Three Silver Objects from Thrace: A Technical Examination

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THE MAIN PURPOSE of the technical examination, carried out in New York at The Metropolitan Museum of Art, was twofold: first, to confirm the authenticity of a Thracian silver helmet in the collection of the Detroit Institute of Arts (Figure 1); second, to compare the technical characteristics of the helmet with those of a silver cup in the collection of the Metropolitan Museum (Figure 2).[1] The decorations on these objects are sufficiently similar to suggest a relationship, one that might be proved or disproved on the basis of the technical evidence. A third object, a silver vase from the Detroit Institute of Arts (Figure 4), was also examined, mainly because it had been acquired along with the helmet and was thought to have been part of the same treasure.

The study consisted of two parts: the determination of the methods of manufacture and surface characteristics through visual and microscopic examination; and the determination of the elemental composition through neutron activation analysis of small samples extracted from the objects. For the latter purpose, samples were obtained by hand drilling, using a small, high-speed, stainless-steel drill bit. After the surface drillings were discarded, samples weighing about 1 milligram were collected.

1. At the time the examination was undertaken, the writer was Senior Research Chemist at The Metropolitan Museum of Art. A discussion of the helmet, cup, and related Thracian objects precedes this article; see A. E. Farkas, "Style and Subject Matter in Native Thracian Art," *MMJ* 16/1981 (1982) pp. 33–48.

HELMET

Figure 1

The Detroit Institute of Arts, 56.18

Dimensions

WEIGHT: 811 gm.

HEIGHT: 24 cm.

DEPTH: measured at exterior surfaces, from back to front: 20.1 cm.

WIDTH: measured at exterior surfaces, from ear to ear: 18.7 cm

THICKNESS OF METAL:

at bottom edge: 3.8–4.9 mm., on average 4.4 mm.
just above edge: 0.98–1.43 mm.
at 5 cm. above edge: 0.42–0.52 mm.
at 10 cm. above edge: 0.50–0.58 mm.
at 10 cm. below top: 0.52–0.62 mm.
near top: 0.55–0.62 mm.

Method of Manufacture

The helmet is hammered from one piece of silver; original hammering marks are still visible on the interior surface. The bottom edge is thickened over the entire area. The decoration is produced by chasing and engraving on the outside; some areas of decoration appear to be slightly raised above the surface by repoussé.

Most lines were made with a pointed chasing tool. Chisel marks are visible in the curved lines. A pointed engraver was used to produce the elongated punches

that indicate the hair of the animals. Other chasing marks that can be identified are solid dots with a diameter of 1.1 millimeter and squares framing open circles. The latter tool mark (1.2 × 1.2 mm.) appears in the horns of the goatlike animal on the left side of the helmet (Figures 1, 5, 6), and will be discussed further below.

1. Helmet, Thracian, 4th century B.C. Silver, H. 24 cm. The Detroit Institute of Arts, Sarah Bacon Hill Fund, 56.18 (photo: Detroit Institute of Arts)

Condition

The helmet has suffered various losses as a result of mechanical deformation and embrittlement of the silver metal. There is a large loss on the forehead; two smaller losses have occurred on the proper right side near the ear, and two on the proper left side in the area near the ear and between the ear and forehead respectively. Many large and smaller cracks occur in various places on the helmet.

The deformations have been restored in recent times, when solder repairs were also made at breaks and major cracks. These repairs are clearly visible on the inside of the helmet.

Of interest are the repairs on and around the break across the proper right cheekpiece, from the top of the space reserved for the ear to the space reserved for the eyes. Two repairs can be seen, each consisting of a roughly cut support strip of silver (2.5 × 1.3 cm., approximately 1 mm. thick). Each strip is fastened to the helmet by two rivets, one on each side of the break. These repairs may well be ancient and were probably made relatively soon after the helmet was manufactured. They are certainly quite different from the recent solder repairs, which in parts have been applied over them.

