A Cypriot Silver Bowl Reconsidered
2. The Technique and Physical History of the Bowl

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THE EXAMINATION and conservation of a silver phiale from Cyprus in the Metropolitan Museum has provided an opportunity to investigate both the technique used to make it and its subsequent physical history. This bowl or phiale (MMA 74.51.4557; Figures 1, 4), of which approximately one-third is preserved, was sent for treatment to the Museum's Sherman Fairchild Center for Objects Conservation in July of 1997, along with a number of silver bowls, bowl fragments, and other vessels. All had been acquired by the Museum in the nineteenth century through General L. P. di Cesnola, and all were subjected to various treatments over subsequent decades. During our latest conservation efforts it became apparent that a close look at these silver vessels could reveal specific aspects of Archaic metalworking industries in the eastern Mediterranean. It was equally clear that their condition reflected the modern history of changing attitudes toward archaeological materials. In the present article I will address the initial creation of the silver bowl, its slow deterioration, and the series of restorations it has undergone, since all of these processes combine to make up the artifact as we see and respond to it today.

THE BOWL AND ITS BACKGROUND

The phiale under consideration was made by hammering sheet metal into the desired shape, tracing the linear designs in the interior of the bowl, and then completing the shapes of the figurative elements in three dimensions, in repoussé. While the best evidence for the details of its manufacture comes from the phiale itself, ancient representations of both metalworkers (mainly from Egypt) and their tools help convey, visually and practically, the nature of metalworking in the eastern Mediterranean during the first millennium B.C. If the tools and methods implied by the physical condition of the bowl match those found in archaeological contexts and artistic representations, we may properly use the latter to form a picture of the specific materials, tools, and processes employed in the manufacture of our particular silver bowl.

The first steps in making the bowl involved acquiring the silver and preparing an appropriately sized disk, or billet. Sources for its metal cannot be determined. I know of no texts that indicate where the silver used in Cyprus originated. However, ancient Egyptian texts report that some of the silver worked in Egypt came from Cyprus,[1] so a local source may have supplied some of the raw material for Cypriot silversmiths. In most workshops a combination of scrap silver, containing a variety of alloys, and silver from ingots would make up the metal to be worked; such a mixture, however, renders elemental analyses inconclusive in identifying the source of the metal. Moreover, it is likely that both ingots and scrap silver were traded throughout the Mediterranean. As traders exchanged raw materials, metalsmiths probably exchanged ideas, with the result that methods as well as metal, no doubt, crossed boundaries.

The question of whether a Cypriot or Phoenician artisan made the bowl has been addressed already by Dr. Karageorghis. During the early first millennium B.C., the Phoenicians were expanding their sphere of influence westward in the Mediterranean, thus disseminating the characteristic objects of their culture, notably, worked metal bowls of bronze, silver, and gold. Such bowls should provide insights regarding metalwork in the eastern Mediterranean. However, Phoenician craft activities have been neither identified nor adequately understood in their own homeland, since so little has been excavated at important Phoenician sites such as Sidon and Tyre.

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The notes for part 2 begin on page 30.
Figures 1–3 referred to here appear in part 1 of this article.

Figure 4. Drawing of traced design in silver bowl MMA 74.51.4557 (drawing: Elizabeth Hendrix)

Rather, we must examine artifacts found elsewhere that are thought to exhibit "Phoenician" characteristics; unfortunately, this activity can quickly become circular, when attempting to differentiate "Phoenician" from local characteristics.

So far, technology has not clarified the problem. The examination of MMA 74.51.4557 reveals nothing that can definitively declare its artistry Phoenician rather than Cypriot.[2] However, epigraphic evidence can be used to identify Phoenician products, as in the case of a silver phiale with a Phoenician inscription, among pseudohieroglyphs, that reads "Blš, son of the metal caster."[3] The bowl has no provenience, though unsubstantiated evidence sug-

gests it may have been found on the west coast of Italy. Its interior design—of a smiting pharaoh—is similar to that on one of the Museum's Cesnola bowls, described below (MMA 74.51.4556; Figure 11). It is well known that the Phoenicians borrowed characters and symbols for decorative purposes from lands beyond their borders, so one could argue that a Phoenician workshop created both the Cesnola and the "Italian" bowls. Nonetheless, 4557 comes from Cyprus, bears Cypriot inscriptions, and perhaps a local style, so for now it seems most prudent to consider it the product of a Cypriot silversmith.

In order to form billets of convenient size, the metal was melted and poured into smaller crucibles to divide it into appropriate portions, which were then hammered into flat disks. The shaping of the properly sized blank into a vessel was often achieved by hammering as well.[4] Two hammering techniques, "sinking" and "raising," were defined and described in detail by Herbert Maryon in 1949.[5] To create a form by sinking one hammers the metal sheet into a hollow made in a block of wood or similar material, the blows of the hammer stretching the metal from the rim down toward the center of the bowl. A shape that is raised, by contrast, is made by hammering the sheet, over an appropriately shaped anvil, on what will become the exterior surface of the object. Here, the metal is compressed to form its shape. In both cases, as the sheet is worked it becomes harder until, eventually, further hammering can no longer shape the metal easily.

