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Getting Hammered: The Use of Experimental Archaeology to Interpret Wear on Late Bronze Age Hammers and Modern replicas

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Metalsmithing tools such as hammers are rarely recognised for their significance in understanding prehistoric metalworking technology. Their development and specialisation signal new metalworking techniques and a wider array of the types of metal objects being made. Our knowledge of ancient metalworking is further enhanced by examining the wear on these tools. The various scratches and dents all provide insight as to how the tool was used by smiths and in some cases can aid in the interpretation of metalworking activities relating to specific tasks (Fregni 2014).

> Wear is a valuable indicator of how tools were used and its presence can provide information such as if a hammer was used with another tool, or on sheet metal. Because bronze is softer than modern steel, there is more evidence of damage and wear, giving us a narrative of use embedded in the face of the tool.

Experimental archaeology has proved to be an important archaeological resource for interpretation of these tools and how they were used. Programmes of experiments have enabled archaeologists to answer questions regarding durability and performance of metal tools such as axes and weapons (Mathieu and Meyer 2002; Roberts and Ottaway 2003), however little work has been done to similarly assess metalsmithing tools. Tools such as hammers, anvils, and chisels are necessary for sharpening axes and swords, forming objects from sheet metal, and decorating objects with chasing and repoussé.

Which way is up? Understanding hammers and their uses

Understanding how these tools were used is essential in designing experiments. Hammers from Bronze Age contexts were compared to modern equivalents in order to assess how they might have been used in antiquity. Correlations were made between ancient hammers to tools that were visually similar and are still in use for tasks such as forging, riveting, and jewellery work. Objects such as the small, slender hammers with faceted faces resemble hammers used for riveting or by jewellers for forming precious metal objects (See Figure 1). There are also hammers with wedge-shaped faces that resemble modern forging hammers (See Figure 2) and hammers with curved faces that would be used for planishing, or smoothing forged sheet metal (See Figure 3). However, the most common type of hammer found from the Late Bronze Age in Britain is rarely seen outside of specialist blacksmith workshops where it is used for sheet metal work. This type of hammer has a facetted face and was in use until the turn of the last century when sawblades and other sheet metal objects were still made by hand (See Figure 4).

Wear is a valuable indicator of how tools were used and its presence can provide information such as if a hammer was used with another tool, or on sheet metal. Because bronze is softer than modern steel, there is more evidence of damage and wear, giving us a narrative of use embedded in the face of the tool. For example, if the hammer was used to forge bronze sheet metal, the metal on the face of the hammer will become distorted, resulting in burring (See Figure 5). Burring is caused by the movement of metal along the surface of the hammer face as it is pushed or pulled by the direction and angle of the blow. This results in excess metal forming a flange beyond the edge of the face. It can be useful in determining the intensity of the work, in addition to the direction in which the smith was working. Burrs on the top edge of the hammer face develop when the smith brings the hammer down in an arc, landing the blow near the centre of the face and pulling the tool slightly in order to stretch the metal towards the body.

Likewise, hammers used in conjunction with another tool such as a chisel will have small dents on the surface of the face. By understanding the wear and damage on tools, we can recognise many of the tasks that they were used for.

Maintenance and repairs to tools are also forms of wear. Hammer faces that have been dented or distorted can be restored by abrasion using stones or sand. This activity can still be seen in the form of parallel scratches, often with finer scratches overlaying coarser ones showing multiple steps in smoothing the face of the tool.

Replicating ancient tools

The experimental programme exploring the uses of Bronze Age socketed hammers began with an examination of tools in museum collections. A search was made and a total of 31 hammers were selected for analyses. These tools were measured and photographed, and recorded in a database that also included evidence of wear such as different types of distortion and scratches (See Table 1).

