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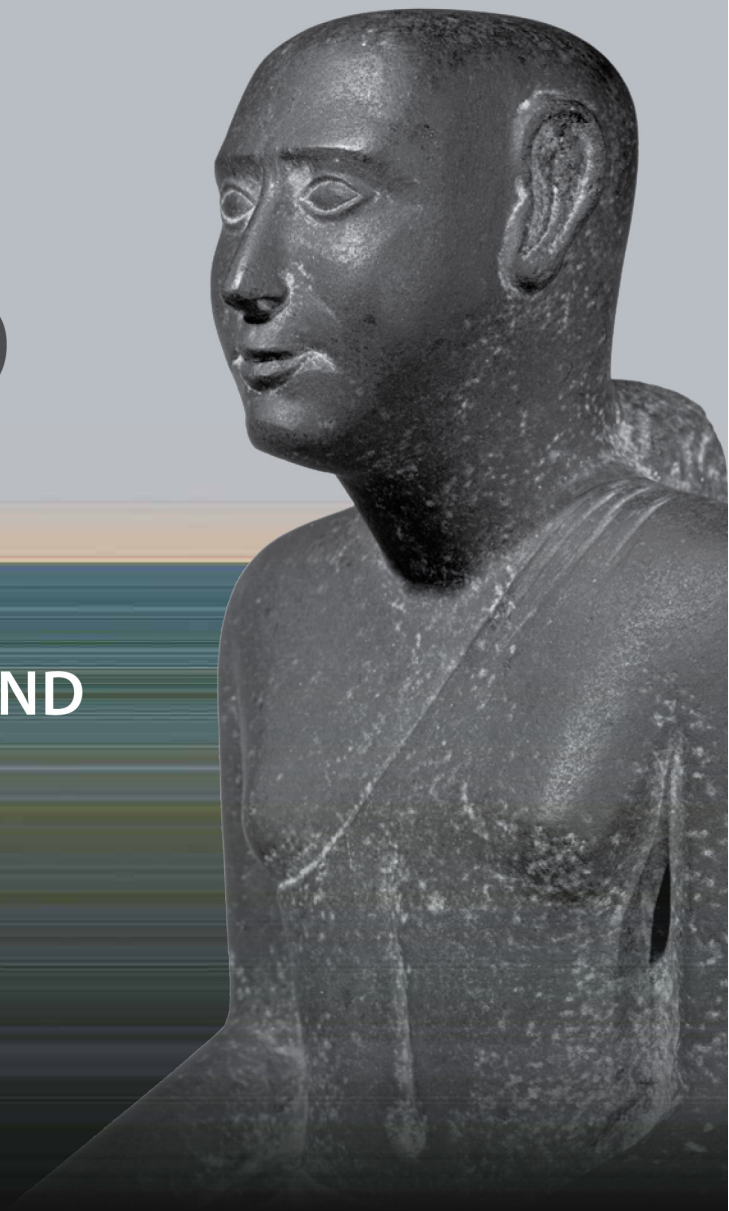
KARANIS REVEALED

DISCOVERING THE PAST AND PRESENT OF A MICHIGAN EXCAVATION IN EGYPT



Edited by
T. G. Wilfong
with the assistance of
Andrew W. S. Ferrara

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Discovering the Past and Present of a Michigan Excavation in Egypt

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Kelsey Museum Publication 7

Ann Arbor, Michigan, 2014

In memory of Traianos Gagos (1960–2010)

Image Sources
Sources for figure images are given in captions; object photographs are Kelsey Museum file photographs, except for the following:
Randal Stegmeyer for the Kelsey Museum: **2**, **8**, **17**, **28**, **29**, **30**, **32**, **49**, **74**, **76**, **79**, **81**, **88**, **124**; Andrew T. Wilburn: **135**

Cover
Foreground: Statue of a seated priest (KM inv. 8218, number **1** in the catalogue)
Background: Image by artist John Kannenberg, derived from photographs he took on a visit to Karanis in 2010. The image is based on a view of Lake Qarun (Moëris in Greek, Mer-wer in Egyptian). The center of the Fayum farming region of which Karanis was a part, the lake featured in ancient Egyptian myths as a site of creation. This graphic was originally created to accompany Kannenberg's *Mer-wer Remix Project* based on a field recording made in the lake itself (see pp. 179–181 for a description of this project).