At this point the artisan will have to reheat, that is, anneal the partially formed object in order to continue shaping it. Metal atoms are held together in a crystal lattice that allows the planes of atoms to slip past each other when subjected to the stress of hammering. Imperfections, or "dislocations" within the lattice, create weak points in the structure, which in turn allow the planes to slip past each other more easily than is possible in a perfect lattice. On the other hand, a "pileup" of dislocations results during hammering, since these anomalies tend to remain in place while atoms in the regular sections of the lattice slip past them. The effect of this accumulation of tangled dislocations is an irregular lattice structure—for the smith this means a stiffer, less malleable metal structure, referred to as work-hardened. In order to regain workability the dislocations must be untangled by heating the metal, which allows the atoms to settle back into a regular crystal formation, a process known as annealing. This operation may be repeated until the desired

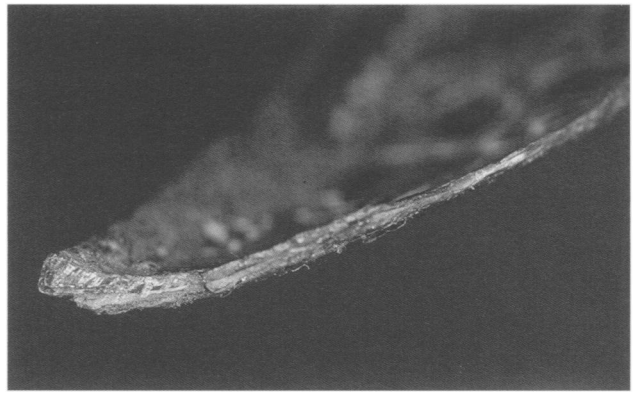


Figure 5. Cross section of rim of silver bowl in Figure 1 (photo: Elizabeth Hendrix)

shape is achieved, although heating the metal, for example a silver alloy, too often or for too long at once can initiate internal corrosion by oxidation, thereby weakening the structure; experience and skill forge the expert smith.[6]

The broken rim of the bowl reveals that the artisan folded the edge over toward the exterior (Figure 5). The turned edge both serves to increase the strength of the bowl at the rim, where it is most vulnerable to mechanical damage, and provides a visual "finish" to the edge. The top of the rim was then flattened by hammering after the rim was folded. The same technique was applied to the edges of the other silver bowls with preserved rims that I examined in the course of this project.

Once the desired shape of the phiale was achieved, the smith would planish the surface to smooth out the hammer marks, scratches, and other blemishes that might have occurred during the forming of the bowl. Planishing is carried out by a light hammering all over the bowl, the force of the blows just enough to level the marks left by the more forceful hammering that shaped the bowl. Smooth stones used for this purpose are shown on New Kingdom Egyptian wall paintings from Saqqara;[7] the final polishing would be accomplished by rubbing an abrasive on the surface with pads of leather or cloth.[8]

The decoration on the interior of the phiale, described by Dr. Karageorghis in the first section of this survey, was traced into the metal with pointed and chisel-like tools driven by gentle tapping with a small hammer. Initially, the design may have been scratched or painted on the metal, as suggested by a painting in a tomb in Thebes of metalworkers inscribing a vessel (Figure 6); the tool kit on the

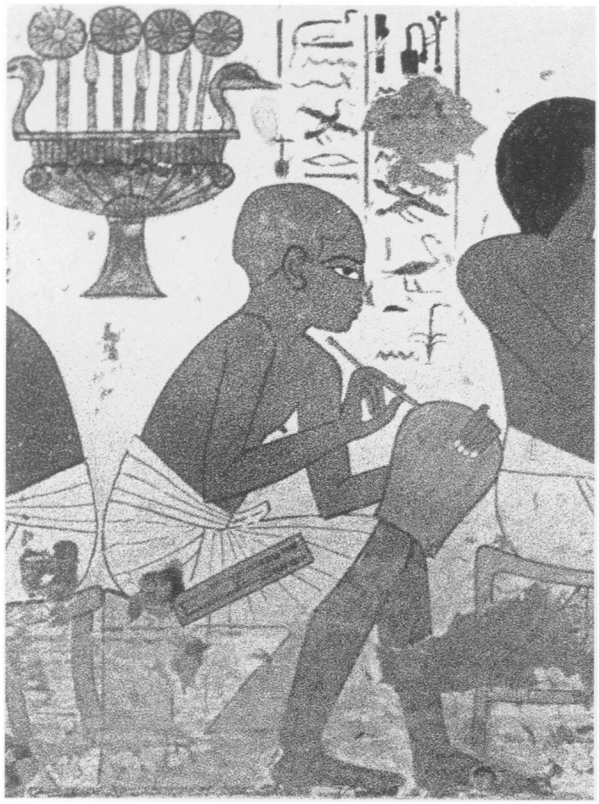
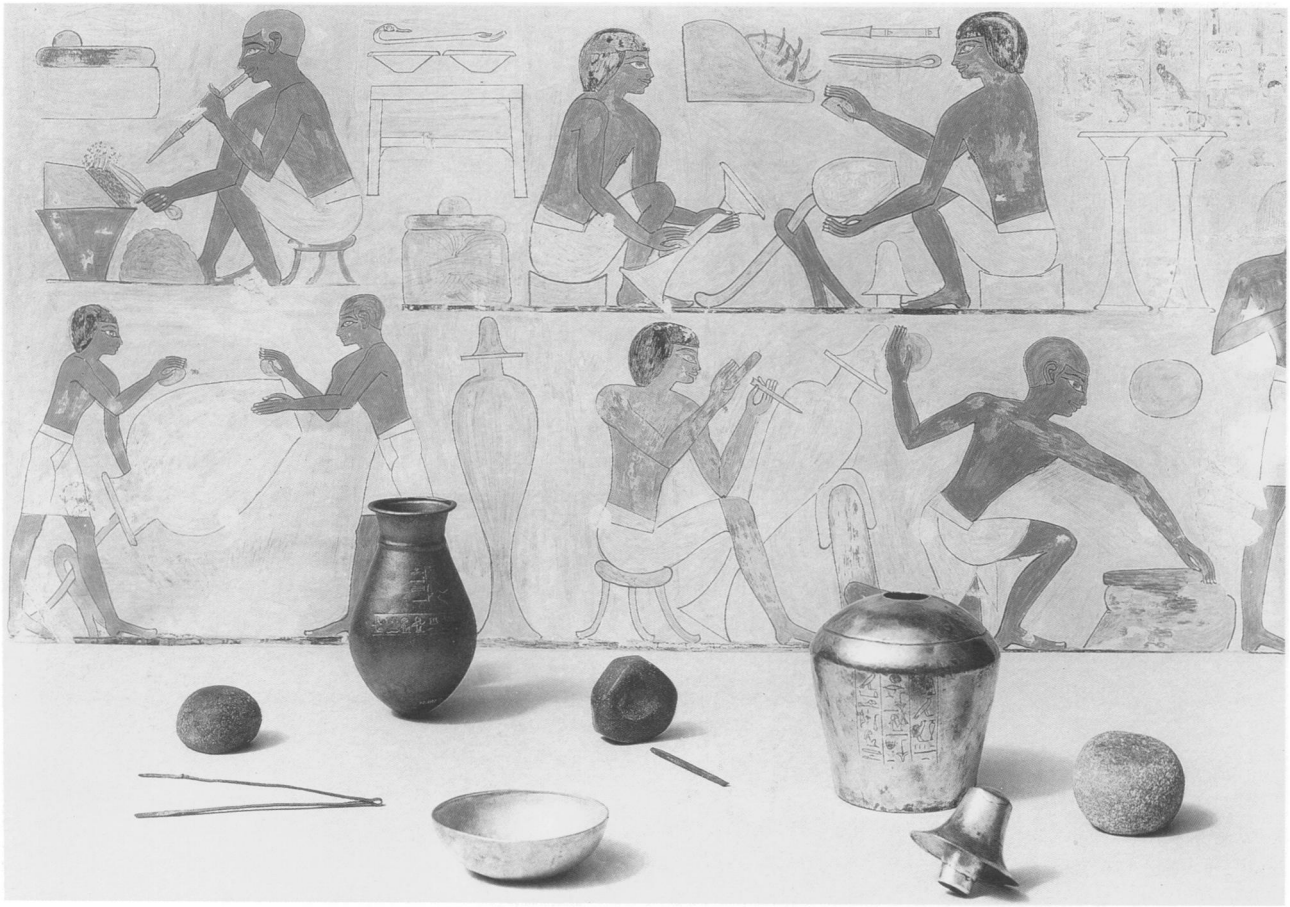