Hammer	Accession Number	Museum	Condition
Hatfield Broad Oak Hoard	151.94	Colchester Museum	Burred, Corroded face
Grays Thurrock Hoard	02/142	Colchester Museum	Very corroded
Nortthampton Hoard	119-28	Northampton Museum	Corrosion, Dings or small dents on both facets of face
Isle of Harty Hoard	1927.2511	Ashmolean Museum	CorrosionApex poorly defined and worn on PL,Parallel scratches evenly spaced, Scratches perpendicular to top edge, Random scratches, Damage to edges of face, Asymmetrical face
Minnis Bay	1961 10.6 33	British Museum	Burred, CorrosionHammer faces appear to have been maintained. Symmetrical face, Scratches perpendicular to top edge, Scratches parallel to top edge,
Bunwell Hoard	1984.1.5	Norwich Castle Museum	Burred, Beautiful condition, asymmetrical face apex pushed up on PL (apex is 10.5 mm from

			top edge on PR and 7 mm on PL), Parallel scratches evenly spaced,
Cranwich Hoard	1993 198.1.1:A	Norwich Castle Museum	Faceted, asymmetrical face but corroded (apex is 7.4 mm from top on PR and 6.4 mm on PL), flash broken off, Parallel scratches evenly spaced, Random scratches
Salisbury Hoard	1998 1-1 224	British Museum	Corrosion,worn, rounded face
Hevingham Hoard	2003.171.1-6	Norwich Castle Museum	Asymmetrical face, apex pushed up on PL, Parallel scratches evenly spaced,
Thorndon Hoard	52 G-26 88	British Museum	Appears that the hammer face was maintained before deposition. Dings or small dents on both facets of face.Damage to apex of face. Two sets of fine parallel scratches evenly spaced on edge of narrow facet of the face. Long parallel/perpendicular scratches on the wider facet of the face. Parallel scratches evenly spaced, Casting seams in interior are on top and bottom rather than sides Asymmetrical face apex higher at PL
Hambledon	AY 407.2	Winchester Museum	Heavily burred, heavily corroded, Parallel scratches evenly spaced, Scratches perpendicular to top edge
Isleham Hoard	X20.1	St Edmundsbury Heritage Service	Corrosion,Face pitted but scratches visible, Scratches perpendicular to top edge, Dings or small dents on both facets and edges of face
Isleham Hoard	X20.2	St Edmundsbury Heritage Service	Corrosion, very uneven well used surface, heavily burred, Damage to edges of face, Deformation or cracks on face, Asymmetrical face
Isleham Hoard	X20.3	St Edmundsbury Heritage Service	Corrosion,Very uneven, Asymmetrical face, well used surface, heavily burred, Deformation or cracks on face
Donhead St. Mary's Hoard	IC5A.5	Salisbury & South Wiltshire Museum	CorrosionPeaked face, very symmetrical
Grays Thurrock Hoard	02/143	Colchester Museum	Burred, CorrosionAppears that the hammer face was maintained before deposition, Parallel scratches evenly spaced, Scratches

