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ARTICLE

Scale armor on the North American frontier: Lessons from the John G. Bourke armor

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In 1870, as he was starting his career as a frontier army officer and anthropologist, John Bourke collected a gorget composed of iron scales and the story that it was a relic of early Spanish exploration of the Plains. This paper describes the Bourke armor and assesses its manufacture, history, and cultural context. The origins of the armor remain uncertain, but it seems unlikely that it arrived during initial Spanish explorations of the Plains. The armor probably dates from before the early nineteenth century.

KEYWORDS Plains warfare, armor, frontier trade

In this paper, we describe and assess the cultural context of an element of scale armor in the collection of the Nebraska State Historical Society (NSHS). As narrow as that topic may sound, the armor in question deserves attention. It

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was collected by an important frontier army officer and early anthropologist, Captain John Gregory Bourke, who mentioned the armor in his published accounts of frontier service. The armor also has remarkable similarities to archaeologically recovered scale armor from northwestern New Mexico that has been linked to the sixteenth century Spanish explorations of North America. If connections to an early researcher and the initial European explorations of the Plains are not enough, the Bourke specimen also opens for consideration the kinds of iron armor acquired and used by native Americans before the middle of the nineteenth century. This paper reviews the known history of the armor, describes how it was made, and discusses processes that may have brought it to the Plains.

The history of the Bourke armor

The documentary history of the Bourke armor begins in the early 1870s when Captain Bourke acquired it. Burke had a distinguished career as a cavalry officer on the staff of General George Crook and as a pioneer anthropologist (Porter 1986). Bourke served at many posts in the Plains and southwest during the Indian wars. He published both accounts of his service and several ethnological studies (Hodge 1896). The armor is mentioned twice in his recollections. In his 1891 memoir "*On the Border With Crook*," Bourke says that he decorated his adobe quarters at the frontier post of Camp Grant in Arizona with an array of ethnographic and natural history specimens as well as "a suit of armor which had belonged to some Spanish foot-soldier of the sixteenth century" (Bourke 1891:7). This was Bourke's first posting after he graduated from West Point in 1869. Photographs of officers' residences at frontier posts indicate that panoplies of arms and locally acquired ethnographic specimens were popular military decorations (Brown 1992:41), but Bourke seems to have viewed the armor as more than mere decoration. He says that the armor was "found by Surgeon Styers [sic], of the army, enclosing the bones of a man in the arid country between the waters of the Rio Grande and the Pecos, in the extreme southwestern corner of the State of Texas" (Bourke 1891:7–8). Bourke's description of the armor is not precise, but he made it sound complex and attractive "a suit of armor – breast and back plates, gorget and helmet – nicely painted and varnished, and with every tiny brass button duly cleaned and polished."

Bourke offered a fuller treatment of the armor in the third volume of his diaries:

> Doctor [Charles] Styers [sic] was a gentlemanly and skilful medical officer. I did not see much of him during the trip, on account of my duties. He very kindly presented me with a suit of old Spanish armor consisting of breast and backplate, helmet and gorget, found near the Western extremity of the "Llano Estacado" or "Staked Plains". This armor was simple in style and construction and no doubt once covered the body of a Spanish or Mexican foot-soldier, who must have lost his life while on some expedition of discovery or war, years and years ago.

> The helmet was a Plain, round casque, with hole in top from which a plume perhaps descended; this helmet was provided with a fixed visor of sheet iron and a gorget or neck-piece of hammered iron scales upon a backing of linen [.] Back and breast-plate require no detailed description; they were merely concave plates of sheet-iron, shaped to fit the body and when in condition for service must have been held in position by buckles at the sides. The breast plate was ornamented around the edges by a line of brass buttons: I carried this old armor with me to Arizona, where the breast and back plate were stolen. The casque and gorget I afterwards gave to the wife of Judge Savage of Omaha, by whom it has been preserved with great care. The age of this armor I never could learn; it was of the style used by Infantry in the 17th and 18th century, but may have been of any period prior to our occupation of Texas and New Mexico: its preservation from rust, is attributable to the extremely dry climate of the Staked Plains where rain falls so seldom (Bourke 2007:255).

These two descriptions are inconsistent. In 1891, Bourke says that the armor had been found "more than twenty years ago … enclosing the bones of man" (Bourke 1891:7). His diary is less certain, saying only that it "no doubt … covered a body" (Bourke 2007:255). The basis of that assertion is not clear. In both of Bourke's descriptions, the armor seems to have included front and back plates as well as a helmet with a fixed visor, and a gorget, or neckpiece. Bourke seems certain that it is remnant of a Spanish military exploration, but describes the armor as both decorated with brass elements and painted, making the piece sound ornamental. In spite of treating the armor like a battle-worthy arm, Bourke is almost dismissive of the breast and back plates, saying they were "merely … sheet iron" (Bourke 2007:255). What seems certain is that the element Bourke called the gorget is indeed the scaled piece in the NSHS collection, since he says that it was made of "hammered iron scales" (Bourke 2007:255).

Bourke seems to have met Dr. Charles Styer at Camp Grant, but their association may have been tenuous given that he consistently misspelled the doctor's name. Dr. Styer was a resident of Pennsylvania who entered the regular army as an assistant surgeon in the 1867 after service in the Civil War (Heitman 1903:935). He served in various southwestern posts and was married in Las Cruces, New Mexico. He may well have taken part in campaigns against the Apache, Comanche, or Kiowa that brought US troops to the arid southwestern corner of the Great Plains known as the Llano Estacado or Stake Plains. Dr. Styer left the army and the southwest by 1878.

