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Gold Thracian appliques: authentic or fake?

Appliqués thraces en or : authentiques ou faux?

Ivelin Kuleff*, Totko Stoyanov** and Milena Tonkova***

Abstract: A few years ago, 25 gold appliqués with a total weight of 255 g and dated to a period between the 5th and the 3rd centuries BC were offered to the National History Museum in Sofia (Bulgaria). Some Bulgarian archaeologists – experts in the field of toreutics – expressed the opinion that the offered finds are originals. At the same time, the results of an investigation carried out by the Bulgarian Police brought evidence to the contrary, and, on these bases, started a hearing of the case. Using a non-destructive method of investigation (ED-XRF), the concentrations of Ag, Au, and Cu were determined. A detailed observation of the surface of the finds with reflective optical microscopy was carried out, and, at the same time, stylistic parallels of the offered finds were sought by comparing them to the known similar ancient appliqués. On the bases of the chemical composition, technological observations, and the comparison with parallels of similar chronological finds reported in the literature, we established that the 25 golden appliqués offered to the Museum by the treasure hunters are fake.

Résumé : *Il y a quelques années, le Musée National de Sofia (Bulgarie) a acquis 25 appliqués en or, d'un poids total de 255 gr, datées du Ve-IIIe siècle av. J.-C. Des archéologues bulgares, experts en toreutique, ont identifié les objets comme étant des originaux. Cependant, des recherches menées par la Police bulgare ont débouché sur une remise en question de l'authenticité de ces pièces.*
Une étude non destructive (par ED-FX) a permis de déterminer les concentrations d'argent, d'or et de cuivre des appliqués en or. Leur surface a été observée minutieusement au microscope optique et une analyse stylistique et iconographique a été réalisée. Les résultats de l'analyse de la composition chimique du métal, les observations technologiques et la comparaison avec des parallèles archéologiques ont finalement permis de formuler la thèse que ces 25 appliques en or sont fausses.

Keywords: authentication, Bulgaria, copper, ED-XRF, gold, silver.

Mots-clés : *argent, authentification, Bulgarie, cuivre, ED-FX, or.*

1. Introduction

A few years ago, 25 gold appliqués with a total weight of 254.83 g and dated to a period between the 5th and the 3rd centuries BC were offered to the National History Museum in Sofia (Bulgaria). Some Bulgarian archaeologists – experts in the field of toreutics – expressed the opinion that the offered finds are originals. At the same time, the results of an investigation carried out by the Bulgarian Police brought evidence to the contrary, and, on these bases, started a hearing of the case. The authors of the present study were involved in this project as experts aiming to determine if the offered appliqués are original or fake.

Using energy dispersive X-ray fluorescence analysis (ED-XRF) for the determination of the basic chemical composition of the objects, reflective optical microscopy for a detailed observation of the surface of the finds, and research for stylistic parallels to the offered finds in the existing literature, we propose our opinion regarding the originality of the appliqués. This paper presents the results of this investigation.

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2. Experimental

Materials

The description of the investigated objects is provided in Table 1. In Figures 1 and 2, some images of the objects in question are presented. The place where the investigated gold appliqués were found is unknown, because they were offered to the National History Museum in Sofia (Bulgaria) by treasure-hunters. It was assumed that the objects were found somewhere in north-eastern Bulgaria.

Method of analysis

The chemical composition of the investigated 25 gold finds was determined using ED-XRF (Shimatzu EDX-720) at the Laboratory of Conservation and Restoration of the National Archaeological Institute with Museum of the Bulgarian Academy of Sciences (NAIM). The X-ray lines used for analysis and other parameters of the instrument are presented in Kuleff *et al.* (2009). The analytical results obtained are presented in Table 2.

