flax fiber

Test number	Number of a fragment	Sample	Color of thread	Identification of a thread
43	13	a branch of a palmette	beige	camel + flax fiber
44	13	a branch of a palmette	red	camel + flax fiber
45	14	a border of a fish	beige	camel + flax fiber
46	14	a border of a fish	brown	camel + flax fiber
47	14	a border of a fish	red	camel + flax fiber
48	14	turtle, a leg	red	camel + flax fiber
49	14	turtle, a leg	beige	flax
50	14	turtle, contour of armour	brown	camel + flax fiber
51	14	the top turtle, contour	brown	camel + horse hair
52	14	the top turtle, armour	green	camel
53	14	the top turtle, a leg	beige	camel + flax fiber + horse hair
54	14	the middle turtle, a leg	beige	camel + flax fiber
55	14	the middle turtle, contour	brown	camel + horse hair
56	14	the centre of a palmette	green	camel + flax fiber
57	14	the centre of a palmetto	green	camel
58	15	contour of a diamond	dark brown	camel + horse hair
59	15	décor of a diamond	beige	camel
60	16	tendril	brown	camel
61	17	thread stitching to a band	brown	flax + camel wool
62	17	contour of a palmette	brown	camel
63	18	fragment of fabric (warp thread and weft thread)	brown	camel + flax fiber
64	18	thread of the S- volute	brown	camel
65	18	contour of a palmette	red	camel + flax fiber
66	18	contour of a bird	dark brown	camel
67	18	bird figure	beige	camel + flax fiber
68	18	whip stitching thread of a fabric's edge	red	camel
69	18	fish whisker	beige	camel + cotton thread + horse hair
70	18	thread of a palmette	beige	camel
71	3	warp thread	brown	flax
72	3	weft thread	brown	flax
73	3	warp thread	khaki	flax + camel wool
74	3	weft thread	khaki	flax
75	3	warp thread	green	camel
76	3	weft thread	green	camel
77	4	warp thread	green	camel
78	4	weft thread	green	camel + cotton thread
79	4	warp thread	brown	camel
80	4	weft thread	green	camel
120	14	warp thread	beige	camel
121	14	weft thread	beige	camel
123	14	contour of turtle leg	brown	camel + horse hair
124	14	turtle leg	red	camel
125	14	the center of the palmette	green	camel
126	18	warp thread	beige	camel
127	18	weft thread	beige	camel
128	18	weft thread	beige	camel
129	18	bird tail	red	camel
130	18	contour around the bird	brown	camel + flax fiber
131	18	bird figure	beige	camel + horse hair + cotton thread
132	18	contour of a fish	dark-brown	camel + horse hair
133	18	fish tail	beige	camel
134	18	fish tail	red	camel

Separate parts of the “hanging”