By its next published notice, the armor had made it to Nebraska. On November 17, 1907, Robert Gilder, a well-known frontier painter and historical researcher, published a feature article on the armor in Omaha's *Sunday Herald* (Gilder 1907). By Gilder's account, Bourke had used the armor to adorn his quarters as he moved to posts across the West. Gilder also says that during this use of the armor, visitors to Bourke's quarters may have removed some of the scales from the neckpiece, but the photo included with his article shows that it was remarkably intact. The photo shows that by 1907, the scaled element had been attached to a

FIGURE 1 The "front" of the Bourke armor. Most of this surface is covered by overlapping shield-shaped scales with several incomplete scales down the front median. Note the wood slat tacked to the top edge.

wooden slat fitted with a central wire suspension loop. The slat and the loop are still attached to the armor (Figure 1).

Some years before 1907, and certainly before his death in 1896, Bourke transferred the armor to Judge James W. Savage, an early student of Spanish explorations of the Plains. By the time of Gilder's article, the armor was the property of William R. Morris, an Omaha lawyer, "with a passion for collecting antiquities" (Gilder 1907). Morris died about 1900 and his family retained the armor until 1961 when Richardson Morris donated it to the Joslyn Art Museum. In 1990, it was transferred once again, this time as a donation to the NSHS. The armor seems never to have been publicly exhibited and, since 1907, it has not been discussed in print.

Construction of the scale armor

The Bourke armor is composed of a series of fabric layers to which have been attached a dense covering of iron scales (Figure 1). In outline, the armor is an irregular pentagon with a semi-circular opening in the midpoint of the long margin. It has two short parallel lateral margins. Opposite the long margin, the edge of the armor forms an inverted chevron. The whole armor is essentially shoulder width and has a neckline opening. The armor would be worn to protect the chest or the upper back. Some parts of the armor are missing, but overall, enough original form remains to show its construction.

For descriptive purposes, we considered the long straight margin the top of the armor, the bottom being chevron-shaped. The scale-covered surface is the front of the armor, while the opposite surface is the back (Figure 2). Left and right sides of the armor are defined while looking at the scaled surface with the top upward.

The armor is approximately 66 cm wide across the top edge, which is tacked to a strip of unpainted wooden slat with a wire loop that appears to have been attached for some time. The neckline is formed at the center of the straight margin. This

FIGURE 2 Back of the armor. Most of this surface is covered with Fabric 2. Chevroned lines are cotton threads, which attached tapes with riveted scales to the front surface. Note rectangular scales along most of armor's bottom.

semi-circular opening measures 20.3 cm across and 9.5 cm in maximum depth. The straight lateral margins measure 15.2 cm. Along the current lower margin of the armor, a low inverted chevron is centered on the semi-circular neckline. The low point of the chevron is 17 cm below the neckline.

The base layer

Fabric 1, currently visible as the back of the armor, is the core of the armor in that all of the other components are attached to it. The base layer is composed of coarse bast fiber. Both the warp and weft are similar Z-twist threads that are irregular enough to suggest that they were not machine spun. The warp is denser (44 threads/inch) than the weft (34 threads/inch). The base fabric is light tan in color with some brown discoloration, particularly on the bottom right. The base was formed by single piece of fabric cut to a pentagonal shape. The edges were not hemmed. The fabric is intact along the top, neckline, and the edges, but toward the bottom, the fabric is tattered and missing along the same areas where scales are absent.

The degradation is worst in the middle of the right side and near the far left corner. Small tears and holes with rivets, scales, or exposed tape are common throughout this layer. Parallel horizontal stitching is visible across the back of the whole length of the base fabric. This stitching is how the tape with scales was attached to the front.

Woven tapes

The twill woven cotton tapes to which the iron scales that form the front surface of the armor were riveted are called Fabric 2. They measure approximately 3.0 cm wide and consist of two colors. The main yarn of the warp and weft appears to be natural or undyed. Near both selvaged (woven so it will not fray) edges there are stripes formed by eight-thread wide flat-woven sections with blue warp. In use, the tapes were folded in half lengthwise and iron scales were riveted on the doubled thickness. Scales were placed low enough on the open side of the folded

tapes to allow a doubled portion of fabric to protrude above the scales. The exposed fabric above the scales was where the tapes were sewn on to the base layer.

Scales were attached by a pair of rivets that passed through the doubled-cloth layers into holes in the scale and through round washers, and then peened closed. That is, the rivet heads are on the back of the tapes and the peening is toward the front. Scales were densely placed on the tapes. In no case is there a noticeable gap between the scales, but the spacing is not completely regular. In some cases, the scales abut one another, but otherwise, they slightly overlap the adjoining scale. The pattern is inconsistent, with some scales above or below adjacent scales, and others slightly overlapping on either side.

Doubled woven tapes with scales attached were sewn onto the base fabric in generally parallel rows across the entire front of the armor following the contour of the chevroned lower edge of the armor. There are seven continuous rows of tapes with shield-shaped scales below the neckline. Three additional strips of scaled tape filled in the areas to the left and right of the neckline. Scale placement became irregular on these sections of the armor as the angled rows approached the straight top. On both sides, the topmost row was added parallel to the straight top of the armor (see Figure 1). A single row of rectangular scales forms the lower, chevron-shaped edge of the armor.

Although the scales were apparently and systematically attached to the tapes as a separate step before the sewing began, some scales may have been manipulated as the tapes were being stitched to the base. Changing the direction of the tapes to match the contour of the lower edge of the armor thus separated scales along the central line. To fill this parting of the scales, trimmed scales were fitted into the tapes. These partial scales are variously shaped, but they were attached with a rivet or two. Similarly, trimmed and partial scales were fitted along the margins of the neckline. Trimmed scales are also present down the center of the armor where they were fitted to the curvature of the neckline. This cutting and fitting would have demanded adjustment to specific conditions presented as the tapes were fitted over the shape of the garment. The construction likely required metal working tools that would not be part of a tailor's kit.

The tapes were sewn on to the base fabric with a double thread of bast fiber (Thread 1). This thread was knotted and began on the back of the right side of the armor, extending across to the left. Stitches passed up to the front and back downward. Stitches were approximately 2.5 cm apart (the width of the scales) and placed between the rivets that attached the scales. The tapes were securely attached, as the thread for each scale was passed through the base twice. In several places, the thread seems to have been carefully made to pass back on itself as a securing stitch.