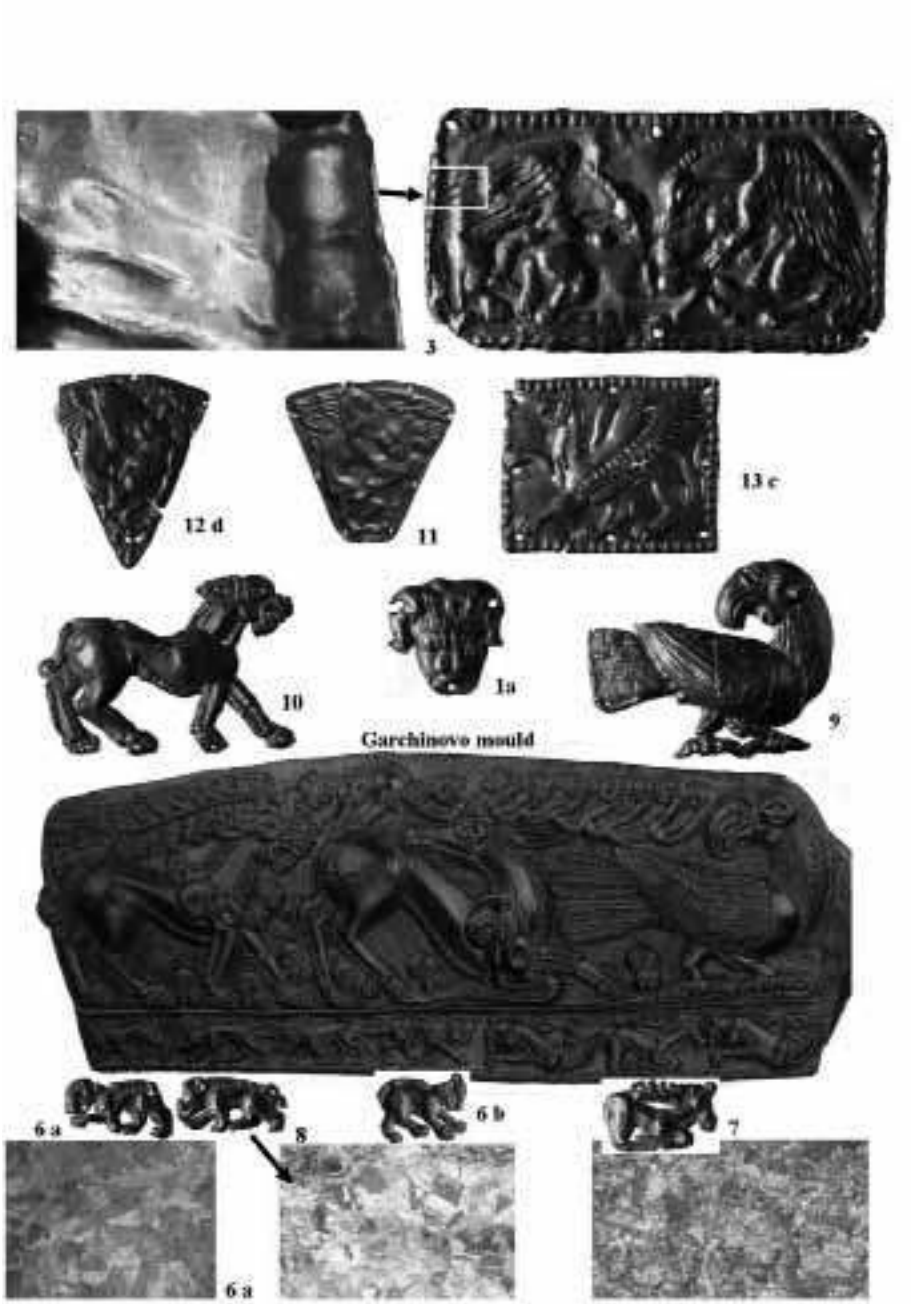

Figure 1. Images of the investigated objects and some optical observations. 1a = head of ram (5 objects); 3 = struggle of animals (3 objects) (rectangle form); 6 ÷10 = 'copies' of some of the figures on the bronze mould from Gartshinovo (6 objects); 11, 12d = griffon attacking goat (5 objects); 13c = image of griffon (4 objects); Garchinovo mould – image of the bronze matrix from the village of Gartshinovo. Images under the microscope of the surface of some of the objects, showing the texture.
Figure 1 : Photographies des objets étudiés et des observations optiques.
1a = tête de bélier (5 objets) ; 3 = combat d'animaux (3 objets) (forme rectangulaire) ; 6-10 = empreintes de certaines figures du moule en bronze de Gartshinovo (6 objets) ; 11, 12a = griffons attaquant un bouc (5 objets) ; 13c = représentation d'un griffon (4 objets) ; moule de Gartshinovo – photographique du moule en bronze du village de Gartshinovo. Prises de vue microscopiques de la surface de certains des objets illustrant la texture.