Test number	Number of a fragment	Sample	Color of thread	Identification of a thread
136	MP-930	embroidery with volutes, the warp thread	brown	camel
137	MP-930	embroidery with volutes, weft thread	brown	camel
138	MP-930	border, warp thread	green	camel
139	MP-930	border, weft thread	green	camel
140	MP-930	leaf's thread	beige	camel
141	MP-930	stem's thread	beige	camel
142	MP-930	contour of a volute	dark-brown	camel + horse hair
143	MP-930	contour of a volute	beige	camel + horse hair
144	MP-1676	thread used in the sewing the border	beige	camel
145	MP-1676	contour of a diamond	brown	camel + horse hair + cotton thread
81	MP-1677	contour of a diamond	green	flax + camel wool
146	MP-1677	warp thread	brown	camel
147	MP-1677	weft thread	brown	camel
148	MP-1677	weft thread	light-brown	camel
149	MP-1677	center of a diamond	green	camel
150	MP-1677	border of a diamond	green	camel
151	MP-1677	border of a diamond	beige	camel
152	MP-1677	warp thread	brown	camel
152a	MP-1677	weft thread	brown	camel
153	MP-1679	warp thread	brown	camel
153a	MP-1679	weft thread	brown	camel
154	MP-1679	warp thread of the border	beige	camel
154a	MP-1679	weft thread of the border	beige	camel
155	MP-1679	diamond's thread	dark-beige	camel + flax fiber
156	MP-1679	diamond's thread	green	camel + horse hair
157	MP-1679	stitching thread of the border's fragments	beige	camel + flax fiber + cotton thread
162	MP-1768	stitching thread of the border's fragments	beige	camel
82	MP-1919	warp thread	brown	camel
83	MP-1919	weft thread	brown	camel
84	MP-1919	warp thread	beige-green	camel
85	MP-1919	the stitching thread of the border's fragments	beige	camel
163	MP-1926	fragment of polychromic fabric	green	camel + cotton thread
86	MP-1927	warp thread		camel
87	MP-1927	weft thread		camel
88	MP-1927	Contour of a diamond (with hair)	brown	camel + horse hair
164	MP-1937	fragment of monochromic fabric	brown	camel
164a	MP-1937	fragment of monochromic fabric	brown	camel
95	MP-2515	warp thread of the monochromic fabric	brown	camel
96	MP-2515	weft thread of the monochromic fabric	brown	camel
97	MP-2515	warp thread of fabric with diamond décor	brown	camel
98	MP-2515	weft thread of the fabric with diamonds	brown	camel
99	MP-2515	stitch thread of a band	red	camel
100	MP-2515	contour of a diamond	dark brown	camel
101	MP-2515	thread of a diamond	beige	camel
102	MP-2515	cross in the center of a diamond	темно-brown	camel
103	MP-2515	oval in the central part of a pattern with fish and birds	beige, thin thread	camel

Test number	Number of a fragment	Sample	Color of thread	Identification of a thread
104	MP-2515	oval of the central part of a pattern with fish and birds	beige, thick thread	camel
105	MP-2515	oval of the central part of a pattern with fish and birds	dark brown	camel
106	MP-2515	rosette	beige	camel
107	MP-2515	rosette	dark brown	camel
108	MP-2515	thread sewed in a diamond	beige	camel
109	MP-2515	thread sewed in a diamond's contour	beige	camel
110	MP-2515	spiral	beige	camel
111	MP-2534	a tripe of the tigers' skin	brown	camel
112	MP-2534	the thread from the tiger's back	brown	camel
113	MP-2534	the sewing thread	brown	camel
114	MP-2534	warp thread	brown	camel
115	MP-2534	waft thread	brown	camel
116	MP-2534	the border of the tiger's head	dark brown	camel
117	MP-2534	tiger's head	beige	camel
118	MP-2534	tiger's toenail	beige	camel
119	MP-2534	the sewing thread	beige	camel
158	MP-2536	warp thread	green	camel
159	MP-2536	waft thread	green	camel
160	MP-2536	warp thread	brown	camel
161	MP-2536	waft thread	brown	camel

Conclusion

The above-described results of the polypolarization analyses of threads for the main piece of the “cover” and its separate parts allowed us to come to the following conclusions. The photographs of the majority of samples of the threads in polypolarization show the closest similarity to the standard photographs of camel wool (fig. 6-7). This conclusion is true for both monochromic and polychromic fabrics, for the threads of embroidery, and for the threads used in sewing together the different parts of the “cover.”

Meanwhile, the analyses of several samples showed a similarity with “etalon” samples of the flax threads (fig. 8). These samples belong to the main part of the “cover” №3, №7, №9, №10, №14, №18. The similarity allows us to assume that flax threads were used, in some cases, not only for the details of embroideries but were also added as ornamental stripes into the warp made out of camel wool. It explains the presence of flax fibers in some threads of camel wool and the presence of single camel hair in a number of flax threads. Such inclusions could get into the wool and flax threads at a time of selection of samples, or during the weaving process, when the wool and

flax fabrics were interchangeable produced on a same loom.

Of special interest are the fibers of cotton traced in several samples (fig. 9). We cannot exclude that these fibers got to the threads of the main part of the “cover” as foreign inclusions during the selection of samples because during the initial restoration the “cover” was attached to the cotton gauze. However, the similar traces of cotton fibers were noticed in the threads from other parts of the “cover” that did not undergo restoration and were preserved in their original state (samples 157 and 163; sample 157 had also the fibers of flax). This fact indicates that microscopic pieces of the cotton fibers could get to the camel yarn either through the air, as the pieces of cotton dust, or as the remains of the cotton fibers on the loom, where fabrics out of camel wool were woven after the cotton one.