Figure 6. Tempera facsimile in the Metropolitan Museum of a wall painting in the New Kingdom Tomb of Nebamun and Ipuky (T181), showing the metalworker's tool kit. The Metropolitan Museum of Art, Rogers Fund, 1930, 30.4.103

artisan's lap seems to contain brushes.[9] This artisan has been interpreted as sketching the design on the vessel with a brush.[10]

The tracing tool looks very similar to a chisel but has a rounded rather than cutting edge. When held against the metal and tapped at the other end with a hammer, the metal underneath the tracer's edge is compressed. With the tool held at a slight angle, the hammer's impact will nudge it forward so that a relatively continuous line can be made.[11] This process is depicted on wall paintings from Egypt, in the tombs of Rekhmire, Meri, and Puyemre, in enough detail to be able to see both the tools and the manner in which they are used (Figure 7).[12] In

Figure 7. Wall painting in the New Kingdom Tomb of Rekhmire showing metalworkers (from Norman de Garis Davies, *Tomb of Rekh-mi-ré at Thebes* [New York, 1925], pl. 11)



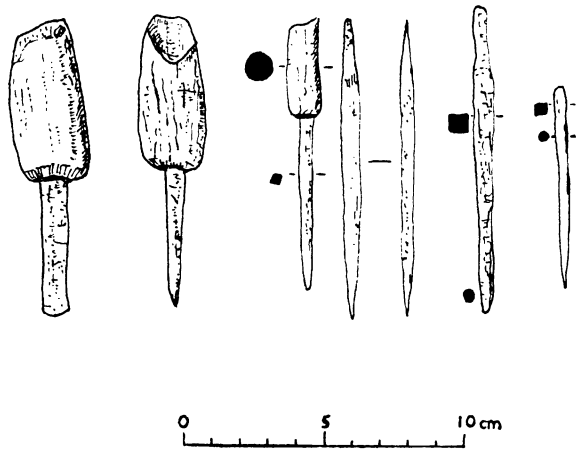


Figure 8a. Early and Middle Cypriot copper or copper-alloy tools from Lapithos, Cyprus (after Hector Catling, *Cypriot Bronzework in the Mycenaean World* [Oxford, 1964], fig. 4:11)

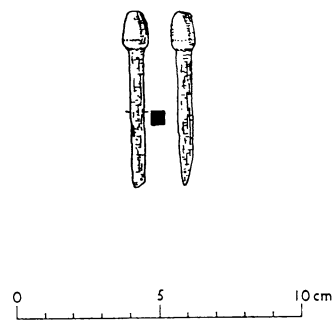


Figure 8b. Late Cypriot copper or copper-alloy tool from Lapithos, Cyprus (after Catling, *Cypriot Bronzework*, fig. 10:2)

all cases the tool is held against the vessel with one hand while the artisan taps it with a small stone held in the other. The tool is positioned at an angle of slightly less than ninety degrees to the surface of the vessel, indicating that the force applied to the metal sheet is primarily perpendicular.

Tools that may have been used by metalworkers have occasionally come to light during archaeological excavations on Cyprus and elsewhere in the eastern Mediterranean, though such mundane objects might well have escaped the attention of explorers intent on recovering works of art. Suitable tools for tracing have been found in a Middle Cypriot tomb at Lapithos and in a Late Cypriot tomb, also at Lapithos.[13] They provided the artisan with an edge that was easy to control in restricted areas (Figures 8a, 8b). Although these contexts are earlier than our silver bowl, there is no reason to believe the artisans on Cyprus had lost either the tool types or the techniques of their predecessors; our bowl suggests that they were familiar with both.