code	description
1-a-151*	An appliqué in a shape of a ram's head with holes (Fig. 1)
1-b-155	An appliqué in a shape of a ram's head with holes
1-c-156	An appliqué in a shape of a ram's head with holes
1-d-161	An appliqué in a shape of a ram's head with holes
1-e-173	An appliqué in a shape of a ram's head with holes
2 - 2177	An appliqué - a head of the Gorgon-Medusa, with holes (Fig. 2)
3 - 2117	Rectangular appliqué – two griffons attacking a horse, with holes (Fig.1)
4 - 2066	Rectangular appliqué – a lion attacking a griffon, with holes (Fig. 2)
5 - 2653	An appliqué with a bust representation of goddess
6-a-246	An appliqué in a shape of a lion (?) walking to the left, with holes (Fig. 1)
6-b-435	An appliqué in a shape of a lion walking to the right, with holes (Fig. 1)
7 - 500	An appliqué in a shape of a kneeling deer, with holes (Fig. 1)
8 - 360	An appliqué in a shape of a boar walking to the left, with holes (Fig. 1)
9 - 2742	An appliqué in a shape of a eagle, with holes (Fig. 1)
10 - 2310	An appliqué in a shape of a lion walking to the right, with holes (Fig. 1)
11-1214	Trapezoid appliqué – winged lion attacking a goat, with holes (Fig. 1)
12-a-596	Triangular appliqué – winged lion attacking a goat, with holes
12-b-654	Triangular appliqué – winged lion attacking a goat, with holes
12-c-679	Triangular appliqué – winged lion attacking a goat, with holes
12-d-761	Triangular appliqué – winged lion attacking a goat, with holes (Fig. 1)
13-a-831	Rectangular appliqué – a griffon to the left, with holes
13-b-930	Rectangular appliqué – a griffon to the right, with holes
13-c-955	Rectangular appliqué – a griffon to the left, with holes (Fig. 1)
13-d-1076	Rectangular appliqué – a griffon to the right, with holes
14 - 1385	An appliqué with a representation of two griffons attacking a goat, with holes (Fig. 2)

Table 1: Description of the investigated objects.
* = The numbers represent the weight of the investigated appliqués, expressed roughly in centigrams.
Tableau 1 : Description des objets étudiés.
** = Les nombres représentent le poids des appliqués exprimé en centigrammes.*

Typological classification

A preliminary analysis carried out on the representations on the appliqués in question leads to their division in two general groups. The first one (Table 1, Nos. 1-3, 11-14 – in all, 18 pieces) includes artefacts having parallels in finds from the 5th-4th century BC rich burials in Scythia. Some five subgroups could be distinguished as well: 1) five appliqués with representations of a ram's head (Fig. 1: 1a; see Artamonov 1970: 36-39, Abb. 35, 48; Galanina and Grach 1986: Abb. 80); 2) three appliqués representing animals struggling (Fig. 1: 3; Fig. 2: 4, 14; see Artamonov 1970: 36-39, Abb. 35, 48; Galanina and Grach 1986: Abb. 118; Treister, 2001: Fig. 63); 3) subgroup of 5 appliqués representing a winged lion attacking a goat (Fig. 1: 11, 12d; see Artamonov, 1970: Taf. 122; Galanina and Grach, 1986: Abb. 106); 4) subgroup consisting of 4 appliqués representing a griffon (Artamonov, 1970: Abb. 93; Galanina and Grach, 1986: Abb. 195; also the gold appliqués from a rich grave at Kralevo, NE Bulgaria – Echt 2004: Kat. No 224g); and 5) an appliqué representing a head of Medusa (Fig. 2: 2; see Artamonov, 1970: 36-39, Abb. 35, Taf. 103; Galanina and Grach, 1986: Abb. 218, 259).

The 6 pieces of the second group (Table 1, Nos. 6-10) are representations of animals which are to be qualified as clumsy imitations of some of the animals that are part of the famous bronze mould from Gartshinovo, Shumen district, NE Bulgaria (Fig. 1: centre 6-10; see Damyanov, 1998; Treister, 2001: 161-168, Figs. 1-2; Venedikov and Gerasimov, 1979: 94-96, 370, No 152).