Some samples of camel wool have the inclusions of horse hair (fig. 10). As a rule, such samples are represented by the contour threads of geometric figures (diamonds) or zoomorphic images (contour of the turtle's shell). Such contour threads (the contours of the diamonds in the first place) were attached to the fabric of the embroidery with the thin threads of camel wool. This fact

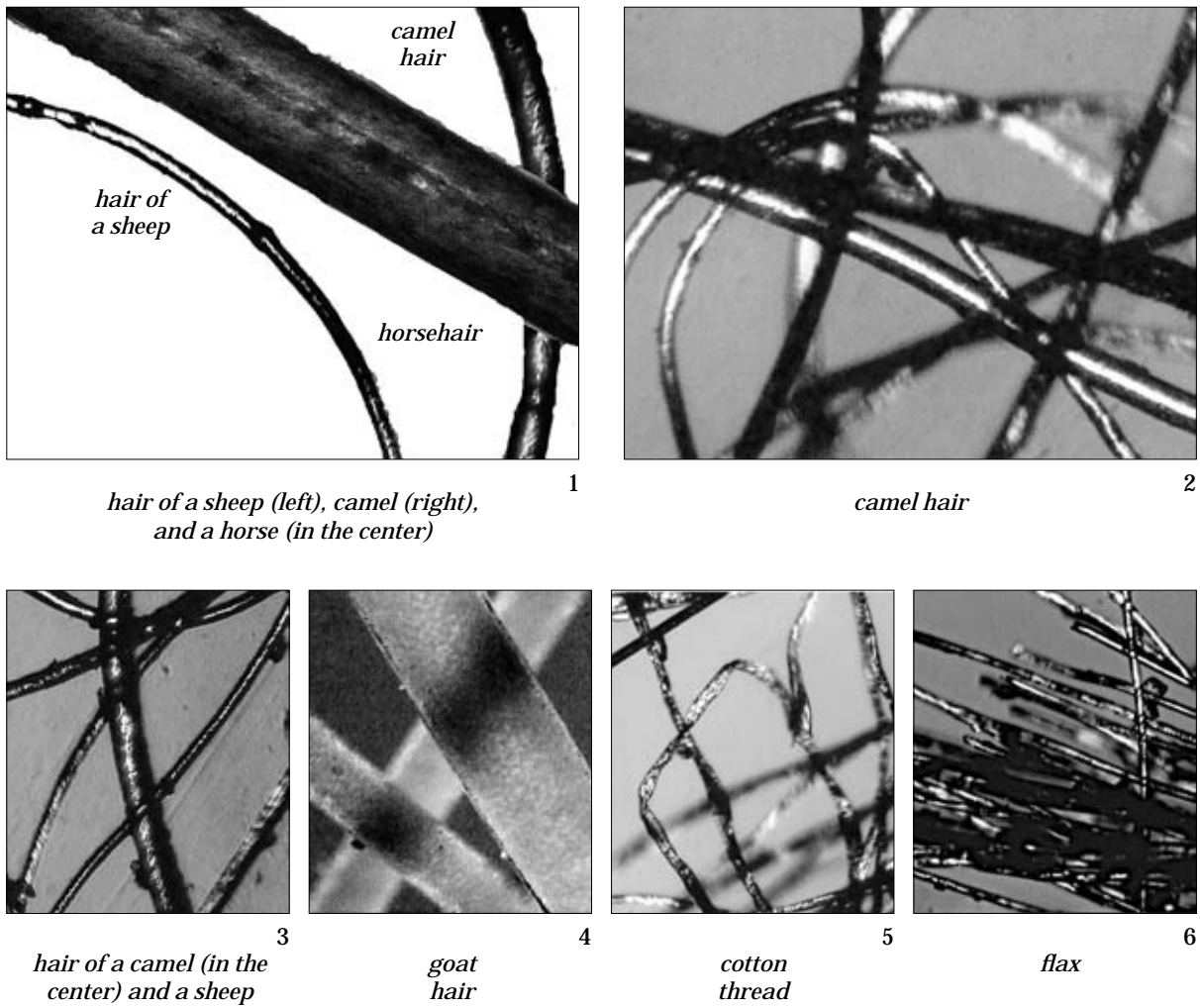


Fig. 6. Standards of hair of animal and vegetative fibres in polypolarization.