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A Leather Cuirass Discovered at Karanis, Fayum, Egypt from the Late 3rd and Early 4th Centuries AD

Andrew W. S. Ferrara

The presence of the military and soldiers in the history of Karanis is a well-established fact. Many of the initial settlers of the site during the reign of Ptolemy II Philadelphos (282–246 BC) were most likely Macedonian soldiers, gifted grants of land for their service. During the 1st and 2nd centuries AD, many Roman soldiers settled in the village after having completed their tenure in the army, their positions and activities recorded in papyri. From the 3rd century onward, however, there is no information, textual or archaeological, pertaining to soldiers in the village, with one exception. In 1925, during the first year of excavation, the Michigan team unearthed a significant piece of leather armor from house 193, room A (KM 3631, object **138** in the catalogue of objects above). Though no detailed archaeological information was recorded, the material from elsewhere in the structure suggests that the armor be dated to between AD 250 and 350. This then represents the "only" piece of military equipment from the village beyond the 2nd century and therefore opens new avenues to understanding Karanis's position within the later imperial Roman martial structure.

The Karanis armor consists of rows of individual leather scales, sewn together in lines and then each row layered underneath the adjacent upper level. The scales are attached to each other by two leather thongs threaded through two sets of holes, lacing out and then back in the front, the pattern repeated through the back of the adjacent scale. The rows of scales are connected to each other by an additional thong threaded in the same manner, though it only enters every three to four scales. The scales, on average, have the dimensions of 5.6 cm in length, 2.1 cm in width, and 3.9 mm in thickness, while the thongs are between 1.5 and 3.5 mm in width. In addition, some parts of the armor retain a supplementary leather edging, which appears to have encompassed the outer edge of the piece. Furthermore, there appears to have been a leather backing covering the reverse side of the rows, though this material is of a different type from that used to form the scales themselves. Finally, traces of pigment have been noted on the leather, and their high iron content indicates the application of red paint/dye (see the technical discussion on pp. 129–139 below).

