Hate or glory: a categorical and experimental consideration of Bronze Age halberds in Scotland in relation to MBA weaponry

Rachel Faulkner-Jones

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University of Edinburgh

School of History, Classics and Archaeology

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ABSTRACT AND LAY SUMMARY

Despite being one of the largest collections of their type in Europe, the Early Bronze Age halberds in Scotland have not been catalogued or analysed since Coles' 1968-9 work. Accordingly, every halberd in Scotland was recorded and catalogued to assess the size and level of preservation of the assemblage. Experimental work using a replica halberd was designed to determine the combat capabilities and limitations of the weapon, and to determine the extent of damage inflicted on the blades during interpersonal combat. Prior to this, experiments using a replica Middle Bronze Age dirk from Friarton, Perthshire were designed to establish the methodology and experimental protocol. During the creation of the experimental protocols, parameters considered included the design and manufacture of the replica, the human tissue analogue used, the layout and audience for the experiment, and the subsequent data analysis. The experimentally derived data on the dirk were compared with extant catalogue data to investigate whether the damage inflicted on the replica blade could be observed on the prehistoric dirks. Following the methodology and experimental protocol refined following the investigations with the replica dirk, the replica halberd experiments were then undertaken, first using Synbone™ as a skeletal tissue proxy, and secondly a pig carcass as a soft tissue proxy. The damage to the replica halberd blades observed following the experiments was analysed and compared to the newly-catalogued prehistoric halberd assemblage An interpretative model synthesising all the halberd data was then derived as one possible interpretation as to the uses and distribution of the halberds; the halberds were shown experimentally to be functional combat weapons, able to be used effectively with no great amount of training or mobility, and the mending and conservation evidence in the prehistoric assemblage is hypothesised to be linked to their role as combat and political power proxies in long-distance communication networks across northern Europe.

This thesis consists of 89,646 words.

DEDICATION

For my daughter Ada, an excellent reason for this taking six years instead of three.

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ABBREVIATIONS

ACMS	Aberdeenshire County Museum Services
ADS	Archaeological Data Service
BAR	British Archaeological Report
CUP	Cambridge University Press
Disc Exc Sc	Discovery and Excavation in Scotland
EBA	Early Bronze Age
EUP	Edinburgh University Press
GMRC	Glasgow Museums Resource Centre
HV	Hardness Value
ILW	Innovative Learning Week
JRSAI	Journal of the Royal Society of Antiquaries of Ireland
MBA	Middle Bronze Age
NGR	National Grid Reference
NMS	National Museums Scotland
PBF	Prähistoriche Bronzefunde
PPS	Proceedings of the Prehistoric Society
PPS	Proceedings of the Prehistoric Society
PSAS	Proceedings of the Society of Antiquaries of Scotland
TAFAJ	Tayside and Fife Archaeological Journal
XRF	X-Ray Fluorescence

LIST OF PUBLICATIONS BY THE CANDIDATE

Faulkner-Jones, R. 2013. "Non-funerary weapon deposition in Bronze Age Scotland", MSc (Research), University of Edinburgh: Scotland.

Faulkner-Jones, R. 2016. "Experiments with the replica Friarton dirk", *Tayside and Fife Archaeological Journal* 21-22, 1-6

Faulkner-Jones, R. 2017. "Middle Bronze Age Weaponry in Scotland: a case study in applied queer theory" in O'Sullivan, R., Marini, C. and Binnberg, J. (eds.) *Archaeological Approaches to Breaking Boundaries: Interaction, Integration, and Division (Proceedings of the Graduate Archaeology Oxford Conferences 2015-2016; British Archaeological Reports International Series: 2869* (Oxford: Archaeopress), 7-13

Faulkner-Jones, R. 2020. "Applying Experimental Techniques to Combat Archaeology and Catalogue Studies: Exploring the Scottish Halberds" in Mason, O. and Cooper, M. (eds.) *Proceedings of the annual Neolithic Early Bronze Age Research Student Symposium 2014-2018* (Oxford: Archaeopress)

Chapter 1 – Introduction

1.1 Background

“Out of the sea a man rose, a fellow came up from the billow:
He was not as big as big goes, nor all that small as small goes
But as tall as a man’s thumb, as high as a woman’s span.
Copper was the hat on his shoulders, copper the boots of his feet
Copper mittens on his hands, copper the patterns on the mittens
Copper the belt round his waist, copper the axe at his belt,
Its handle tall as a thumb, blade as high as a fingernail”
Kalevala, Book II

The Early Bronze Age halberd is the earliest European weapon type that can unequivocally be considered a weapon, in that it is not suited for any function other than interpersonal combat (Mercer 2007:127) - unlike the contemporary flat axes and small daggers, which could also have been used for other purposes including carpentry, and food and textile production, as well as potentially in combat. The largest and best-studied assemblage of halberds in western Europe is found in Ireland, where type-specific research began early in the twentieth century (O’Riordain 1937) and has continued since (Harbison 1969, O’Flaherty 2002). The Scottish halberd assemblage, however, has not received the same degree of scrutiny, nor of publication. A Scotland-specific catalogue (Coles 1968-9) noted the prevalence and variety of the halberds, and a later catalogue of British axes included all of the then-recovered blades as a type of axe, rather than as distinct objects in their own right (Schmidt and Burgess 1981), but comparatively little analytical study had been applied to the assemblage. However, there has been more generally a recent renaissance of halberd studies across Europe (though not specifically in Scotland), where modern scientific methods and contemporary theoretical approaches have been applied to the assemblages to better understand their use and distribution (for Britain, see Bray and Pollard 2012; Dolfini 2011; Molloy and Grossman 2007; Needham et al 2015; Needham forthcoming; O’Flaherty 2002 and 2007; O’Flaherty et al 2002; Pollard, Bray and Gosden 2014; Pollard and Bray 2015: for continental Europe, see Brandherm 2004 and 2011; Horn 2013a and b, 2014 and 2017). Scientific approaches include provenance studies based on compositional analysis (Bray and Pollard 2012; Bray and Gosden 2014; Pollard and Bray 2015), edge-wear analysis (Dolfini 2011; Horn 2017), and experimental testing (O’Flaherty 2007). Theoretical approaches include closer examination of the psychology of combatants (Molloy and Grossman 2007) and considerations of non-combat uses of halberds (Horn 2017, Lenerz-DeWilde 1991). It is within this wider framework of cross-disciplinary advances in the field that this thesis is framed.

The specific focus on the Scottish halberd assemblage is founded on the author's previous study of the Scottish Bronze Age assemblage (Faulkner-Jones 2013), and relied heavily on the accessibility of the material held by museums across Scotland, as well as the co-operation of curators across the country. The application of experimental procedures was based on critiquing and applying the findings of recent experimental testing (O'Flaherty 2007; see also 'The First Halberds in Europe', a Newcastle University project funded by The Prehistoric Society). The importance of accurate and reliable catalogues to artefact studies has been amply demonstrated by the literature since before World War II (O'Riordain 1937, Harbison 1969, Burgess and Gerloff 1981, Schmidt and Burgess 1981, O'Flaherty 2002), and the lack in Scotland's case of a region-specific, up-to-date catalogue of halberds was a serious hindrance to research. Prior to this thesis, senior specialists in the Scottish Bronze Age were unsure even of how many halberds had been found in this country (Cowie, pers. comm.). By applying contemporary approaches to a hitherto little-studied assemblage, as well as undertaking primary data collection to understand the fundamentals of the halberd assemblage, this thesis offers both support and counterpoints to the current body of research and aims to demonstrate the efficacy of novel theoretical approaches, experimental testing, and the importance of compiling accurate catalogues to typological studies.

It has been argued by Liebmann and Rizvi that 'theory lag' (Liebmann and Rizvi 2008:1) is present in contemporary archaeology, whereby theoretical developments in adjacent disciplines such as anthropology and sociology are not adopted by archaeological researchers until a significant period of time – a decade or more, in most cases – has elapsed. This tardiness is to be regretted, as many comparatively recent theoretical advances in such disciplines could spur archaeological research to new and hitherto unexplored reaches. As a case in point, this project will incorporate Queer and Feminist methodological approaches, first developed in anthropology, and which emphasise deviant over normative viewpoints and interpretations across traditional disciplinary boundaries (Voss 2000:184). The aim is to facilitate multiple positions and interpretations without prejudging their validity (Dowson 2000:163). The emphasis on reflexivity and scrupulous, unambiguous reporting, with a self-awareness of latent bias which are characteristic of Queer and Feminist theory (Rubio 2011:24), should be conducive to ‘good science’, and therefore form a valuable addition to the archaeological methods toolkit (Tomaskova 2007:271).

1.2 Aims and Objectives

This thesis was undertaken during a particularly fruitful period for halberd studies, a renaissance following several decades of comparative neglect by researchers (summarised by O’Flaherty (1998)). Additionally, the project began during the run-up to the Scottish Independence Referendum, held on 18th September 2014, which brought significant publicity to Scottish heritage and culture, and highlighted how understudied many aspects of Scottish cultural history are when compared to the rest of the United Kingdom and wider Europe (for instance, the choice of holding the referendum on the 700th anniversary of the Battle of Bannockburn did not feature heavily in UK media coverage, but was noted repeatedly in Scottish newspapers (Blain et al (2016)). Furthermore, the widespread Local Authority budget cuts instituted by the current and previous governments (2010-present) have resulted in reduced opening hours and access at many smaller museums, making the need for an up-to-date, accessible halberd catalogue even more pressing. Lastly, it goes without saying that the limitations on travel and mass gatherings resulting from the Covid-19 pandemic throughout 2020-21 have led to an increased focus on remote working, learning, and accessibility, all concerns which have affected the final presentation of this work.

The aims of this thesis was therefore firstly to record (including measurement, description, and photography to a common standard) all of the halberds found in Scotland and extant in 2014 in order to establish the size and state of preservation of the halberd assemblage. Building on this initial data collection, an assessment of the potential uses of halberds could then be made on an informed basis, and interpretative models developed to account for the data subsequently gathered during this project.

The objectives are therefore:

- To evaluate and demonstrate the viability and accuracy of replica weapon testing, including an assessment of the most suitable human tissue proxies.

- To document and evaluate how the data gathered from replica weapon experiments can best be applied to the prehistoric assemblage[s], using the dirk as a pilot project.

- To document and evaluate whether Queer and Feminist theory can successfully be applied to experimental and combat studies in archaeology, exercising primarily reflexive approaches, multi-linear interpretations, minority group voice vocalisations, and scrupulous accountability.

- To determine, if possible, the relationships (if any) between the Scottish halberds and the halberds from Ireland, Wales, and mainland Europe, and to offer an interpretation for the distinct distribution patterns and morphological differences observed.

1.3 Structure of the Thesis

Each chapter of this thesis will describe a different part of the research:

- Chapter 1 presents the background to this thesis and details the aims and objectives of the research, as well as its structure.

- Chapter 2 provides a literature review which summarises the history of halberd research as well as furnishing a background to the Bronze Age in Scotland, theoretical and scientific approaches, and offering a critical analysis of selected studies which have been founded on use of replica weaponry.

- Chapter 3 details experimental work undertaken by the writer using a replica of the Friarton dirk (Perth Museum and Art Gallery (hereafter PMAG)) , and employing Synbone™ as a proxy for human bone and various pig parts as proxies for human soft tissue.. The outcomes of these endeavours and pilot data from these chapters were used to identify issues in the structure and progression of the replica experiments, and to incorporate any demonstrable advantages developed during the tests and analyses into the halberd analysis, as well as being inherently important to the study of Middle Bronze Age weaponry and experimental procedures in and of themselves.

- Chapter 4 evaluates examples of prehistoric dirks displaying the same deformation and hafting plate damage incurred during the dirk experiments, based on an analysis of catalogue data (Burgess and Gerloff 1981) for the Scottish Middle Bronze Age dirk assemblage. The combination of experimental results with accurate catalogue data informs the interpretation offered at the end of the chapter, and establishes a precedent for the halberd study undertaken in the later part of the thesis. One of the issues identified at this stage by the author and supported by discussions with Mark Hall at PMAG and Trevor Cowie at the NMS, was the volume of artefacts which had been catalogued but not then analysed further to due time and other resource constraints, as was the case with the Friarton dirk, resulting in a large and underused corpus of archaeological data.

- Chapter 5 details the methodology deployed to create the halberd catalogue (Appendix 1). This methodology can be used to record any artefact type; the sample museum recording sheet developed by the author is included here.

- Chapter 6 describes and reviews the creation of a replica halberd, including considerations of material and creation methods. It also reviews the choices of human tissue proxies, audience, wielder, and methods of wielding. Consideration is given to the issues and suggestions raised, and the problems encountered, during the replica dirk experiments discussed in Chapter 3. The application of some aspects of Queer and Feminist theories to the development of the experimental methodology is also detailed, specifically the importance of identifying biases, being explicit in developing methodologies, and critically facilitating multiple viewpoints and interpretations without prejudging their validity. The first stages of experimentation using the replica halberd and Synbone™, a human skeletal tissue proxy which mimics a human skull and leg, is then recorded. This stage involves two separate instances of experimentation to evaluate the halberd's efficacy against prone and upright opponents. The chapter concludes with a critical discussion of the preliminary results and an evaluation of the theoretical methods underpinning the experiments recorded here.

- Chapter 7 details and evaluates a second stage of experimentation, in this case using the same replica halberd and tissue from a previously-slaughtered pig to mimic a human shoulder and torso. This part of the project was by necessity performed under different conditions than the Synbone™ experiments previously considered. The consequences of these differences are addressed and the preliminary results from the soft tissue experiments are evaluated.

- Chapter 8 draws together the newly-recorded halberd catalogue data and the data from both sets of experiments using the replica halberd, and identifies several types of damage to the implement. Comparison is made between the damage observed on the implement as a result of the experiments and similar damage observed on other halberds in the prehistoric assemblage from Scotland. Interpretations as to the use of the halberds in prehistory are offered, informed by the comparative exercise. Finally, based on the analysis of the catalogue and the experimental data, a new category of halberds, here termed Group Tom na Brataich, is proposed, which complements the existing typology of four types based on Irish type finds which are commonly used for the European blades (Harbison 1969) (contra Needham et al 2015).

- Chapter 9 synthesises all of the data and results from Chapters 5-8 into hypothetical models for the creation, use, circulation, and eventual deposition of the halberds in Early Bronze Age Scotland, wherein the halberd develops into political *pars pro toto* and are exchanged between polities as physical diplomacy signifiers. A *pars pro toto*, a part on behalf of the whole (OED), is used here to indicate that the halberd is used as a representative portion of the elite socio-political influence and power across Scotland, Ireland and northern England. This interpretation is offered as one way in which the data produced by this study, as well as the results of current research into chemical biographies and provenancing (Bray and Pollard 2012; Bray and Gosden 2014; Pollard and Bray 2015), can be considered holistically in order to produce a multi-linear narrative, which explicates the wide range of variety seen across the halberds, their unusually high levels of arsenic, and the evidence of curatorship and repair of damaged blades. Developments (Dowson 2000; Danielsson 2012) in sociological theory, particularly the application of selected Queer and Feminist approaches, also form part of the approaches adopted in the elaboration of this model and are further discussed here.

- Chapter 10 details and evaluates the conclusions of the thesis and considers the limitations and the potential of the work undertaken. Each of the research objectives outlined in Section 1.2 is addressed in turn to demonstrate where and how they have been met and, in some cases, exceeded. A reflexive approach consistent with a feminist perspective is proffered on the progression of this project over time, in which problems encountered are considered; the chapter closes with some suggestions for future work.

- Appendix 1 (in a separate volume) is the halberd catalogue,. It includes its own table of contents.

Chapter 2 – Literature Review

2.1 Metallurgy and the Smiths

Metallurgical study is a hybrid research field, spanning experimental archaeology, traditional excavation, oral history, ethnography and mythological studies, as well as chemistry and material sciences. Begun in earnest in the UK in the late 1800s with the publication of catalogues of collections in national museums (Wilde 1881), the first metallurgical studies were largely typological, with little critical analysis introduced as to the creation or function of the metal objects. Moving forward in time, detailed interpretations and models of the manufacture and roles of the metal objects have inevitably been heavily influenced by contemporary theoretical paradigms; many studies of non-ferrous metal production were formulated in the late nineteenth and early twentieth century, and consequently have relied heavily on post-Marxist economic models. For instance, Childe talked of peripatetic smiths "seeking markets for their skills" (Childe 1940:163), implying a purely economic role for their craft and ignoring the significance of political influence, prestige item creation, and the ritualistic importance of the smith's transformative powers.

The manner in which copper and bronze were worked from ingot to object has been little discussed in recent Scottish Bronze Age studies. Published information on prehistoric smelting and refining in Early Bronze Age Britain continues to rely largely on Coghlan and Case's 1957 paper, though Neil Burridge, a metal smith specialising in prehistoric techniques, has been casting copper alloys using prehistoric technology for several years – including chiselled stone moulds, smelting his own ore, and using stone, leather and bone tools to finish the objects. His methods have been published in cases where researchers have commissioned replica weapons and shields for use in their studies e.g. O'Flaherty (2007); Uckelmann and Modlinger (2011); this is also the case for some of Burridge's work on experimental pyrotechnology (Simon Timberlake, pers. comm.).

As with many prehistoric artisans, the smiths themselves have not until recently been studied in great detail, only the objects they created; this largely holds across all periods of human existence wherein metal was worked, which presents an issue. The creation of the metal item, the alchemical transformation of ingot by fire into a usable object imbued with meaning, may have meant that the smith was set apart from the rest of their community and held in a similar position to the clergy or spiritual leaders, as was the case in medieval Ireland (Budd and Taylor 1995:140). This has recently been challenged, however: Molloy and Mödlinger argue that by the MBA and into the LBA (1500-800BCE) in Europe, crafting metal was "a commonplace and socially visible activity, which was in many regions a venue for enhancing social integration and stability" (Molloy and Mödlinger 2020:169). While serving as Keeper of the National Museum in wartime Scotland, V. Gordon Childe, heavily influenced by Marxist-Leninist theory, established a four-stage evolutionary development of bronze technology, culminating in the widespread use of low-cost bronze tools (1944:17; Ralston 2009). Subsequent work on prehistoric metallurgy (e.g. ApSimon 1969, Gerloff 1975) followed Childe's bronze-industry precedent, framing metalworking as an elongated form of the contemporary scientific process: rationally, objectively, logically, the smiths would progress step-by-step through informed experimentation, building on each previous stage to advance intellectually and technologically until complex metallurgical skills developed (Wertime 1964:1261, 1973:875). The model of bronzeworking as a logical evolutionary set of industrial processes persevered, with successive scholars refining and expanding it in terms of post-Marxist models of production (Northover 1980), industry (Burgess 1974), and zones of trade and exchange (Northover 1982). Pertinently, it also meant that the function of the smith was broken down into several specialist roles, which have been conducted in a mutually exclusive fashion. This does not, however, account for the difference between a skilled craft and skills at a craft – more recent research has shown that many steps of the copper and bronze making process can be learned relatively quickly (skills at a craft); concurrently, many of these skills take years of theoretical and practical repetition to perfect (a skilled craft) (Molloy and Mödlinger 2020:180). It is entirely plausible, therefore, that BA metallurgy was much more of a community craft than 20thC researchers believed. By the late 1980s, the processes of extraction, smelting out impurities and alloying, and casting were considered to have been distinct stages and modelled to have been the responsibility of three separate men (Tylecote 1987:17). That the smiths were all men was an uncontested fact throughout these theses; although deftly dismantled by Budd and Taylor (1995:137-8), this latent assumption persists, and is covered in greater detail in Section 2.7.2. It is worth noting here that this multi-stage evolutionary model was heavily influenced by modern methods for extracting and smelting iron, which is a fundamentally different process. Iron extraction requires many more skilled crafters; prehistoric pyrotechonology did not produce enough heat to ever fully melt iron, which was instead worked through forge and anvil hammering to shape the furnace-heated metal; conversely, copper melts at a much lower temperature and can be cast using pre-prepared mould, a much less technologically complex process that is more forgiving of error and learning-by-doing (Molloy and Mödlinger 2020:177). Assertions of required technological skill by BA researchers should therefore be treated with caution.