			perpendicular to top edge, Scratches parallel to top edge
Single find / Lakenheath	1927 2662	Ashmolean Museum	CorrosionVery heavy, rounded face, Dings on edge of face
Leigh II Hoard	276.55	Southend Museum	Corrosion,A lot of abrasion, Scratches perpendicular to top edge, Scratches parallel to top edge
Leigh II Hoard	276.56	Southend Museum	Corrosion,Wedge shaped face, could be a stake, distinct apex
Grays Thurrock Hoard	02/144	Colchester Museum	Corrosion,Appears heavily used, severe burring, Deformation or cracks on face, fragment
West Kennet Longbarrow hoard	1987.45.1	Wiltshire Heritage Museum in Devizes	Corrosion,Asymmetrical face appears higher on PL, although corroded, Dings or small dents on both facets of face, Damage to edges and apex of face
Salisbury Hoard	1998 1.1.225	British Museum	Burred, Corrosion,Angled face, Damage to edges of face
Salisbury Hoard	2000 1.1.226	British Museum	Corrosion,Asymmetrical face
Salisbury Hoard	2001 06.01.1	British Museum	Burred, Corrosion,Has loop, possibly cast from modified axe mould. Face is modified to have triangular shape
Salisbury Hoard	1998.9.1.227	British Museum	Corrosion,Wedge shaped face, Scratches perpendicular to top edge, Damage to apex of face
Taunton Workhouse Hoard	42 A	Taunton Museum	Burred, Parallel scratches evenly spaced,
Lusmagh Hoard	83 02.18.20	British Museum	Slanted face, Scratches parallel to top edge, Dings or small dents on one facet of face
Lusmagh Hoard	83 02.18.21	British Museum	Slanted face, Dings or small dents on one facet of face, Damage to apex of face, Damage to edges of face
Burgess Meadow Hoard	AN 1836 p 122.23	Ashmolean Museum	Corrosion,Parallel scratches evenly spaced, Scratches could be maintenance, but hammer is very corroded
Beechamwell/single find	NCM 1949.209	Norwich Castle Museum	Burred, Corrosion,Tanged hammer , unusual dings and dents all over body, Dings on edge of face, very burred, Asymmetrical face
Carleton Rode Hoard	NWHCM : 1845.70.16	Norwich Castle Museum	Burred, Corroded face

TABLE 1. HAMMERS EXAMINED IN MUSEUM COLLECTIONS AND THEIR CONDITION.

A portion of the hammers were also analysed for chemical makeup with pXRF. This was used in combination with previously published analytical data in order to replicate alloy recipes that would be used for recreating the hammers (Brown and Blin-Stoyle, I959, Hughes, 1979, Tylecote, 1986, Northover, 1989).

The experiments

The programme of experiments was designed to use the tools in tasks that would have been routine in the Bronze Age. Before the tools were used, they were measured, photographed, and impressions taken using a polymer compound. After use the tools were examined for evidence of wear, and recorded in the same way in order to compare the results.

Replicas of two types of socketed hammers were cast using an alloy of 85% copper, 10% tin, and 5% lead. Putting the hammer heads on handles was as much an experiment as the cast portion of the tool. No hammers have been found with remnants of wooden handles, so handles were made from a variety of woods including oak, cherry, and willow. These were made in varying lengths and widths to maximise the hammer's functionality for different tasks. Heavier oak handles were used for forging hammers, while cherry was used for lighter, chasing hammers where a springier action is desired. Initially, the haft was secured with rawhide. However it was found that if the section of the handle that went into the socket was carved to fit exactly, and then a small strip of leather wrapped around it before insertion, the hammer head was secure and needed no additional binding.

The experiments included removing flashing from cast objects, sharpening an axe, carving a stone mould, forging bronze bars, and maintaining the tools.In order to ensure the success of the experiments it was important that the tasks be undertaken by experienced metalsmiths.

Removing flashing from cast objects: a replica hammer and chisel were used to break flashing from several axes after they were removed from the mould and allowed to cool. The axes were supported on a large, flat piece of flint that was used as an anvil. The action was performed quickly and easily with no visible damage to the hammer or chisel.

Sharpening/putting an edge on an axe: A socketed hammer was used to restore the edge on a bronze axe that was cast from 10% tin bronze. The experiment was performed by Mr Pádraig Mc Goran, a professional sculptor and metalsmith. Mr Mc Goran is a member of Umha Aois, a group based in Wicklow, Ireland dedicated to researching and experimenting with Bronze Age metalworking technology. The axe was being used to carve a log when it hit a nail beneath the bark, gouging a large notch in the edge. The blade was ground back so that it had a curve similar to its shape before the damage. The hammer was used as cast, without hardening and was hafted with a heavy oak handle for additional weight. A large bronze bushing was used as an anvil. After ten minutes of hammering, the axe was annealed in a charcoal fire. After an additional 45 minutes the blade was 0.9 mm thick and the axe blade was finished with light sanding and stropping with leather Initially the axe blade was 95.2 mm from tip to tip and 35.4 mm from the centre of the blade to the edge of the stop. After sharpening the axe blade had widened to 99 mm and lengthened to 38 mm, giving the blade more pronounced points at the corners of the blade (See Figure 6). The hammer was initially chosen because of the wide flat face of the lower facet, however the work was done using the top facet of the hammer's face since it was found that there was more control. It was noted that the hammer did not rebound in the same manner as a steel hammer does when hammering bronze. In addition, unlike a steel hammer, the bronze hammer left no marks on the edge of the axe. The metal was planished—that is that the hammer smoothed the metal as it was used—leaving a relatively even bevel leading to the edge. Overall the hammer performed excellently, however the apex of the face was reduced to a flattened band across the centre, and the circumference of the face was deformed and burred.