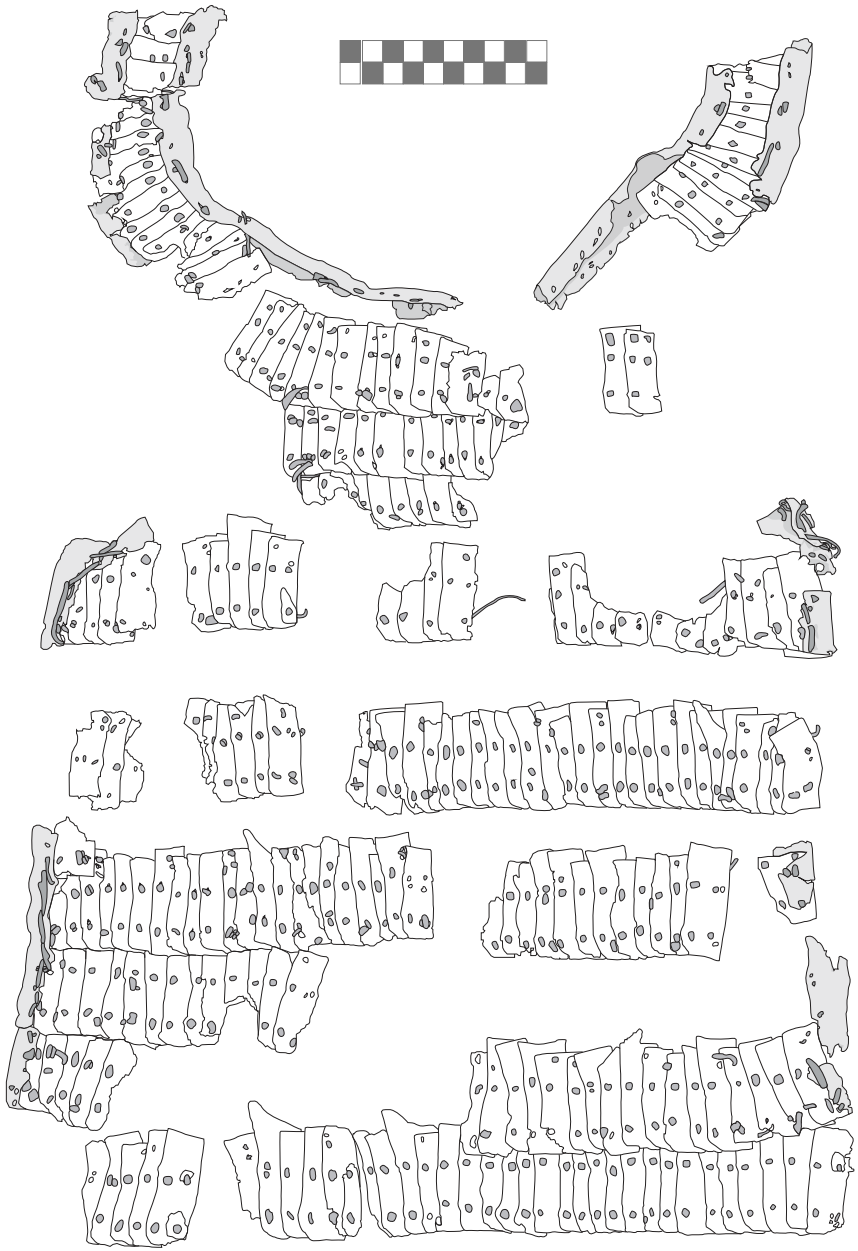

Fig. 41. Reconstruction of Karanis leather armor, **138** (KM 3631; drawing by Lorene Sterner).

Fig. 43. Curator Terry Wilfong, Curatorial Assistant Andrew Ferrara, and Conservator Claudia Chemello discuss the layout of the leather cuirass.

Fig. 42. Photograph of cuirass after treatment, as exhibited.

That the color can be noted only on portions of individual scales, and the iron peak does not occur equally across the rows, points to the fact that paint was applied after the armor's assemblage and not to the entirety of the artifact. From the proportions of the existing piece, and the various arrangements of edged rows, the armor seems most likely to have been designed as a cuirass for a torso. The reconstruction (figs. 41–43) reveals a front panel with scale row shoulder pieces, which would have continued into a back panel of leather rows, or attached to a textile rear piece. The primary restriction on further investigation of the artifact comes from its extremely brittle nature, which limits its handling and the possibility of comparison and identification.

No exact parallels to the Karanis armor appear among surviving Roman military equipment. This is due most likely to the perishable nature of leather and the inhospitable climate of most of the empire. The surviving similar pieces of chest armor are all of metal. The cuirass is constructed in a manner most similar to *lorica squamata* (scale armor) and *lorica lamellar*, though there are differences

between both types and the Karanis example. With *lorica squamata*, the scales are attached to each other and to a backing fabric, and, as noted above, no backing textile has been discovered on the sample piece (Southern and Ramsey 1996, 97). Traditional *lorica lamellar*, on the other hand, has no backing material but has the plates overlapping upward, which differentiates it from the Karanis material, where the scales go downward. The closest example is actually a piece of thigh (rather than chest) armor that was excavated at Dura-Europos in modern-day Syria. This artifact has scales attached to each other and does not have a backing textile. The plates also overlap downward, covering the structural lacing behind them (James 2004, 122–124). That this comparable piece was also found in the eastern half of the empire points not only to the compatibility of the climate with preservation but also the possibility of such leather-styled armor being more extensively used across the eastern regions due to its appropriateness to the hot and dry environment.

There are, however, some deductions about the Karanis armor that may be made from the information available. The piece would have been costly to produce given the scraping and conditioning of the leather as well as the process of forming the scales and assembling the overall structure. It seems unlikely that the scales were attached directly to any textile as no fibers have been discovered upon examination. The armor would most likely have slipped over the head and either laced to the opposite backed rows or have been secured with a separate belt, like a tabard. (This is difficult to determine as none of the edge pieces have additional lacing, but little of this edging survives.) Material considerations make it unlikely that this armor would have been used in combat. Given the thickness of the scales and the minimal protection around the shoulders and neck, it seems highly unlikely that the garment would have offered much in the way of protection against swords or spears. Arrows might have been defended against more easily, though this would also have depended upon the layers of material worn underneath the scale rows. In general, however, the cuirass would have been most useful against knives, clubs, and the like, rather than any more elite weaponry. This specific orientation away from intensive combat, along with the noted unlikelihood of private commission, points to the high possibility of the armor stemming from the *limitanei* section of the Roman army.