The Childean school of metalwork production also placed the smiths in a subservient role to the chiefly elite, bound to a single socio-political grouping in the manner of the smiths in the literate Aegean and Mediterranean proto-urban civilisations (Childe 1944). However, this model is difficult to transpose into non-literate, non-urban Bronze Age Scotland. The complex processes involved in turning copper ore into a finished product would almost certainly have had to have been heavily ritualised, so that the complex information required could be shared accurately between smiths; this would then have underpinned the high status and isolation of each smith, as the holder of information not shared with the wider social group. Using mythology as a source from which to draw archaeological inferences is not unproblematic; author bias, translation issues, literary interpretations and artistic license muddle the texts, and present a host of issues, not to mention the abuse of mythology and archaeology in 20th century ideological nation-building (Dyson 2008:63 and throughout; Molloy 2016; Herklotz 2020). Nevertheless, as recurring motifs, the widespread presence of the divine bronze artisan is striking. Mythological examples of magical smiths can be found across Europe, where metallurgy preceded literacy; in prehistoric Ireland, Goibhniu, one of the three gods of art (Tré Dée Dana), was a smith and weapon maker who provided the weapons for the Tuatha De Danaan, who eventually defeated the Fomorians and took control of Ireland (Carey 2012:355). Goibhniu also presided over a feast, the Fled Goibhnenn, where his guests drank vast amounts of alcohol. However, instead of becoming debilitatingly drunk, as with most godly feasts, Goibhniu's guests were protected from old age and decay, transforming into immortals. The Welsh god Govannon is a direct adoption of this earlier Irish deity (O'Flaherty 1999:34). A carving of Goibhniu was found in Milk River, southern Alberta, Canada, following the Irish diaspora into the Americas, which clearly shows the smith with a deformed leg (see Figure 2.1 below). This trait correlated with what is known of Hephaistos, who is often described as having a club foot or similar deformity. Petroglyph analysis is beyond the remit of this thesis, but it is worth noting that modern research posits that the technological process of pecking an image into the rock is closely linked to making the artefact represented – they are both enactments with materials and materialities, and represent a "technology of enchantment" (Fahlander

2019: 193, 205). First Nation peoples use petroglyphs as a means of communication within their communities and simultaneously with mythical entities: “the material and figurative representations of powerful imagery need to be directly related to similar beings elsewhere… as material articulations, the powers of the motifs allude to the abilities, agencies and relations of what is portrayed, rather than what it is or may symbolise” (Fahlander 2013:206).

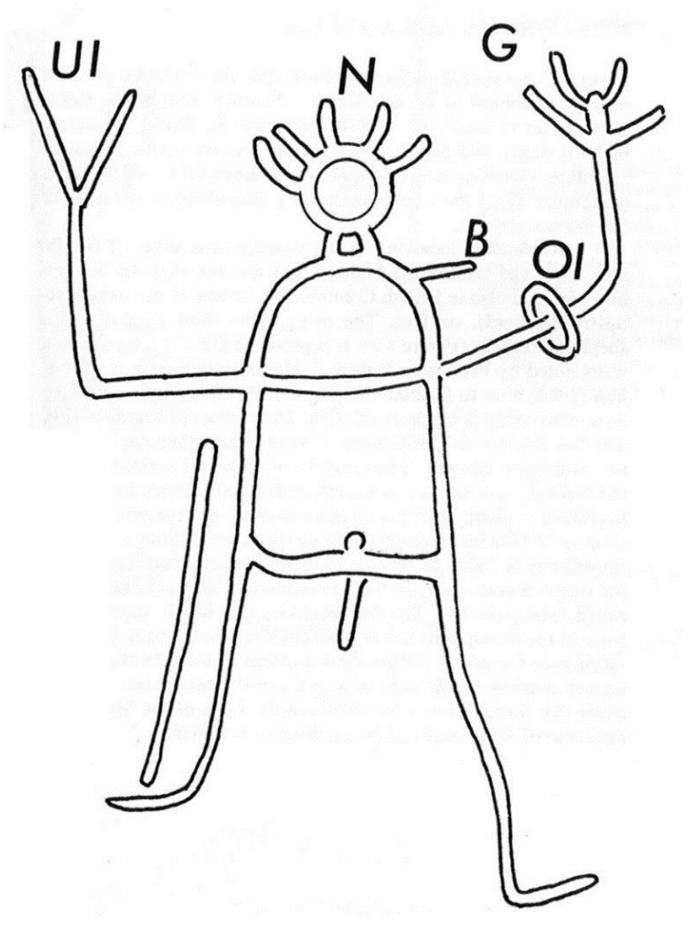

Figure 2.1 *– Schematic of the petroglyph of Goibhniu from Alberta, Canada. His fingers, hairstyle and arm band spell his name in Ogham. His right leg is demonstrably shorter than his left, and he carries a dirk and a walking stick. © Teaching Resources, University of California, Riverside*

A parallel to the Goibhniu myth can be found in Classical mythology. In the Greek pantheon, Hephaistos, bronze smith and son of Zeus, created the dwelling on Olympus in which the gods live (West 2007:155). At a feast, he served the other gods drink – much to their amusement – and provides the fire to cook the food at Thetis’ wedding. Hephaistos also has a club foot, a further link with the Goibhniu myth.

> "He spoke, and the goddess of the white arms Hera smiled at him, and smiling accepted the goblet out of her son's hand. Thereafter beginning from the left he poured drinks for the other gods, dipping up from the mixing bowl the sweet nectar. But among the blessed immortals, uncontrollable laughter went up as they saw Hephaistos bustling about the palace."
>
> Homer, Iliad (Homer, Jones et al. 2003:568)

Bronze, and by extension the bronze smith, is also accorded transformative, life-giving properties; it is Hephaistos' bronze axe which births his sister Athena from Zeus' head (cf. Cline 2010).

> "In the day when the skilled hand of Hephaistos wrought with his craft the axe, bronze-bladed, whence from the cleft summit of her father's brow Athena sprang aloft and pealed the broad sky her clarion cry of war."
>
> Pindar, Olympian Ode 7.33 (Conway 1972)

The Bronze Age divine creator smith is also found in Ugaritic mythology, where Kothar crafted items to help heroes; the Vedic smith Tvastr also created powerful items for other gods, and shapes human and animal forms while yet in the womb (MacDonell 1995:116-118). The Ossetic lesser deity and artisan Kurdalogan forged armour and weapons for human heroes, as well as powerful items and magical items like enchanted flutes and cradles (Talley 1978). In the Hittite pantheon, Hasammili was a divine smith who worked in the Underworld; but little else is known of this god (West 2007:155). The divine smith myth persists into the Iron Age and beyond, in instances such as Wayland the Smith (Volundr in Old Norse; Welund in Old English; Weiland in Old German) – who not only created enormously powerful weapons and items, but was also described as lame (Gordon 1954:65). The recurrence of this motif is notable, though of course not to be taken literally; however, a more holistic approach to non-traditional sources (cf Section 2.7.1) can yield valuable data: a recent survey of the Stymphalos Valley incorporating archaeology and Hellenistic mythology showed how archaeological and geological sciences can, with care, be augmented with history, literature and mythology (Walsh et al 2017).

The Indo-European myth of the presence of a life-giving maimed smith, respected and powerful but set apart from the hierarchical power structure, serving alcohol to the elite but none the less not recognised as menial or subservient, strongly indicates a shared origin for this persistent motif - possibly as part of a widespread oral tradition of transferring and sharing privileged information in non-literate European communities. While considering the forms that said communities could use to transmit complex information, Budd and Taylor (1995) rejected Childe's 'itinerant smiths' (1944) and Sandars' 'tinker-craftsmen' (1971) models because they are both based on non-bronze metallurgy; Childe's example refers to later ironsmiths, whereas Sandars drew on evidence of small-scale leadworking in the Near East. Instead, Budd and Taylor argue that by abandoning the long-held assumption that bronze smiths were tied by economic necessity to a single ruling elite, a proposal can be made whereby the smith and the elite ruler became the same person: where "military and political leaders were actively and intimately involved in competitive ceremonies of bronze making and the various disposal [*sic*] of its results" (Budd and Taylor 1995:140-1). This is a significant break from preceding interpretations, and though not widely accepted or adopted by researchers since it was advanced, will play a vital part in the interpretations and proposed model developed in this thesis (Chapter 8).

In support of this rejection of Childe's bronze-industry model, the writer should be mindful of the duration of the Bronze Age, the *initial* period in which the copper and bronze items would have been in circulation (in whatever form); copper and bronze continue to be used and circulated long after the Bronze Age ends (Budd and Taylor 1995:138). In short, given this longevity and based on the metal artefacts known in the surviving archaeological record from Scotland, metal objects here would have been incredibly rare: during the period of peak weapon deposition in the Late Bronze Age in the modern county of Aberdeenshire (6313 km^2), depositions (including hoards, stray losses, and intentional single deposits) were occurring at an average of one every twelve years, assuming a uniform rate of deposition over the period (see Figure 2.2). Across Europe, it took several centuries for bronze to become a widely used material in object manufacture; other materials, such as flint, continued to be used in the manufacture of everyday objects throughout the Bronze Age (Marciniak and Greenfield 2013:457-67). Consequently, it can be assumed that flint knapping was a relatively common skill, taught freely within a society, and with few disincentives for trial-and-error learning, as flint is a relatively common raw material found particularly across Fife, Aberdeenshire, Argyll and the Orkneys (Wickham-Jones and Collins 1977-8). Conversely, metal casting would have been a significantly more specialised skill: it has been suggested that because copper is much rarer than flint, trial-and-error learning would have been discouraged (Olausson 2013:451). While copper and bronze can be recycled by melting down broken or miscast items, this would have consumed resources; fuel would have been required and a mould for every cast, but such considerations would not necessarily have entirely prohibited trial-and-error learning.

Even allowing for the recycling of some metal objects leading to their non-appearance within the archaeological record, copper alloy objects would not have been ubiquitous in early Bronze Age society, and their creation and appearance in society was thus a special and uncommon event. Bronze can only be melted down and recast a handful of times before oxidization becomes a critical issue, making the resulting cast brittle and aesthetically unattractive (Olausson 2013:451; see Section 9.3). Cutting-edge research into the recycling and reuse of bronze, in the form of the multi-institution, pan-European FLAME project (The Flow of Ancient Metal across Eurasia, flame.arch.ox.ac.uk), has shown that recycling was not widespread in the Early and Middle Bronze Ages in Europe. The sample is irradiated with high-energy x-rays, causing electrons from the atom's inner orbital shell to dislodge. The vacancy is filled by an atom from a higher energy orbital shell, which releases a fluorescent x-ray of a wavelength specific to that element as it drops down to the lower energy level. This emitted x-ray can then be measured, and the characteristic element identified. XRF data can also indicate the relative proportions of each element, as well as the trace elements present; it is non-invasive, non-destructive, and relatively simple to test.[1] While this perspective did not include analysis of any Scottish bronzes, its application to the Scottish halberds is considered in Chapter 9 and demonstrates that the "special" status accorded to the halberds, visible in their unusual deposition patterns and short-term period of production, was also present during their creation and curation. Arsenic is lost each time copper is melted (annealed); x-ray fluorescence (XRF) analysis to establish the elemental composition of Bronze Age copper and bronze objects has shown high levels of arsenic in many of the objects tested from the European Bronze Age, indicating that the copper had only been annealed once: this was particularly noted for Early and Middle Bronze Age weapons, and halberds most especially (Bray and Pollard 2012:862). This perspective is explored further in Chapter 9, and XRF analysis was carried out on a halberd from Banff – possibly one of the missing

[1] See www.oxford-instruments.com/businesses/industrial-products/industrial-analysis/xrf

Auchingoul hoard halberds – the results of which are noted in its catalogue entry and discussed in Section 5.2.

Furthermore, the acquisition of copper in Scotland would itself have been a relatively uncommon event; notwithstanding ongoing research at a copper mine at Tonderghie, Dumfries and Galloway (Pickin and Hunter 2008). Ireland contains the closest and most abundant copper sources accessible to prehistoric Scottish metallurgists. Indeed, Ross Island in Killarney represents the earliest known copper mine in Europe, dating from 2400BCE (O'Flaherty 1999:33), and XRF analysis has shown that most, though not all, of the Scottish halberds are made from Ross Island copper (Bray and Pollard 2012). Extracting, processing, and crafting copper and bronze objects would therefore have involved trade and knowledge exchange across Britain and Ireland, and potentially further across Northern Europe (O'Brien 2014).

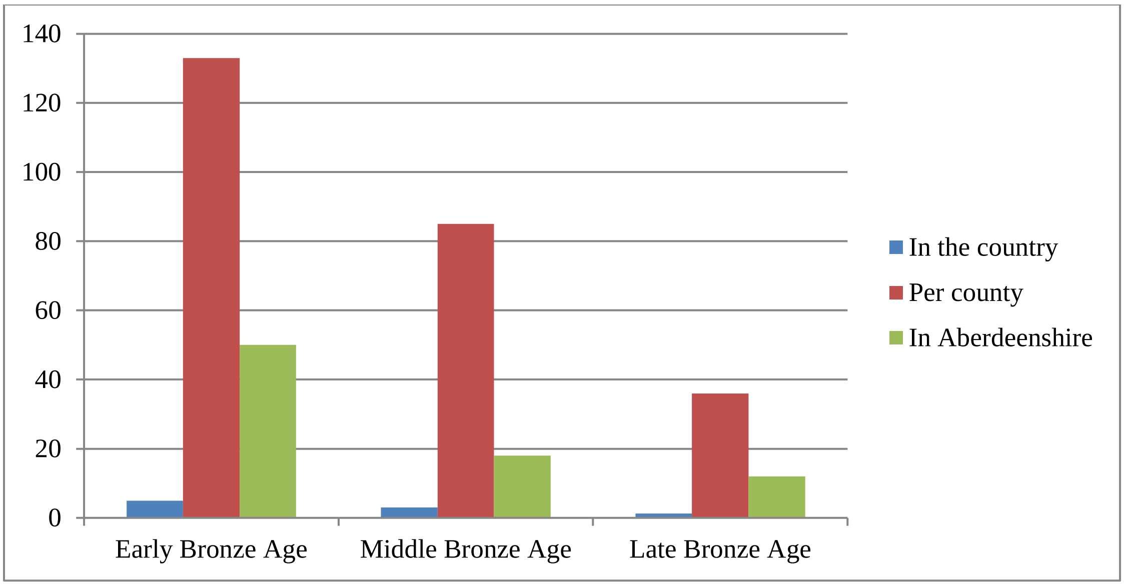

Figure 2.2 *– Interval (in years) between metal depositions in Scotland throughout the Bronze Age (assuming a constant rate of deposition). Faulkner-Jones 2013:38*

2.2 Chronology and Demarcation from the Neolithic

The broader study of Bronze Age Europe is best considered as a series of interlinked research fields, rather than as a homogenous unit. The presence of worked copper altered the social and political structures of European society, which in turn facilitated the dissemination of copper and copper alloy objects and further technological developments. The introduction of metallurgy to Central and Northern Europe occurred at around 2800BCE; worked copper appeared in the Near East and Levant from the 6th millennium BCE, which delineated a Chalcolithic Period between the Neolithic and Bronze Ages

(Gilead 1988, Levy and Shalev 1989). However, a western European Chalcolithic is significantly harder to identify, and is not routinely recognised by archaeological researchers (though see Allen, Gardiner and Sheridan (eds) 2012); the European Early Bronze Age is generally agreed to have begun by 2800BCE, contemporaneously with the appearance of the Beaker ceramic tradition (Needham et al 1997, Bradley 2007:144). The introduction of ferro-metallurgy in the first millennium BCE in northern Europe, and to a lesser degree the increasing contact and trade with the Mediterranean civilisations, marks the transition from the Bronze Age to the Iron Age (Cunliffe 2004:1-2).

The Bronze Age in northern Europe is best considered typologically, rather than as a fixed chronological period. As noted above, the extraction and processing of copper ore into finished objects demarcates the Early Bronze Age (or Chalcolithic, in Italy and the Near East (Schuhmacher 2002:264)) from the late Neolithic period. Halberds, awls, flat axes, and small dirks were the first distinctive tool types to be made from this metal; their presence in an assemblage indicates an Early Bronze Age date, with more complex tool forms being developed in the subsequent Middle and Late Bronze Age periods (as exemplified for Scotland by Coles 1959-60, 1963-4, 1968-9). However, the northern European halberds studied here are very rarely found with organic matter (contrastingly, Iberian examples are frequently found in graves, thereby allowing for an absolute date of deposition (Schuhmacher 2002:270)). Their typologies can be contradictory and difficult to relate between countries (see Section 2.4.3, below) – notwithstanding the uncertainty inherent in relating typological change to chronological development, a product of post-Darwinian rationalisation (Mithen 1989:492). As such, a secure and uncontested chronology for the origin and spread of metal technology may be beyond the reach of researchers for now.

However, AMS dates from Wales (Needham et al 2015:11) and Schuhmacher (2002:265-70) categorically demonstrate that metallurgy had progressed to the point of halberd production in Britain and Ireland by the middle of the third millennium BCE. It is unclear how long it would have taken for the early smiths to develop the skills and technology required to produce these halberds; although the earliest absolute dates for the halberds are ~2600BCE, it is likely that copper metallurgy had already been practiced for several generations prior to this date.