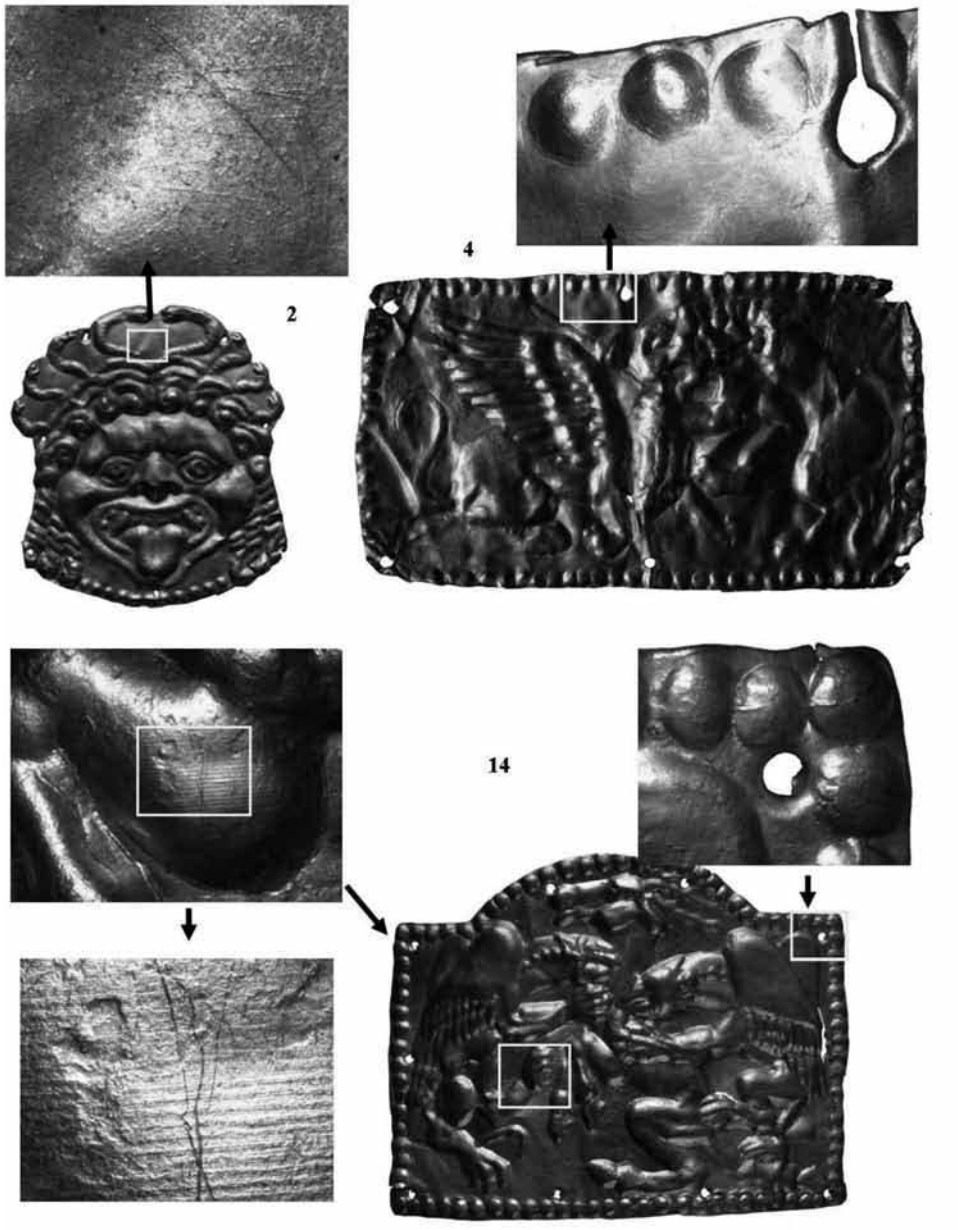

Figure 2: (See colour plate) Images of the investigated objects and some optical observations.
2 = Medusa (1 object) – image under the microscope showing traces of casting (photograph by P. Penkova); 4 = image under the microscope showing a very smooth surface with lack of traces of use (photograph by P. Penkova); 14 = traces indicating the use of a rolling-mill for the preparation of thin foil (photograph by P. Penkova).
Figure 2 : (Voir planche couleur) Photographies des objets étudiés et des observations optiques.
2 = Méduse (1 objet) – prise de vue microscopique montrant les traces de moulage (photo de P. Penkova) ; 4 = prise de vue microscopique montrant une surface polie sans traces d'utilisation (photo de P. Penkova) ; 14 = traces d'utilisation de cylindres pour la réalisation de fines feuilles.