Twill fabric

Fabric 3 is present on the back of the top edge of the armor. The surviving fragments of this cotton fabric are tattered and incomplete, hence assessing the original shape of this fabric and overall role in the armor construction is impossible. Surviving fragments have a dark brown color that is noticeably different from the color of the base

fabric. A couple of fragments of this twill fabric are attached at the top of the armor, but under a leather strip that covers the top edge. A small section of similar fabric is present on the bottom row of scales (see Figure 2). It is possible that this twilled fabric may have covered the entire back of the armor, completely covering the base fabric (Fabric 1) and serving as an extra layer of protection from the hard scales for the individual wearing the armor.

Fabric edging

Fabric 4 along the top edge and neckline of the armor appears to have been added late in the construction or perhaps much later after the construction was finished. The edging fabric is composed of flat-woven bast fiber that appears similar to the base layer, Fabric 1. A tan fabric strip covers the top portion of the first layer of scales and is present across both shoulders and the curve of the neckline. The edging is very fragmented with some areas completely missing. It has several patches of black discoloration. It looks similar to the base fabric (Fabric 1) and may have originally been folded over the edge of the armor toward the back. The edging is attached with rivets that pass through some of the scales (Figure 3). The rivets measure about 0.6 cm in diameter on the front and 0.8 cm on the back. The rivets seem similar to those that attach the scales to the tapes.

Leather edging

This is the final portion of the armor. Like the fabric edging, the leather edging may have been added late in the life of the armor. The leather appears to have had a darkened finish. The edging is attached in two pieces at the top along either side

FIGURE 3 Detail of overlapping scales riveted to doubled twilled tape. Note placement of scales slightly below the fold creating the surfaces stitched to base fabric. Slotted screw head with fragment of leather strap is at the center.

of the dip in the neckline with larger rivets than those that were used to attach the scales to the tape. The rivets are placed approximately 4.5 to 5.1 cm apart, each measuring 0.5 cm in diameter on the front and 0.8 cm in diameter on the back. The leather strips are attached to the back of the armor and stand upright rather than wrapping around the edge. The molding strip from which the armor currently hangs is nailed to the upright sections of the leather. The leather was possibly attached to the armor when the wood strip was added.

The iron scales and other metal fittings

The front surface of the armor is covered with iron scales that fall into two distinct categories composed of essentially identical pieces. The regularity of the scales strongly suggests that they were systematically produced with a well-controlled jigged stamping process.

Shield-shaped scales

Most of the armor is covered with shield-shaped scales. The scales have a straight upper edge with lateral edges that start straight and perpendicular to that margin. At the midpoint, the lateral sides curve to a point. The top width of the shield scales measures 2.5 cm and they are about 3.8 cm long. Each scale has a crimped ridge along the top edge and the straight portions of the side margins. They are slightly dished with the concave surface against the tape backing. Each scale has two holes near the upper corners where flat-headed rivets attached them to the fabric tape, Fabric #2. The rivets have a diameter of 0.3 cm on the front and 0.6 cm on the back.

Two variations appear among the shield-shaped scales. As described above, 16 of the scales were trimmed and fitted into spaces created as the scaled tapes bent at the center of the chevron or the neck opening. Trimming generally involved removing an upper corner so that all of the scales are attached to the tape by only a single rivet. Aside from the trimming, they all appear identical to the intact scales. One intact scale, however, appears to reflect a slight production failure (Figure 4). This scale is the same size as the others, but shows a groove along one lateral margin as if it had not been cleanly detached and required a second strike. If this scale is a second, the placement at the very end of one of the scaled tapes may be significant. Perhaps, it was placed on a tape only after other scales were used. This apparently imperfect scale calls attention to the general regularity of the shield-shaped scales. While the scales were the product of controlled production, but the irregular scale suggests that production involved some hand work.

Rectangular scales

Rectangular scales are present along the bottom margin of the armor. Like the shield-shaped scales, these scales are identical to one another, and attached to a doubled fabric tape with flat-headed rivets. Their treatment is similar to the shield-shaped scales. The rectangular scales measure 3.2 cm at maximum length and 2.5 cm in width. Opposite the riveted margin, on their unattached, lower edge,

FIGURE 4 Miscut shield-shaped scale.

rectangular scales create a scalloped edge. Each scale has quarter circles in the corners, separated by two semi-circles. That is, each has three indentations in their lower edge so that together the scales present a continuous margin of fine scallops. The half circles measure 0.64 cm long and 0.8 cm wide. In addition to the completely intact rectangular scales, a single trimmed scale fits the gap that was created in the lower edge of the armor where the rectangular scales formed the inverted chevron.

The armor currently has 302 scales, 280 shield-shaped scales and 21 rectangular edge scales, with one unattached shield scale that was submitted for metallurgical analysis. The total appears to include most of the original scales, but some scales and fabric have obviously been lost along the lower left corner of the armor. Regular spacing of rectangular scales along the lower edge of the armor would accommodate 32 scales, only 21 survive. Reconstructing the original number of shield-shaped scales is harder to determine since their spacing is somewhat irregular. An estimate based on a regular spacing suggests that 12 shield-shaped scales are missing. Those reconstructions suggest that the armor originally had at least 325 scales.

Bolts with spanner nuts

On both the left and right sides, leather straps were attached to the front surface of the armor by iron bolts. The bolts were located in the second scales of the third row of scales up from the bottom, but they were placed below the adjoining upper scale so that they are not easily visible. The bolts passed through the straps, selected scales, all of the fabric layers, and finally through another leather washer before being secured by brass nuts. The bolts measure 7 mm across the head and the round brass nuts that secure them are slotted on opposite margins to accommodate a spanner. At least one of the bolts appears to have been sawed off and slightly peened after it was secured to the brass nut (Figure 5). The leather straps secured by the screws were approximately 1.7 cm wide but only portions survive, so it is

FIGURE 5 Brass spanner nut on the back side of the armor. The coarse texture of Fabric 1 and the stitching that attached tapes of scales to the front surface are clearly visible.

impossible to determine their original length or what purpose they served. Whatever their purpose, the straps and the bolts that secured them were certainly added after the armor had been fully formed. They could have been the last step in the manufacturing process, or may have been added while the armor was in use.