Evidence for the use of metal – manifested as the actual metal artefacts themselves or as tangential evidence, such as stone moulds for their production or petroglyphs depicting metal objects –is present across Europe from the mid third millennium BCE at the latest, despite varying settlement, economic, ceramic and burial traditions. The differences between societies across Europe are marked: the sprawling Bronze Age Mediterranean civilisations and the emergence of hierarchical city-states in Greece, Anatolia, the Levant and northern Africa bear little resemblance to the smaller-scale settlements found in western Europe. For instance, the complex social stratification and leadership in the Near East and Mediterranean is discussed in depth by Kristiansen and Larsson (2005, 61-107); compare this to the less complex stratification apparent in the southern Scandinavian burial record observed by Bergerbrandt et al (2017), and the apparent lack of evidence for territorial or resource control in central Germany, despite ostentatious displays of material wealth in the elite burials (Uhner 2017). Despite the societal differences, Bronze Age Europeans were not static either socially or economically: trade, population movement and communication between societies across Europe is attested in the material and burial record – Baltic amber and British copper in the Mediterranean, Egyptian and Mediterranean glass beads in Scandinavia, to note but a few examples (Sabatini and Melheim 2017, Bergerbrandt et al 2017). More research exists on the links between mainland Europe and Scandinavia with the Mediterranean and Near East than for Scotland, but some parallels can be drawn. The settlement record in Early Bronze Age Scotland consisted of small clusters of houses which were occupied for several generations before being abandoned when their inhabitants moved (see, for instance, the well-excavated and well-recorded Late Bronze Age settlement at Cladh Hallan (Atkinson et al 1996, Parker Pearson, Sharples and Symons 2004)); it does not support the model of large-scale communities inhabiting an area for a protracted period of time, as was the case in the relatively huge contemporary Mediterranean and Near Eastern civilisations. However, there are some common underlying structural similarities which demarcate Bronze Age societies from those models of the preceding Neolithic period. Kristiansen and Larsson (2005:56), for example, hold that the Bronze Age can be identified by the emergence of complex systems of chiefdoms governing by deploying their symbolic prestige and power, expressed through the production and trade of elite goods, rather than by the presence of copper alloy itself. While a plausible theory, their model proves difficult to implement on a local or regional level within Scotland and cannot be applied – for instance – to aid in interpreting or dating individual sites here because the chiefdom system which underpins the Scandinavian interpretations cannot be demonstrated conclusively in Scotland. With all these caveats and considerations in mind, and based on the absolute dates from graves and ceramics across the UK noted throughout the above section, the periods referred to in this thesis are therefore: Early Bronze Age 2600-1800BCE; Middle Bronze Age 1800-1200BCE, Late Bronze Age 1200-800BCE.

The unique geography and geology of Scotland dictate that the study of the Bronze Age here requires both further research opportunities and foci: the islands and archipelagos, for example. These have not received the same degree of 'island archaeology' focussed scholarship as has occurred in the Aegean (Berg 2018), though the contrast between island and mainland is a current field of investigation (Fleming 2008:19). The wildly different landscapes of the Highlands and Lowlands make for different agricultural practices, access routes, settlements – and consequently interpretative models - astutely described by Noble and Stevens (2008) regarding Bute, an island straddling the Highland Boundary Fault (the geological delineator between the hard quartz-mica-schist bedrock of the Highlands and the basalt-sandstone bedrock of the Lowlands).

For the purposes of this research, "Scottish archaeology" should therefore be considered as a geographic limitation for concentrated research, rather than as a unified socio-cultural entity, and allowance made for significant variation and scope over time and space. One consideration in terms of modern geopolitical boundaries on evidence recovery should be noted, however, and that is the comprehensive aerial photography record covering Scotland but which stops at the border, due to the concerted and long-term recording efforts of RCHAHMS beginning in 1976 (Noble et al 2019). Particularly when investigating wider landscape use, as discussed below, having a national database with concentrated ploughzone sampling which does not extend across the modern border will inevitably lead to a distorted image of activity, occupation, and taphonomic processes (cf Haldenby et al 2010).

With this in mind, there remains sufficient evidence to indicate a move towards enclosed or delineated field systems in the Bronze Age, well-documented for southern England (Yates 2007) and central, northern and western Europe (Bradley 1977), potentially indicating a greater reliance on settled agriculture and livestock than in the Neolithic period, but it is unclear when in the Bronze Age this development occurred. The study did not specifically include Scotland, but making allowances for regional variances, a similar development could, theoretically, be postulated. Furthermore, Bradley noted forty years ago that there were issues in dating and interpreting field systems (1977:268); as these, including the use of vague terminology across multiple systems, and the difficulty in identifying aggregate versus cohesive field system construction, have not been resolved care should be taken when extrapolating from such subjective data. Northern Europe, including Scotland, does undergo comparatively large-scale deforestation in the Early Bronze Age, with birch and hazel woodland giving way to open expanses of heath (Bunting et al 2007:114-5). Pine trees were manually removed from peat bogs, as bog pine, throughout the Late Neolithic, Early and Middle Bronze Ages (3100-1250BCE) (Tipping et al 2007:159-161). The cognitive impact of clearing and dividing up the landscape has led Parker Pearson to dub the Bronze Age the 'Age of Landscape Change" (Parker Pearson 2005: 25, 48), but he drew his primary evidence from Wessex and rural England. This is a very subjective and farming-centric interpretation of the Bronze Age and does not account for regional variations in the landscape, as well as cultural and social differences between communities.

Indeed, the interpretations of the social implications of field systems are contradictory and yet unresolved. The amount of labour required to build the field systems, the continuing labour required to maintain and effectively and productively farm them, and the cognitive coherence required among a community that enables a group to divide up a swathe of land have been interpreted as evidence for greater social cohesion and co-operation in the Bronze Age, with smaller groups clustering and merging into wider communities around a central core base that intensifies around the newly-drawn divisions of landscape (Gosden 2013:112-7). However, that same archaeological evidence has been interpreted as symptomatic of a fragmentary society which moves around and away from a core settlement as the population increases and decreases naturally over time (Gosden 2013:111, after Brück 2006). As part of this second interpretation, criticism has been levelled at applying so-called 'common-sense' approaches, where modern concepts of ownership and inheritance have been blindly and unthinkingly applied to a pre-Marxist, pre-industrial, prehistoric society (Gosden 2013:111, after Brück 2006). The struggle to reconcile established object-based interpretations of social organisation, such as chiefdoms and the lingering undertones of culture-history models, with current landscape-based models focussing on ecological impacts and the socio-economic effects of dispersed farming communities, is ongoing (Roberts 2013:544). Queer theory can help to avoid some of these epistemological traps and is discussed further in Section 2.7.1.

In addition to the use of copper and bronze, the Bronze Age can be recognised (and distinguished from the Neolithic) in the ceramic record. The ceramic assemblage in Scotland is vast, and the significant degree of regionality is only now being fully recognised and researched (Needham 2005, Mason 2017). An in-depth, nuanced discussion in not attempted here; a very brief overview, however, can aid the discussion of chronology. Beaker pottery is found across the south and east of England and the eastern coast of Scotland, and indicates an Early Bronze Age, if not Chalcolithic, date (Laing 2003:28). Non-Beaker ceramics comprise cups and urn-shaped food and funerary vessels with a range of decorative features such as out-turned collars, corded and impressed patterns, and applied clay 'grape' decorations (Laing 2003:29-32); the collared urns in particular show the influence of Beaker pottery styles in Scotland, and can therefore indicate an Early/Middle Bronze Age date. The appearance of the Bell Beaker phenomenon across Chalcolithic and/or Early Bronze Age Europe (c.2800-1800BCE) is a major indicator used by many researchers to signal the end of the Neolithic (Needham 1996, Needham 2012), though the assumption that they represented an invasion of British soil by aggressive Continental Europeans (per Childe 1937:3) has been questioned in favour of more nuanced interpretations. Migration and movement across Ireland in response to socio-economic factors in the Late Bronze Age has recently been demonstrated by Armit et al (2014); the genetic evidence for mass migrations during the Early Bronze Age across the whole of northern Europe is clear and based on multiple continent-wide studies (Allentoft et al 2015 for a detailed overview of the Bronze Age European genome; Haak et al 2015 for some of the implications of the east-west migrations). A Beaker cist burial from Achavanich in the Highlands demonstrates that the woman buried there was from continental Europe, with no local ancestry: a clear indication of migration to Scotland during the Early Bronze Age (Hoole et al 2018).

Identifying the Bronze Age is, therefore, a matter of considering typologies of metal and pottery as well as absolutely dating the available organic remains. As this thesis concerns halberds (an Early Bronze Age phenomenon) and a replica Middle Bronze Age dirk, with a primary focus on Scotland, further discussion of the Neolithic/Early Bronze Age transition, the specific features of the Central and Eastern European Bronze Ages, or the ceramic traditions would be unnecessary.

2.3 Weapons and the Existence of a Warrior Elite

Axes, dirks, clubs and projectiles are all found in the Neolithic and earlier and could all have been used to inflict interpersonal damage. However, they all also fulfil other functions – such as chopping wood, butchering and eating meat, hunting, and leatherworking (Schulting and Fibiger 2012:2). However, the halberd, the principal class of material culture considered in this thesis, is not suited to any function other than interpersonal combat (see Chapter 6).

Much of the literature on European Bronze Age societies is heavily influenced by the proliferation of metal weaponry, including axes and dirks, and their relationships to the newly developing complex social structures identified from the Early Bronze Age. Antony (1996) provides an analysis and critique of the relationship between craft specialisation and political development in which he stresses their interrelatedness; he draws a clear line between complex political development and the increasing specialisation of metal weaponry. What is unclear, however, is whether the significance of the new metal weapon type[s] initially arose from the extant prevalence of interpersonal combat, as status signifiers, or as a combination of the two. Combat theory is discussed in detail below (Section 2.8), but in the context of an overview of the European Bronze Age, the emergence of a so-called 'warrior elite' cannot be overlooked. These changes in economy and settlement and the introduction of metal (Bruck and Fonteijn 2013) indicate developments in the accompanying political structures throughout the period, most notably from the Middle Bronze Age onwards; for instance, the appearance of rich graves with valuable grave goods appear across many areas of Europe, from Greece to Norway, from c1700BCE, demonstrating the elite focus on drinking, feasting, horse-drawn transport, and elaborate personal adornment and jewellery, including beautifully-crafted weaponry (Hafsaas-Tsakos 2013:79).

Interestingly, warrior graves – inhumations with associated weaponry - are not a major feature of the British Bronze Age. The Scottish halberds were all found singly or in hoards, either single-weapon or in association with dirks and sometimes spearheads: not one was deposited with human remains. In fact, there is not a single site record from Scotland or Ireland where human remains have been deposited with a metal weapon[2].

[2] The possible halberd and cremation at Rathgall, Ireland, does not have a secure association: the cremation urn is dated to the Late Bronze Age, and given the complete dearth of weapon/cremation depositions in the

There is some indication that the Scottish Bronze Age communities later adopted and adapted the continental 'chariot burial' tradition by the Late Bronze Age: a hoard deposited at Horsehope Craig, Peebles, contained the bronze fixtures for a four-wheeled waggon, as well as several axes and a possible rapier, but no human or animal remains (Piggott 1955; Coles 1959-60:123-4); there is no evidence that the practice was adopted any earlier than the Late Bronze Age, however. The presence of swords in the archaeological record, even if not associated with individual burials, is often used as a proxy for the existence of a warrior elite, for reasons which will be discussed further in Section 2.8.2. Whilst this refers primarily to the Late Bronze Age, the existence of earlier Bronze Age weaponry has not been considered indicative of an elite presence in Scotland. It is the aim of this study to show that similar reasoning can be applied to Early Bronze Age halberds and, to some extent, to the Early and Middle Bronze Age dirks as well, thereby drawing attention to the possible earlier presence of an elite engaged in warfare.

2.4 Halberds: Etymology, Origins, Dating, Typology, and Distribution

A halberd consists of a stout triangular blade which is hafted at right angles to a substantial wooden shaft using three or more squat rivets; metal-hafted halberds are known from the central European Aunjetitz culture, but not from northern Europe (O'Flaherty 1998:79). Halberds are the earliest known metal weapon form in Europe: although predated by flat axes and daggers, the halberd is unsuited to any other utilitarian function (such as hunting, butchery and woodworking). Its wide reflective blade and perpendicular hafting on a long handle (see Figure 2.3) makes it highly visible and demonstrative; in terms of function, the halberd has always been interpreted solely as a weapon rather than a tool, being exclusively suited to inflicting interpersonal damage. Figure 2.3 outlines the technical terms used in this study.

UK, the proposed association seems more likely to be the result of poor recording practices and a 30 year gap between excavation and publication, than a paradigm-changing site (Rafftery 1971).

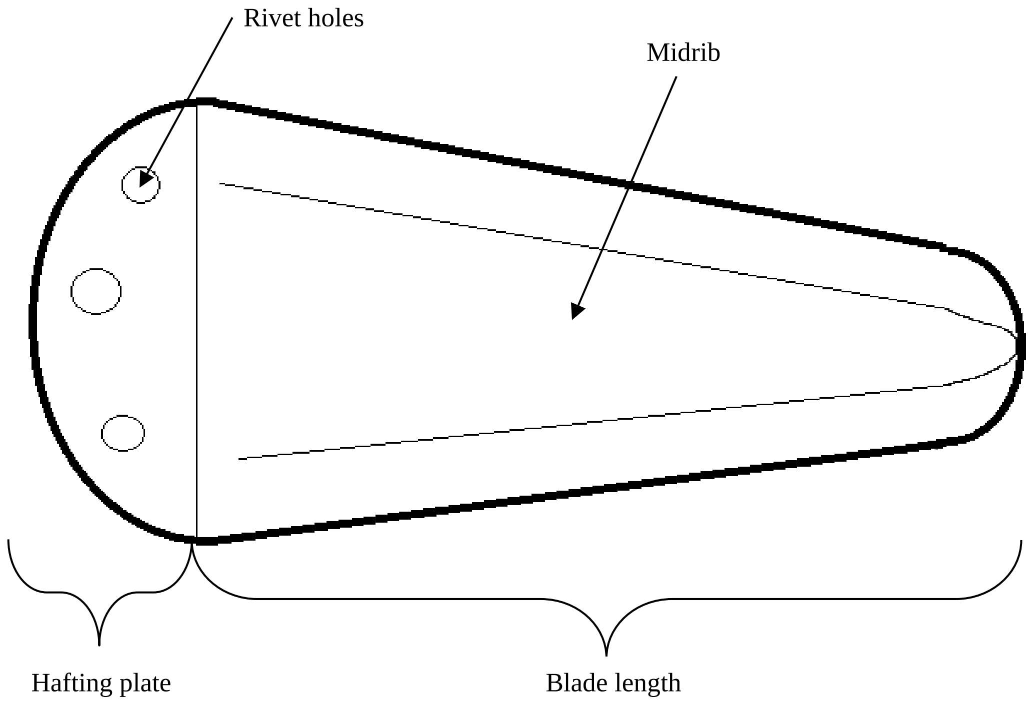

Figure 2.3 *– Simplified diagram of a halberd, showing the terms used in this study*

Early Bronze Age halberds should not be confused with the hafted halberds found in Medieval Europe. The medieval halberd (also spelled halbard or halbert) appeared in the late 13th century AD, and was used for the next 200 years; combining a spear and an axe, the weapon consisted of a very long (c.1.6-2m) haft with a socketed axe blade and protruding spike, to which was later added a further curved spike opposite the blade (Brunner 2013), both of which were nailed to the haft (Devries and Smith 2012:29). The spikes and blade made the halbert particularly effected in grappling mounted opponents and was used by infantry soldiers across Europe throughout the 14th and 15th centuries AD (Gilbert 2003:71). The Bronze Age halberd is a completely different weapon: there is no spike protruding from the top of the blade, nor is there a hook or grapple on the obverse of the blade. The medieval halberd was designed for use by foot soldiers against cavalry; the Bronze Age halberd was produced during a time when horses had very recently been introduced to Britain, and the process of domestication only just begun (Ryder 1981:301-410). The bronze or copper blade is affixed to the wooden haft using rivets; the blade is not socketed. The prehistoric items to which the descriptor halberd was first attached by Wilde (1857-61) were found in Ireland (O'Flaherty 1998). Similar blades were soon after recognised in Scotland and Iberia; metal-hafted halberds from the Unetiče territory in central Europe had already been classified as weapons, and the northern European blades were quickly recognised as being of a similar type (despite being hafted in wood rather than metal) (O'Riordain 1936). The halberds were produced solely during the Early Bronze Age in Europe, after which they completely vanish from the archaeological record.

2.4.1 Distribution

Halberds are found across Europe, with Ireland having the most of any single (modern) country. However, rather than a relatively uniform distribution at the continental scale as with the contemporary flat axes, halberds are found in fairly distinct clusters. High concentrations are found in northern Europe – in Ireland, Scotland, Wales and in Scandinavia – with further clusters in Germany, Iberia, and Italy. The comparative lack of research on the European halberds has led to some recent reprovenancing studies, emphasising the importance of primary analyses on these objects rather than relying on extant, potentially inaccurate, works (Brandherm and O'Flaherty 2001; O'Connor et al 2009).

Figure 2.4 *– Centres of halberd production and circulation in the Early Bronze Age. Clockwise from top left: Ireland and Scotland; the Aunjetitz culture; the Unetiče culture; Italy; Iberia*

However, a more useful approach would be to examine the density of halberd deposition, in order to determine how commonly or frequently these weapons were being deposited, and where, to aid subsequent interpretative models (Chapter 9). When expressed as a ratio of recovered halberds to total landmass (Table 2.1), Ireland and Scotland have the highest densities of halberd depositions - by significant margins. The Scottish assemblage, however, is very difficult to study in relation to specific depositional patterns as, frequently, recovery data is lost due to the halberds being found during farming or land work. Investigating patterns of deposition in relation to waterways (cf. Faulkner-Jones 2013), for instance, is rendered all but impossible by the poor data record; even the halberds found in hoards are not unequivocally associated, and could easily have been accumulative rather than a single hoard deposition (such as the Bute hoard, discussed in detail in Knight 2019). This does not undermine this project; quite the opposite, as Knight notes that the multi-period hoards across the UK strongly support the concept of conserving earlier, “special” objects – an idea discussed at length in Chapter 9 (Knight 2019:20). It should be noted (as O’Flaherty (2002) did in the primary source used in this work for the Irish halberd data), that the level of research into Early Bronze Age weaponry varies widely across Europe. Ireland, Scandinavia and Spain have relatively comprehensive halberd catalogues with secure provenances; the Iberian and Irish halberds have been catalogued in the Prähistoriche Bronzefunde series (Brandherm 2003, Harbison 1969), an invaluable resource.