3. Results and Discussion

Chemical composition

All the investigated objects are prepared from an alloy with very high gold content – 89% to 99.4%, corresponding to a range between 21.4 and 23.8 carats gold (see Table 2). On the basis of the analytical data, the investigated objects could be classified in two groups:

1) objects with basic chemical content of Au and Ag without copper – 6 objects (4; 6-a; 6-b; 7; 8; 10). These objects are prepared practically from pure gold (23.8 carats);

2) objects with basic chemical content of Au, Ag and Cu – 19 objects (1-a; 1-b; 1-; 1-d; 1-e; 2; 3; 5; 9; 11; 12-a; 12-b; 12-c; 12-d; 13-a; 13-b; 13-c; 13-d; 14).

According to their copper content, the objects belonging to the second group could be additionally divided in 3 subgroups:

2.1) objects with copper concentration of less than 2.7%, lower than that of Ag – 9 objects: 1-a; 1-b; 1-c; 1-d; 1-e; 2; 3; 9; 11. The values of the ratio Ag/Cu are between 1.2 and 4.9;

n°	object	gold [%]		silver [%]		copper [%]		Ag/Cu
		M±SD	RSD	M±SD	RSD	M±SD	RSD	
1	1-a-151	97.78±0.06	0.06	1.44±0.04	2.8	0.81±0.07	8.6	2.53
2	1-b-155	97.66±0.08	0.08	1.61±0.09	5.6	0.72±0.05	6.9	2.24
3	1-c-156	97.54±0.23	0.24	2.02±0.04	2.0	0.55±0.10	18.2	4.93
4	1-d-161	97.26±0.11	0.11	2.10±0.06	2.9	0.64±0.05	7.8	3.28
5	1-e-173	97.77±0.04	0.04	1.43±0.02	1.4	0.80±0.03	3.8	1.79
6	2-2177	98.06±0.06	0.06	1.11±0.05	4.5	0.85±0.03	3.5	1.31
7	3-2117	98.67±0.28	0.29	1.03±0.03	2.9	0.30±0.30	100	3.43
8	4-2066	96.91±0.08	0.08	3.09±0.08	2.6	< 0.001	-	(3090)
9	5-2653	96.93±0.62	0.64	0.64±0.37	57.8	2.43±0.26	10.7	0.26
10	6-a-246	99.24±0.01	0.01	0.76±0.01	1.3	< 0.001	-	(760)
11	6-b-435	99.41±0.03	0.03	0.59±0.04	6.8	< 0.001	-	(590)
12	7-500	99.22±0.02	0.02	0.78±0.02	2.6	< 0.001	-	(780)
13	8-360	99.18±0.03	0.03	0.82±0.03	3.7	< 0.001	-	(820)
14	9-2742	99.20±0.21	0.21	0.61±0.02	3.3	0.19±0.19	100	3.21
15	10-2310	99.16±0.04	0.04	0.84±0.04	4.8	< 0.001	-	(840)
16	11-1214	93.76±0.69	0.74	3.19±0.22	6.9	2.64±0.16	6.1	1.21
17	12-a-596	89.00±0.93	1.04	2.45±0.05	2.0	8.55±0.89	10.4	0.29
18	12-b-654	90.76±1.47	1.62	2.57±0.05	1.9	6.67±1.48	22.2	0.39
19	12-c-679	89.47±0.43	0.48	2.46±0.07	2.8	8.07±0.42	5.2	0.30
20	12-d-761	90.47±0.57	0.63	2.46±0.03	1.2	7.06±0.57	8.1	0.35
21	13-a-831	92.65±0.30	0.32	2.59±0.06	2.3	4.76±0.24	5.0	0.54
22	13-b-930	91.86±0.54	0.59	2.52±0.02	0.8	5.61±0.52	9.3	0.45
23	13-c-955	92.26±0.71	0.77	2.57±0.04	1.6	5.17±0.67	13.0	0.51
24	13-d-1076	92.35±0.55	0.60	2.64±0.09	3.4	5.01±0.64	12.8	0.53
25	14-1385	89.75±0.48	0.53	2.33±0.03	1.3	7.92±0.52	6.6	0.29