Using bronze tools to carve a stone mould:A hammer and two chisels were used to carve a piece of purple limestone. Before work the face of the hammer was 35 mm wide, with an upper facet of 17 mm and a lower facet of 23 mm. After the work was completed, the hammer was36 mm wide with a bevelled face that measured 21 mm for the upper facet and 22 mm for the lower. The face was also covered in small dents from hitting the butts of the chisels (See Figure 7).

Forging bronze: A hammer with a wedge-shaped face was used to forge 8 mm diameter 10% tin bronze round bars into square bars for making chisels. The hammer was used as cast, with no prior hardening. Work was done continuously for one hour and nine pieces were forged with a combined length of 756 mm. Within ten minutes of work, the hammer performed as well as a steel hammer. After 20 minutes of use, the top edge of the face had a distinct burr and the bottom edge was rounded. After one hour, the hammer had rippled distortion marks above and below the apex of the face, which was now flattened (See Figure 8).

Maintaining tools: During the course of the experiments the hammers sustained noticeable wear, including burring, dents, and rounded facets. After having been used for carving the stone mould, the face of hammer was restored using a piece of coarse Derbyshire gritstone. The process took five minutes for the upper facet and ten minutes for the lower facet, which had sustained more damage. Afterwards the hammer was ground against a piece of finer gritstone for two minutes in a direction perpendicular to the first grinding. The grinding left fine parallel horizontal scratches, although some deeper vertical scratches remain from the coarser stone (See Figure 9).

The condition of these tools was compared to wear seen on the original prehistoric tools in museum collections, and a connection could be made between the wear exhibited on reconstructed tools, and the original ancient ones. However, while their use in Bronze Age contexts could be inferred by the resemblance between the wear seen on experimental tools, it cannot be assumed that they are definitely the result of specific tasks (Roberts and Ottaway, 2003, 123). Hammers serve a variety of purposes, and although modern tools often have specialised functions we cannot assume that this was the case in prehistory.

Wear on archaeological tools

The hammers examined in museum collections were now assessed for wear and damage in order to compare them to the replica tools used in experiments (See Table 2). This wear can be categorised either in the form of a smoothed surface or damage such as nicks and dents. As seen in the experiments, hammers used directly on metal developed smooth faces with rounded facets, and burrs on one or more edges. However, the hammers that were used to strike other tools had small dents on their faces. Maintenance such as abrasion can remove evidence of damage, but the fine scratches that remain are another form of wear.

Number of Hammers	Type of Wear	Interpretation of Wear
12	Burring	Heavy use. Location of burring can indicate direction of work.
1	Rounded face	Used for sheet metal work
5	Deformed face	Heavy use, possibly mounted upright and used as a stake
5	Small dents	Hammer used to strike chisel or other metal tool
10	Fine parallel abrasions	Maintenance by abrasion, either with sand or whetstone
7	Apex of face asymmetrical	Heavy use, possibly for sheet metal. Change in apex can indicate handedness of smith.

TABLE 2. TYPES OF WEAR AND INTERPRETATIONS.