However, the halberds from France, Italy and the Low Countries are much less well studied, and their catalogues are fragmentary and not standardised. Scotland’s Bronze Age metal artefact assemblage was catalogued by Coles (1959-60, 1963-4, 1968-9 for Late, Middle and Early bronze age respectively), though little critical analysis was offered at that time. Since then, despite being second only in size to the Irish halberd assemblage, the Scottish material is frequently neglected in European syntheses (see Kristiansen 1998, Kristiansen and Larsson 2005). Although finds are published regularly, the comparative lack of analysis into the wider Scottish Bronze Age metalwork assemblage since 1970, especially the halberds, has resulted in a lack of basic archaeological data (though see Cowie and Inglis 1988, Cowie and O’Connor 2001 and Cowie 2004 for analyses). For instance, the number of halberds recovered from Scotland has been unclear for several decades, as museum holdings have moved in and out of storage, labels are mislaid, and provenances are secured or thrown into doubt (cf. O’Connor et al 2009, as well as Chapter 5). A complete catalogue of all Scottish halberds was therefore compiled as a focal part of this work; it can be found in Appendix 1. This includes some of the halberds recovered from Wales as well; during the research, it quickly became apparent that the Welsh halberds were few enough in number to warrant inclusion based on very little extra expenditure in time and effort. Furthermore, for such a small number of blades, the range of shapes, sizes and preservation meant that the inventoried Welsh halberds provided valuable counterpoints to the Scottish types. The timely publication of Needham et al (2015) included a complete and comprehensive re-evaluation of the Welsh halberd assemblage, which rendered similar work on the Welsh halberds unnecessary in this catalogue. (Needham et al 2015 is discussed in much greater detail in Section 2.7.2, as well as later in this section; it includes none of the Scottish halberds and does not negatively impact on this work).

As part of the catalogue construction, investigation was made into the number of halberds which were recovered in Scotland but cannot be physically found in museum holdings. Blades which are recorded but which have since been lost or subsumed into private (and inaccessible) collections have been researched and included where provenance and type has been satisfactorily established; those which exist as a footnote, or cannot be traced in museum records, curatorial or finders' memories, or any other archives, have not been included. Full details of the catalogue methodology are given in Chapter 5. The distribution of halberds in Europe is therefore left at national level, given in the table below; the distribution of the Scottish halberds (as well as is known) is shown in Figure 8.1.

***Table 2.1** – The number of halberds recovered across western and central Europe, after O'Flaherty (2002), the figures for Scotland and England/Wales have been updated to account for halberds found since 2000.*

	Number of halberds recovered	Land mass (km^2)	Halberds: land mass (km^2)
Ireland	186	84,421	1: 454
Germany	104	357,021	1: 3,433
Spain	64	505,992	1: 7,906
Scotland	59	78,387	1: 1,329
France	45	674,843	1: 14,997
Italy	32	301,338	1: 9,417

Scandinavia	30	878,257	1: 29,275
England/Wales	17	151,156	1: 8,891
Benelux	3	74,640	1: 24,880

Working solely from the raw numbers of known halberds, Ireland would appear to be the most obvious origin for halberd manufacture, with the technology and perhaps even finished blades travelling east through trade networks across the rest of Europe. An Irish origin for halberd manufacture is also upheld typologically (Schumacher 2002:281). However, the Irish origin model is not accepted by all researchers. It is possible that the high rate of discovery is due to survival and/or recovery bias; the bogs provide excellent preservation conditions for metal and organic remains, unlike the acidic soils of Scotland (O'Flaherty 2002:28). The existing syntheses on Early Bronze Age weapons tended to favour a Central European origin, as the Unetician culture manufactured stone and flint weapons what are similar in shape and weight to the metal halberds (Coles 1968-9:35). ApSimon (1969:31) also notes that the tubular beads from the Migdale hoard in Scotland closely resemble beads from the Nitra group in Slovakia, suggesting contact between Central and Northern Europe from 2400BCE onwards. However, ApSimon goes on to favour an Irish-Scottish focus based on ceramic traditions, particularly the distribution of Collared Urns (1969:42-7).

Furthermore, there is a pronounced level of regionality in European-wide studies of halberd manufacture and deposition. Halberds are not found in association with human or any other surviving organic remains anywhere in the British Isles (see Footnote 1, Section 2.5), making them impossible to date absolutely by association (except one, discussed hereafter). The wooden haft very rarely survives (if, indeed, the halberds were deposited with the haft intact); where it does, spectacular care must be taken in its excavation to avoid the wood disintegrating upon removal, as with the hafted halberd from Altnamacken, Co. Armargh (Flanagan 1966: Plate 1). However, Needham et al (2015) managed to successfully excavate, preserve and date the halberd from Trecastle, Powys, Wales (next section), and derive a region-specific typology and development sequence for the Welsh halberd assemblage. The level of region-specific analysis is sufficiently detailed to make it very difficult to adapt the sequence for non-Welsh material, however: a more detailed critique of the paper is given at the end of Section **Error! Reference source not found.**. Unlike the single and hoard depositions c haracteristic of northern European halberds, Iberian halberds are uniformly found in graves of adult males over 35, frequently over 50, years of age. Moreover, in contrast to the rounded hafting plates seen on the British halberds, Iberian blades present a flared hafting plate unique to the region, indicating indigenous design and manufacture rather than the local adoption of an imported weapon form (Aranda-Jimenez et al 2009:1041-2). Similarly, Italian halberds display both Aegean and Western European design influences, suggesting that Italian halberd manufacturers were influenced by co-existing cultural traditions from across Europe (Dolfini 2011). ApSimon (1954) initially agreed with the Italian origin model, before moving towards the indigenous innovation suggested by the ceramic traditions (1969:31). Schumacher (2002:271) suggests a terminus ante quem of 2050BCE for the French halberds that closely resemble blades recovered in Italy, but this assumes a very rapid dispersal of the technology throughout Europe, as well as long periods of halberd manufacture and use.

2.4.2 Dating

Where the wooden haft has not been recovered, dating the halberds relies largely on referencing various ceramic traditions and typological sequencing of the blades. There are problems with both approaches, which will be dealt with in turn. Firstly, the association between ceramic traditions and halberds has largely focussed on the Wessex Culture, with processual archaeologists dating the halberds by direct correlation with Wessex material (Butler 1963, Bradley 1980:59). However, as Bradley discusses (1980:59-63), the methods of ceramic sequencing change from type to type; the Early Bronze Age Wessex types – originally defined by the ceramics from rich barrow-burials (Piggott 1938) - are related to local landscape changes, which makes extrapolation to non-local ceramics difficult, whereas the Thames tradition is sequenced solely on ceramic artefact typology. Chronological comparisons also suffer from inaccurate radiocarbon dates and outdated calibration curves (Bradley 1980:63). Furthermore, the issues with imports, influence, immigration and native innovation within pottery studies do not make for an uncomplicated correlation between halberds and ceramics; the link between Early Bronze Age Beaker pottery, indicative of the Neolithic/Early Bronze Age transition, and the Beaker People within the culture history paradigm is deeply problematic, and can be found even in otherwise theory-light sherd-identification handbooks (Laing 2003:27). Finally, as discussed above, halberds are not found in association with cinerary urns, and comparisons must therefore remain speculative at best.

Similar issues arise when considering direct typological sequencing of the halberds. As European halberds fall into three major groups (Irish, Unetician and Iberian), most typologies use type-finds from the large concentrations on which to base their categories. However, there is very little overlap between the typologies for the three major European groupings. Furthermore, during this research, it quickly became clear that although Ireland has the largest concentration of halberds in northern and western Europe, the widely-used typology based on Irish type finds does not work when transplanted onto the Scottish assemblage, nor the Welsh. Such a pronounced level of regionality, even within the British Isles, suggests that typological dating may be overly simplistic and may not take into account the influence of local and regional traditions and manufacturing techniques. One recent example of this is Needham et al (2015), which includes a very detailed revised typology of the Welsh halberd assemblage (discussed further in the next section). It is argued that the Welsh halberds evolve from a basic three-rivet shape over time, and that dates can be estimated based on the number and placement of rivets (Needham et al 2015:27). There are some issues with this model, not least of which is the difficulty in applying it to other assemblages (the differences in appearance between the Italian and British halberds are noted earlier (Needham et al 2015:22)); the majority of the Scottish halberds, for example, have more than three rivet holes – it is difficult to see any supposedly earlier halberds giving way to the later form in Scotland using Needham's chronology, despite the size of the assemblage.

The AMS date from the Trecastle halberd of 2470-2200calBC, corroborated by two further dates from the associated ringditch, is a much surer indication of the period of manufacture for the halberd (Needham et al 2015:11). The issue of old wood is addressed and confidently dismissed in that study (Needham et al 2015:11), but this is not always the case. Oak fibres from an unprovenanced halberd from Ireland were recently radiocarbon dated to 2294-2134 calBCE, but with a margin of 300 years because oak is very long-lived: the heartwood can form up to 300 years before the outer layers (although this is not an issue for dating branch wood) (Bell 2014:15-16). The Early Bronze Age period of manufacture and distribution (though not necessarily deposition) of the halberds used throughout this paper is therefore supported by the handful of absolute dates provided here; ceramic and typological corroborations are included for reference where appropriate but remain significantly less reliable than the absolute data.

2.4.3 Typology

Halberds from northern and western Europe are usually classified according to the dominant Irish typology as established by Harbison in 1969. This is a four-type system based on eponymous Irish type finds, and is as follows:

> **Type Carn**: an asymmetrical copper blade with a rounded midrib and rounded hafting plate, hafted with three thick rivets which are arranged in an equilateral triangle formation.
>
> **Type Cotton**: an asymmetrical copper blade with a curved midrib and bevelled edges. The hafting plate can be rounded or squared and features three round-headed rivets arranged in an equilateral triangle formation. The blade edges have two sets of grooves* running parallel to the bevelled edges.
>
> **Type Clonard**: a short copper blade with a squared and shouldered hafting plate. It is hafted with four round-headed rivets which are arranged in a square.
>
> **Type Breaghwy**: a symmetrical blade with a straight, flattened midrib, made from bronze. The edges are bevelled, but otherwise display no grooving or ribbing. There are a minimum of three rivet holes (though usually more), arranged in an arc.
>
> (Harbison 1969 39-46)

*Harbison (1969:41) refers to these linear indentations as 'blood grooves', a persistent and deeply problematic misinterpretation. Long blades, usually swords, dating from the Viking period onwards, present a narrow channel down the centre of the blade called a 'fuller'. This strengthens the blade and prevents fissures and fractures developing over time. Fullers also appear on single-bladed knives and daggers from the Middle Ages onwards in Europe and have been used for many centuries by smiths in Japan and Nepal (Oakeshott 2012). They do not materially reduce the amount of metal required to forge a blade, nor do they make the blade a more efficient piercing weapon (O'Flaherty 2002:102). Despite this, there is a widespread misconception that these grooves were a deliberate casting choice to facilitate the greater flow of blood out of one's enemy and towards the combatant's hand and arm rather than feet. This is completely unfounded and implies a host of repercussions as to the blades' use, function, and symbolism. As such, the term 'blood grooves' will not be used to refer to the grooves and ribs on north-western European halberds. Given the symmetry and fine tooling displayed on the grooved halberds, it is much less controversial and more evidence-based to interpret the grooves and ribs as decorative artistic expressions.

Harbison's typology was a great improvement on the previous systems – Macalister's typology of six classes based on blade shape and number of rivets (1928), and O'Riordain's system, also of six types and based on relative size (1937) – which were both difficult to apply to single finds and non-Irish halberds. As can be seen, Harbison's system is based on the shape of the blade, midrib and hafting plate, the number of rivets and the metal used to make the blade; the relatively clear distinctions between types allows the typing of single, un-associated, un-provenanced and non-Irish halberds. To this, two further types should be noted that will be referred to later in this study. In his doctoral thesis, O'Flaherty proposed an Ireland-specific halberd type, the defining characteristic of which is a very wide midrib, one which occupies more than 66% of the total blade width (O'Flaherty 2002:87). Although this proposed type would greatly help in categorising many of the 'problematic' Irish halberds, it has not yet been widely adopted by researchers; it is the reason, however, for the actual and proportional midrib width being recorded in the catalogue here, and the type is noted where relevant as O'Flaherty Theoretical (Appendix 1). The second additional type is newly proposed by this study, discussed in much greater detail in Section 5.7 and is called Group Tom na Brataich.

These two additional types are not proposed lightly. The biggest critiques of Needham et al (2015) offered here are that the revised typology for the Welsh halberds is cumbersome, excessively sub-divided, and difficult to apply to non-Welsh assemblages. Furthermore, poor preservation and material loss from the hafting plate mean that it is sometimes difficult to ascertain how many rivet holes a halberd has (see, for instance, the blades from Perth Museum and Art Gallery). The issue of multiple episodes of riveting, discussed in detail in Section 8.4 are not addressed at all in relation to the halberds, though some analogous work on LBA palstaves in NW France and the UK indicates that the variation in quality and conservation is unusual but not necessarily limited to the EBA halberds (Fonjijn and Roymans 2019:7). Finally, the Montelian evolution model, whereby simple shapes and technology naturally and logically give way to more complex objects regardless of adaptations or responses to the contemporary environment (Sørensen 2015:91), is steeped in post-Marxist rationalist-capitalist notions of worth, value and the inherent order of progress (Needham et al 2015:25). Typologies in other disciplines (notably the biological sciences) have changed over time to reflect research advances and modify the common typological features: for instance, the shift in ecological typologies from Montelian classifications based on how things look, towards Darwinian models of shared descent and ancestry; archaeology has either maintained the Montelian approach, or abandoned typologies completely, neither of which serve as useful research tools (Sørensen 2015:90). Furthermore, as the halberd completely disappears from the archaeological record in the Late Bronze Age, it is not appropriate to use evolutionary models because the peak form, the final and most complex halberd type (Breaghwhy), is not adopted into the long-term toolkit for continual use and adaption, as was the case with dagger and the later sword types (Burgess and Gerloff 1981; Burgess and Colquhoun 1988). The underlying issue connecting these critiques is that the proposed typology is not a useful tool, which has been recognised to some extent with other BA weapon typologies as well (cf. Gabillot 2006:290-292). Wonderful as an updated catalogue of the halberd assemblage is, a typology should not be the final product of research.

> "I question whether 'applying typologies' have simply become a matter of identifying similarities and differences without reflecting on why this matters and in which ways it matters, and why we select these rather than other similarities and differences. Has typology become a trope, in the sense of a commonly recurring device, a cliché, but lost its power as a tool to think with?"
>
> Sørensen 2015:85

This issue is beginning to be more widely recognised: a recent discussion of a socketed axe hoard in Devon criticises the unwieldy and unhelpful typology, and notes that it offers no interpretation as the how or why of the specific deposition groupings (Roberts et al 2015:373-4). The two additional types adopted in this study serve to categorise previously difficult halberds – particularly among the Scottish assemblage, where the Group Tom na Brataich comprises the majority of the recorded halberds (Chapter 8, Appendix 1), and thus to improve the utility and applicability of the typology to the interpretations and model offered within this study.

To return to typological dating methods, Type Carn is supposedly the oldest known halberd type in Europe, being relatively simple in shape and design and made from copper. Type Breaghwy blades, on the other hand, are more complex in design and made from tin bronze, which requires knowledge of alloying techniques and access to tin as a raw material. If this development is accepted (lack of absolute dating material aside), one would suppose the advent of compositional metal analysis and trace element analysis would secure the dating sequences into a fixed order. However, lead isotope analysis is costly (both in time and money) and has only been used for a small percentage of British Bronze Age metal artefacts, though the results are promising and have helped to identify several copper mines and internal trade routes within the British Isles (Rohl and Needham 1998). XRF analysis, though significantly cheaper, has not yet been widely undertaken, though recent publications have started to address this lack of compositional data (Bray and Pollard 2012). Lead isotope and XRF analysis data can sometimes be cross-referenced to produce a nuanced dataset through cluster analysis, as is the case for the Ross Island copper mines; however, this is not an appropriate technique for alloyed metals or recycled objects, which severely limits its applicability to much of the European archaeological record (Pollard and Bray 2015:998). Arsenical copper is no longer considered indicative of Irish manufacture, as copper with high arsenic content has been recovered from France and Central Europe (Coghlan and Case 1957, Schumacher 2002:276). The addition of <10% tin to the molten copper, resulting in bronze, has tacitly been interpreted as the final stage of innovation in Bronze Age metallurgy, treated and deposited differently, and bronze Type Breaghwy halberds have therefore been interpreted as coming from the later period of the Early Bronze Age (O'Flaherty 2002:113). However, it has been suggested that casting in copper was an intentional, deliberate choice on the part of the smiths who knew how to alloy bronze and had access to tin, due to the fact that copper blades are more easily repaired and are less brittle than bronze blades (O'Flaherty 1998:77). This has not been tested or trialled experimentally, but if true, would significantly undermine the existing Carn-Breaghwy evolutionary model in halberd development. Furthermore, time depth is rarely considered in detail in compositional analysis studies: metal travelling from source to use point within a decade would indicate trade, but more sinuous, multi-stage routes involving exchange, gifting and possibly functional use does not signify trade in the same sense (Pollard et al 2014:626). For instance, compositional analysis has indicated that the Ross Island copper found in southern England travelled extensively through Scotland first, undergoing major episodes of annealing and recycling along the way (Pollard et al 2014:630). Compositional data is very valuable to ongoing metal studies, but should be critical approached, as with any other data.

a)

b)

c)

d)

Figure 2.5 *– The four types of halberd in Harbison's typology: a) Type Carn (Roscrea, Tipperary, Ireland, acc. 1854 0714.214); b) Type Cotton (Maryville, Blackrock, Cork, Ireland, acc. 1849 0301.47); c) Type Clonard (Ballygawley, Tyrone, Ireland, acc. WG 1596); d) Type Breaghwy (Wroxeter, Shropshire, England, acc. 1905.1106.1). All blades held by the British Museum. Photographs: author's own, © British Museum. Not to be reproduced without express permission from BM curators*

2.4.4 Use

Despite being recognised as a specific artefact type over a century ago, the functionality of halberds as weapons has only been determined within the last decade. Uniquely among prehistoric weapons, halberds have laboured under the label of non-utilitarian weapon of mysterious and unknown function for many years. Harbison deemed the halberds "the most puzzling and problematical leitfossil of Early Bronze Age Europe" (1969); they were later deemed "one of the most remarkable and perhaps enigmatic artefacts of the first half of the Early Bronze Age" (O'Kelly 1989:164-5), and questions as to their function in combat were raised without further investigation, as well as modern value judgements on tastefully displaying wealth: "Puzzling objects… large, extravagant and unwieldy" (Waddell 1998:92). A significant amount of latent capitalist and rationalist theory influences the early halberd studies (and, indeed, continues to be used by some scholars such as Harding (2000) and Kristiansen (2005)). This is not an appropriate place in which to delve too deeply into post-Marxist economic theory, but there are a few pertinent points which should be noted. Post-Marxist (i.e. post-1945) theory involves scrutinising the degree to which the economy impacts the social landscape (Shanks and Tilley 1988:166); Marx held that society is inextricably shaped by the economy, and that technological innovation and economic organisation were the defining traits by which human progress could be tracked (Shanks and Tilley 1988:167). Childe was heavily influenced by the work of Marx and his contemporaries, and his syntheses reflect this (Hodder and Hutson 2003:217). Theoretical approaches have developed and diminished since this time, and the current landscape is one in which post-Industrial Revolution concepts of wealth, value, economics and currency, among others, should not be uncritically applied to prehistoric societies (Fontijn 2016:5). The early descriptions of halberds as extravagant (Wadell 1998:92) is an example of applying modern economic value judgements onto a pre-modern object from a social system founded on a dissimilar economic system, and one in which an object's 'value' may not be related to its scarcity or fiscal cost.