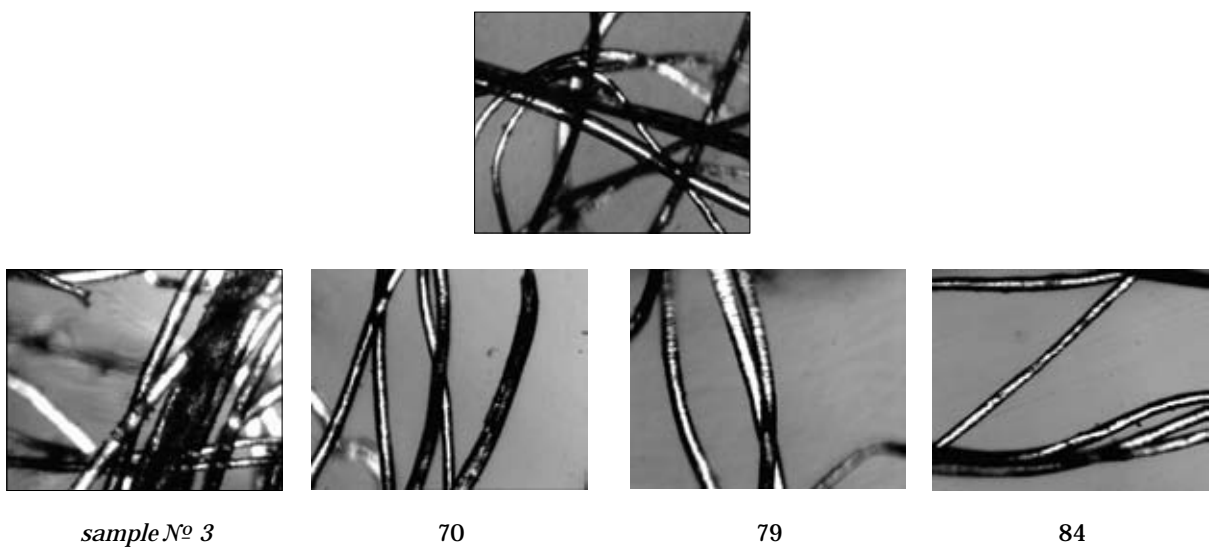
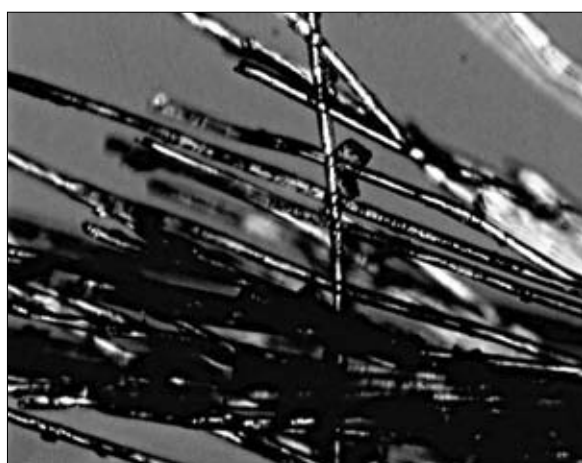


Fig. 7. A reference photo in polypolarization of a wool of a camel and samples of the "veil".