Table 2: The concentrations of gold, silver and copper in the investigated objects.
M = mean value; SD = standard deviation; RSD = relative standard deviation RSD = $\frac{M}{SD}100$ [%]
Tableau 2 : La concentration d'or, d'argent et de cuivre des objets étudiés.
M = valeur moyenne ; SD = écart-type ; RSD = écart-type relatif RSD = $\frac{M}{SD}100$ *[%]*

2.2) objects with copper concentration higher than 4.5%, higher than that of Ag – 9 objects: 12-a; 12-b; 12-c; 12-d; 13-a; 13-b; 13-c; 13-d; 14. The values of the ratio Ag/Cu are between 0.3 and 0.5;

2.3) one object (5-2653) with copper concentration of 2.4%, which is higher than that of Ag (0.64 %), but below 2.7 %, with an Ag/Cu ratio of 0.26.

The distribution of the investigated objects according to the concentrations of Au and Cu is presented in Figure 3.

In all investigated objects, the concentration of iron was below the detection limit (< 0.001). Iron was found practically exclusively in areas presenting inhomogeneities visible with the naked eye. The presence of tin or platinum was not detected in any object.

The results of the analysis could be briefly summarized as follows: the objects are produced using gold alloys with very high purity – from 21.4 to 23.8 carats. Objects 5 and 11 are produced with a material which is different from the material used for the production of the other objects. Objects 6a, 6b, 7, 8, and 10 were produced using an alloy containing only gold and silver. Objects 1 and 2 were probably produced using the same alloy used for the production of appliqués 6a, 6b, 7, and 8. Object 4 was produced using the so-called 'gold for artificial teeth'. Copper was added to the alloy used for object 4 and objects 12, 13, and 14. Probably object 12a was produced first; subsequently, the content of copper in the alloy decreased, as shown in Figure 3, presenting the sequences of production. According to this hypothesis, the last object that was produced is 13a. The reduction

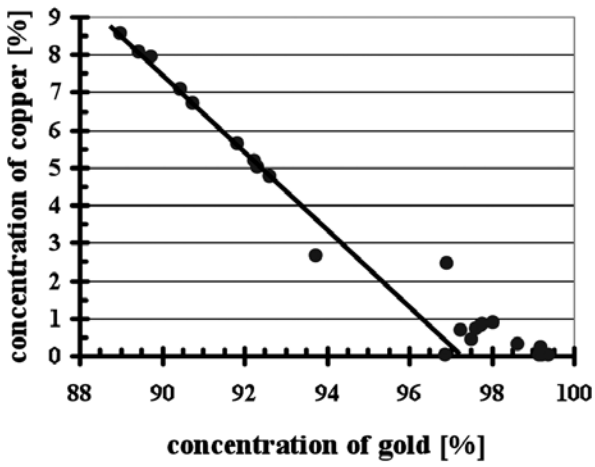

Figure 3: Diagram of concentration of gold *vs* copper in the investigated objects.
Figure 3 : Diagramme de concentration d'or vs cuivre des objets analysés.

Figure 4: Images under the microscope of the appliqués (photograph by P. Penkova). very smooth surface with lack of traces of use; a view of the appliqués.
Figure 4 : Images sous loupe binoculaire des appliques (photographies par P. Penkova). surfaces très lisses sans signe de traces d'usure ; vue des appliqués.

of the concentration of copper is due to oxidizing of copper during the melting of the alloy.