The handful of halberds hafted onto metal shafts were immediately assumed – without any sort of testing or experimentation - to be decorative only, as the metal shafts would undoubtedly shear and shatter under stress (O'Flaherty 2002:75). Interestingly, this issue of (non)functionality is tied inextricably to the term 'halberd'. In one of the earliest museum catalogues to attempt the classification of bronze weapons, Irish halberds were deemed "curved scythe-shaped swords" (Wilde 1857-61:451). Notwithstanding Wilde's propensity to label everything a sword, the halberds (or “curved scythe-shaped swords”) are then noted as being “most formidable weapons” (ibid 451). The difference in how the same artefact is treated depending on a label or name is worth keeping in mind when working with prehistoric weaponry.

Rather than add to the body of armchair archaeology and speculation, O’Flaherty (2007) designed a series of experiments using a replica Irish halberd (Type Carn) on a long oak shaft in order to scientifically determine whether the halberd could be used as an offensive weapon, or whether the point would crumple, as assumed by previous researchers (cf. Coles 1968-9). Repeated trials indicated that even with a slightly softer blade than the prehistoric halberds (the replica was cast using 0.2% arsenical copper, rather than copper with a higher arsenic content, or tin bronze, as used in the Bronze Age), the halberd cleanly punctured a series of sheep skulls, incurring no damage at all to the blade (O’Flaherty 2007:428). The study was limited in its choice of human tissue analogue, as the sheep skulls were denser than human crania; there was also no investigation into the different ways the halberd could have been wielded, or any exploration of different set-ups to test how the halberd handled against upright opponents, for instance; the experiments designed and enacted in Chapter 6 address these gaps. Comparisons to the earlier Neolithic clubs and much later medieval pole-axe and other polearms suggest that the shaft would also have been used offensively, most likely to club the opponent to the ground before delivering a mortal blow with the metal blade; this would also reduce the risk of missing the opponent and hitting a stone or similar, which would be more likely to damage the blade (O’Flaherty 2007:430; Ramsey 2016; Dyer and Fibiger 2017; Gall 2018). Long shafts with bulbous ends are frequently depicted as petroglyphs across Europe (see Figure 2.6, below), and blunt force trauma accounts for the majority of the mortal injuries present on the bodies from the Bronze Age battlefield cemetery at Tollense in north-east Germany (Jantzen et al 2010:430). The function of the Scottish halberd is discussed further in Chapter 6; a more detailed discussion of the theoretical approaches to violence and the forms of combat is given in Section 2.8 in this chapter.

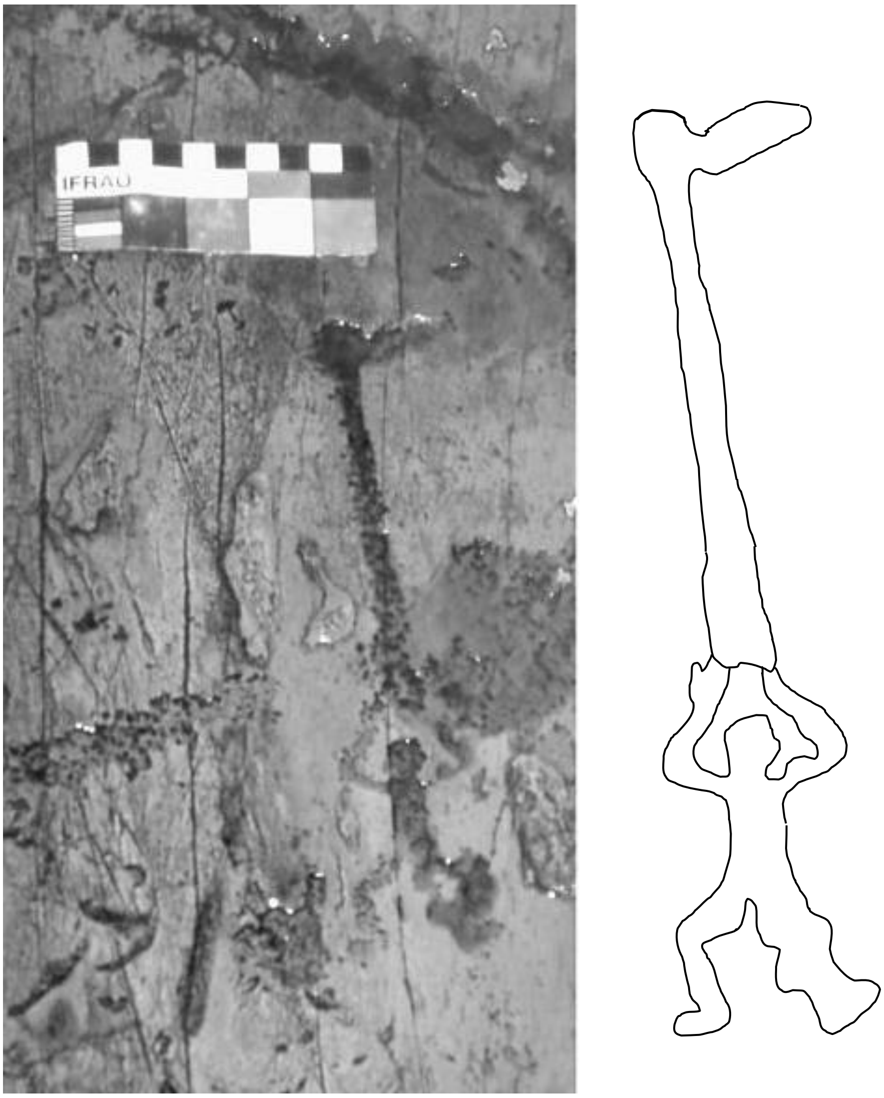

Figure 2.6 *– Petroglyph depicting a person wielding a halberd hafted onto a long bulbous shaft at Fontanalba in the French Alps. Photograph: Bahn 2008:33; author's line drawing, after Bahn.*

2.5 Dirks or Rapiers: Etymology, Origins, Typology, Dating and Distribution

Dirks or rapiers are narrow two-edged blades with a trapezoidal hafting plate (though there are other varieties and shapes used), to which is riveted an organic hilt. The blade edges are ogival, parallel or tapering. Typologically, the only difference between a dirk and a rapier is length: dirks are shorter than rapiers, but otherwise identical in every respect. There is no indication that the longer blades were used or deposited differently than the shorter blades, and it should therefore be understood that the term dirk/rapier will hereafter be used to refer to *all* narrow tapering blades with trapezoidal hilts. Despite the etymological association with the modern dirk (skean dhu), Bronze Age dirks do not resemble their modern counterparts. Modern dirks are single-edged blades with a broad, squat hilt; prehistoric dirks are double-edged and have a much more slender hilt.

2.5.1 Origins

Dirks are found all over Europe. Some scholars from the mid-twentieth century held that the specific dirk forms originated in Central Europe, from the Únětice/Aunjetitz culture (the Czech and German spellings) or subsequent Tumulus culture in the area covering modern Slovakia and the Czech Republic (Trump 1959-60:2). However, as with the single-origin models for halberds, closer examination of the weapon assemblages showed that there was once again pronounced variation in regional groupings that do not support a Central European single-origin model (Coles 1963-4:112). The relative paucity of dirks and rapiers in Scotland was attributed by Trump as indicative of an over-reliance on trade from Ireland and little to no Scottish manufacture or design (1959-60:1). Although not as prolific as some areas, Scotland has yielded 55 dirks, by no means an insignificant or statistically unviable assemblage. However, there has not yet been a region-specific study undertaken for the Scottish dirks/rapiers. There has, however, been a previous foray into a regional typology; Rowlands' synthesis for southern Britain described a three-class system, and was the first to recognise the development from a trapezoidal butt to the wide variety of smaller butts (Rowlands 1976:64; see Section 2.5.2 for further discussion of dirk/rapier typology). There is precedent, therefore, for adopting a slightly narrower geographic scope in this study.

2.5.2 Typology

As with the halberds, the earliest typology for dirks/rapiers derived from catalogues of museum holdings. The Irish dirks were initially believed to be diminutive versions of leaf swords, rather than a distinct class of artefact (Wilde 1857-61:439). Throughout, the weapons are interchangeably referred to as dirks, daggers and stilettos (ibid 449), and their perceived function seems to be awkwardly ascribed to the middle ground between tool and weapon.

> "Daggers, serving occasionally as scians or knives, like the Highlander's dirk, are, in use and generally in form also, but miniature swords, though… differ… in their mode of hafting."
>
> Wilde 1857-61:426

No attempt is made by Wilde at this early stage to classify the dirks or rapiers into types or groups; dirks are dismissed as diminutive swords, and rapiers as a variant form of the leaf-shaped sword (Wilde 1857-61:442). It is worth noting from the above quotation that the association with modern (post-medieval) dirks or skean dhus was made at the earliest stage in dirk/rapier studies and has lingered since – despite being potentially misleading. Similarly, the term 'rapier', with its overtones of fencing and swordplay, appears not long after, when the term is used to distinguish between long and short daggers (Evans 1881:257-54). No further work is carried out on British dirks/rapiers until the middle of the twentieth century, when the Welsh material was catalogued by Grimes (1951). It is in this monograph that the term 'dirk' is used consistently for the first time, after which it became the accepted term – despite the typological differences between modern and prehistoric dirks, described in the introduction to this section.

There then followed the publication of three typologies within eleven years of each other. Trump's 1959-60 paper was the first, and therefore broke new ground, but contributed little to the discipline. Three primary groupings are established, with many internal sub-classes in each, but these groupings are poorly described and delineated (if at all – Group I is referenced but never actually detailed) (Trump 1959-60:3). Despite a purportedly Scottish focus, the narrow range of studied dirks/rapiers proves problematic, leading to a distinct bias towards south-east England and the assumption that the blades found in Scotland were in fact of London manufacture (Wandsworth group, Trump 1959-60:7); Scotland is therefore relegated to provincial status, an issue which would continue throughout wide-scale studies for the next 50 years (cf. Kristiansen 1988 and Earle and Kristiansen 2010, both of which subscribe to the centre-periphery model of economic and social development, placing Scotland firmly in the periphery). Wider Britain was not wholly ignored, however, though the breadth and complexity of the dirk assemblage is not covered extensively: "Weapons similar and only very slightly inferior... were made in the Fens and Ireland" (Trump 1959-60:7). Trump's work further dates itself into irrelevance through the protracted use of culture-history and a significant degree of narrative license and authorial subjectivity. The movement of copper and bronze through northern Europe is explained by the migration of Irish smiths to Scandinavia, whereupon they were met with suspicion and hostility by the "ungrateful" Nordic communities and hounded back to Britain c.1400BCE, hence the similar stylistic and decorative traditions, negating any consideration of local regional adaption and stylistic tradition (Trump 1959-60:2-3). The monolithic interpretation of the dirk/rapier's use as a weapon by men only, dismissal of Bronze Age communities' innovation, arable competency, interpersonal communication skills and moral values are demonstrated in the following passage.

> "[The blades] were used for killing a man's enemies and his prey. Since the people of Middle Bronze Age Britain lived almost exclusively by cattle raising, we can be sure they went in for cattle raiding, because the two inevitably go together in primitive communities."
>
> Trump 1959-60:14

Unsubstantiated by any data or interpretative evidence, Trump's typology is included here to represent how author bias, insufficient scrutiny of first principles, and little consideration of contemporary theoretical advances can affect a consideration of a physical assemblage. The conflation of evidence and subjective interpretation leads to inaccurate and misleading conclusions: the passage quoted above uses the evidence of the dirks' suitability as a weapon (which is true, though not necessarily the only function of the dirks) to substantiate a subjective interpretation of the unsophisticated, primitive community. Recognising the difference between data and interpretation is critical in studies such as this doctoral project, and this literature review should contribute to differentiating between the two.

There can be little surprise, then, in reading how Coles, in his catalogue of Middle Bronze Age metalwork from Scotland, makes no apology for revisiting the material so soon after Trump's paper (Coles published in the 1963-4 volume of the Proceedings of the Society of Antiquaries of Scotland, barely three years after Trump's own PSAS article). He fully rejects Trump's groupings, instead following his own conventions established in his earlier work on Late Bronze Age metalwork (Coles 1959-60, 1963-4:82-3). However, despite identifying the need for a new typology based on the shape of the blade and hilt, Coles does not go on to develop this idea further into a workable classification system (Coles 1963-4:114).

The third typology from this decade is the one which is still used as the standard in dirk/rapier studies. Despite being drawn from a relatively restricted pool of blades from north-east England, the classification system derived by Burgess (1968:3) was the clearest and most applicable typology created to date. His groupings are as follows:

- **Group I**: blades displaying ribs and grooves
- **Group II**: a ridged blade with a flat lozenge section

- **Group III**: a blade which displays a triple arris (narrow ridges on each side of the blade)

- **Group IV**: a blade with a relatively flat midsection and concaved or bevelled edges

This typology was adopted by Burgess and Gerloff in their 1981 catalogue of British dirks and rapiers and has remained the preferred method of classifying dirks and rapiers in Britain since (see also O'Connor and Cowie 1995 for its application to the more recently discovered Scottish blades). There was also a later attempt to formulate a region-specific typology for southern Britain, which included the transition from trapezoidal hilts to a wide range of shaped and size (Rowlands 1976:64). However, the proposed broad schema meant that very different sizes, shaped and decorated blades were presented as the same type, confusing the classification boundaries and making the typology unhelpful in wider interpretations. As such, notwithstanding the importance of hilt shape, this typology was not adopted by Bronze Age researchers.

2.5.3 Dating

Typologically, dirks develop from Early Bronze Age flat knife or dagger forms (Burgess and Gerloff 1981). Burgess' 1968 typology posits the more elaborate stages of development, from the relatively simple Type I through to the more aesthetically elaborate Group IV. This is upheld in the material record: though usually deposited as single finds, there are at least two instances of Scottish dirks/rapiers being included in mixed-assemblage hoards. The Kincardine hoard from Abernethy included two small socketed axes of a very early type, both displaying Irish influences. The Callander hoard of two rapiers, a socketed axe and a spearhead with asymmetric loops has had its association questioned due to its early discovery (1830) and subsequent poor recording (see Fig. 7 in PSAS 1955-6:463, which clearly shows two fragmentary rapiers of Groups III and IV). However, the updated chronology for the Wilburton period in the south of England places the development of socketed axes in the mid to late Middle Bronze Age, much earlier than previously though (see Eogan 2000:30). The association with Groups III and IV, which develop in the second half of the Middle Bronze Age, is therefore chronologically sound.

2.5.4 Distribution

Dirks and rapiers are relatively common in Britain, with particular concentrations in south-east and north-east England. A total of 55 dirk/rapiers are known from Scotland (following Burgess and Gerloff 1981 and O'Connor and Cowie 1995), with notable concentrations in the south and east. This includes several blades that are recorded in museum holdings or acquisitions but have since been lost. The map below shows the locations of all known dirk/rapiers in Scotland.

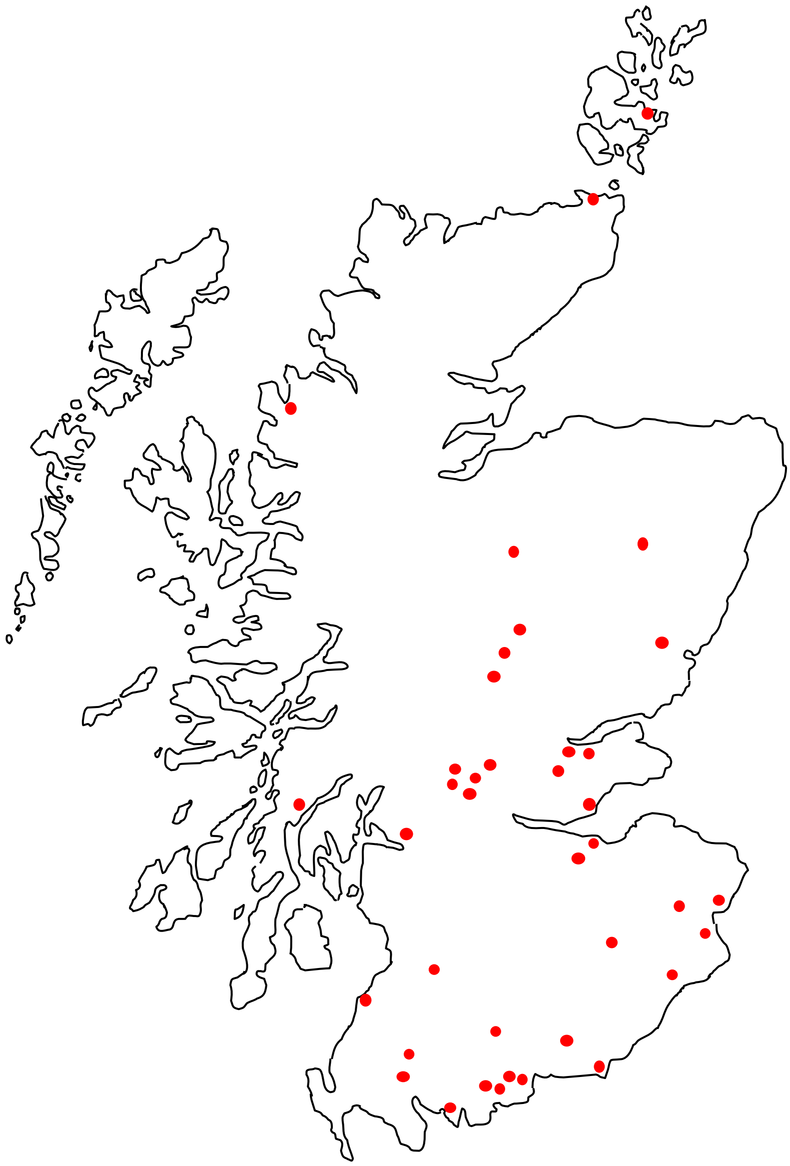

Figure 2.7 *– Map of all known locations of dirk/rapier depositions in Scotland. Though the south and east show the most depositions, the west coast, highlands and islands are not completely inactive during the Bronze Age; this is not reflected in many syntheses from the early and middle twentieth century. After O'Connor and Cowie 1995:346, with author's additions of dirks located since publication.*

2.6 Scotland in the European Bronze Age

Modern geopolitical boundaries cannot be unthinkingly applied to Bronze Age communities, but the area studied in this thesis can be more easily understood as part of a wide network of trade and communication. Although the halberds studied here are primarily Scottish, a handful were found in northern England (see the Wrexford and Maryport halberds, Appendix 1); although 'Scotland' is used throughout this work to refer to the area studied, this includes these halberds found in the Debatable Lands (Robb 2018) and should be understood as such. An appropriate approach to the concept of space and economy would be to consider comparative patterns of landscape use and settlement locations (Earle and Kristiansen 2010). Although focussed primarily on Scandinavia, Earle and Kristiansen's work can easily be extrapolated for Scotland. Both regions have similar physical geography, which swathes of fertile land bounded by sea, highlands or bogs; the settlement patterns in both regions are not yet comprehensively researched, but excavations have shown small scattered settlements with associated farmland and wild resource exploitation in both areas. Settlement patterns can change from county to county, let alone country to country, as well as over time, so this is not to suggest a single Bronze Age settlement pattern for the whole of northern Europe (Cooney and Grogan 1999:99). Excavations in Scotland show small clusters of agricultural settlements are found inland and seasonal occupations cluster along the coastlines (Earle & Kolb 2010:69); there is a correlation with similar physical landscapes and settlement patterns, as a comparative regional study in Central Europe (Szazhalombatta, Hungary) shows larger and denser settlements forming in the Middle Bronze Age (Artursson 2010:100). It would not, therefore, be unreasonable to extrapolate that Scotland underwent changes similar to those observed in Scandinavia, with small clusters of farming hamlets aggregating into small villages as the Bronze Age progressed, in contrast to the vast city-states and empires flexing their power to the east. Jensen goes further and proposes a system of 'ambulatory villages' which drift to follow the most fertile areas as agriculture depletes soil nutrients (Jensen 1989:111). This is less appropriate for Scotland, where inhospitable high ground and less fertile soils are common; a more feasible scenario is one in which a series of permanent settlements rely on cultivation and pastoralism on the fertile plains, with temporary camps of ephemeral settlements along coastlines or loch shores to exploit lacustrine and marine resources. For instance, the settlement site at Oldmeldrum, Aberdeenshire, 25km inland, was occupied for many successive generations (White and Richardson 2010:24), as was the settlement at West Acres, Newton Mearns, Clyde Valley

(Toolis 2005:475), which shows several phases of overlapping roundhouse construction (see Figure 2.8). It has also been suggested that in settlement sites such as the Green Knowe unenclosed platform settlement that although the roundhouses were occupied for only a generation or two before being pulled down, the settlement area itself was continuously occupied. New houses were built in pasture or arable fields, with crops planted over the remains of old houses, and cattle and pigs kept in fallow fields (Jobey 1978-80:94).