During the period in question, the Roman Empire was in a state of flux, morphing into what would become the Byzantine state, and the military was changing along with it. Unfortunately, there is little documentation or archaeological evidence about the army from this time, and even less pertaining to Egypt

specifically, so some generalizations must be made. One major shift that occurred within the military was the split between the units that made up part of the field armies (*comitatenses*) and those placed at the forts on the frontiers (*limitanei*), a gradual process that seems to have begun under Diocletian (284–305) and continued under Constantine (307–337) (Goldsworthy 2003, 202). The *limitanei* contained several different types of units, including the old auxiliary corps of infantry cohorts and cavalry *alae*. The role of the *limitanei* was primarily to patrol and garrison the frontier, as well as collecting annual state taxes, offering judicial administration, escorting dignitaries, etc. While they were able to handle simple external attacks and public disorder, anything beyond that would require the intervention of the *comitatenses* (Goldsworthy 2003, 202).

The armor would seem to correspond perfectly to the role of the *limitanei*, placing it within a military context and yet not one that would be involved in extensive warfare. The policies of the *limitanei* offer further explanations for the cuirass's discovery in Karanis. As the corps was associated with specific camps in the frontier regions, troops tended to become integrated with the area around their fortifications, owning land and raising families (Alston 1995, 151–155). Recruitment for the *limitanei* involved the obligatory enlistment of the sons of soldiers and enforced conscription from the land around the forts (MacDowall 1995, 9–10). Additionally, while the field armies were supplied with equipment from state manufacturing camps (*fabricae*), the *limitanei* produced their own weaponry, the more elaborate equipment being individually commissioned (Coulston 1990, 150). Such articles would then be personal property, and thus remain with the soldiery after retirement, which might explain the cuirass's discovery in Karanis.

With regard to the likelihood of a *limitanei* soldier in the region, two groups have been identified within the Fayum during the period of investigation. One was the Cohors (infantry) Numidarum, based at Narmouthis at the start of the 4th century, though the unit appears to have left the area by the 340s (Bell 1962, 13). The other, and considerably better documented, force was the Ala Quinta Praelectorum, a cavalry division based at the fort in Dionysias. It is, in fact, from this company that much of the information regarding the role for *limitanei* within the Roman military in general stems, due to the extensive papyri archive of Flavius Abinnaeus, commander of the *alae* from 342 or 346 to ca. 350 (Bell 1962, 6–12). Within the documents, soldiers from Dionysias are mentioned as collecting taxes from several villages in the Fayum including Karanis, and one particularly tantalizing papyrus mentions, at least, an attempted recruitment from the Michigan-excavated site itself

(*P.Abinn.* 35: Bell 1962, 87–88). While it would go too far to state that the armor came from the *alae* during the time of Abinnaeus, given the evidence, it seems very possible that a *limitanei* soldier could have been based in the Fayum and owned property or lived in Karanis between ca. 250 and ca. 350.

Though no direct textual documentation exists to confirm the presence of military personnel in Karanis during the late 3rd and early 4th centuries, the excavation of the cuirass and the potential circumstances seem to indicate that at least one soldier lived there during the period in question. If he was a member of the *limitanei* (as strongly suggested by the armor), his duties most likely revolved around establishing the manifestation of imperial authority and gathering of military taxes on the frontier. The well-made cuirass would have both offered protection against unruly civilians and acted as a badge of status, with its red dye perhaps indicating a painted insignia or symbol emblazoned on it. Whether the soldier was a native of the village or owned property there, either during service or in retirement, will remain undetermined, each option posing more questions. The evidence does, however, raise the possibility of other soldiers living in Karanis after the 2nd century, which would represent a continuation of the tradition of military personnel being based in that village, and in the Fayum region as a whole.

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Examination and Conservation Treatment of a Roman Leather Cuirass in the Collection of the Kelsey Museum of Archaeology

Claudia Chemello

In 2011, the Kelsey Museum of Archaeology planned a display of archaeological artifacts from the site of Karanis, Egypt, entitled "Karanis Revealed." The artifacts, excavated by the University of Michigan in the 1924–1925 Karanis field season, included fragments of Roman leather body armor, thought to be a cuirass. The misshapen, fragmentary, and extremely fragile pieces of the cuirass have been stored in various environments since excavation and were eventually accessioned into the collection of the Kelsey Museum. The process of examination and documentation of the armor is described, as well as the problems associated with a past treatment that used oil to preserve the leather, its consequences, and the conservation options for treatment.

Description of the Armor

The cuirass consists of numerous rectangular pieces of leather sewn together to form overlapping scales. The armor, although made from leather, is similar in appearance to the metal armor type *lorica squamata*, the so-called scale armor formed from rectangular metal lamellae. The armor has previously been identified in Kelsey Museum accession records as a cuirass, referring to body armor for the torso, although not enough of the cuirass survives to make an accurate assessment of its exact placement on the body.