The high concentration of gold (21.4 to 23.8 carats) and relatively low concentration of silver (less than 3.5 %) shows that the investigated objects were probably not produced from native gold. This assumption was supported by the relatively high concentration of copper (higher that 3%) in some of the investigated objects (12, 13, and 14). Therefore, it could be established with great probability that at least part of the investigated appliqués were produced with artificially prepared alloys. It could also be demonstrated with certainty that the appliqués were not produced with electrum – the alloy used for most of the investigated breast plates from Thrace (see Kuleff *et al.*, 2009). At the same time, the hypothesis that the objects were produced using natural gold with a very high purity is impossible to accept. Such a hypothesis is not supported by the data about natural gold from Transylvania (Romania) (see Cojocaru *et al.*, 2003), Bulgaria (Kovachev *et al.*, 2007a), and Republic of Macedonia (Kovachev *et al.*, 2007b; Stefanova *et al.*, 2007), which are the nearest gold sources to the probable place where the artefacts were discovered.

Therefore, according to the results of the analysis, the gold used for producing the appliqués could be determined as technologically worked and refined gold, to which, in some cases, copper was intentionally added.

According to the analytical results presented in Table 2, it is possible to propose that for the production of part of the appliqués (objects 12, 13, and 14), copper was intentionally added to the gold of object 4. The composition of the gold alloy (97% Au and 3% Ag) corresponds exactly to the so-called 'tooth-alloy' used by the dentists. The concentration of silver (2.5%), which could provide plasticity to the alloy, was not sufficient, and, in some cases, cracks can be seen on the plates. These aspects represent evidence for a low level of professionalism and a lack of knowledge regarding work with such types of material.

The ratio Ag/Cu for objects 12, 13, and 14 is between 0.25-0.55. This aspect represents an additional argument that the alloy used for their production was prepared intentionally.

At the same time, there is no analytical data concerning the chemical composition of Scythian gold objects from the period between the 5th and 3rd centuries BC available in the literature. The lack of such types of analyses makes a decision about the authenticity of the investigated appliqués very difficult, because the proposed origin of these objects is Scythia.

Figure 5: Image under the microscope showing lack of traces of use on the surface of the appliqués (photograph by P. Penkova).
Figure 5 : Images sous loupe binoculaire illustrant l'absence de traces d'usure sur la surface des appliques (photographies par P. Penkova).

Technological and traceological observations, archaeological parallels and evaluation of the results

The analysis of a group of breast plates from ancient Thrace belonging to the same period has shown that all the plates are produced from natural gold – the concentration of the copper in the plates is below 1.1%, and the Ag/Cu ratio is between 5.9 and 71.3. These artefacts show clear evidence of hammering as a manufacturing technique, and many scratches on both surfaces (Kuleff *et al.*, 2009).

According to the investigations carried out on the surface of some of the objects under consideration here with optical microscopy, it appears that they were produced using a casting technique (see Fig. 2: 2 upper). This result is in contradiction with the known hammering technique used by the craftsmen of the Late Iron Age (for general observations, see Treister, 2001). The use of a casting technique is most probably the reason why plots of faceted surface structures can be observed under the microscope on the pieces of the 'Gartshinovo group' (Fig. 1: 6-8). This fact and the intentional (most probably) coarse, barbaric appearance of these appliqués are indications of forgery.

Using optical microscopy in most of the investigated objects with parallels in Scythia (No 2, 3, 13a-d, 14), evidence of tracks on the surface were found, indicating the use of a rolling-mill for the preparation of thin foil (see Fig. 1: 3; 2: 14-left). This aspect represents direct evidence for the forgery of the offered appliqués. At the same time, according to the results of the investigation by optical microscope, no evidence of wear, or scratches due to usage, has been found on the surface of the objects (see Fig. 2: 4, 14 right). This represents yet another evidence for the forgery of the offered appliqués. Some of the beads of the rows on the borders of plaques Nos. 3, 4 13a-d, and 14 look oddly amorphous, and hemispheres are connected on some spots with strips resembling traces of casting (Fig. 1: 3; 2: 4, 14-right). This is quite illogical, considering that such ornaments were performed with a punch by the ancient goldsmiths.