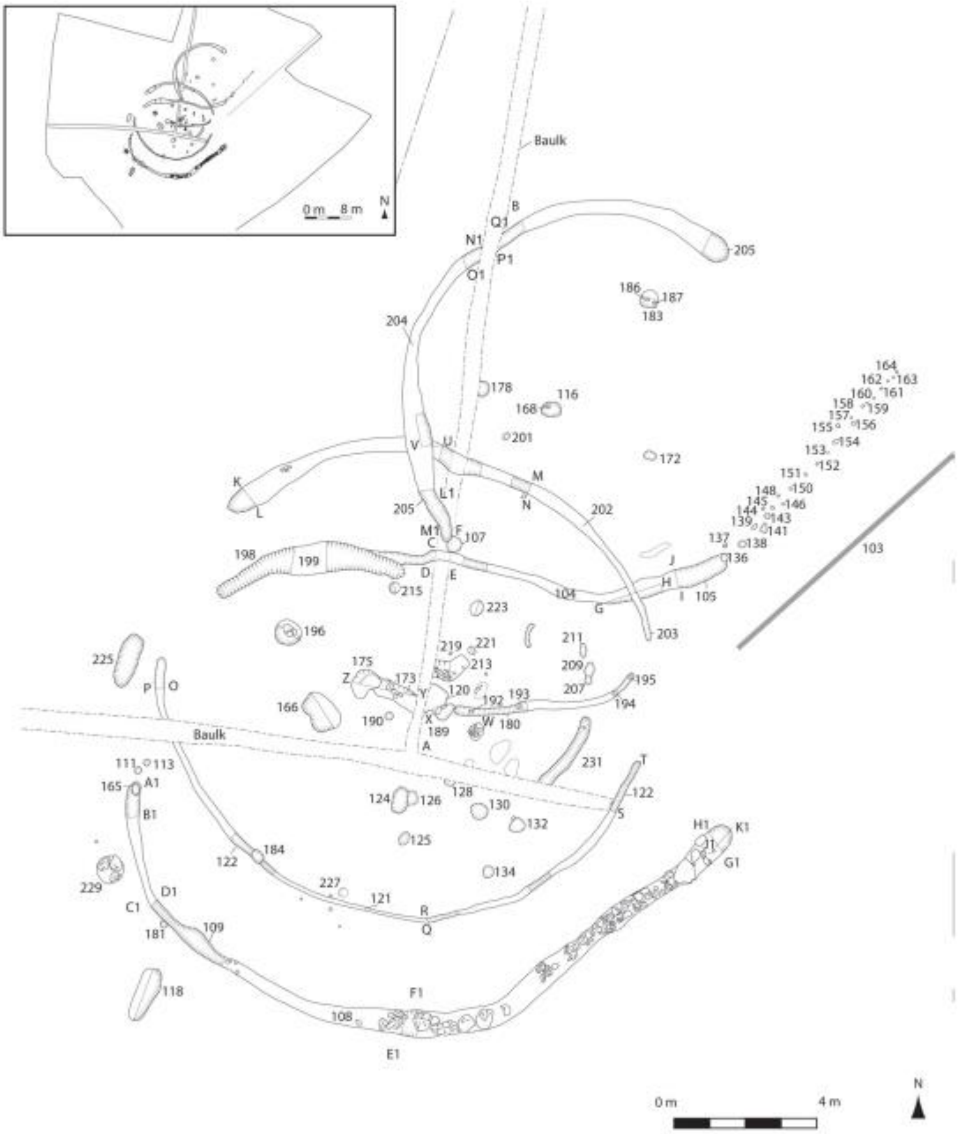

Figure 2.8 *– Site plan from West Acres, Clyde Valley, showing successive roundhouse construction phases. This indicates that the site and its immediate vicinity was occupied for a long period of time and does not support the 'ambulatory villages' model proposed by* Jensen (1989:111). *(Toolis 2005:475)*

In terms of analysing settlement distribution and density, late twentieth century scholars frequently equated settlement density and complexity with their relation within the trade and status exchange network led by the local ruling elites (see Rowlands 1980:32), wherein large settlements wield more power within a trade network, either because of their greater spending power from the higher concentration of wealthy residents, or by their increased production of tradeable or exportable materials. Both concepts are fundamentally rooted in modern capitalist concepts of wealth accumulation and allocation. Issues with correlating economic and political power aside, the proposed model requires there to be a significant size difference between coastal and riverine settlements, which would have benefitted from long-distance trading contacts, and inland settlements, which would have had to compete internally for land subsistence rights (Rowlands 1980:34-5). Long-distance trade and exchange was clearly a major factor in the movement of technology and ideas (and people, though not necessarily in the aggressive invasions favoured by early 20th century culture-history scholars (cf. Childe 1937)) in the Bronze Age; experiments with Scandinavian Bronze and Iron Age ships have shown that vessels could travel up to 400km per week at sea or through river systems in the temperate climates of northern Europe (Crumlin-Pederson 2010:31). Recent biogeochemical work in Denmark has also shown that individuals were capable, and were routinely, travelling much larger, pan-European distances, and much more quickly, than previously modelled (Frei et al 2015:5). However, this suggested disparity in coastal and inland settlement sizes is not present in the archaeological record, and it must therefore be concluded that the economic and social benefits of trade were not confined solely to trading ports. Post-processual modelling has fallen out of favour among 21st century archaeological researchers, but is useful in simplifying complex systems in order to facilitate further research. Although – as discussed above – settlements differ from region to region, the Scottish Bronze Age settlement pattern can be visually summarised as follows in Figure 2.9.

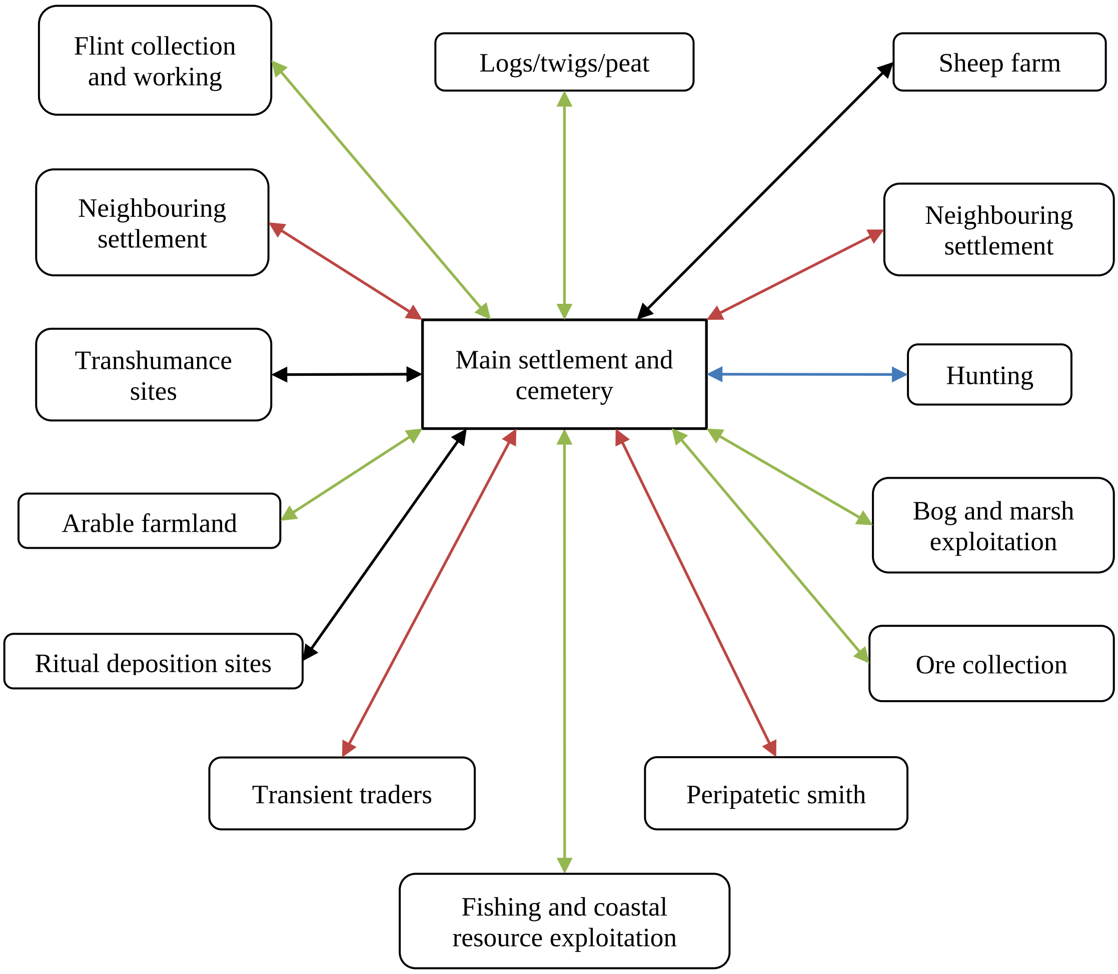

***Figure 2.9** – Bronze Age settlement and economic system in Scotland. Modified from Jensen 1989:115). Green arrows: raw material coming into the settlement through labour; Red arrows: flow of goods, ideas and people in and out of the settlement (trade); Black arrows: expenditure of effort and resources from the settlement for future, rather than immediate, benefit (investment).*

Scottish domestic sites maintained a number of subsistence economic practices immediately adjacent to the houses: phosphate and magnetic susceptibility testing shows that cattle or pigs were routinely corralled or stabled in the land surrounding the houses, and small-scale plant cultivation – similar to an allotment or garden – is frequently recorded in the palynological and microfossil record in the immediate vicinity of the houses (Terry 1995:419, Johnston 2005:213-4). In terms of the wider landscape, palynological analysis from samples from Thy in Denmark indicate that the Bronze Age period was largely defined by wide open areas of grassland with well-managed areas of woodland until c.1000BCE, after which a rapid deterioration in the quality and quantity of woodland led to an increase in peat fuel and poor-quality building timbers (French 2010:36-40). An almost identical pattern is found four hundred kilometres away at Tanum in Sweden, which features a changing shoreline as sea levels rise, but otherwise displays the same progression of landscape exploitation, depletion and heath expansion (French 2010:42). Settlement excavations have shown that Scotland and Scandinavia also have very similar economic bases, with emmer, spelt and einkorn prevailing in the Nordic Early Bronze Age and an increase in hulling (to produce bread) developing in the Middle and Late Bronze Age (Stika and Heiss 2013:78). Soft fruit cultivation, particularly raspberries, was also a common feature of Nordic and Scottish Bronze Age farming (Høgeshø 1995:111). Scotland has an almost identical array of food produced, though with the major addition of barley (Harding 2000:146). Pigs, ovi-caprids and cattle were kept domestically, and wild resources exploited, throughout the Bronze Age (Cowie and Shepherd 2003:164, Stevens and Fuller 2012:718). Major identifiable population expansions occur only in the Late Neolithic and Early Iron Age periods, based on the aggregation of hamlets and farms into villages (Earle & Kolb 2010:62-3); the Bronze Age populations of Scotland and Scandinavia appear not to have expanded beyond small (<20 houses) farming hamlets, linked to fertile, immediately adjacent farmable land, as well as nearby wild resources such as fish and hedgerows. Population estimates are difficult to base on Bronze Age cremations and inhumations alone, as these represent a fraction – between 0.1% and 1% - of the total number of deaths in the Bronze Age communities (Cowie and Shepherd 2003:155). The settlement record is a useful counterpoint to the burials in estimating prehistoric population, but without a nation-wide survey of settlement patterns in the Bronze Age, the population of Scotland during this period remains a matter of educated guesswork; assuming multi-generational dyads living in each unit (see below, Section 2.7.1) in a small hamlet of 20 houses, communities of ~150-200 people can be conjectured.

Although not a closed system, the model of a hamlet or village sized settlement system described above is largely self-reliant and does not strongly feature extensive trading with outside systems. In terms of metallurgy, copper, tin, or bronze is brought into the system as ore or ingots, or in the Late Bronze Age, as imported finished or semi-finished objects which could then be recycled (Bray and Pollard 2012). Given the range of typologies in the Scottish bronze assemblage, as well as the fine detail in finishing and decoration exhibited on some of the extant metal artefacts, it is clear that metal was being worked from an ingot into a finished artefact within some settlements, rather than solely importing the finished articles from elsewhere. In many of the early 20th century post-Marxist models of the development of metallurgy, it was the establishment of a stable agrarian economic base which allowed Bronze Age communities in Scotland to begin experimenting with metal ore extraction and processing, as the food surplus begets role specialisation (Childe 1944). Even if we adopt Budd and Taylor's idea of the bronze smiths being an integral part of the chiefdom, rather than peripatetic and separate (1995:141), stable and permanent settlement sites would still have been required to facilitate the acquisition of ore or worked metal, and to imbue the finished bronze item with meaning or significance. It is also important to note – repeatedly – that Bronze Age northern Europe did not include any major proto-urban settlements, as with the contemporary Mediterranean, and that the societies were not literate. The development of metal weaponry can be contextually examined and interpreted with these notes in mind.

2.7 Theoretical Approaches

As discussed above, new tool/weapon forms appeared during the Early and Middle Bronze Ages, but their function[s] and role[s] have been questioned almost unceasingly throughout the twentieth century, as demonstrated in the following section. It is worth examining the theoretical paradigms applicable to weapon usage at this early stage, in order to avoid unnecessary confusion or semantics during later discussion. It should also become apparent that by applying various aspects of theory to experimental studies using replica weapons, as demonstrated in Chapters 3, 6 and 7 that quantitative data can be contributed to an otherwise theoretical debate. This is particularly significant to the study of halberds, which – as shown in Section **Error! Reference source not found.** – have b een the subject of several mutually exclusive hypotheses as to their potential function[s].

2.7.1 Queer Theory

Queer theory is a paradigm based on challenging normativity and engaging with marginalised voices. Queer archaeology is not explicitly concerned with the visibility of homosexuals in prehistory; rather, it seeks to challenge heteronormativity and the construction of gender in archaeological interpretation, such as the preponderance of the 'family unit' of a mother, father and offspring in economic and social interpretations. Broadly, queer theory aims to visualise and give a platform for "anyone who feels their position (sexual, intellectual, or cultural) to be marginalised. The queer position is no longer a marginal one, considered deviant or pathological; but rather multiple positions within many more possible positions" (Dowson 2000:163). As an opposition to the 'normative', queer theory is eminently suited to the cross-disciplinary nature of archaeology, as it encourages re-evaluation and comparisons of multiple time periods, materials, cultures and environments (Voss 2000:184); it has also been used to attempt to bridge the divide between cultural resource management and academic archaeological research (Campetti 2015). Although not explicitly widely adopted by many archaeological researchers, some high-profile academics are advocating research strategies which encompass the core values of queer theory: ignoring disciplinary boundaries, questioning academic authority, increasing cross-disciplinary sharing and collaboration, becoming more aware of our social responsibility when addressing big issues and informing grand narratives, emphasising critical thinking, and making multinarrative interpretations the norm (Fontijn 2016:8-9). It has also been used pedagogically, in making archaeological teaching more reflexive and open to non-traditional audiences (Burkholder 2015), which will be discussed further below. Although queer theory was explored in a dedicated issue of *World Archaeology* (32:2, 2000), primarily as regards its application to archaeological research, and more recently by the Society of American Archaeology in a session at their annual conference (The 80th Annual Meeting of the Society for American Archaeology, San Francisco, California 2015), where papers covered the application of queer theory to both the practice and analysis of archaeology, it has not been widely applied by mainstream archaeology as a methodological or theoretical approach in Europe. Where queer theory tenets have been applied to existing archaeological research, the results and conclusions have been markedly different to the original work and offer new and alternative ways of approaching and analysing material assemblages (Arjona and Lennen 2015; Rutecki 2015; Blackmore 2015). A paper published as part of a conference proceedings in the March 2017 BAR further develops the ideas and applications of queer theory to experimental archaeological paradigms and is bound into this thesis (Faulkner-Jones 2017). Where appropriate, these tenets of questioning unconscious bias, widening access, and deriving data-based conclusions rather than attempting to prove or disprove a pre-formulated hypothesis have been applied to the methodologies in this thesis, most particularly in Chapters 3, 5, 6 and 7.