Other examples of this type of leather armor are rare. An extensive literature search produced only one example of a similar type of leather armor, excavated at the site of Dura Europos by the Yale University/French Academy excavations in 1928–1937. Among the objects excavated at this site were three pieces of leather armor described as thigh armor (Yale numbers 1938.5999.1009 and 1938.5999.1143). These pieces are made from individual rectangular leather scales laced together with leather thong. Although made from leather, the scales differ in size and shape from those of the Karanis armor, and the lacing system is different.

The overall color of the leather cuirass from the Kelsey's collections is medium brown, with some areas quite darkened from the effects of surface dirt as well

Fig. 44. Overall view of the leather cuirass before treatment (photo author).

as darkening caused by oil staining from a previous treatment. Other areas, including most of the reverse side, are generally a light tan color. The outer surface of the leather is somewhat smooth in appearance, but the inner, or flesh, side is mostly rough, with a fibrous appearance (there are some exceptions where the inner side is smoother). This part of the skin, called the *corium*, is composed of a network of fibrous collagen bundles, clearly visible on the Karanis cuirass. The leather appears to have layers of tissue remaining on the *corium*, as if the skin were not completely scraped. On the outer surface of the leather, called the grain layer, hair follicles are clearly visible on many of the scales, and when viewed with magnification the follicle pattern resembles calf or cow skin (Kite and Thomson 2006). The follicles are numerous, close together, and somewhat regular. One or two of the scales preserve small patches of animal hair that are short and white/gray in color.

The armor survives in six large fragments that are wider than 13.5 cm, as well as nine medium-sized fragments that are wider than 5 cm, with multiple small fragments and a tray of tiny fragments. In addition to the lamellar scale armor fragments, there are multiple fragments of thin leather that appear to have detached from a lining sewn onto the inner side of the cuirass. On several of the larger fragments, the lining remains attached to the armor. In addition, there are strips of edge binding, some still in place on the armor and some detached.

Several of the scales show areas of red color on the outer surface, possibly red pigment. The color was applied after the armor was constructed, as indicated by the fact that usually one half of the scale is missing the red color where it was originally shielded by the neighboring, overlapping scale.

Construction Overview

As described, the armor consists of four main elements: the small, thick scales or lamellae; the thin leather lining; the edge binding; and the leather thong that stitches all the elements together (fig. 44).

Scales: The lamellar scales are generally rectangular in shape and appear to be cut on all sides. A few have ends that are clipped on a diagonal. The average length of each scale is 5.6 cm, with variations as small as 4.9 cm and as large as 6.2 cm. The average width of each scale is 2.1 cm, with variations as small as 1.7 cm and as large as 2.9 cm. The average thickness of the scales is 3.9 mm, with a variation from 1.5 mm to 4.0 mm. The averages were taken from a random sample of 12 scales.

Each horizontal row of scales is arranged in an overlapping pattern. Each scale overlaps its neighbor so that it covers the right, vertical edge. The rows are then stacked and lapped, overlapping from the top down. Three rows of stitching hold the scales together. Two rows of stitching pass through each scale, stitched through two holes at each point, holding each scale to the next. These rows of running stitches pass once through each scale at the bottom and once about two-thirds of the way up. The third row of stitching holds the rows of scales together vertically and is stitched through two holes. These stitches are much longer and straddle several scales; on average about every third scale is caught by a stitch. The holes for stitching were made through the leather from the front to the back, with the occasional hole made from back to front. The instrument used to make the hole appears to have been roughly oval shaped.

Fig. 45. Detail of the exterior surface of cuirass fragment, with overlapping scales and stitching visible (photo author).

The largest of the fragments preserves four partial rows of scales, with fragmentary edge binding and lining *in situ*. Other smaller chunks preserve two and single rows of scales, some with edge binding *in situ*. One fragment of three rows of scales is curved along the top row.

Stitching: The leather thong used for stitching the scales together is approximately 1.5 to 3.5 mm in width, with a roughly rectangular cross section (fig. 45). The thong is mostly light tan to beige in color, is twisted in places, and often narrows toward one end, possibly to assist with threading it through the hole.