Even if we accept that low quality models have been followed in the making of the artefacts in question, many of the basic details of the represented beasts – feathers, paws, even entire limbs, as well as the beak at No 13 – show an

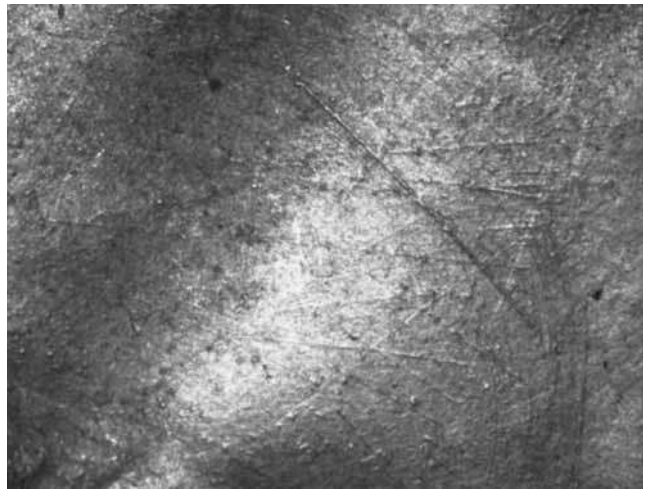

Figure 6: Image under the microscope showing the surface of the appliqué which presented traces of casting (photograph by P. Penkova).
Figure 6 : Images sous loupe binoculaire illustrant la surface des appliques présentant des traces de coulé (photographies par P. Penkova).

iconography and a style which are too unconvincing. In the specialized literature, both on Thracian and Scythian metalwork, it has been established that the artisans always dedicated special attention to a clear, comprehensible representation of the aforementioned animal details, regardless of the personal ability of the craftsmen. Thus, the appliqués under consideration here convey the impression of a wanted coarseness, which, if corroborated with the contents of the metal, represents in our view an indication of a modern forgery.

The only subgroup which might not consist of fakes is the one containing the appliqués with a representation of a ram's head (Table 1, 1a-d; Fig. 1: 1a). Surface morphology observed under the microscope has shown the typical pattern of the use of one or more punches. Thus, these artefacts can be evaluated as roughly performed replicas of the artefacts known from Scythia; this does not exclude the possibility of a forgery of better quality.

Using optical microscopy on some of the investigated objects, some evidence of tracks was found on the surface, indicating the use of a rolling-mill for the preparation of thin foil (see Fig. 2: 14). That is one piece of direct evidence for the forgery of the offered appliqués. At the same time, according to the results of the investigation of the surface of the objects under an optical microscope, no evidence of scratches related to use were found (see Fig. 2). This represents yet another evidence for the forgery of the offered appliqués.

4. Conclusion

There is sufficient evidence that the collection of 25 gold objects offered to the National History Museum was produced from different materials (see Table 2). The grouping of the objects on the basis of similarity in terms of chemical composition generally corresponds to the typological classification of the objects. The high purity of the gold used for producing the appliqués is an evidence for the use of refined gold. This result is in contradiction with the data obtained from the analysis of Thracian breast plates (see Kuleff *et al.*, 2009) and Scythian authentic gold jewellery. These authentic gold finds were usually produced using natural gold, and in many cases electrum – a natural gold alloy with a high content of silver (20-50%). Finds with such a high purity of gold are normally very rare (according to some evaluations, less than 0.15% of all Scythian gold objects are made from the purest gold.)

The objects belong to the so-called 'Gartshinovo group' (Nos. 6 ÷ 10), that are also produced from pure gold (98-99%). Some different textures of the gold, as well as amorphous relief and a very rough manufacture, were identified. The evidence that these objects were produced by casting rather than hammering, which was the common practice in the period under consideration, are arguments that they are actually forgeries. At the same time, we were surprised by the coincidence of the golden appliqués with the matrix from Gartshinovo. This coincidence brings very serious doubt to the authentications of these appliqués.

For other appliqués (Nr. 2 – head of Medusa; Nrs. 3 and 4, 11 ÷ 14 – representing animals fighting) with some Scythian parallels, there are insufficient arguments towards their authentication. At the same time, there is also a lack of data concerning the chemical composition and technology employed in the making of such types of parallels. In order to reach a more adequate conclusion regarding the authenticity of the appliqués, additional investigations are necessary – for example, destructive chemical investigations for the determination of the micro-quantities of certain elements. In spite of this, by using XRF for the determination of the base elemental composition, optical microscopy for observing the scratches on the surface resulting from use, and researching the literature for parallels of the investigated objects, it is possible to obtain objective data for providing some conclusions regarding the authenticity of the gold artefacts.

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