Observations of wear indicated whether a hammer was used directly on a metal object, where the apex of the hammer faces was flattened and the edges were burred. This can be seen in both the hammer from the Isleham Hoard and the experimental hammer that was used to sharpen the axe (See Figures 5 and 6).The experimental hammer was used for approximately an hour to produce the degree of burring seen in Figure 6. The Bronze Age socketed hammers exhibit varying degrees of burring, and in the more extreme cases it could be said that they were used for a longer time or more intensively than the experimental hammer.

Of the 31 hammers examined, twelve hammer faces were burred, four hammers showed damage to the facet on the face, and five hammers were considerably distorted. This distortion could indicate that they had been mounted upright and used as stakes, a use that would also contribute to burring. Socketed hammers have the potential to be mounted upright and used as stakes for forming sheet metal objects (Childe 1946; Untracht 1968; 1985). On some hammers the entire head appeared distorted. This was also seen on an experimental hammer and is an indication of heavy use (See Figure 6).

Eight of the hammers had small dents on the face that could be attributed to use with a chisel or similar tool. While most of the hammers suffered from pitting due to corrosion, some displayed pitting that was not associated with corrosion.

One of the most common signs of wear on Bronze Age hammers is evidence of fine parallel scratches, often in perpendicular layers. Twelve of the hammers examined had fine parallel abrasions, and three had layers of scratches that were perpendicular to each other. These were most often seen at the edges of the face and continued beneath the layers of corrosion, indicating that they were a result of activity in antiquity, rather than a result of modern cleaning. As seen in the experiment, the parallel scratches could be attributed to maintenance from sanding or rubbing with a rough stone. This would be done to restore the face to the proper angle, or to remove dings or other damage to the face of the hammer.

Comparing wear

When comparing the wear seen in the tools used in the experiments and those from antiquity, it was noted that the wear on the faces of the hammers tended to be uneven. It was observed during the experiments that tools used by a right-handed smith mirrored that of a left-handed smith. Similar wear was observed on the hammers examined in museums. When the hammer from the Bunwell Hoard is compared to the ones used in experimental work, it can be seen that handedness affects the direction of the wear (Figure 10), indicating which hand the smith used while using the hammer.

By using these tools in experimental work, improved knowledge of tool function and the organisation of the metalworker’s craft emerged. The experiments provide physical evidence of metalworking tasks and how wear can be used to interpret tool use. When wear on tools used in experiments is compared to that seen on museum objects, statements could be made about the type of tasks for which the original tools were used to perform. In addition, evidence of maintenance such as whetting or sanding indicates that the tool had value since it was considered worthy of restoring the working surface.

Wear can also be used to identify traits as ephemeral as which hand a smith used while hammering.These experiments provide insight and information about Bronze Age smiths and the craft of metalsmithing, and give greater appreciation for objects that have so far received limited study.

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bronze
tools
metal working

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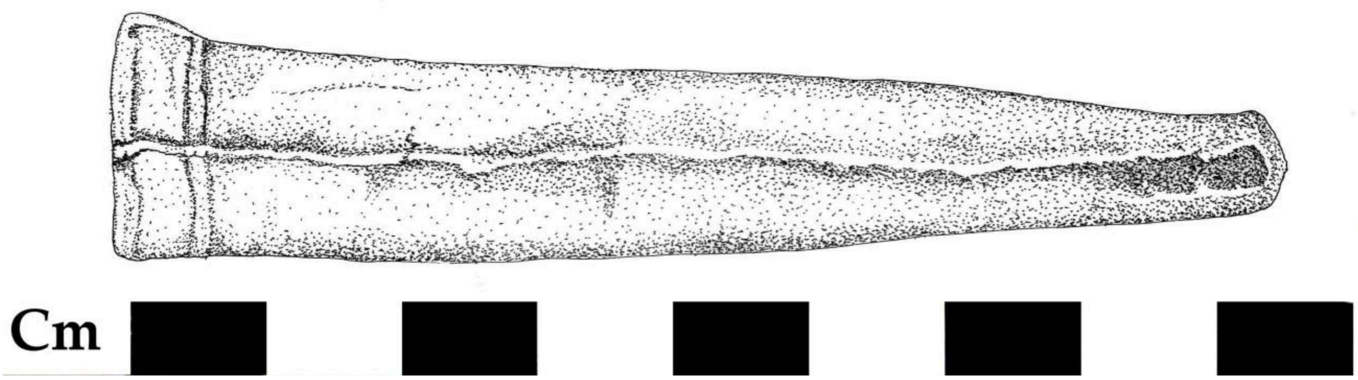