Lining: Thin, light tan to medium brown colored leather was used as a lining on the interior side of the armor, covering the stitching and scales. The lining survives in multiple, small, detached fragments and remains *in situ* on at least five fragments. The lining is stitched in place on the edges underneath the edge binding.

Edge binding: The edge binding is a thin strip of dark brown colored leather, approximately 4 cm wide, which wraps around the edge of the armor from front to back and is sewn in place with leather thong through the scales and lining. Edge binding is preserved *in situ* on ten fragments, and there are numerous detached fragments of the binding.

Treatment and Storage History

Prior to acquisition into the collection of the Kelsey Museum, documentation of previous treatment(s) of the leather cuirass is unknown. Several fragments of

the cuirass were exhibited in 1983 in an exhibition at the Kelsey Museum entitled "Karanis: An Egyptian Town in Roman Times." In 1982, during preparation for the exhibition, the cuirass was examined and treated by the museum's conservator at that time, Amy Rosenberg. During examination, Rosenberg noted that the cuirass had undergone previous treatment. Rosenberg describes the leather in her 1982 report as "exuding oily spots onto paper." A wide variety of dressings for leather are known, especially those that involve fats or oils to increase flexibility and water-proofing properties. Archaeological conservation was a relatively new field of study in 1924–1925, the years of the first field seasons at Karanis, when the leather was excavated. One prominent scientist who stood out at that time for his early impact on the field of archaeological conservation was Alfred Lucas (Gilberg 1997). Lucas authored a seminal work entitled *Antiques, Their Restoration and Preservation* (Lucas 1924). In this work, Lucas describes several treatments for preserving dried archaeological leather, including the use of castor oil, lanoline, sperm oil, and vaseline. Techniques for treatment of dried archaeological leather that became common in the 1960s and '70s include impregnation of the leather with polyethylene glycol and vaseline, at high temperature (Plenderleith and Werner 1971).

Following examination, Rosenberg undertook treatment of the leather, presumably to remove some of the oil. Her treatment records that several solvents, as well as polyethylene glycol, were tested for surface cleaning, without success. Treatment then proceeded to soaking of the fragments in acetone, presumably to remove the oil, a procedure that "removed a yellow stain" (Rosenberg 1982).

Little is known of the storage environment or transport conditions of the leather following excavation, during transfer from Egypt to Ann Arbor, or when it first arrived in Ann Arbor. The majority of the museum's collections were stored on the second floor of the 1890s Newberry Hall building prior to 1994. Between 1993 and 1994, the museum remodeled the third floor of the building, adding more floor space to house the Sensitive Artifact Facility and Environment (SAFE), a space with improved climate control. Since 2009, the leather has been stored in a new climate-controlled storage space in the Upjohn Exhibit Wing, the museum's new addition.

Condition of the Leather

Survival of the leather is almost certainly due to the arid conditions in Egypt at the site of Karanis, which favored the preservation of organic materials including basketry, wood, textile, and items of food such as seeds and grains. The condition of the

leather upon excavation is unknown, although presumably the high temperatures on site and desiccated conditions had already led to some degree of permanent damage due to loss of water present in the leather. Damage may have included loss of flexibility, shrinkage, tearing, and cracking. Fluctuations in relative humidity (RH), particularly low RH, highly possible during years of storage in uncontrolled environments, may have led to further deterioration of the already-desiccated leather.

The pre-1982 treatment of the leather with oil has further contributed to its darkened and brittle state. All of the leather scales appear to have received the oil treatment, but the edge binding and the leather lining show no evidence of the oil. In some of the break areas, the entire thickness of the leather appears to be impregnated with oil. In these areas, the fibrous structure of the leather is no longer visible, and, when viewed under magnification, the cross section reveals a shiny, orange-brown dried residue through the entire thickness of the scale, with no collagen fibers visible. The surface of many of the scales has a shiny appearance, with some areas orange-brown in color. The treatment in 1982 to remove the oil by immersing the entire cuirass in acetone almost certainly removed any moisture that remained in the leather, causing further irreversible stiffness.

The majority of the fragments are buckled and deformed, and many are delaminating. Overall, the leather is extremely fragile and fragmentary, to the extent that handling of the pieces during examination and treatment was kept to an absolute minimum to avoid further breakage and loss. Numerous pieces are cracked and broken, with a lot of small, disassociated loose fragments. In addition to the darkening and embrittlement, some pieces of the leather, notably the dark colored edge binding, appear somewhat powdery.