During the tracing process the bowl would have to be supported from the outside; Maryon mentions pitch, lead, soft wood, or sand as supporting materials,[14] although other materials, such as wax, could have served the same purpose. If the walls of the bowl are thin enough, the metal will be pushed by the tracer into the supporting material, leaving a

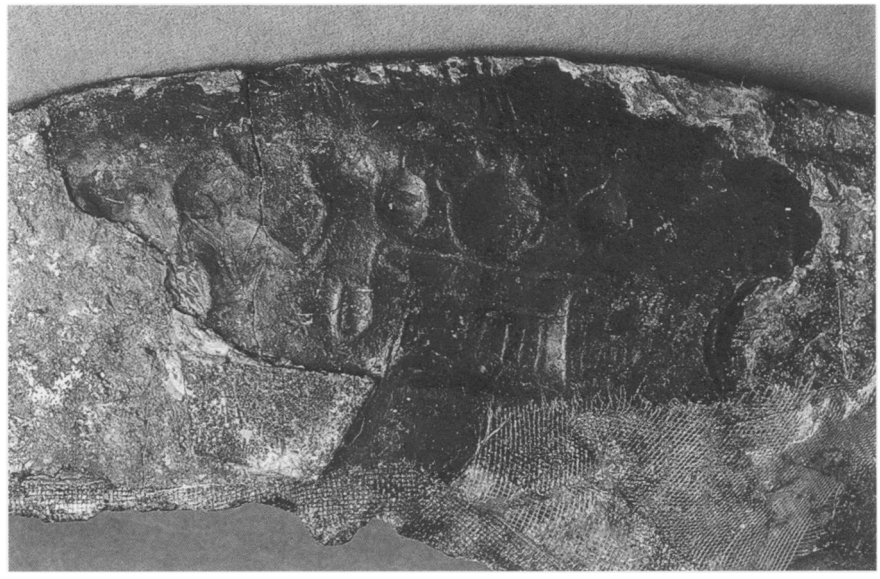


Figure 9. Raised lines made by tracing tool on the back of silver bowl in Figure 1 (photo: Elizabeth Hendrix)

raised line on the outside. The present thickness of our phiale is 0.15 cm, thin enough for the tracer to have made such a raised line, and, indeed, the outlines of the figures are visible on the back of the bowl (Figure 9). Another indication of tracing is evident in some of the curved lines, where a "stepped" pattern resulting from the short length of the tracer tip can be seen (see, for example, the vessels and ladles shown in Figure 9). Under low magnification one can observe that the lines dip at one end in close intervals, evidence of the tapping of the angled tracer. Finally, the ends of the lines are rounded, betraying at once the shape of the tool and how it was applied to the metal (apparent in the arms and fingers of the reclining figures).

Had the design been engraved into the metal, the sharp angle of the burin or engraving tool's cross section might have been evident in the inscribed line.[15] The burin is also pushed along the surface of the object, but, rather than compressing the metal, it cuts and lifts the metal out of the line being made, which often leaves a tapered point at the end of the cut. This procedure makes smooth curving lines and will not produce significant ridges on the back of the vessel, since the force is horizontal rather than downward.

Besides being traced, many of the lines—both straight and curved—are made as a series of aligned points. This technique can be seen toward the back of the king's couch and in some of the lines, including the top rim line, of the large amphora between the offering bearers and the musicians. It is not clear why this technique was used, unless the artisan intended to make a thinner line than was possible with the tracer.

The bulkier areas of the decorative motifs were further emphasized by repoussé, a hammering technique that results in some areas standing out in relief from the background. Varying round-tipped punches are used either to coax the metal outward, within particular boundaries, or to push the background down around the shapes to be left in relief. For our bowl it seems that it was more practical to hammer the relatively small amount of relief from the back. In order to contain the relief within the desired areas of the interior design, the artisan needed some indication on the back of the bowl to know where to apply the punch. One possibility would be to take advantage of the marks on the outside of the bowl resulting from the traced lines. With the repoussé finished, the final form of the bowl was completed.

Both the tools that have been excavated and the depictions of metalworking from Egypt are consistent with the materials and techniques suggested by our silver bowl. We can imagine a metals workshop where smiths, familiar with the general techniques in use throughout the eastern Mediterranean, produced vessels and other artifacts on a full-time basis. Such a shop may well have been located on Cyprus, since the inscription, and possibly the motif, indicate Cypriot patronage.

The Physical History of the Bowl

Over the last twenty-five hundred years the silver of the phiale has slowly deteriorated. Metallic silver survives relatively well in environments that are either waterlogged, or dry and alkaline with low salinity.[16] Evidently these conditions did not prevail for our bowl during its long burial; Cyprus has enough rain and salts to make it less than ideal for preserving metal of any sort. In addition, after the bowl was unearthed it was exposed to the modern atmosphere, and perhaps to both chemical and mechanical cleaning treatments (treatment records were not always as detailed as they are today). On our bowl, several phases of corrosion products were visually and chemically identified.

The surface of the bowl has a mottled dark purplish brown-to-black appearance. Part of the dark patina may be black tarnish, or argentite, often the result of contact between silver and sulfur in the atmosphere; it probably formed after the bowl was excavated.