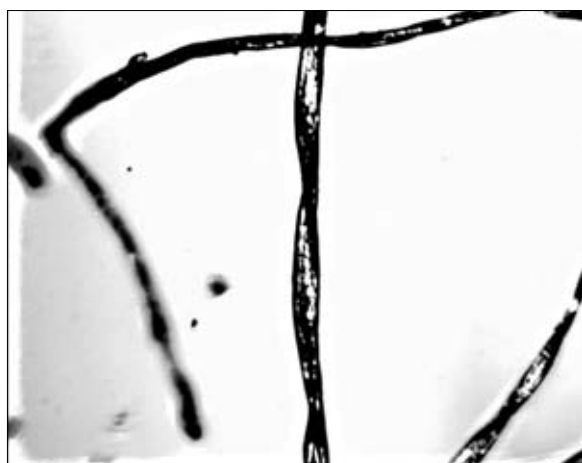


standard of flax

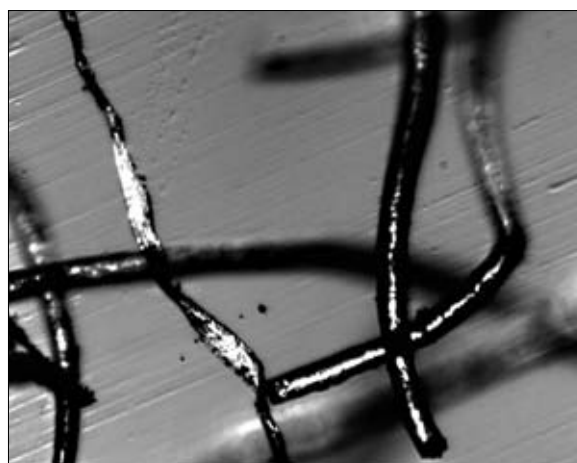


linen thread of the "veil"

Fig. 8. A reference photo in polypolarization of fibres of flax and samples of the "veil".



standard of a cotton thread



*cotton thread in the fabric of the "veil"
made of camel wool*

Fig. 9. A reference photo in polypolarization of fibres of a clap and samples of the "veil".

makes us assume that in this case horse hair did not play a role of the securing a piece in place but gave to the treads of contour the necessary sturdiness, keeping the embroidered images from deforming.

The above-discussed results of the analyses, together with the results of the analyses of the felt carpet from the same kurgan 6 of the Noyon uul

cemetery (Kulikov et al. 2010) represent only the first experiments in the use of the polypolarization method in archaeology as a whole, and in the study of ancient fabrics in particular. These results have displayed the promising outcomes in applying the method and the necessity in the wider application of polypolarization in studies of archaeological objects.