FIG 1. SMALL, SLENDER HAMMER OF A TYPE USEFUL FOR BOTH ORNAMENTAL WOK AND RIVETING.

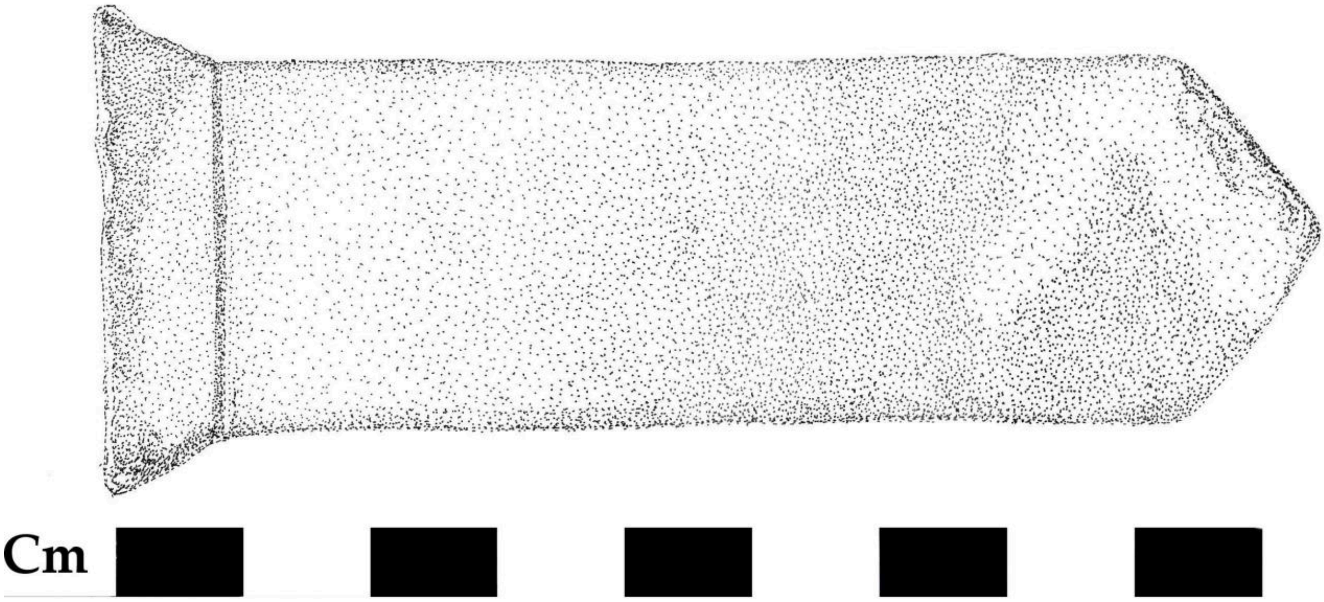

FIG 2. LARGER, HEAVIER HAMMER WITH A WEDGE-SHAPED FACE USED FOR FORGING.