The metal shows clear evidence of a long-term process of natural corrosion. In many areas the surface is etched and pitted, exhibits small cracks, and contains numerous scratches in random directions. Evidence of wear can be observed, in particular at the edges of lines and tool marks. It is evident that the surface has been extensively cleaned, probably by mechanical means. Traces of black corrosion remain visible in lines of decoration.

A circular hole (diameter, varying from 4 to 5 mm.) exists in each of the cheekpieces, located in the lower portion just in front of the space reserved for the ear. They are conical in shape with a diameter decreasing from exterior to interior. Their function is unknown but it may be worth noting that the edges of these holes are worn uniformly, not in any particular direction.

Elemental Analysis

The following samples were extracted for neutron activation analysis:

SAMPLE 1: from interior, proper left side, near edge of space reserved for left ear, 4 cm. above bottom edge;

SAMPLE 2: from corresponding area on proper right side;

SAMPLE 3: in ancient repair on interior of proper right cheek, from lower rivet, below ear;

SAMPLE 4: from supporting strip, next to site of sample 3.

The results are given in Table 1.

2. Cup, Thracian, 4th century B.C. Silver, H. 18.7 cm. The Metropolitan Museum of Art, Rogers Fund, 47.100.88

CUP Figure 2

The Metropolitan Museum of Art, 47.100.88

Dimensions

WEIGHT: 506.8 gm.
HEIGHT: 18.7 cm.
DIAMETER: at rim: 14.8–15.2 cm.
at bottom: 11.5–11.8 cm.
at 6 cm. above bottom: approx. 8.3 cm.
WIDTH OF RIM: 0.5–0.6 cm.
THICKNESS OF METAL: on average 0.42 mm.

Method of Manufacture

The cup is hammered from one piece of silver. The rim has been thickened by folding the upper edge and hammering down the double layer of silver (Figure 3).

The relief decoration is produced by repoussé; the design is applied by chasing and engraving. The chased semicircles in the band just below the rim were repunched over a similar, partly obliterated design, whose initial misalignment may have been the cause for redecoration.

Tool marks include a centering mark in the bottom (diameter, 1.3 mm.), chisel marks in curved lines, solid dots (diameter, 1.3–1.5 mm.), elongated punches by a pointed engraver (used to indicate the hair of animals), and squares framing open circles (discussed below). There are crudely incised Greek letters, probably modern, on the underside of the vessel.

Condition

The silver is in relatively good condition, except for losses which have probably resulted from mechanical deformation. These losses occur in the bottom and in the center and upper part of the vessel. Many breaks and cracks can be observed, especially in the areas near missing metal. Deformation, breaks, and major cracks have been restored. Solder repairs are visible on the inside of the cup.

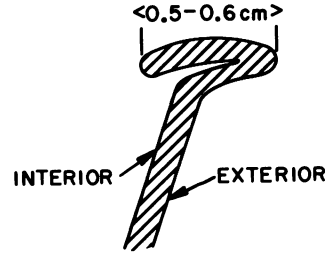
The surface of the metal is not seriously affected by corrosion, although evidence of a long-term natural corrosion process is apparent (slight pitting, randomly distributed scratches, and wear, especially on the edges of tool marks). The exterior of the vessel has been cleaned, probably by mechanical means. Traces of black corrosion still remain, predominantly in the lines of decoration. The interior exhibits a thin brownish-gray layer of corrosion.