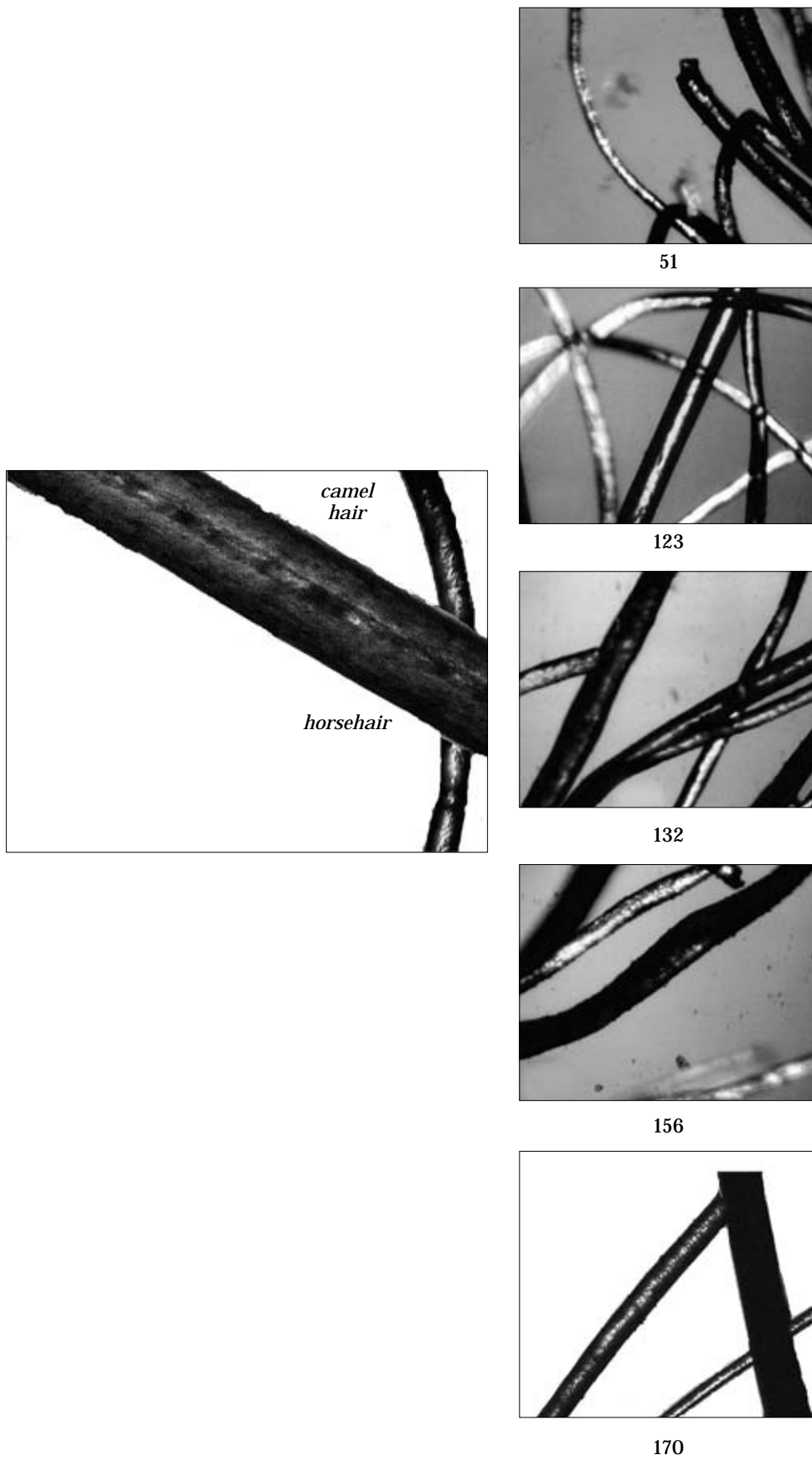


Fig. 10. A reference photo in horsehair polypolarization together with a wool of a camel and samples of the “veil”.

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Experiență de studiere a pânzei din necropola Noin-Ula după metoda polipolarizării

Rezumat

În ultimii ani la Institutul istoriei culturii materiale al Academiei de Științe din Rusia a fost creat un sistem opticoelectronic de studiere a mineralelor și structurilor organice prin intermediul metodei polipolarizării.

O prioritate esențială a acestei metode, în special pentru arheologie, este necesitatea pentru analiză a unor probe de dimensiuni foarte mici, ceea ce, practic, nu modifică forma și structura obiectului studiat.

În articolul de față sunt analizate rezultatele analizei prin metoda polipolarizării a probelor așa-numitului „voal din lână” din tumulul nr. 6 al necropolei hunice de la Noin-Ula, Mongolia de Nord. „Voalul” reprezintă o pânză lată,

cusută din bucăți de diferite stofe. Mostre din baza și ornamentul pânzei „voalului” au fost comparate cu probe etalon de lână ale diferitor animale (oaie, cal, cămilă) și fibre de proveniență vegetală.

Rezultatele analizei prin polipolarizare permit următoarele concluzii. Fotografii prin polipolarizare a majorității fibrelor „voalului” arată că acestea sunt cel mai aproape de fotografiile etalon ale lânii de cămilă. Această concluzie este valabilă pentru pânzele monocrome și policrome, pentru fibrele utilizate la broderie și pentru cele folosite la coaserea bucăților „voalului”.

În același timp câteva mostre analizate indică asupra unor asemănări cu fibrele de in, ceea ce permite presupunerea utilizării inului pentru unele detalii ale broderiei și pentru infiltrarea în baza pânzei din lână de cămilă.

Un interes deosebit prezintă depistarea în câteva mostre a fibrelor de bumbac. Particulele microscopice ale bumbacului puteau ajunge printre fibrele de lână de cămilă pe calea aerului (particule de praf de bumbac), sau ca rămășițe ale fibrelor de bumbac, rămase pe războiul de țesut, la care anterior fuseseră țesută o pânză din bumbac.