When the internal structure of the metal is examined, additional details about the manufacture of

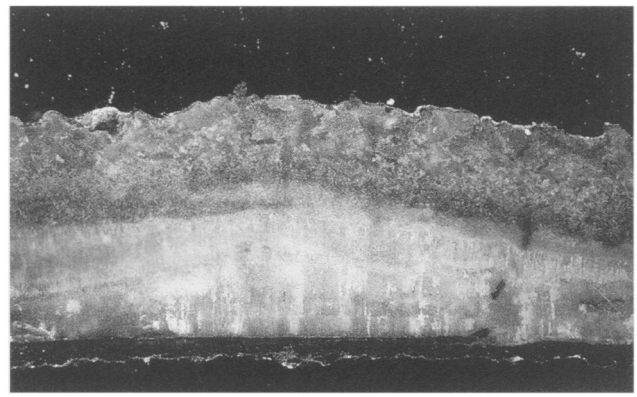


Figure 10. Metallograph of sample from silver bowl in Figure 1, crossed polars at 100x magnification (photo: Elizabeth Hendrix)

the object can sometimes be deduced. For example, the specific alloy can be determined from a polished cross section viewed under the high magnification of a special metallographic microscope. The alloy can help us to formulate questions about the local industry: Did the artisan or patron choose to save on materials by using a baser alloy, or, conversely, deliberately make use of nobler materials by working with a purer alloy? Was strength a factor in choosing the alloy? Or final color a primary concern? Comparable work must be analyzed to begin to answer such questions. Published silver-alloy compositions from a wide variety of time periods and locations in the Mediterranean strongly suggest that the selected alloy was often simply a matter of what was at hand.[17]

In the case of our silver bowl, the metallographic section shows that the silver in the sample has been completely mineralized, that is, converted to a stable, nonmetallic material (Figure 10). A sample from one of the other bowls (MMA 74.51.4556) also revealed that metal was no longer present. Corrosion products, which may have been present at one time, such as copper salts, could have leached out of the bowl during the long period of its burial; as a result, it is uncertain whether the bowl was made originally of pure silver. All that can be said for sure is that the alloy contained no gold, since that corrosion-resistant element would still be present.

Between the times when the phiale was in use and when it was excavated, it was surrounded by earth, moisture, and salts. While it was buried, chemical reactions took place that converted the silver at and below the surface of the bowl to more stable minerals. Elemental analysis of samples from the bowl identified a relatively even distribution of silver, chloride, bromide, and some sulfur.[18] Chlorides in the burial environment, probably from sea salts, reacted with the metal to form silver chlorides, while silver bromide resulted when the silver came into contact with organic material.[19]

When viewed under crossed polarized light, the metallographic section reveals several layers of corrosion (see Figure 10).[20] Both silver chloride and silver bromide are photoreactive and are probably responsible for the visible layering effect of the corrosion. As anyone who has printed black-and-white photographs knows, exposing light-sensitive paper produces a dark image. The same chemical reactions turned the outer layers of our silver bowl dark. Energy from light split the silver from the chloride and bromide ions under conditions that permitted the silver atoms to combine with each other, forming very finely divided particles which appear dark.[21] As more and more of the metal converted to the stable silver chlorides and bromides, these minerals eventually reached a depth beyond the effects of light, remaining pale below that level.

The Conservation History of the Bowl

The modern history of the phiale's physical condition illustrates how such bowls have been appreciated and thus treated over the last hundred years or so. The sequence of events can be summarized as follows:

In 1874–76, bowls and bowl fragments MMA 74.51.4556, 4557, 4558, and 4559 (among others) were acquired for the Museum (Figure 11). Soon thereafter, in 1887, phiale 4556 was published by Allan Marquand.[22] It was presented in a drawing that shows one fragment at the center, with no joining edges to link it to the rest of the bowl. The central motif illustrates an Egyptian figure smiting three enemies.

Myres's *Handbook* of the Cesnola Collection appeared in 1914. Bowls 4556 and 4557 and fragments 4558 and 4559 were all described separately, with the proviso that 4559 possibly belonged to 4557.[23] Myres illustrated 4556 in a new drawing, revealing that by 1914 two fragments had been incorporated into the reconstruction at the center of the bowl.

In 1923–24, Bissing published fragments of the Museum's silver phialae and illustrated our bowl in the earliest photograph known of it.[24] Two fragments of silver, with traced designs of running animals (MMA 74.51.4558a and 4558b), were incorporated in the plaster backing—probably the first restoration of the bowl (Figure 12). The dark, painted plaster is rough and terminates well below the preserved rim of the phiale. Although the restoration is unattractive, it permits the viewer a glimpse of the thinness of the ancient bowl. In his description of the bowl, however, Bissing joined Myres in suggesting that fragment 4559 should be considered a part of the bowl rather than the fragments with running animals, as illustrated in the photograph provided to him for his article.

An early photograph of the bowls on exhibition shows the condition of bowl 74.51.4556 prior to 1934 (Figure 13). It appears, from the shadows around the edges of the silver, that the bowl and the two central fragments rest on the backing plaster