The casque

The helmet in the NSHS collection closely matches the description Bourke presented in his autobiographical publications and is certainly the piece illustrated in Gilder's (1907) newspaper article. Further evidence that the helmet and the scale element have a common history is a simple loop of multi-strand picture hanging wire affixed to a rear interior rivet of the former. The same kind of wire is attached to the center of the wooden slat that holds the gorget. In other words, both were similarly prepared for display.

The helmet is composed of a bowl and an attached bill (Figure 6). Both are made of regularly formed sheet iron. The bowl is a slightly ovoid hemisphere. It is formed of two halves that are joined with brazed laddered seams at the front and rear medians. The seams are well finished, smooth, and the same thickness as the adjacent walls. The sides of the bowl are rounded. Several small dents, and one lateral side, have been bent inward. Its maximum interior dimensions are 21.9 by 17.5 cm and the exterior basal circumference is 64.5 cm. At the top of the bowl is a large round hole that measures 7.6 cm in diameter. The vertical depth from the margins of this hole to the bottom of the bowl is essentially 12.7 cm. The top and bottom edges of the bowl are neatly finished. A lip 4 mm around the top hole was folded onto the interior surface, but not thickened. The lower edge, by contrast, is

FIGURE 6 The casque showing front bill, top hole, and light construction. Note brazed "ladder" seam down front median of the skull section.

neatly rolled into a round, thickened edge that is 3.5 mm thick. The seam of the thickened edge is at the rear median of the bowl. Around the bottom of the bowl, on a line that was scribed on the interior 1.2 cm above the edge are a series of 14 evenly spaced rivets. The rivets have round exterior heads. One rivet is at the front median of the bowl and another at the rear. The others are evenly arranged between these two. The rivets pass through the bowl wall and on the interior are affixed with round iron washers 6 mm in diameter. All of the rivets are present, but four have lost their washers. On the interior, several of the intact rivets hold small bits of a leather strap as evidenced by the surviving fragments. The upper edge of this strap was straight, and if the rivets were at its center, the strap was originally 1.2 cm wide.

The bill of the casque is formed of the same sheet iron used for the bowl and has a round-sided triangular form. The pointed tip of the bill is 6.4 cm from the bowl. The edges are neatly rolled over round wire that is visible on the lower edges of the bill and where the rolled sections meet the bowl. The front of the bill may have been bent downward slightly. In any case, it seems not to have been made as a flat projection. The bill is affixed to the bowl at its broad side by a 1.5 cm edge that was turned upward and attached to the interior of the bowl by three rivets. These rivets are identical to the ones used to attach the leather strap. The central rivet was placed immediately below the central rivet that held the leather strap. These paired rivets give the helmet a small but noticeable front feature.

The casque is currently black, but the exterior appears to be oxidized bare metal. The interior of the bill retains a black painted or japanned finish. This finish was thick enough to cover and fill in open sections of the bill's rolled edge. The lower part of the interior of the bowl also shows a black painted surface. This painted

portion covers 18 cm of the bowl interior. The top of the interior is not finished in this way.

The sheet iron used for both the bowl and the bill measures 0.04 cm thickness. The sheet is smooth and plane, and shows no visible evidence of hammering or spinning. The helmet weighs 500 g.

Metallurgical analysis of the gorget scales

The metallurgical analysis of the armor is based on a single shield-shaped scale analyzed by the archeometallurgy laboratory at the University of Arizona. The analyzed scale had become separated from the rest of the gorget, but it seems to have originally been in the second or third tier of scales on the lower left side of the armor. The analyzed scale was sectioned on a line through both rivets with a thin rotary diamond-edged blade. The top edge with both half rivets in place was mounted in a low-viscosity epoxy resin and ground flat on a mechanical polisher with silicon carbide sandpapers of 240, 320, and 400 grit. The surface was rough-polished with 15-micron diamond paste on a nylon pad, then fine-polished with 3- and 1-micron diamond pastes on a napped synthetic cloth. A perfect polish could not be achieved, because the cloth between the rivet and the plate trapped coarser abrasive particles that were released to produce scratches during fine polishing.

The polished specimen was examined under vertical reflected light at magnifications from 20× to 100×. The thickness of the body is quite consistent at 0.80 ± .04 mm, with the variation being largely due to corrosion. This consistency suggests that the scale was cut or stamped from a plate formed by hot rolling. The metal contains many entrapped slag inclusions (Figure 7). All of the inclusions