În unele mostre de lână de cămilă a fost sesizat păr de cal. De regulă, acestea provin din fibrele utilizate la conturarea figurilor geometrice sau a imaginilor zoomorfe. Părul de cal, în cazul dat, era folosit pentru consolidarea conturului, ceea ce proteja figurile broderiei de deformare.

Lista ilustrațiilor:

Fig. 1. „Voalul” din tumulul nr. 6 de la Noin-Ula.

Fig. 2. Fragmente ale „voalului” 1-7, 9-11.

Fig. 3. Fragmente ale „voalului” 12-18.

Fig. 4. Desen din carnetul lui S.A. Kondrat'ev al schemei amplasării „voalului”.

Fig. 5. Schema amenajării interioare a tumulului nr. 6 și schema amplasării detaliilor „voalului”.

Fig. 6. Etaloane ale părului de animale și ale fibrelor vegetale în polipolarizație.

Fig. 7. Foto etalon în polipolarizație a lânii de cămilă și a probelor din „voal”.

Fig. 8. Foto etalon în polipolarizație a fibrelor de in și a probelor din „voal”.

Fig. 9. Foto etalon în polipolarizație a fibrelor de bumbac și a probelor din „voal”.

Fig. 10. Foto etalon în polipolarizație a părului de cal împreună cu lâna de cămilă și a probelor din „voal”.

Опыт исследования тканей из могильника Нойн-Ула методом полиполяризации

Резюме

В последнее годы в Институте истории материальной культуры Российской Академии Наук (ИИМК РАН) создана система для оптикоэлектронного бесконтактного исследования минералов и органических структур посредством использования метода полиполяризации.

Существенным достоинством метода, особенно для археологии, является крайне малый размер необходимых для анализа образцов, что практически не нарушает форму и структуру исследуемого предмета.

В данной статье рассматриваются результаты анализа методом полиполяризации образцов т.н. «шерстяной завесы» из кургана № 6 гуннского могильника Нойн-Ула в Северной Монголии. «Завеса» представляла собой широкое полотнище, сшитое из кусков различных тканей. Образцы нитей основы и орнамента тканей «завесы» сравнивались с эталонными образцами шерсти различных животных (овца, лошадь, верблюд) и волокнами растительного происхождения.

Результаты полиполяризационного анализа позволяют заключить следующее. Снимки большинства образцов нитей в полиполяризации наиболее близки эталонным снимкам шерсти верблюда. Этот вывод относится к монохромным и полихромным тканям, к нитям вышивок и к нитям, сшивавшим разные куски завесы.

В то же время несколько проанализированных образцов показывают сходство с эталонными анализами нитей льна, что позволяет предполагать использование льняных нитей для деталей вышивок и для вплетения в основу тканей из верблюжьей шерсти. Особый интерес вызывает выявленные в нескольких образцах волокна хлопка. Микроскопические частицы волокон хлопка могли попасть в верблюжью пряжу либо воздушным путем, как частицы хлопковой пыли, либо как остатки хлопковых волокон на ткацком станке, где перед изготовлением тканей из верблюжьей шерсти ткали хлопковые изделия.

В некоторых образцах верблюжьей шерсти отмечено наличие конского волоса. Как правило, такие образцы представлены нитями контура геометрических фигур или зооморфных изображений. Конский волос в данном случае не играл роль крепления к основе, а придавал нитям контура необходимую жесткость, предохранявшую фигуры вышивок от деформации.

Список иллюстраций:

Рис. 1. «Завеса» из кургана 6 в Ноин-Уле.

Рис. 2. Фрагменты «завесы» 1-7, 9-11.

Рис. 3. Фрагменты «завесы» 12-18.

Рис. 4. Рисунок из дневника С. А. Кондратьева со схемой расположения «завесы».

Рис. 5. Схема внутримогильного сооружения кургана 6 и схема расположения деталей «завесы».

Рис. 6. Эталоны волос животных и растительных волокон в полиполяризации.

Рис. 7. Эталонное фото в полиполяризации шерсти верблюда и образцов «завесы».

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Рис. 10. Эталонное фото в полиполяризации конского волоса вместе с шерстью верблюда и образцов «завесы».

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