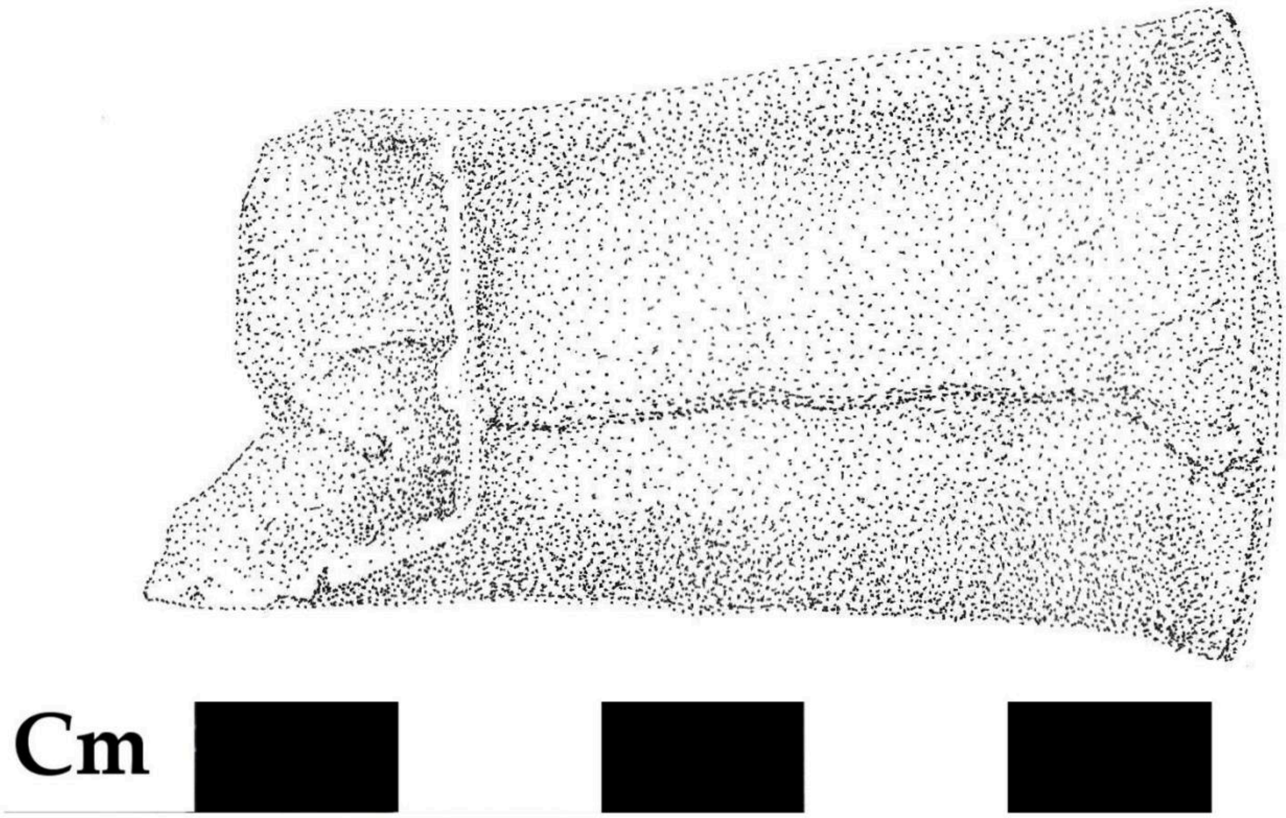

FIG 3. HAMMER WITH A CURVED FACE FOR SMOOTHING METAL.