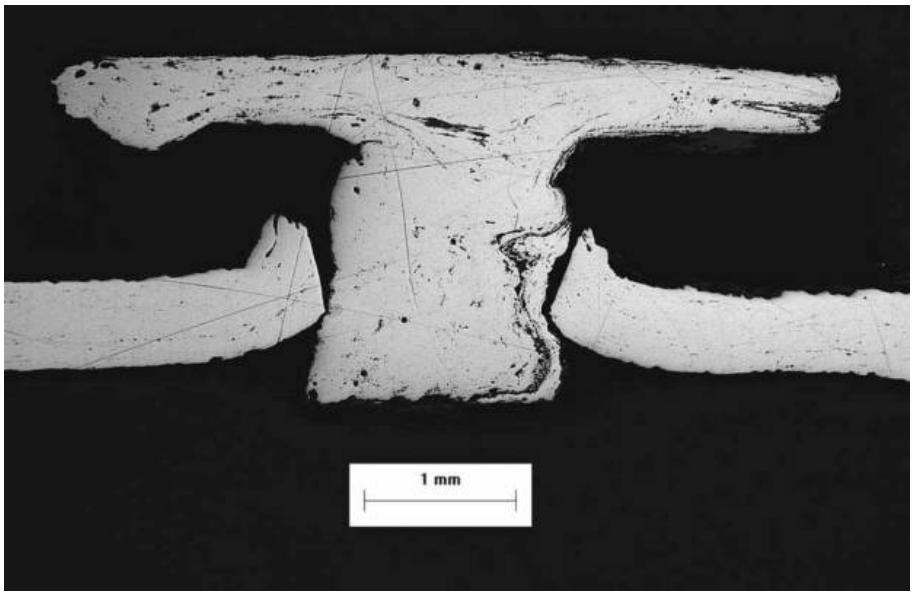

FIGURE 7 Metalographically prepared cross-section of rivet and scale, note evidence that the hole for the rivet appears to have been punched rather than simply drilled. Both pieces have ample inclusions with the rivet apparently coarser.

are glassy, but the larger ones often have partially dissolved crystalline matter in their cores suggesting inadequate time in the forge fire prior to rolling the plate (Figure 8). These slag inclusions show that this plate was made from iron smelted in a bloomery furnace. In bloomery furnaces, metallic iron is directly reduced from iron oxide ore to iron metal without melting, either carbon-free iron or steel, depending upon the technique of the operators. Non-metallic impurities in the ore, such as quartz and clay minerals, combine with some of the iron oxide to form slag. The slag has a much lower melting point than the iron, and thus drains away to the base of the furnace. As the slag drains, the grains of hot metallic iron are pulled together and weld themselves into one or more masses, which are called blooms. Some molten slag is invariably trapped in this process, and while much of this can be squeezed out by hot forging, some invariably remain in the metal.

The presence of slag inclusions distinguishes iron made by the direct process (bloomery) from that made by the indirect process. In the indirect process, iron oxide ores are smelted first to cast iron in a blast furnace. Blast furnaces are generally larger than bloomery furnaces and operate at higher temperatures and more reducing atmospheres. Under these conditions, iron combines readily with carbon from the fuel to produce cast iron, which contains 4.3 to 6.7 percent carbon by weight. Cast iron is molten in the blast furnace and is tapped from it as a liquid, solidifying as pig iron bars that contain almost no slag. To produce low-carbon iron or steel suitable for forging or rolling, pig iron must be re-melted under oxidizing conditions in a second furnace to burn off most of the carbon. Before 1870, cast iron was converted to wrought iron in finery furnaces or puddling furnaces, both of which were made obsolete by the adoption of the Bessemer process from the 1860s and the open-hearth process from the 1870s (Gordon 1996). All of these produced iron with little or no entrapped slag, and metal coming from the latter two

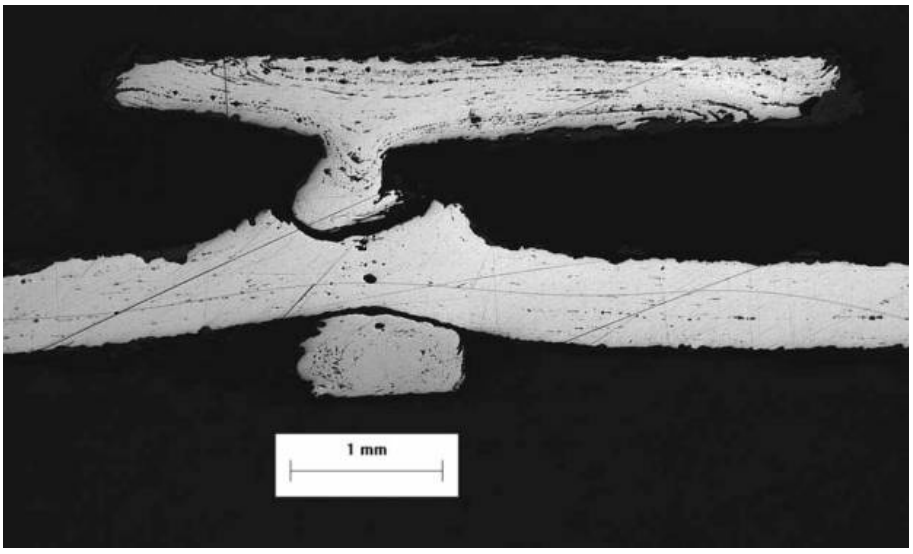

FIGURE 8 Polished surface of a metalographically prepared cross-section of a scale and rivet, note coarse inclusions in scale and especially in the iron rivet.

processes is also recognized by the presence of tiny pink inclusions of manganese sulfides, which are absent from this sample. If the bloomery iron in the Bourke scale armor was imported from Europe, then at least the iron almost certainly arrived prior to the early 1800s. The source of bloomery iron into Spanish colonies would likely be from the Basque region, the main producer of iron for the Spanish sphere (Basurto 1989). No bloomery furnaces have been reported from Mexico, but given the near total lack of industrial archeology or relevant archival research, this negative evidence cannot conclusively rule out the possibility that the iron was made in Mexico.

Both rivets are made of bloomery iron of lower quality than the body. They contain much slag, which shows flow patterns from deformation of the rivet during hot forging, when the slag was in a semi- or fully molten state. These are less obvious in the rivet sectioned through the center (Figure 7) than in the rivet sectioned off-center, where the metal of the rivet overhangs the body (Figure 8).

AMS dating of the fabric

Before it was mounted and polished for metallurgical investigation, fibers between the rivet and the scale were removed and submitted for an Accelerator Mass Spectrometer (AMS) radiocarbon determination at the NSF-Arizona Dating Laboratory. The sample, AA93762, yielded a ^{14}C age of 154 ± 41 B.P. This determination indicates that there is a 95.6 percent probability that the fabric of the gorget was made between A.D. 1665 and 1952. The specimen was cleaned with a solvent extraction prior to dating so that the result cannot be explained by contamination from recent conservation.