Elemental Analysis

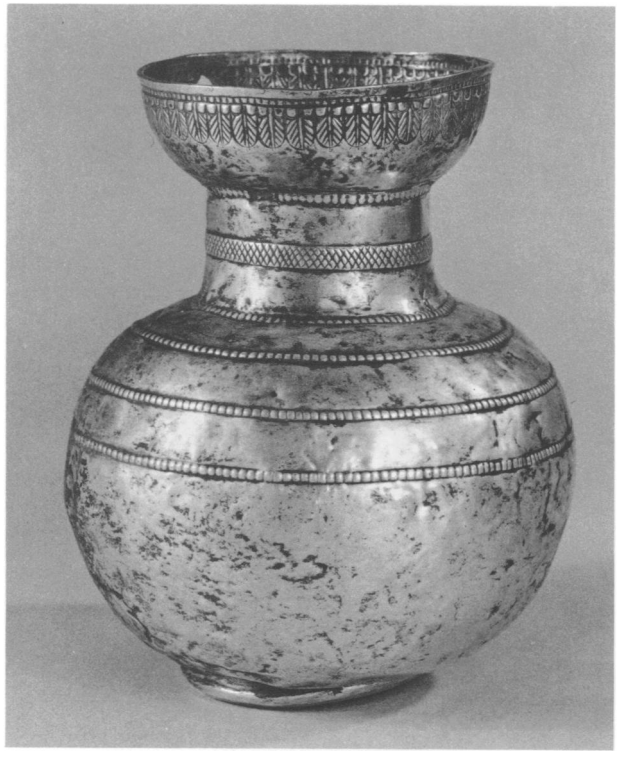
The following sample was extracted for neutron activation analysis:

SAMPLE 5: from inside rim.

The results are reported in Table 1.



3. Cross-section of rim of cup (drawing: Meyers)



4. Vase, Thracian, 4th century B.C. Silver, H. 17 cm. The Detroit Institute of Arts, William H. Murphy Fund, 58.160 (photo: Detroit Institute of Arts)

VASE Figure 4

The Detroit Institute of Arts, 58.160

Dimensions

WEIGHT: 233 gm.
HEIGHT: 17 cm.
DIAMETER: at top: 9.2–9.4 cm.
LARGEST DIAMETER: at 6 cm. from bottom: 14 cm.
THICKNESS: at rim: 2 mm.
at 3 cm. below rim: 0.22–0.30 mm.

Condition

The metal is thin but only slightly corroded and moderately brittle. It appears that before restoration the vase was considerably deformed and probably broken. Its shape has been restored, although small irregularities still exist; a break around the entire circumference at the base of the neck has been soldered. The surface has been cleaned, probably mechanically. Black corrosion still remains visible in the lines of decoration and in small patches on the surface.

Elemental Analysis

The following sample was extracted for neutron activation analysis:

SAMPLE 6: from inside rim.

The results are reported in Table 1.