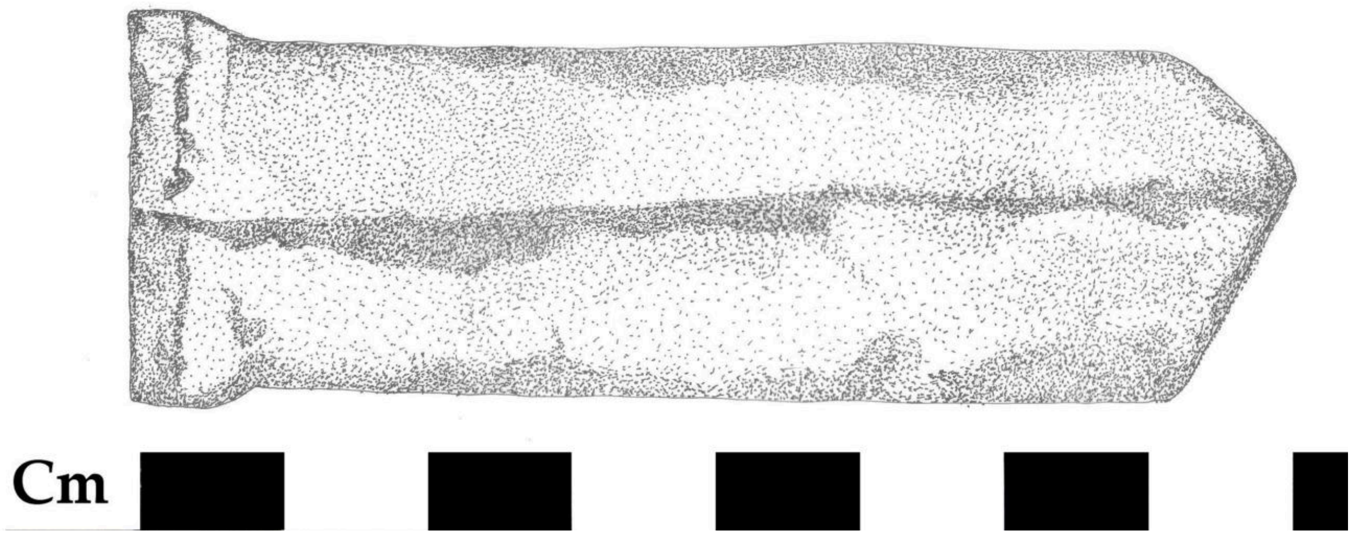

FIG 4. HAMMER WITH A FACETTED FACE. THIS HAMMER IS USEFUL FOR A NUMBER OF TASKS INCLUDING FORMING SHEET METAL AND FOR USE WITH CHISELS OR CHASING TOOLS.

FIG 5. AN EXAMPLE OF A BURRED HAMMER FACE (COURTESY OF ST EDMUNDSBURY HERITAGE SERVICE).

FIG 6. SHARPENING THE AXE: THE AXE AND HAMMER BEFORE SHARPENING ARE SHOWN ON TOP, AND AFTER THE EXPERIMENT WAS COMPLETED THE SAME OBJECTS ARE SHOWN BELOW. NOTE THE CHANGES IN THE DIMENSIONS OF THE AXE BLADE AND THE DEFORMATION OF THE HAMMER FACE AND HEAD.

FIG 7. HAMMER FACE AFTER USE WITH A CHISEL.

FIG 8. BEFORE USE THE HAMMER FACE WAS WEDGE-SHAPED. AFTER USE THE PEAK OF THE WEDGE IS FLATTENED AND BURRING CAN BE SEEN ALONG THE TOP EDGE OF THE FACE (ON THE LEFT).

FIG 9. FINE SCRATCHES CAN BE SEEN ON THE FACE OF THE HAMMER AFTER SANDING WITH GRITSTONE. LARGER SCRATCHES CAN BE SEEN UNDERNEATH THE FINER ONES, ILLUSTRATING THE PROCESS OF STARTING WITH A COARSER ABRASIVE AND CONTINUING WITH A FINER ONE.

FIG 10. EVIDENCE OF HANDEDNESS IN WEAR: BEFORE USE BOTH OF THESE HAMMERS HAD SYMMETRICAL FACES. THE HAMMER ON THE LEFT SHOWS MORE WEAR ON THE PROPER LEFT (THE HAMMER'S LEFT) OF THE HAMMER, WHERE THE APEX IS WIDER AND MORE FLATTENED THAN ON THE PROPER RIGHT. ON THE OTHER HAMMER, THE UPPER PROPER RIGHT OF THE HAMMER IS FLATTENED AND DISTORTED (INCLUDING BURRING) AND THE APEX IS MORE FLATTENED ON THAT SIDE.