Comparisons and context of the Bourke armor

Spanish visits north from Mexico were widely known by the mid-nineteenth century, so Bourke's assertion that the armor had belonged to a "Spanish foot-soldier of the sixteenth century" (Bourke 2007:256) may have been romantic, but not unreasonable. Spanish military explorers, notably including the force led by Francisco Vásquez de Coronado, traveled into the southwest and well into the Plains by the 1540s (Flint and Flint 2003).

Archival research on this entrada has a long history and offered information on how Spanish explorers were organized and equipped (Winship 1896). Description of items in museum collections has also presented information on armor used during the entrada era (Brinckerhoff and Chamberlain 1972; Peterson 1956). Such sources have been significantly expanded by recent careful analyses (Flint 2008; Flint and Flint 2003, 2005a, 2005b) that generally make it clear that the conquistadors carried relatively little armor. Most of the armor they carried was made of padded leather, but Coronado's party had several coats, shirts, and sleeves of chain mail.

Recent archeological discoveries made with systematic metal detection have expanded understanding of the places, events, and material culture that were

associated with Coronado's explorations (Blakeslee and Blain 2003; Blakeslee et al. 1997; Schmader 2011). Hundreds of small crossbow bolt heads and other small metal pieces have been recovered from entrada sites. Discoveries of wire ring mail fragments are not common, but they have been reported from archeological sites as far north as western Kansas (Wedel 1975). An abandoned scale armor would have been scattered into a great many pieces that could easily be located with metal detectors. Still, there appears to be only a single archeological discovery comparable to the Bourke armor. That case deserves special discussion.

In the late 1920s, a mass of rusted iron metal plates was found in open ground near the town of Aztec in northwest New Mexico. The Aztec scales were unsystematically gathered so that their original context is not clear. The scales were maintained in local collections until the mid-1990s when they came to the attention of Dr. Hugh Rogers, a medical doctor and student of local history, who brought the collection to the attention of a number of researchers. A group of six scales were donated to the Arms and Armor Department of the Metropolitan Museum of Art, New York, where they were presented in a pair of publications on the museum's recent acquisitions in Arms and Armor (Pyhrr et al. 2002). The Aztec scales were also described and interpreted in a scholarly paper (Rogers and LaRocca 1999).

The Aztec assemblage, consisting entirely of disarticulated scales, includes a total of 325 pieces, although the reporters estimated that there may have been as many as 500 pieces in the original find. The scales were all heavily rusted and no connecting fibers and fabrics were found. Several of the scales had flat-head rivets in their upper corners. Traces of leather or wool were noted below some of the rivets. The assemblage includes a small number of metal cones and small rectangular pieces that seem to have been cut from shield-shaped scales that form the bulk of the collection. There are two kinds of shield-shaped scales in the Aztec assemblages. A small minority of them have essentially parallel lateral margins with a rather abrupt pointed tip. These scales also have more than one rivet hole on their parallel lateral margins. The great majority of the Aztec scales are identical to the shield-shaped scales of the Bourke armor. They are slightly domed sheet iron plates with crimped edges along the top and upper lateral margins. As described, all measure 25 mm wide by 40 mm long. They have punched holes in the upper corners, several of which hold rivets. The Aztec assemblage has no rectangular scales like those that form the bottom margin of the Bourke armor. Several shield-shaped scales from Aztec appear to be cut or trimmed. These may be comparable to the trimmed scales of the Bourke armor and may indicate that the Aztec scales had been adjusted to fit a chevron or other irregular shape. In sum, there are some differences between the Bourke and Aztec armors, but both were made of identical, systematically manufactured scales that were riveted on to a fabric base. Like the Bourke armor, the Aztec element may have had a chevron shape. The Aztec assemblage may be incomplete, but the number of scales from Aztec is similar to the number of scales used to make the Bourke armor. The two pieces may have been approximately the same size.

Two of the Aztec scales were subjected to metallographic examination at the University of Arizona. Rogers and La Roca (1999) published only a summary of that analysis, which showed that both scales were made of bloomery iron. Recent re-examination of the Aztec specimens shows that they are almost identical to the

Bourke scale. The thickness of the body of the Aztec sample is the same as that from the Bourke scale (0.80 ± 0.4 mm), and the rivets appear almost identical. The only significant difference is that many of the Aztec scales had a thin coating of tin, which would have changed the color and delayed the rusting of the surface.

The interpretation that Rogers and LaRocca (1999) and Pyhrr et al. (2002) offer for the Aztec scale armor reflects expert appreciation of the development of European and world armor. To Rogers and LaRocca, the regularity of the Aztec scales cannot have been achieved by native American manufacture. Rogers and LaRocca also think that they do not match the techniques used on Asian scale armor made as late as the eighteenth and nineteenth centuries. Since scale armor was considered obsolete in Europe by the fifteenth century, Rogers and LaRocca offer two potential explanations for the Aztec assemblage. First, they speculate that the scales may have come from old and obsolete late Medieval gear brought to the New World and made accessible to a soldier of modest means. Alternatively, they suggest that the Aztec scales may be proof that manufacture and use of scale armor persisted later than has been commonly understood "in late medieval or Renaissance Europe" (Rogers and LaRocca 1999:230).

The possibility that obsolete and recycled arms were used by European explorers of the New World certainly deserves consideration, but the genuine paucity of archeological evidence of scale armor at early exploration era sites must mean that the style was at most an extreme rarity in Europe by the sixteenth and seventeenth centuries. Armor composed of iron elements attached to fabric was made into the nineteenth century on the southern side of the Mediterranean basin and across much of North Africa (Springs 1993:33). Scale armor, with shield-shaped elements riveted to a fabric base and featuring chevron-shaped gorgets, was also used by Polish–Hungarian "karacena cavalry" in the seventeenth and eighteenth centuries (Brzezinski 1987:45). Other evidence suggests that, far from being a lost and forgotten design, the construction of scale armor existed in Europe and America up through the nineteenth century.