2.7.2 Gender and Feminist Theory

Queer theory can be contextualised as a brand or offshoot of feminist and gender theory, which (in Europe and north America) sprung from second-wave feminism in the 1960s and continued for over two decades (see Evans 1995). As queer theory seeks to give a platform to marginalised voices, feminist theory began in examining the role of women in the world as well as amplifying female-led research. In terms of its application to this study is in identifying and addressing latent bias. The most obvious – and pernicious –

example of latent gender assumption in combat studies is the assumption that the warriors in Bronze Age society were male, and the subsequent and unthinking referral of the elites as 'he' (see Coles 1968-9, Osgood 1998:6-23, Cooney and Grogan 1999:112, Kristiansen 1999). This phenomenon can also present as an explicit gender assumption, where weapons and 'masculinity' are directly correlated, seemingly based primarily on modern notions of male aggression and expression, rather than the archaeological evidence (see Traherne 1995, Kristiansen 2002, Hafsaas-Tsakos 2013). Through this association of weapons and men, women are rendered completely invisible in interpretations of the metal material record. The association of aggression with masculinity also homogenises the perceptions of men, both in prehistory and in modern times, and reinforces the concept that the only 'true' masculinity is the one exemplified by the swaggering, testosterone-fuelled, physically fit fighting man. The equation of physical power and dominance with political power and dominance has also led to the assumption (in many studies) that the political elite were all men; consider the rich burial of the Egtved Girl in Denmark, who travelled extensively in her life and was buried under a swan's wing. The detailed and relatively objective biomolecular study of her remains segued into an unfounded and unsupported assertation that she was the wife of a powerful political figure (Frei et al 2015:5), negating any discussion of her occupying a powerful position on her own merits. The 'theory lag' has resulted in archaeology not yet whole-heartedly embraced the developments in theoretical approaches that have occurred over the last 30 years (Liebmann and Rizvi 2008:1). It is now appropriate to do so. It is worth noting at this late stage of the literature review that the majority of English-language works on combat and economic theory, as well as all bar one of the weapon catalogues, have been written by male academics. Intentionally or otherwise, this has led to a range of implicit gender assumptions which have become entrenched within the combat and economic theoretical paradigms. These hinder interpretative efforts and present a very biased and homogenous image of prehistoric Britain which does not engage with a diverse audience; this runs counter to the approach adopted in this project, discussed at greater length in Chapters 3 and 6. This is particularly noticeable in studies of halberds and the Scottish Bronze Age, as most of the work in this field was undertaken prior to the wider development and application of gender, queer, post-colonial and intersectional theory on archaeological research.

There has been some recognition in archaeological research that implicit gender assumptions are damaging supposedly objective interpretations, but little coherent consensus in how to remedy and prevent such damage. For instance, it has recently been recognised that interpretations of dirks in Bronze Age Iberia are being clouded by gender stereotypes: dirks from male graves are interpreted as weapons, whereas identical dirks found in female graves are interpreted as tools (Anconda-Jimenez et al 2009:1044). The concept of fighting males – as mentioned above – is also harmful, as it homogenises the male experience and overlooks all other expressions and labours of the prehistoric male. A study of Iron Age Italian cemeteries indicated that the male skeletons suffered heavy trauma during their life; close examination revealed that these injuries were more likely to be the result of heavy manual labour, rather than combat, and that male-dominated cemeteries should not be automatically interpreted as the result of a skirmish or raid, but of (for instance) a mine collapse (Robbs 1997:127). Gender assumptions damage perceptions of men and women alike, as has been recognised in the wider literature, and in keeping with the current theoretical work, the terms gender theory and feminist theory are used interchangeably throughout this study and should be understood as such.

Gender theory as applied to distinct academic disciplines arose in the 1980s with the publication of several works of feminist approaches to archaeology and anthropology, primarily in North America, all building on the development of second-wave feminism happening in wider society at the time (Conkey and Spector 1984). Being a cross-disciplinary field, which combines theoretical and practical approaches, archaeology is an ideal space in which to reflect on the production and interaction of cultural and natural judgements (Tomaskova 2007:267). The major focus of early feminist-inspired archaeology in North America was to re-assess concepts of labour divisions and the disparity in value between men’s and women’s work, a research focus which arose concurrently with the collapsing notions of masculinity and femininity in wider feminist theory (Voss 2000:181-4). This did not, however, translate to a similar flourishing of gender research in Europe, perhaps because European archaeology and anthropology are much more separated as academic disciplines than in the United States (Voss 2000:183). It should be noted that gender-based archaeological discourse has remained at approximately 2.5% of all mainstream publications since 1980, even at its peak (Danielsson 2012:20) and cannot therefore be considered as to have ever been wholeheartedly embraced by the wider archaeological community.

Gender archaeology was initially solely concerned with addressing value judgements in the study of prehistoric economies and making the female role visible in archaeological interpretations. Methodologically, gender archaeology emphasises reflexivity, the position of the archaeological subject, and the political implications of archaeological research (Tomaskova 2007:271). Practically, gender archaeology involves being aware of implicit research bias, such as the western dichotomies of sacred/profane and the binary gender system (Tomaskova 2007:98); the projection of modern values onto prehistoric societies (such as the feminine Venus figurines described by Gimbutas (2001)), and the use of non-traditional media, particularly internet platforms, to convey interpretations and information and encourage involvement among the wider community, not just specialised academics (Tomaskova 2007:101, Rubio 2011:35).

Gender archaeology has developed since the 1980s and is now part of an intersectional theory movement encompassing post-colonial and queer approaches. The commonality between these three paradigms is that traditionally, white heterosexual male archaeologists have had an epistemological privilege, making their views the dominant voice in archaeological interpretation by legitimising specific and potentially limited constructions of the past (Dowson 2000:162). By giving those with an epistemological disadvantage agency and a platform, a more nuanced, reflexive and engaging archaeological discourse emerges. This is not to imply, as some scholars have, that marginalised communities provide a 'better' interpretation due to their awareness of oppressive structures (Rubio 2011:28), but rather to be aware and open to non-normative interpretations without imposing unnecessary subjective value judgements

2.7.3 Post-colonial Theory

Post-colonial archaeology is perhaps slightly less relevant in this thesis than other theoretical paradigms because prehistoric Scotland does not survive in protected extant indigenous communities, unlike the First Nations and Native Americans in North America. However, the fundamental tenets of post-colonial theory are based on reflexive examinations of representation and ideology, as well as the methodology of obtaining archaeological data, which are both concerns relevant to this study (Liebmann and Rizvi 2008:4). Among European and North American scholars, the focus on 'otherness' in societies in Africa, Polynesia and among the First Nations is relatively easy to conceptualise, and is a long-established academic discipline (Harrer 1963, for instance). However, there is less discussion of the European 'other', and prehistoric European societies are often framed as ideological (and sometimes cultural and genetic) precursors to modern European society, rather than as distinct and unknown entities (Fontijn

2016:6). Eurocentricity should therefore be recognised as a post-colonial bias. Furthermore, the regional and global political climates have undergone a profound shift during the course of doctoral study (2013-2019). The rise of popular nationalism and dialogues concerning globalisation and isolationism, from the Scottish Independence Referendum in 2014, to Brexit and the election of Donald Trump in 2016, and the rhetoric surrounding the refugee crisis, mean that a thorough grounding in post-colonial discourse is necessary to contextualise the climate in which this study was undertaken, and any resultant latent author bias. A recent oration by Professor Fontijn noted that the emergence of a pan-European trade and communication system concurrent with the development of bronze technology created a 'Europe', with free movement, favourable trade conditions and cultural contact, thousands of years before the establishment of the EU (Fontijn 2016:5); archaeology should not therefore wilfully blind itself to contemporary political discourse, especially as it can inform so many latent author biases. Additionally, Rizvi's methodology in excavation in Rajasthan was developed using post-colonial discourse, focussing on the language used on-site and in reports, the integral inclusion of the community around the site and – perhaps most importantly – demonstrated the ability of the professional archaeologists to relinquish power and authority in the field (Rizvi 2008). She therefore demonstrates how a theoretical paradigm can be applied successfully to a real-life situation, removing the Marxist critique of post-colonial theory that it divorces the theory from reality (San Juan 2002:221), and sets a precedent for the successful application of contemporary theory to practical experimental work developed in this study.

2.8 Combat Theory

As this thesis focusses on the practical functionality of the EBA halberd, as well as consequential symbolic uses, combat theory and related theoretical paradigms applicable to weapon usage, creation, and wielding should be examined at this early stage, in order to avoid unnecessary confusion or semantics during later discussion. As discussed above, new tool and weapon forms appeared during the Early and Middle Bronze Ages, but their function[s] and role[s] have been questioned almost unceasingly throughout the twentieth century, as demonstrated in the following section. It should also become apparent that by applying various aspects of combat theory to experimental studies using replica weapons, as demonstrated in Chapters 3, 6 and 7, that quantitative data can be contributed to an otherwise theoretical debate. This is particularly significant to the study of halberds, which – as shown in Section 2.4.4 above – have been the subject of several mutually exclusive hypotheses as to their potential function[s].

2.8.1 Inter-personal Combat and the Scale of Fighting

Metal weapons tend to survive relatively well in the archaeological: pre-recovery, metal does not decay at the same rate as organic material, and oxidation and material loss depend on the acidity and water content of the soil in the deposition matrix. Post-recovery, metal artefacts tended to be better recorded and preserved in museum holdings compared to ceramic and lithic material recovered at the same time, perhaps due to the perceived higher value of metal compared to pottery and stone (see, for instance, Smith 1857-9). Metal objects recovered from private land during the 19th century period of antiquarianism also tended to remain in the private collections of the landowners in much higher proportion than ceramic and lithic items, and were sometimes gifted between the landed elites, and so were preserved for eventual acquisition by a museum (or not: see the two halberds in Dunrobin Castle (Appendix 1)). This is not to suggest that private collections automatically confer perfect preservation: abrasive cleaning to make the metal shine can damage the surface and remove any informative patina (see the Culloden halberd, Appendix 1), and there is at least one instance of a halberd being engraved by the finder (halberd 1905 1106.1, British Museum, Appendix 1). As the metal blades are visually appealing and emotive, engaging modern non-specialist audiences, they have typically been the focus of much research and analysis since the early 1900s. This has also included a critical re-examination of how the weapons were used, as well as the nature of combat in prehistory. Without contextualising the combat, assumptions may be made which artificially and inaccurately influence research into the artefacts.

Understandably, combat theory in the twentieth century has been greatly influenced by the breakdown and ongoing consequences of 19th century European imperialism and global conflicts, which have contributed to the development of the concept of 'total war'. Total war refers to conflict wherein every resource is mobilised against the opponents and conflict is not restricted to the battlefield. Forced and/or mass conscription, repurposing factories, civilian labour, transport, national finances and intelligence, non-combatant casualties, and the strategic destruction of non-battlefield targets (including policies such as 'scorched earth', 'no quarter', blanket bombing, and the use of atomic weaponry) are all involved in the waging of a total war (Chickering and Förster 2003:8). The earliest documented total war policy was enacted by Genghis Khan in 13th century Mongolia, when entire cities and populations were destroyed during large-scale military conflict (Terry et al. 2011:717). However, total war only became the norm for inter-personal conflict during the 20th century, most particularly from the Second World War onwards. The dedication of all resources on every side of a conflict for the wholesale eradication of the opposition was previously unknown on such a scale and transformed war from once-remote conflict to destruction and disruption to the very heartlands of civilian life. Churchill's outraged response to the Luftwaffe's blitzkrieg on London from a radio broadcast from 11th September 1940 exemplifies how war was brutally brought to the heart of civilian Britain during World War II, a radical departure from the imperial wars of the preceding century, fought in far-flung countries having very little immediate effect on the British populace. Large sections of this broadcast were quoted by Mayor Giulianni after the terrorist attack on New York in 2001, which were a further extension of the total war paradigm.

> "These cruel, wanton, indiscriminate bombings are, of course, a part of Hitler's invasion plans. He hopes, by killing large numbers of civilians, and women and children, that he will terrorise and cow the people of this mighty Imperial city, and make them a burden and an anxiety to the government, and thus distract out attention unduly from the ferocious onslaught he is preparing… this monstrous product of former wrongs and shame has now resolved to try to break our famous Island race by a process of indiscriminate slaughter and destruction."
>
> Churchill 2003:250

However, prehistoric combat would not have resembled modern warfare at all. Etymologically, 'war' implies the existence of a state system, as it is defined as the violent result of conflicting principles or forces between two or more antagonistic state systems (Shorter OED 1973:2503). It is also interesting to note that in Europe, the word 'war' only appears c.1050AD from a Medieval Latin root; before this, the Old English gewin was used, which translates as 'struggle' or 'strife' and does not imply a wider socio-political prerequisite. It has been argued that in the absence of a higher authority to settle disputes, any armed combat in pre-state societies could be classed as 'warfare' (Osgood 1998:4); however, this is not upheld etymologically, and applying a term laden with political suppositions blankets over the various different levels of combat and conflict possible in a non-state society. It is of vital importance to recognise this at an early stage. Many studies of prehistoric conflict do not distinguish between war, raiding, sporadic interpersonal conflict (such as one-on-one combat), judicial violence, and endemic or systematic intra-social violence, such as spousal abuse. Several of these types of conflict are heavily ritualised and socially prescribed: consider capital punishment, a form of judicial violence, and its contemporary use in 31 American states as the penalty for aggravated intentional homicide, a form of sporadic interpersonal combat (cf. Godfrey v. Georgia 1980). Without making clear these definitions and distinctions, the scale, scope and significance of violence becomes unclear. Despite its myriad authors and unifying theme, Violence and Warfare in the Past (Martin and Frayer 1997) does not define 'warfare' until the end of the final chapter, where Ferguson presents his take on warfare as a potential theoretical interpretation: "War is waged when it's in the best interest of the political elite… War [is] an expression of a political structure" (Ferguson 1997:334-5). The role of the political elite and the state structure is inextricably linked to the concept of warfare, and care should therefore be taken when delineating various forms of interpersonal conflict.

Furthermore, the proto-civilisations in the Bronze Age Mediterranean did not develop a form of war that would be recognisable to modern observers. The Greek Bronze Age army-based conflict recorded in the Iliad does not follow modern combat conventions: in Book 7, after assembling a huge fleet of ships and massing their armies at the gates of Troy, Hektor and Aias (Ajax) meet to speak. Their huge armies then proceed to sit down, and the two champions fight in single combat in full view of both sides for most of the day. Realising neither can win, the two men congratulate the other on their prowess in combat, exchange symbolic tokens of their warrior status (Hektor gives Aias his sword, receiving Aias' belt in return), and leave – taking their armies with them (Hammond 1987). Rather than lose thousands of soldiers in a pointless and inconclusive battle, this single combat duel is representative of the meeting of two opposing forces: the warrior armies leave with the champions, and a stalemate established without a single casualty. This is not presented as abnormal and could therefore have been an established procedure in settling disagreements or establishing ideological supremacy in Bronze Age Europe. The symbolic exchange of weaponry in lieu of combat will be integral to the model proposed in Chapter 9.

Furthermore, when considering large-scale combat involving tens or hundreds of active participants, academic discourse tends to homogenise the combatants – terms such as armies, warring bands, warrior factions etc. are used, whereas it could be helpful to instead think in terms of collective individualism instead (Molloy and Grossman 2007:196). An army or fighting group does not function as a one single unit with one single cohesive consciousness. In modern and historical conflicts, there are a number of studies and individual accounts which disagree with official military histories and indicate that a large proportion of combatants were at the very least unwilling to fire at their opponents, and often did not (Grossman 1995:17-28). It has been argued that most of a warrior's focus would be on maintaining their guard and the collective defence, rather than on attacking and killing an opponent (Molloy and Grossman 2007:200). The act of killing in combat is not an expression of impulsive aggression, but instrumental - a premeditated act of violence, which causes a parasympathetic neural response in humans which makes us shy away from actually killing another human (Molloy and Grossman 2007:189-91). Social conditioning is required to overcome the neural response to aggression: a warrior must not only train physically, but also mentally, to become capable and adept at fatal interpersonal combat. Psychological research has identified the optimum mental state for interpersonal combat. 'Condition Red' describes the point at which a person is mentally ready to engage in extreme aggression: it is characterised by a rapid heart rate (115-145 bpm), an increase in the speed of cognitive and visual reactions, an improvement in muscle memory, and a decrease in complex cognitive processing and fine motor control (but not sufficient to disable the aggressor). Condition Red is reached through extensive muscle training (to improve muscle memory to compensate for the reduced cognitive function and lower fine motor skills) and stress inoculation through realistic stressful training (Molloy and Grossman 2007:191-3). However, pushing too far with the mental and physical training results in Condition Black, or a state of barbarian rage: once the heart rate exceeds ~160 bpm, peripheral vision is lost, depth perception and auditory ranges shrink dramatically, cognitive capabilities rapidly decrease, pain tolerance skyrockets and fine motor control all but vanishes. The aggressor cannot be reasoned with or controlled and may not notice minor flesh wounds – not an ideal state for one warrior among many (Molloy and Grossman 2007:192). Aggressive acts take a serious mental toll on combatants, as well as physical, and there has been very little discussion of prehistoric PTSD or similar mental health consequences: however, it is not difficult to imagine that situations such as the one between Hektor and Aias above would be seen as preferable for all concerned compared to a full-scale conflict.

The symbolic role of combat and proxy expressions of combat are frequently discussed in terms of weapon studies (Kristiansen 2002, Anderson 2011), but rarely in terms of violence and conflict management. For instance, during a discussion of the Linearbandkeramic ‘exotic’ axes, which were made from flint from many hundreds of kilometres away from their deposition sites, consideration is only given to their functionality as woodworking tools or aggressive weapons, and their potential status significance is neither acknowledged nor discussed (Keeley 1997:311). It is unclear whether this is due to the disparity between the disciplines of archaeology and anthropology, an unwillingness to contextualise weapons for fear of speculation, or over-cautiousness of returning to an imperialistic culture-history paradigm. To ignore the social and political context of weapons and conflict artificially isolates the weapons and enables the creation of top-down hypothetical models (see the introduction to Chapter 8).

The relative scarcity of halberds compared to the geographical distance between settlements and even the most conservative population estimates, even in the concentration areas of Ireland, Germany and Scotland (see Section 2.4.1), strongly imply that the halberds were not used to equip even a small army; if massed battles did occur, metal weapons were exceptions, not the rule (Jantzen et al 2010 report that the skeletal evidence for mass conflict indicate the use of wooden or stone clubs, and lithic projectiles (shot and arrows) rather than bladed weapons). More data as to the specific function[s] and combat capabilities of the halberd is included in Chapters 6 and 7.