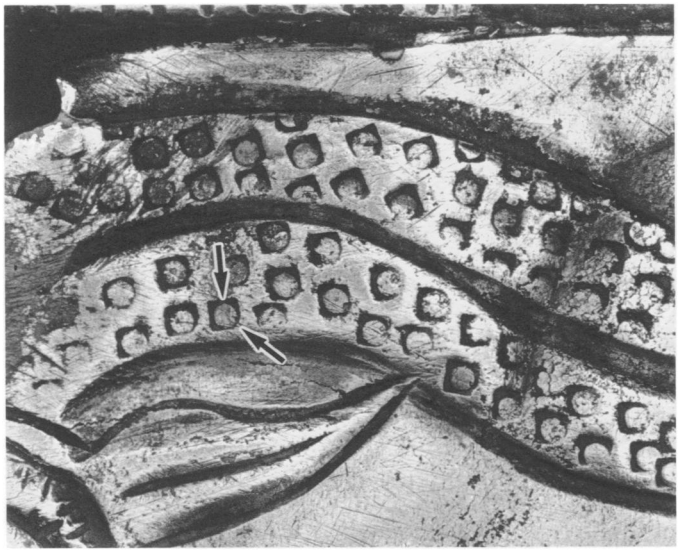
CONCLUSIONS

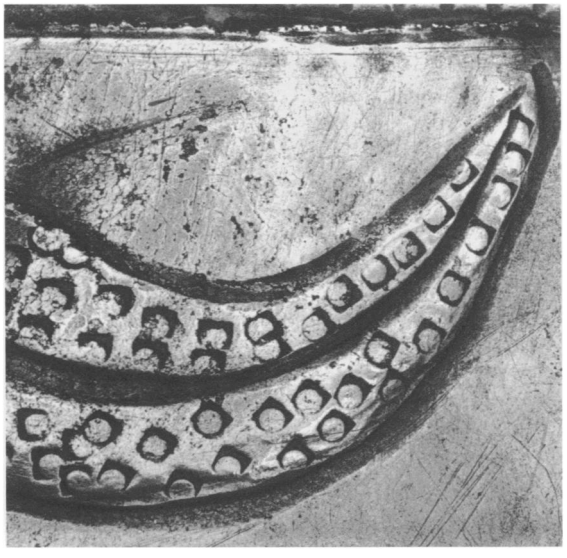
The technical evidence produced in this investigation strongly supports the authenticity of the helmet, the cup, and the vase. The nature and extent of the corrosion of the silver, together with the wear and randomly distributed scratches visible on the surface, are indicative of a long-term natural process. The elemental compositions are consistent with the suggested period of manufacture and not with modern silver alloys. There is no evidence of a recent date of manufacture, nor is there any indication that any part of the decoration was applied recently to an ancient vessel.

A metallographic study of cross-sections of the metal could conceivably have provided further evidence of the method of manufacture, the nature of the corrosion, and the presence of slag particles and other impurities. The major justification for such a study would be for authentication purposes by the examination of discontinuous precipitation of copper in the silver. However, owing to the low concentration levels of copper,[2] this phenomenon is not expected to have occurred, and therefore no metallography was performed.

A careful examination of the tool marks leads to the conclusion that at least one common tool was used in applying decoration to the helmet and the cup. The mark in question appears on the helmet in the horns of the goatlike animal (Figures 5, 6) and more abun-

2. F. Schweizer and P. Meyers, "A New Approach to the Authenticity of Ancient Silver Objects: The Discontinuous Precipitation of Copper from a Silver-Copper Alloy," *Archaeo-Physika* 10, Proceedings of the 18th International Symposium on Archaeometry and Archaeological Prospection (Bonn, 1978) pp. 287–298.



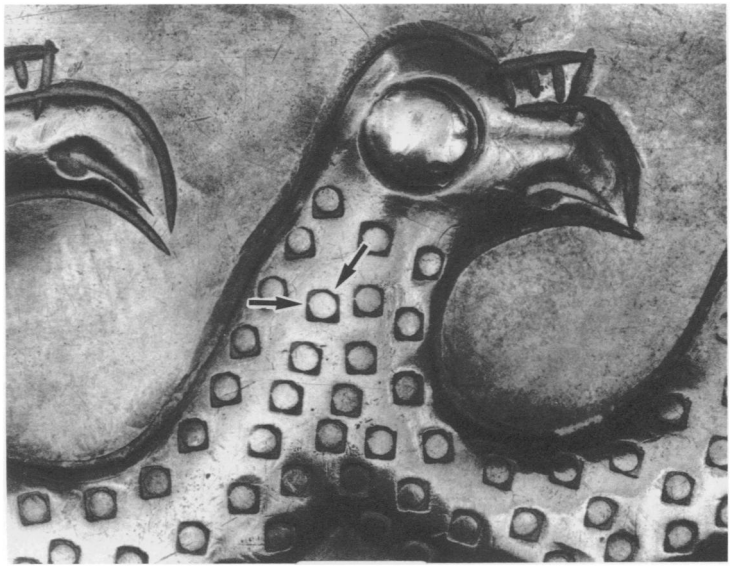


5–7. Details of Thracian helmet and cup showing the marks made by a single chasing tool, with a nicked corner on the outside square and a pointed nipple on the inside circle, evidence that both objects were made in the same workshop

5, 6. Details of horns of animal on Thracian helmet (Figure 1); cf. Figure 7

7. Detail of border of bird heads on Thracian cup (Figure 2); cf. Figures 5 and 6

dantly on the cup in the border of bird heads (Figure 7), on the large bird, and on the antlers and feet of the animals. Each mark is roughly square on the outside (1.2 × 1.2 mm.) and round on the inside (diameter, approximately 0.95 mm.). The mark shows two imperfections: a nicked corner of the square, and a pointed nipple on the circle, 135° counterclockwise from the nicked corner (see arrows in Figures 5 and 7). There is no doubt that a single tool produced the marks on both objects. Other marks, such as those used for the hair of the animals on the helmet and the cup, are very alike and may indeed be identical; but they do not exhibit sufficiently distinct characteristics for us to state with confidence that they were produced by the same tool. However, the fact that at least one common tool was used indicates that both helmet and cup were made in the same workshop, possibly but not necessarily by the same person. In favor of the attribution to a single silversmith is the similarity of workmanship, evident in the execution of the design, inaccuracies in chasing and engraving of lines and in other elements of the decoration, overlapping punches, and so on. On the other hand, there are differences, such as the much higher relief



in the cup, to suggest that more than one person may have been involved in the manufacture of the two objects.