A number of popular mid-century operas, notably Richard Wagner's *Tristan und Isolde* (1865) and *Die Walküre* (1870), included roles that required armor. Many images of the era present male and female performers in armor. These images indicate that in addition to fabrics with printed or embroidered scale patterns, some nineteenth century operatic costumes had sections covered with metal plates, studs, or scales. Rogers and LaRocca's (1999:230) dating of the Aztec armor rests on the presumption that scale armor had disappeared in European by the fifteenth century. But these images offer evidence that scale armor was known and made in Europe and the West well into the nineteenth century.

Fraternal rituals present another context within which scale armor was being made and used during the nineteenth century. Masonic rituals involved several roles that required armor costumes. Armor and other fraternal costumery appears to have been highly diverse in style and construction. Some costume armor, like turn of the century outfit worn by the young women in Figure 9, seems to have been made of printed cloth. The cut of her chevroned gorget, however, parallels the design of the Bourke armor. The anonymous 1890's lodgeman (Figure 10) wears a similar chevroned gorget, but his appears to have been made by a

FIGURE 9 Young woman wearing a costume of scale-patterned cloth, note chevon-shaped gorget.

network of closely spaced metal scales. Once again, these fraternal outfits demonstrate that scale armor remained a part of western design vocabulary well into the nineteenth century. The popularity and frequency of Masonic organization meant that these garments were common and familiar and widely distributed across North America. Masonic organization could also have provided a mechanism for bringing costumery to the frontier. Lodge goods were readily available through illustrated catalogs and could have reached the frontier early in the nineteenth century. Many mountain men and leaders of the early western fur trade were Masons. Trade records show that at least ceremonial Masonic swords were sent to pre-Civil War rendezvous (Anonymous 2006:9). Kit Carson is also known to have joined a Masonic lodge in Taos, New Mexico, in 1854. The association may be incidental, but Masonic records in Philadelphia indicate that Dr. Styer who discovered the Bourke armor, became a Mason in 1865.

To the degree that scale armor was available on the frontier, native Americans seem to have been interested consumers. Thick leather, occasionally in multiple

FIGURE 10 An 1890's lodge member wearing a chevron-shaped gorget of closely spaced metal fittings.

layers, or overlapping arrangements of discs were worn as armor by both Plains and southwestern horsemen and warriors (Fletcher and LaFlesche 1911:79; Secoy 1992:16). Hairpipe breastplates were also a popular military accouterment among Plains tribes (Jones 2004; Taylor 2005) that Gelo and Jones (2009:60) have suggested were related to Indian-made hide armor.

Historic descriptions of the use of metal armor by Plains warriors include those of the 1780s Comanche leader known as Camisa de Hierro, because he wore a "coat of mail" (John and Benevides 1995:36). Camisa de Hierro supposedly took this garment, an "iron shirt," from a slain Apache opponent. Other names referencing armor were not uncommon among Plains communities (Grinnell 1956:71). In the 1850s, another bold Comanche leader, Iron Shirt, wore a mail garment. He was killed in May 1858 by Texas Rangers firing a buffalo rifle. The iron garment worn by Iron Shirt did not survive, but is mentioned in several after-the-fact accounts of the fight where he was killed (Fehrenbach 1968:502; Gelo and Jones 2009:60). Accounts of that combat seem to be more than a bit apocryphal, but two aspects are relevant to the Bourke armor. First, Iron Shirt's armor is described

as consisting of overlapping plates like the scales of a fish (Sowell 1884:66), suggesting scale armor. Second, Iron Shirt's armor was said to be "left on the bones of some forgotten Spanish soldier" (Fehrenbach 1974:431) implying ancient Spanish origin. Discovery of Iron Shirt's armor encasing a skeleton appears to be speculative, but stories about skeletons in armor were in circulation by at least the 1880s. Since Iron Shirt's story is remarkably similar to the tale that Captain Bourke presented with his armor, indications are that discovery accounts of supposed Spanish armor may have been a popular frontier story.

In addition to Comanche fighters, Grinnell (1956:71) mentions armor-wearing warriors among the Cheyenne, Apache, Pawnee, and Kiowa. These accounts do not suggest that iron armor was ever common, but they do indicate widespread interest in imported armor and familiarity at least with stories of its use. The chronology of these stories is hard to pin down, but accounts presented by Grinnell suggest that armor was in use during the mid-nineteenth century. Accounts presented by Grinnell (1956:75) indicate that Plains warriors such as the Cheyenne Alights on the Cloud regarded iron shirts as useful defensive wear at least against arrows. Plains warriors also seem to have considered iron armor a worthy accouterment. As recognized by Cowdrey (2013) a photograph of Alight-on-the-Cloud seems to show him wearing a scale garment (Figure 11). A recently discovered ledger book that appears to date from the 1860s documents the exploits of the Cheyenne Bowstring Society (Cowdrey 2013). The book shows an engaged warrior wearing a geometrically scaled shirt (Figure 12).

Rich treatments of armor among Plains warriors are also found in the letters George Bent wrote to George Hyde (Hyde 1969, see also George Bent Papers,

FIGURE 11 Cheyenne warrior, Alight-on-the-Cloud (center) shown in a pre-1860 photo. He seems to wear a scaled garment over his chest. Used with permission of the American Philosophical Society.