All the fragments are dirty; the dirt varies from a thick, muddy accretion, with embedded grass, to a thinner dusty coating. Insect damage is visible on many pieces, with damage varying from loss of the grain surface only to areas eaten all the way through. The lining is the thinnest piece of leather and as such was the most readily subject to damage. Most of the lining has been lost, with some small sections still stitched in place on the inner side of the armor and the remainder as tiny, loose fragments (fig. 46).

Assessment and Treatment

In consultation with curatorial staff, conservators decided that the overall approach to treatment would be preventive in nature and follow principles of minimal intervention. The condition of the leather and its long-term stability were critical

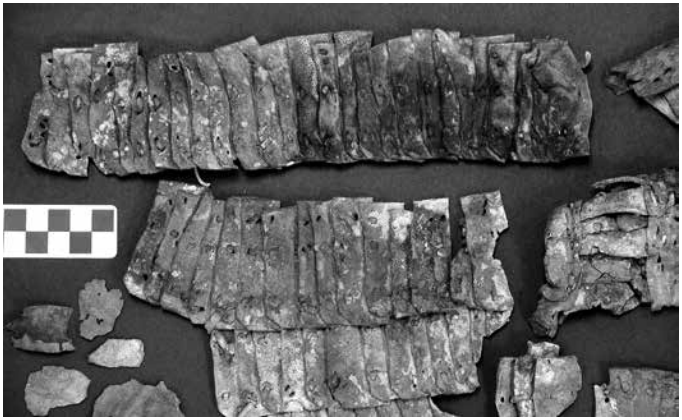

Fig. 46. Detail of various fragments, showing staining and darkening due to previous oil treatment, deformation, and surface dirt (photo author).

considerations, as was the level of deterioration already sustained by previous treatments. An added and significant obstacle was the extreme embrittlement of the leather, causing difficulties in handling. It was further considered to be too aggressive to introduce yet another material, possibly in the form of a consolidant in an attempt to make the leather more pliable, with an unsure outcome and possible irreversibility. Based on the results of humidification tests on samples of the leather with water and solvent vapors, this proved to be a wise course of action.

The first major priority for the leather was full documentation. The pieces were photographed digitally and a condition report recorded into the museum's conservation database. All of the pieces of the armor were described, including the construction and sewing technique, measurements of the individual components, and description of their state of preservation. Arrangement of the fragments during examination afforded a greater insight into their possible layout and position on the torso, and close examination clarified details that were previously unknown or unrecorded. These included the fact that the garment was originally lined, the correct orientation of the scales, the survival of areas of red color on the outer surface, and the likely sequence of construction.

Following documentation, all pieces of the leather were gently cleaned using a soft brush and low suction vacuum cleaner under magnification. Further cleaning was achieved with soft synthetic cosmetic sponges to dislodge areas of resistant dirt. Barely moistened cotton wool swabs of 50:50 deionized water and ethanol were gently rolled over the surface in discrete areas to further remove dirt and grime. Care was taken not to overdampen the surface, to reduce the possibility that

it would become tacky and shiny from reaction with the oil, and to avoid the possibility of localized swelling or staining.

Reshaping of the leather was discussed as a possibility for some parts of the cuirass that were deformed, particularly pieces that appeared to belong to the shoulder and upper torso area. This option was ultimately rejected for several reasons, the most significant of which was the fact that, when tested, the leather scales (the most brittle component of the cuirass) were not rehydrated or softened by either water or solvent vapor and were made slightly tacky by solvent vapors. The edge binding and lining were slightly softened by the water and solvent vapor, but they were also significantly darkened by both. In light of the difficulty of introducing moisture into the leather, the introduction of a consolidant to allow for reshaping was not considered feasible due to the effect of the previous treatment with oil. In addition, the leather can withstand very little pressure without breaking. Reshaping was also not practical without firm stylistic information about the position of the individual pieces of armor on the body.

Tanning Identification

The leather was spot tested for the presence of vegetable tannins with a simple, nondestructive test to establish the presence or absence of vegetable tannins using iron(III) sulfate. The iron(III) ferric ions react with the phenolic compounds present in vegetable-tanned leathers, producing a dark blue or green coloration (Odegaard 2000). Vegetable tanning was the most common form of tanning in use during the Roman period (Cronyn 1990; van Driel-Murray 2002).