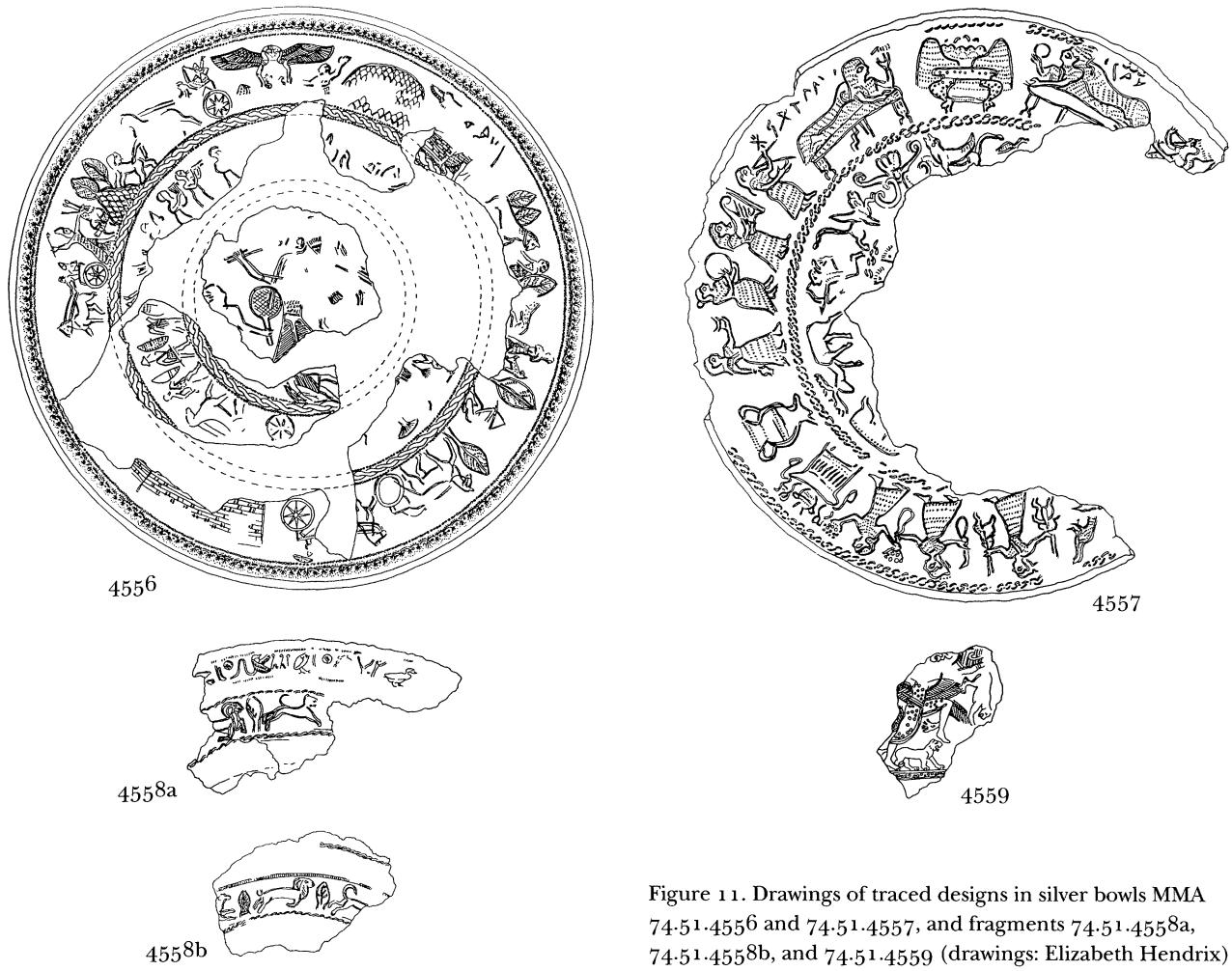


Figure 11. Drawings of traced designs in silver bowls MMA 74.51.4556 and 74.51.4557, and fragments 74.51.4558a, 74.51.4558b, and 74.51.4559 (drawings: Elizabeth Hendrix)

rather than being incorporated into it, thus preserving for the viewer a sense of the metal's original thinness.

Detail photographs dating to September 1934, recording new conservation work, show our bowl combined with fragment 4558b in a new position (Figure 14); 4558a was probably removed during this treatment. Now the plaster restoration is smoother and continues to the height of the original rim. An inscribed line, cut into the plaster before it was painted, isolates 4558b from the offering bearers on our bowl. Is this line meant to indicate to the viewer that the fragment does not belong to the rest of the bowl? It is curious that fragment 4558b was moved to a new location in the bowl, rather than being simply removed. Below the musicians the plaster restoration fills in a loss at the griffin's wing (see Figure 15), which had been preserved in the pre-1934 photograph. The missing fragment was recently located in storage and has been restored to its proper location during the present treatment of the Cesnola silver.

A photograph from May 1938 shows our bowl in a new plaster setting, with fragment 4559 placed at the center and neither of the fragments, 4558a or 4558b, present (Figure 15).[25] This reconfiguration may have been a delayed response to the earlier suggestions that 4559 belonged to 4557. Fragment 4559 (see Figure 11) does not belong to this bowl, however. Regardless of whether the mythical subject matter was appropriate to the rest of the iconography, examination under low magnification makes plain the different quality of the traced design: 4559 belongs to a design that has been rendered in exceptionally fine lines, quite different from the bold and vigorous lines of 4557. This was the last time that the bowl was restored prior to its present treatment. In the meantime, it was frequently published, from 1939 to 1985, in a broken condition as well as in an earlier, better-preserved state.[26]

Figure 12. Earliest known photograph(pre-1934) of silver bowl MMA 74.51.4557, combined with fragments from silver bowl MMA 74.51.4558

Figure 14. September 1934 photograph of silver bowl MMA 74.51.4557

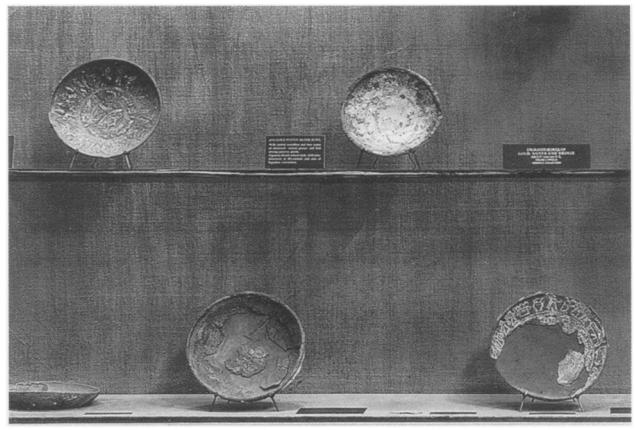


Figure 13. Early photograph of silver bowls MMA 74.51.4556 and MMA 74.51.4557 on display in the Metropolitan Museum