Further evidence of their relationship is found in the elemental compositions (Table 1). The silver of both the helmet and the cup is characterized by low copper contents, virtually identical gold contents, and

TABLE 1 Elemental Compositions

Elemental compositions of samples weighing approximately 0.5 milligrams were determined by neutron activation analysis at Brookhaven National Laboratory. Concentrations of silver, copper, and gold were obtained by instrumental methods; the reported concentrations for these elements are based upon the assumption that silver, copper, and gold are the only elements present in significant concentrations. The elements iridium, zinc, tin, arsenic, antimony, selenium, iron, cobalt, and mercury were determined by a neutron activation analysis technique that included chemical separations. A more detailed description of the analytical techniques, with discussions of the accuracy and significance of the reported data, can be found in the literature.[3]

		Concentrations in percent			Concentration in μg/g (ppm)								
OBJECT	SAMPLE	Ag	Cu	Au	Ir	Zn	Sn	As	Sb	Se	Fe	Co	Hg
Helmet	1	99.5	0.269	0.231	<0.0002	4.0	<13	0.86	0.019	0.081	12	0.095	0.051
	2	99.5	0.213	0.253	<0.0005	6.5	<34	1.2	0.043	<0.18	<13	0.11	<0.073
Cup	5	99.7	0.0656	0.242	<0.0005	0.98	<22	<0.04	0.025	<0.18	≤4.8	0.054	<0.069
Vase	6	99.5	0.267	0.272	<0.0004	3.2	<22	<0.05	<0.031	<0.12	6.9	0.060	<0.044
Helmet, rivet	3	95.9	1.78	2.29	0.0069	4.1	<11	<0.1	0.020	0.14	≤3.7	0.033	0.099
Helmet, strip	4	95.4	3.02	1.55	0.00035	7.3	<22	0.33	0.029	0.16	<2.7	0.028	0.018

extremely low iridium contents.[4] The similarity in elemental compositions, especially in the gold and iridium concentrations and to a lesser extent in the concentrations of other elements, provides a strong indication that the silver was produced from a common ore source. Evidence that the silver used for the vase, the third object examined, also originated from the same source is found in the remarkable similarity between its elemental composition and the compositions of the helmet and the cup.

Although the vase does not exhibit sufficiently characteristic technical properties to claim a connection with the helmet and the cup, its method of manufacture and the execution of its design are sufficiently similar to those of the other two objects to suggest the possibility of a common date and place of manufacture.

The elemental compositions of the rivet and the repair strip in the helmet (samples 3 and 4) differ considerably from the composition of the helmet itself. All that can be said is that their moderately low amounts of copper and relatively high amounts of gold are unlike modern silver alloys. Although these repairs were not made from the same silver as the helmet, their compositions support the suggestion that they are ancient.

3. P. Meyers, L. van Zelst, and E. V. Sayre, "Determination of Major Components and Trace Elements in Ancient Silver by Thermal Neutron Activation Analysis," *Journal of Radioanalytical Chemistry* 16 (1973) pp. 67–78; idem, "Major and Trace Elements in Sasanian Silver," *Archaeological Chemistry*, ed. C. Beck, Advances in Chemistry Series, 138 (Washington, D.C., 1975) pp. 22–33; P. O. Harper and P. Meyers, *Silver Vessels of the Sasanian Period:* I. *Royal Imagery* (MMA, New York, 1981) pp. 150–163.

4. The iridium concentrations for the helmet, the cup, and also the vase are below the detection limits of the analytical method used.