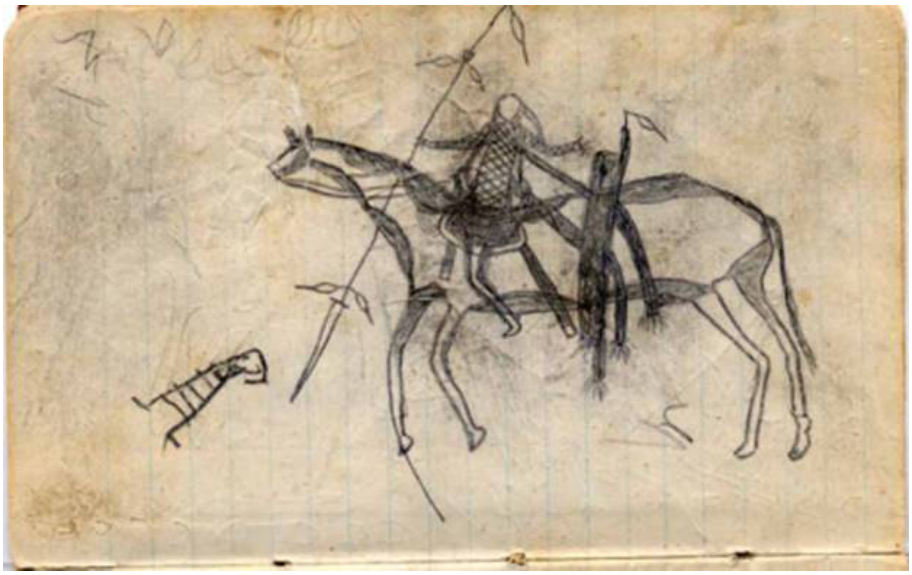

FIGURE 12 A pictographic drawing from the pre-1860 Ledger associated with the Cheyenne Bowstring Society, note the central figure is shown wearing a scaled garment. Used with permission of the PILA, Plains Indian Ledger Art.

Western Americana Collection, Beinecke Rare Book and Manuscript Library, Yale University). These letters were written in the early twentieth century, but Bent was a keen observer and a well-connected participant in Cheyenne society. In his letters, he mentions events that involved armor in the 1840s and 1850s and even in the post-Civil War era. In fact, some of these stories are repeated, suggesting once again that they were well remembered and much recounted.

The Bent accounts present some specific information that may be relevant to the Bourke armor. In a January 1911 letter to Hyde, Bent says that he had seen the armor worn by the Cheyenne warrior Medicine Water and describes it as looking like "fish scales, small pieces very near round about big a quarter dollar, were fastened on with steel wire" (Grinnell 1956:72). In another undated letter in the Yale archives, Bent mentioned Medicine Water and his armor again, saying that the coat of mail had been bought from the Arapahos who had bought it from Mexicans. Bent also states that a Caddoan warrior had taken a coat of mail from a slain Comanche and had given the item to an Army office at Fort Cobb, Oklahoma, a post that was abandoned in 1869 when Fort Sill was opened. While they differ in specifics, these accounts recall the stories Bourke published on the origins of his armor. They indicate that people on the southern Plains frontier were interested in armor and familiar with scale construction.

Conclusions

The Bourke armor is likely a European or Euroamerican product that was brought to the Plains. Unfortunately, the questions of who made the armor, when, and how it arrived on the Plains cannot be unequivocally answered on the basis of the information and analyses presented here.

The fibers and fabrics used in the armor are chronologically and culturally indistinct. Bast and cotton fibers used to construct the armor were readily available to tailors and other manufacturers before the turn of the nineteenth century. Even before the advent of the gin, cotton used to make the twilled tapes to which the scales were attached was available in Europe and colonies across the world.

The regularity with which the scales of the Bourke armor were made shows it to be the product of industrial production. Jig stamping to achieve routine production of regular pieces was well within the capability of colonial American artisans (Mulholland 1981:106). The slotted bolts and spanner nuts that attach the armor's leather straps do not fit a clear type, but they are well formed and finished, suggesting that they were the results of a systematic manufacturing system.

The metallographic similarities between the New Mexico (Aztec) and the Bourke scales, and the fact that both are undoubtedly made of bloomery iron, strongly suggests that they were made no later than the early nineteenth century. After that time, the amount of bloomery iron made in the United States and most of Europe was minuscule. Thus, the iron in the scales must have originated before the early nineteenth century. Since the radiocarbon date on the cloth to which the Burke armor was riveted falls, after calibration, between 1650 and 1950, this garment was likely less than 200 years old when it came into Bourke's possession. The evidence shows that it is not possible that this armor was an obsolete medieval piece pressed into long hard service after the discovery of the New World.

The persistence of costume armor for use in operatic and fraternal activities suggests that although scale armor had lost its utility to European military forces by the time the New World was being explored, European and post-Colonial New World artisans had not forgotten the concept of scale armor. It remained an active if archaic archetype during the nineteenth century. The Bourke armor is therefore unlikely to be costume armor made in the United States during the second half of the nineteenth century for operatic or fraternal activities, since by that time in the country, the amount of iron made in bloomery furnaces was a tiny proportion of all iron manufacture. Still, wherever the armor originated, and whatever its makers may have intended, scale armor likely fulfilled the tactical and symbolic needs of Great Plains warriors. It was used and valued by warriors of the Great Plains. Trade networks of that region certainly provided means of bringing exotic goods to consumers.

With an anthropologist's curiosity, Captain John Bourke collected the scale armor, because it was an interesting artifact. Nearly 150 years later, his characterization remains apt. Viewed in context of modern analytical methods and broad documentary sources, Captain Bourke's armor exposes cultural dynamics and historical issues of the Plains frontier. The armor was certainly not new when Bourke acquired it. But AMS dating and paucity of comparable pieces at sites dating from the initial entrada make it unlikely that it was among the arms carried by the earliest Spanish explorers of the Plains. The armor was certainly brought to the Plains where native warriors formed an eager market for this military gear. Scale armor like Bourke's may have originated as arms in Eastern Europe or from old arsenals elsewhere in Europe. But by the time Bourke got his armor, newly made or recycled iron scales were also being incorporated into theatrical and ritual costumes in Europe and

the United States. Stories linking the armor to the skeleton of a Spanish soldier are not credible, but there is ample evidence that many people on the frontier were interested in armor and stories about its use.

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