Figure 15. May 1938 photograph of silver bowl MMA 74.51.4557, combined with fragment 74.51.4559

Since 1938, the thinness of the silver bowl—even in its corroded condition—was entirely obscured by the thick plaster backing. Evidently the motif in the interior was the most important feature of the bowl in the opinion of the person who decided to restore it in this manner; second in importance was the fact that the extant remains did indeed come from a bowl. The end result was an overall shape in which the traced designs and figures on the silver fragments were further enhanced by being filled in with modern white paint. The layers of modern restoration materials thus made it difficult to appreciate the original substance of the phiale, perhaps because that was not deemed of great importance. Certainly, the evidence for the manufacturing technique, such as the raised tracing on the back of the bowl, was not considered worth presenting to the viewer.

On the other hand, the fragments of silver were more or less protected over the years by their heavy plaster armor. The brittle mineralized silver was handled on a number of occasions, judging from the various states of preservation documented in the photographs of the bowl over the last six decades. Had there been no backing, the bowl would have suffered numerous additional losses.

When the bowl was brought to the conservation laboratory in 1997, it was in four large pieces, riddled with cracks running through both the silver and the plaster restorations. Fragments of silver jutted out vulnerably from these main "sherds." As the plaster was carved away from the silver it became

apparent that it had been applied in three layers: first was a relatively pure plaster-of-Paris layer sealed with shellac. This was followed by a layer in which a water-soluble glue (probably animal glue) had been added. Finally the hardest, outer layer was applied, and the whole restoration, inside and out, was painted a dark brown to match the dark tones of the patina. In other words, considerable care was expended in constructing the plaster restoration. What seems insensitive to our eyes was probably carried out with thoughtful attention.

Since the legibility of the traced design has always been important, it was filled with a material that contrasted with the background. Paint continues to enhance the linear designs, since it is the only way to highlight the motifs and decoration. In order to determine whether any of the layers of varying colors had been applied in ancient times, one of the fragments (4558a) was analyzed by SEM/EDS (see note 18). The top layer of paint included titanium, introduced as a white pigment in the early twentieth century;[27] the middle layer contained carbon black and flakes of brass (an alloy of copper and zinc which postdates ancient Cyprus); and the bottom layer consisted of calcium carbonate. Presumably this last could have been applied in antiquity or sometime before the dark layer was painted on top of it.

One of the effects of previous "chalkings" was that some of the motifs on the bowls and fragments were obscured by too much white, while others were invisible due to the total lack of the filling color. Further confusion was created by the white paint filling in scratches and pits in the surface that have nothing to do with the design. In the present treatment I removed all the modern white paint (which, unlike the calcium carbonate, was soluble in acetone), and then, with the aid of a binocular microscope, lightly painted in the lines of the design with pale dull purple acrylic.

The bowls have been restored so that the delicacy of their dimensions—including their original thicknesses—and the range of styles employed for the interior designs can be best appreciated. Fragments can still convey the shapes of the bowls from which they came while they also tell of the effects of time on the substance of works of art. The material and technology embodied in these ancient silver vessels, as well as the decorative motifs, provide information that enhances our understanding of the eastern Mediterranean during the first millennium B.C., both from a technological and an art-historical point of view.

Acknowledgments

I would like to thank Joan R. Mertens and Vassos Karageorghis for the opportunity to study and work with the Cesnola Collection's silver, and for much excellent advice during both the treatment and the report phases of this project. Susan M. White assisted in preparing metallographic samples, and Mark T. Wypyski carried out elemental analyses by SEM/EDS. Special thanks are due to James H. Frantz, Richard E. Stone, Dorothy H. Abramitis, Deborah Schorsch, Lisa Pilosi, Anne Heywood, and John M. Russell for assistance in interpreting analyses and for reading and making comments on the text, and to the other members of my department for their helpful suggestions.

Notes

1. Wolfgang Helck, *Materialien zur Wirtschaftsgeschichte des Neuen Reiches (Teil VI)*, Akademie der Wissenschaften und der Literatur, Abhandlungen der geistes- und sozialwissenschaftlichen Klasse, Jahrgang 1969, 4 (Mainz and Wiesbaden, 1969), pp. 968–69. The sense of the text may mean that the silver merchants simply passed through Cyprus, so the island may not have been the actual source of the metal.
2. However, see Glenn Markoe, *Phoenician Bronze and Silver Bowls from Cyprus and the Mediterranean* (Berkeley, 1985), pp. 9–10, 19.
3. Ibid., pp. 108–9, and E10.
4. "Spinning" a shape on a lathe will not be discussed here.
5. Herbert Maryon, "Metal Working in the Ancient World," *American Journal of Archaeology* 53 (1949), pp. 94–95.
6. On the structure and properties of some metals used in antiquity, see David A. Scott, *Metallography and Microstructure of Ancient and Historic Metals*, The Getty Conservation Institute (Los Angeles, 1991), pp. 1–3, 7, and 129, fig. 205: copper-silver binary system phase diagram.
7. Bernd Scheel, *Egyptian Metalworking and Tools* (Princes Risborough, Aylesbury, Bucks., 1989), p. 39, fig. 42, after Selim Hassan, "Excavations at Saqqara 1937–38," *Annales du service des antiquités de l'Égypte* 38 (1938), pl. 96.
8. Cf. Scheel, *Egyptian Metalworking*, pp. 38, 40.
9. Norman de Garis Davies, *Tomb of Two Sculptors at Thebes* (New York, 1925), pl. 11.
10. Jürgen Settgast, "Die Silberschale des Merenptah," *Jahrbuch Preussischer Kulturbesitz* 23 (1986), p. 135.
11. Cf. Maryon, "Metal Working," p. 115.
12. Cf. Settgast, "Silberschale," p. 135, fig. 26a–c. In the New Kingdom tomb of Rekhmire, at Thebes, gold and silver workers are depicted on wall paintings, and their work is described in superscriptions. All the steps of the operation are shown here except the initial smelting of the ore. Molten metal is carefully poured into crucibles, beaten into disks, raised or planished over slanted anvils, rubbed smooth with stones, and finally embel-