The test was performed on tiny fibers of the leather removed from the reverse side. The solution was also applied directly to an unobtrusive area on the front surface of the leather, on pieces of scale, the stitching, the lining, and the edge binding. In each case the sample was viewed under magnification, and no color change was observed. While the result may initially indicate that the leather is not vegetable tanned, modification of the leather during burial, for example by chemical decay, and post-excavation treatment with an unidentified oil may have affected the result and need to be investigated further. The result may also indicate that the leather was not tanned or tanned using another method.

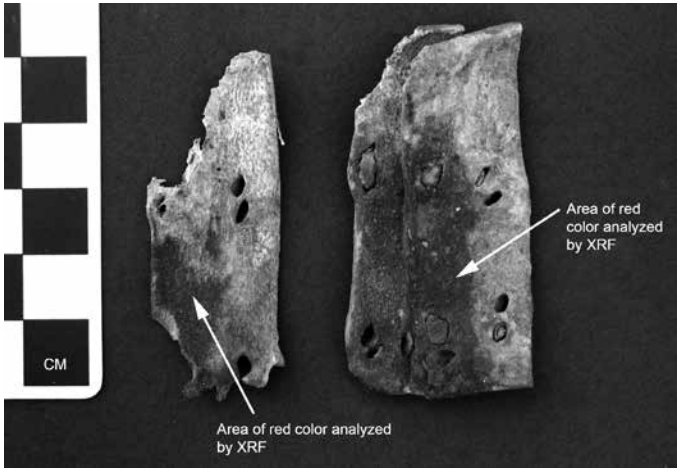

Fig. 47. Detail of the two scales with strong red coloration visible on the outer surface (photo author).

Investigation of the Red Color

As described, several of the scales from the leather cuirass appear to have areas of red pigmentation on the front surface. The application of color appears to be deliberate and was made after the scales were sewn together, as the color is not present where a scale was overlapped by an adjacent scale. Examination with optical microscopy revealed that in some areas the color was powdery and matte in appearance. In other areas it was somewhat hidden underneath the darkened coating of oil.

X-ray fluorescence spectroscopy (XRF) was used to identify major elements in areas of particularly strong red coloration on two detached scales (fig. 47). The red areas were analyzed directly with a handheld Brucker Tracer III-SD instrument. The XRF analysis produced a spectrum consisting of a series of peaks. The energy at which each peak occurs and its height correspond to the element present and its quantity. XRF measurements recorded very strong amounts of iron, as well as small amounts of calcium, probably from the burial environment. The large amount of iron detected in the red areas suggests that these areas were colored with an iron compound. Whether the iron originated from a mineral or organic source and whether it was applied as a pigment or as a dye require further investigation.

Future Research

The display of the Roman leather cuirass in the collection of the Kelsey Museum presented an important opportunity to learn about the condition and preservation of this unique artifact. Although the fragments of the cuirass are extremely deteriorated, with a largely unknown treatment and storage history, the survival of this artifact is quite remarkable. The extreme fragility of the material has guided conservation efforts, with the principle of minimal intervention being the fundamental concern of current conservation efforts.

The results of this initial investigation have opened numerous avenues for future research. Discovering what kind of oil was used to coat the leather would be helpful in determining whether its harmful effects on the leather can be lessened. The effect of the oil on the skin may have compromised further technical examination, but the use of the oil itself provides valuable information about historical conservation treatments and their effects over time.

Additional investigation of the skin might provide further clues as to the curing and/or tanning technique used for the skin. The study of DNA extracted from the leather could firmly determine the animal species used in the manufacture of the armor and confirm visual observations, although the extraction of DNA from archaeological specimens is extremely difficult since often no DNA survives in ancient tissues and what little does survive is frequently contaminated (Hofreiter 2001). Further study of the red coloration could help determine the source of the color and how and why it was applied, providing clues to the decoration of military armor.

Acknowledgments

The author would like to thank Terry Wilfong for including this incredible and unique object in the exhibition "Karanis Revealed," providing an opportunity for examination and treatment. The examination and conservation work would not have been possible without the help of my colleague Suzanne Davis, who helped examine, describe, and document the cuirass. Andrew Ferrara gave many helpful insights into the history, use, and possible configuration of the armor. Caroline Roberts, then Samuel H. Kress Conservation Fellow at the Kelsey Museum, shared helpful information and references about the conservation of leather, and Bruce Kaiser of Bruker Elemental generously agreed to loan a portable XRF to the Kelsey Museum for several weeks for analytical work. Lorene Sterner provided assistance with the digital images.

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