lished with traced designs. Few paintings illustrating metalworkers are known from the Twenty-first to the Twenty-sixth Dynasty (ca. 1070–525 B.C.), or the Late Period (ca. 525–332 B.C.), suggesting this subject was of less interest to Egyptians during the first millennium B.C. than it had been previously. I know of only one Late Period tomb decorated with depictions of metalworking. Three artisans simultaneously hammer sheet metal on an anvil, while implements for annealing are also evident. On the history of metalworking in Egypt, including illustrations from Twenty-sixth Dynasty and the Late Period, see Bernd Scheel, "Studien zum Metallhandwerk im alten Ägypten, III: Handlungen und Beischriften in den Bildprogrammen der Gräber des Neuen Reiches und der Spätzeit," *Studien zur altägyptischen Kultur* 14 (1987), pp. 252, 261; and Luise Klebs, *Die Reliefs und Malerein des neuen Reiches (XVIII.–XX. Dynastie, ca. 1580–1100 v. Chr.), Teil I: Szenen aus dem Leben des Volkes* (Heidelberg, 1934), p. 111.

13. Hector Catling, *Cypriot Bronzework in the Mycenaean World* (Oxford, 1964), p. 64, and fig. 4:11 (MC tomb), p. 95, and fig. 10:2 (LC tomb).
14. Maryon, "Metal Working," pp. 116, 122.
15. See, for example, the engraved inscription on a silver bowl of Merenptah; Settgast, "Silberschale," fig. 24.
16. Catherine Sease, *A Conservation Manual for the Field Archaeologist*, 2d ed., Archaeological Research Tools, 4 (Los Angeles, 1992), p. 2.
17. See, for example, the analyses in Nathaniel H. Gale and Zoe A. Stos-Gale, "Ancient Egyptian Silver," *Journal of Egyptian Archaeology* 67 (1981), pp. 111–12; M. Kallfass, J. Paul, and H. Jehn, "Investigations on the Embrittlement of an Antique Roman Silver Bowl," *Practical Metallurgy* 22 (1985); Lawrence Becker, Lisa Pilosi, and Deborah Schorsch, "An Egyptian Statuette of the Saite Period—A Technical Study," *MMJ* 29 (1994); and, for a general discussion of the subject, see Scott, *Metallography and Microstructure*, and Appendix F for specific analyses.
18. Elemental analyses of the structure of the bowl and paint samples were carried out by Mark Wypyski on a scanning electron microscope (SEM) equipped with an energy-dispersive spectrometer (EDS).
19. Janey M. Cronyn, *The Elements of Archaeological Conservation* (London, 1990), p. 231.
20. Microscope = C. Zeiss Axiovert 405 M; light source = Zeiss xenon arc; photograph at 100x magnification using Kodak Tungsten 64 speed film.
21. Carroll B. Neblette, *Photography: Its Materials and Processes*, 6th ed. (Princeton, 1962), pp. 180–95, and R. E. Stone, personal communication.
22. Allan Marquand, "A Silver Patera from Kourion," *American Journal of Archaeology* 3 (1887), pp. 322–37, pl. 30.
23. John L. Myres, *Handbook: Cesnola Collection* (New York, 1914), p. 464.
24. Friederich Wilhelm von Bissing, "Untersuchungen über die 'phönikischen' Metallschalen," *Jahrbuch des deutschen archäologischen Instituts* 38–39 (1923–24), pp. 217–18.
25. When the 4558 sherds were removed, a small fragment from 4558a must have broken off, since it was incorporated in the 1938 restoration of 4556 along with several other "homeless" fragments of silver. These fragments were removed during the present treatment, and the one belonging to 4558a was reattached.
26. Most references (not cited here) discuss the bowls without illustrating them. Illustrations are published in: Einar Gjerstad, "Decorated Metal Bowls from Cyprus," *Opuscula Archaeologica* 4 (1946), pp. 10ff., pl. 8 (Fragment 4556); R. L. Alexander, "The Royal Hunt," *Archaeology* 16 (1963), pp. 247ff., figs. 5, 6 (Fragment 4556), reproducing Myres's 1914 drawing; Terence B. Mitford, *The Inscriptions of Kourion*, Memoirs of the American Philosophical Society, 83 (Philadelphia, 1971), p. 12 (Fragment 4557), in 1938 condition; Peter Blome, "Phönizische Dämonen auf einem attischen Krater," *Archäologischer Anzeiger*, 1985, p. 577, fig. 4 (Fragment 4556), reproducing Myres's 1914 drawing; Hartmut Matthäus, *Metallgefässe und Gefässuntersätze der Bronzezeit, der geometrischen und archaischen Periode auf Cypern*, Prähistorische Bronzefunde, 2, vol. 8 (Munich, 1985), p. 165:430, pls. 36, 38 (Fragment 4556); Markoe, *Phoenician Bronze and Silver Bowls*, pp. 252–53 (Fragments 4557, 4559; shown in broken condition on p. 252); Robert Laffineur, ed., *Amathonte*, vol. 3, *Testimonia, 3: L'orfevrerie* (Paris, 1986), p. 185 (Fragment 4556).
27. Max Doerner, *The Materials of the Artist and Their Use in Painting*, trans. Eugen Neuhaus, rev. ed. (New York, 1962).