2.8.2 Non-violent Functions of a Violent Symbol

The prestige and status value of weaponry, particularly halberds, has been recognised since the beginning of weapon studies (see O’Flaherty 1998:75). The economic value of metal is frequently cited as a reason for the relative scarcity of metal weapons, as well as the root of their prestige value – not only does a weapon indicate that the owner is wealthy enough to have bought or commissioned it, but many chiefdom models show political power deriving from the bottlenecked control of wealth through the ownership of land and the means of production (Earle and Kristiansen 2010:244; this theory is in direct opposition to Rowlands (1980:49), who favours a system of inherited symbolic power, rather than directly derived from economic control). The scarcity of metal weapons in north-west Europe precludes their sole use as offensive weapons: <60 halberds from Early Bronze Age Scotland is barely enough to equip a village, let alone an army (see the settlement size estimates in Section 2.6). Furthermore, the time-depth should be noted:

the Early Bronze Age covers two millennia (~2600-1800BCE), and it is highly unlikely that all of the halberds were in circulation and/or use at any one given moment in time.

A short bulletin on bronze casting proposed a model for an 'extended assemblage', whereby objects cast from a single mould are "conceptually linked by their common origin" (Webley and Adams 2016:1). Each object could then be differentiated through – for instance – decoration, or hafting using different woods, but would retain an innate relationship to its mould-mates, even if they were traded or exchanged to very disparate places. Decoration and the visual presentation of the bronze weapon objects is a significant factor in many non-violent interpretations of the weapon assemblage. A detailed study of the bronze socketed axe hoard at Langton Matravers from the Late Bronze Age comprehensively debunks the post-Marxist value economics interpretation favoured by Harding and Kristiansen, where bronze was deliberately removed from circulation to maintain its value (see also Fontijn 2016:5 for a further rebuttal of post-Marxist rationality). The very thin bronze axes have a high tin content, making them brittle and weak, but each axe was cast with a single-use clay mould (the cores of which remain in some of the axes, indicating that some axes at least were not hafted), signifying that the thin, brittle shape was an intentional casting choice (Roberts et al 2015:380). The authors postulate that the high tin content and unsuitability as an offensive weapon were deliberate aesthetic choices, because the tin produces a silvery finish to the axe, which was more important than its combat capabilities. The hoard was deposited during the transition period between the Late Bronze and Iron Ages, when ironworking was starting to become more widespread in Britain: the silvery axes act as a cognitive bridge between the old, known technology of bronze metallurgy and the new, unknown ferrometallurgy (Roberts et al 2015:386). The concept of decoration being used to "confront [an object's] ambiguous, transgressive, or dangerous nature" (Webley and Adams 2016:7) is one which is being increasingly recognised and discussed in weapons studies.

2.9 Application of Theory to Practical Study

The specific methodologies used in this thesis are discussed in detail in their relevant chapters (3, 5 and 6, most especially Section 6.3); however, there are some points which have arisen directly from the theory discussed here which can be mentioned at this stage. Firstly, some specific terminologies have been utilised: the gender-neutral 'combatant' or 'fighter' is used in place of a gendered pronoun to avoid latent assumptions. This also avoids the laden term 'warrior', as the concept of 'war' – as discussed in Section 2.8.1 –

is demonstrably not an appropriate term for Bronze Age Scotland or for the types of combat discussed and trialled in this study, lacking as it does state-level government or any evidence of massed armed units. Secondly, heteronormativity is not assumed at any stage of economic interpretation: the 'family unit' is not used as a concept in any economic, political or social modelling, and any hypothetical kinship alliances remain gender- and sexuality-neutral. Thirdly, females are assumed to be as capable as males at assuming combat-based social and political power, as well as the creative and technological skills required for metalworking, though there the presumption that all combatants are fit and able-bodied is maintained throughout (this will be discussed further in the experimental methodology, Section 6.3.8). It is hoped that by adopting a reflexive attitude to this work, new interpretations can be offered where appropriate which are based on the available evidence rather than on previous interpretations or doctrines.

Chapter 3 – An Experimental Investigation into the Efficacy of a Middle Bronze Age Dirk as an Offensive Combat Weapon

The Middle Bronze Age dirk/rapier in Scotland, as established in the literature review (see Section 2.5), has been the subject of more research than the Scottish halberds, most of which was undertaken prior to 1990. However, the dirk/rapier has none the less received relatively little analytical attention, particularly when compared to swords and axes: although comprehensively catalogued (Harbison 1969, Burgess and Gerloff 1981), the dirks have not been the subject of much interpretation or analysis (see Trump 1959-60), unlike the swords (see Kristiansen (2002) and Molloy (2007) for two excellent examples of further study using swords). Furthermore, similar to much of the work published on halberds, research has focussed on whether the dirk was a functional combat weapon, a ubiquitous tool for daily life, a prominently-displayed status signifier, or a combination thereof. Certainly, dirks have been subjected to the same level of gendered interpretation as have most other metal artefacts from the Bronze Age based on little, if any, data; the most common of these is that dirks from female graves are interpreted as tools, whereas identical artefacts from male graves are taken to be weapons (cf. Varberg 2013:156). It is here proposed, therefore, that rather than add another basic catalogue and armchair analysis to the existing body of literature, a more novel approach will be taken which will result in scientific data from which a nuanced interpretation can be drawn. Section 3.2 explores the issues with previous studies more closely; in short, despite (or because of) a growing body of experimental work, methodologies are inconsistent and heavily depend on the theoretical background of the researcher, as well as the extant work for the specific artefact being tested. At the time of researching and writing this chapter (2013-14), none of the more recent experimental research had been published; there was therefore a much smaller, and much less coherent, body of methodologies from which to draw. The only way to conclusively establish whether a 'typical' Scottish Bronze Age dirk was capable of inflicting mortal injury is therefore to attempt to replicate, as closely as possible, combat conditions wherein the dirk could have been used, and to evaluate its efficacy in damaging soft and skeletal tissue. This will also show what, if any, damage is inflicted **on** the blade as a result of interpersonal combat; this can then be used to identify similar evidence of combat on the prehistoric dirks by comparing experimental data with a catalogue analysis. This chapter establishes the methodology by which the halberds will be evaluated; any issues arising herein can therefore be addressed at this early stage to increase the rigour of the subsequent halberd experiments.

3.1 The Dirk

The primary consideration for replica weapon testing is the replica weapon itself. As the research aim of this study is to assess the combat capabilities of the Middle Bronze Age dirk in Scotland, it is imperative that the dirk used is as accurate and representative of the prehistoric blades as possible, otherwise the results gained are of little significance.

Fortunately, an opportunity arose early on in the project for accurate weapon testing. A chance conversation with Mark Hall at Perth Museum and Art Gallery resulted in the production of a replica of the Friarton dirk. The Friarton dirk was recovered from the River Tay, close to Friarton, an area of Perth. It was fully published soon after its recovery (Cowie et al 2011), and remains one of the best-preserved Middle Bronze Age dirks to have been found in Scotland to date.

Figure 3.1 *– The Friarton dirk. This Middle Bronze Age dirk is in exceptional condition, with a small area of damage to only one section of the hafting plate, leading to the loss of the rivet. © Perth Museum and Art Gallery, Perth and Kinross.*

The dirk was recovered from the River Tay, and given the rivet remaining in situ, it is highly probable that the dirk was deposited in the river or riverbank still hafted, and the wooden or bone hilt subsequently decayed in the water. The blade itself is in exceptional condition – the small break on the rivet plate and a small notch on one edge of the blade are the only instances of damage on the blade. The dirk measurements (Cowie et al 2011:11) are as described in Table 3.1.

***Table 3.1** – The measurements of the Friarton dirk (Cowie et al 2011:11).*

Weight	125.1 g
Length	197 mm
Maximum width	54 mm
Maximum thickness	8 mm
Rivet: maximum cap diameter	10 mm
Rivet: maximum stud diameter	8 mm
Rivet: stud length	19 mm

The state of preservation of the dirk allowed an accurate replica to be designed, duplicating the dimensions and design of the original dirk. The replica was created using Middle Bronze Age techniques, which included: open stone mould casting; the use of 10% tin bronze; fine detailing and incised decoration; fine edge hammering using bronze tools, rather than stone; and a hilt made from ash wood. The dirk was made by Neil Burridge, a specialist in Bronze Age reproductions for museum-based research.

***Figure 3.2** – The replica Friarton dirk, created by Neil Burridge. The blade itself is an exact replica, though the hilt is based on single-cast sword hilts from the later Bronze Age. © Perth Museum and Art Gallery, Perth and Kinross, Scotland.*

The hilt itself is similar to the hilts and pommels of the later swords found in Britain, particularly the Carp's Tongue swords from the River Thames and surrounding area (Colquhoun and Burgess 1988:107). The wide, flat pommel may not, therefore, be an accurate representation of the original hilt shape; this must be born in mind throughout this chapter. Furthermore, the hilt was made from ash, rather than oak; ash is a very soft wood, which should also be remembered throughout this chapter.

3.2 Cutting and stabbing tests: Precedent and Previous Studies

As noted in the introduction to this chapter, dirks have been the subject of several competing interpretations over the previous two centuries. The dirks occupy an uneasy position between tool and weapon in the literature (Wilde 1857-61:462; Trump 1959-60:2-7; O'Connor and Cowie 1995:347; Aranda-Jimenez et al 2009:1044), but very little has been done beyond educated speculation to determine whether dirks were capable of being used as weapons in interpersonal combat. The replica Friarton dirk was, therefore, ideally suited to experimentally determining whether this dirk was capable of inflicting serious injury on human tissue.

Experimental cutting and stabbing trials using replica weapons have been fairly uncommon in archaeology but have recently been the subject of much more focussed research; the three most pertinent to this study are the Late Bronze Age sword trials by Kristiansen (2002), the Early Bronze Age halberd trials undertaken by O'Flaherty (2007), and the Middle/Late Bronze Age spearhead trials by Anderson (2011). These studies will be discussed in detail later in this section Recently, more intensive research into Middle and Late Bronze Age weaponry in northern Europe have produced a wealth of data; these have, however, often focussed on use-wear analyses (Crellin et al 2018, Gentile and van Gijn 2019, Hermann et al 2020), and the socio-economic cause and effect of combat (Molloy 2017, Horn and Kristiansen 2018, Kristiansen 2018). None of these more recent studies have the benefit of such a well-documented prehistoric assemblage as exists for the Scottish MBA dirks, and none systematically compare the experimentally-derived data to the prehistoric catalogue data. . The novelty of this method of archaeological investigation – the three earlier studies mentioned here were published within the last 18 years - means that there is not yet a coherent methodology for replica trials; these three studies all follow different methodologies, investigate different aspects of Bronze Age weaponry, and present their findings in various ways. However, an informed critique of the previous experiments has led to the methodology devised specifically for this doctoral thesis.

Archaeological combat testing has little to no established, widely accepted, scientifically rigorous, fundamental methodology. The first of the three trials critiqued here concerned bronze blades from Scandinavia, overseen by Kristiansen (2002) at the University of Gothenburg. Kristiansen's experiments were with replica bronze swords, and the aim was to assess the functionality of the swords; it was unclear how exactly this was achieved. The assumption that the swords' short hilts prevented their being wielded was disproved by Kristiansen's affixing a hilt to a sword, then moving through a series of (unspecified) motions with the blade (Kristiansen 2002:322). He then proceeds to analyse damage to prehistoric blades based on where stress would occur during combat, but without undertaking any combat motions or stressing the blade.

Figure 3.3 *– Examples of the damage inflicted to the blades as part of the unspecified trials undertaken by Professor Kristiansen . The lack of scale bars, labelling and colour in the images throughout the paper seriously limits the utility of the study. Kristiansen (2002:325)*

Furthermore, he asserts that Early and Middle Bronze Age weapons affixed to the hilt with rivets only "could hardly withstand serious and repeated blows in combat" (Kristiansen 2002:325), based on stabbing trials which are not demonstrated, explained, or rationalised. The assumptions made about the role of body armour, both of boiled leather and of sheet or worked bronze, are not upheld with experimental testing, relying instead on Mediterranean vase paintings and 'common sense', that bugbear of combat archaeology (Kristiansen 2002:326-7). Finally – fundamentally – he also assumes that all prehistoric fighters were right-handed and male (Kristiansen 2002:320). The importance of recognising the role of the wielder is a more recent research focus, but one that has yet not been addressed in depth (see Molloy 2008 for a detailed overview in relation to M-LBA Aegean swords) As an early foray into experimental combat testing, several valuable points were established: the importance of using real people in trials, the pitfalls of relying on supposition, and the necessity of reviewing multiple branches of evidence before reaching a conclusion. However, the lack of detail as to the nature of the combat attempted, the first-principle assumptions as to gender and ability without testing or accounting for other possibilities, and the difficulty in replicating his experiment means that there is significant methodological progress to be made before beginning the replica trials in this study.

Another experimental study relevant to this thesis is Anderson's (2011) work on Late Bronze Age spearheads. An unspecified number of replica spears were commissioned, along with a sword and a metal shield. The spears were all edge-hardened and annealed twice before a random sample of 13 were subjected to a Vickers Hardness test (Anderson 2011: 600-601). A range of combat motions were then enacted, covering a range of movements, angles of striking and materials struck. Damage to the spear blades and the defending material was then analysed, with particular reference to similar damage present on the Bronze Age artefacts. It was expected that this study would form a rudimentary blueprint for the replica trials designed as part of this thesis. However, several problems immediately become apparent upon closer reading of Anderson's (2011) paper. As the spears were neither quantified nor individually identified, it was impossible to determine how many of the blades displayed damage, whether blades were used repeatedly or just once, and how representative the damage edges presented in the paper were of the weapon sample as a whole. Furthermore, the results themselves were communicated very poorly, to the extent where it was often unclear whether the damage was the result of a spear or sword blow (see Figure 4, Anderson 2011:604, which is captioned as resulting from 'sword strikes' but referred to in the text as resulting from spear slashes). Confusion of the terminology also rendered many of the conclusions unclear, as did the poor explanation of the images (Figure 3.4 below shows Figure 6 from the report (Anderson 2011:606), apparently displaying 'flattening damage', for instance, but does not make it clear whether the blade shown is one from the experiments, or a diagnostic photograph from a previous paper).

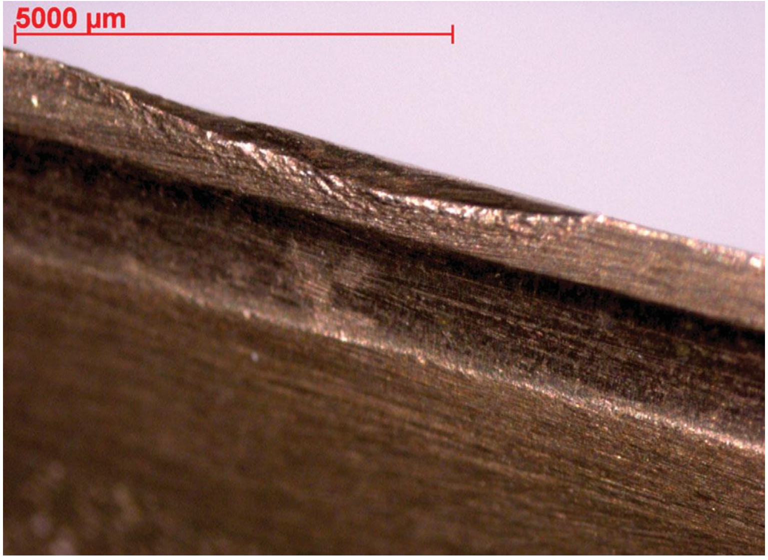

Figure 3.4 *– Image depicting 'flattening damage'. While the scale bar is very useful, the total lack of contextualising information renders this image effectively useless. A table of data above the original image notes that 'flattening damage' was not studied on the original spears, and there is therefore no original archaeological data. Anderson (2011:606)*

Comparisons with damage in the artefact record is not only inconclusive, as none of the experimental damage matches the damage on the prehistoric weapons, but go so far as to cast doubt on the veracity of the experiment as a whole. One explanation for the disparity between experimental and prehistoric damage was that the replica spears were hardened much more than their Bronze Age counterparts, resulting in different damage patterns; that is, the tendency of the replicas to chip, rather than the bending observed on the prehistoric spears (Anderson 2011:607). Despite the inclusion of the Vickers Hardness Values, no information was provided on the wielders, the levels of force inflicted, or the specific levels of damage incurred by the weapons and inflicted on the defensive material. As such, this trial would be virtually impossible to replicate, given the information provided in the paper, and therefore serves little purpose as a research tool.

In contrast to the two above studies, O'Flaherty's (2007) replica halberd trials were a significant leap forward in terms of reliability and accuracy. Of primary importance is the fact that this experiment involved a replica halberd, specifically cast and hafted on an oak shaft for use in these trials. Meticulous levels of detail could therefore be recorded, such as the metal composition of the blade, the exact measurements of the blade and shaft, and the weight of the weapon as a whole. Reference to Bronze Age petroglyphs determined how the blows were to be delivered (overarm, delivering a heavy punch to the frontal plate which was capable of piercing bone and cartilage) (O'Flaherty 2007:426). Twenty sheep heads were used; this could have posed a problem, as ovine frontal plates are two to three times as thick as human frontal plates. However, the replica halberd made a clean, thorough incision on every one of the twenty heads without significant damage to the blade, indicating that there would be no issue with piercing human skulls (O'Flaherty 2007 428).

Figure 3.5 *– The replica halberd was fully capable of making clean, deep punctures to the ovine frontal plates. O'Flaherty (2007:427).*

These trials will obviously have greater significance for the replica Scottish halberd trials (see Chapter 6, in particular Section 6.1), but there are some points which can be brought to bear on the dirk trials. Firstly, the importance of taking good quality measurements and retrieving reliable and accurate data is maintained throughout. Secondly, a useful sample size – in this case, twenty heads – is required to ascertain the impact that combat has on the weapon itself. In this context, 'useful' refers to a sample sufficient to categorically prove or disprove the hypothesis – in this case, whether the halberd was capable of inflicting mortal injury. The sample size could therefore be significantly larger or smaller than initially anticipated, depending on how easy or complicated the hypothesis is to dis/prove. A reflective, reflexive attitude was therefore adopted which meant that the experiment was sufficient to fulfil a primary research goal, a core tenet of a queer archaeological approach (Dowson 2000:163). Thirdly, the data was contextualised using petroglyphs and artefact evidence, lending credence to the final conclusions. Fourthly, by using the same person to inflict all of the blows to the same point on the skull, the force inflicted by the blade was kept relatively uniform, conferring a high level of reliability to the results. All of these points are fundamental to constructing a solid methodology and producing reliable results.

Figure 3.6 *– The replica halberd used by O'Flaherty in the trials. This study showed a marked improvement in recording techniques, clarity in data presentation, and replicability; for instance, the replica halberd was presented with a full set of weights and measurements. O'Flaherty (2007:424)*

However, O'Flaherty's (2007) study is not impervious to criticism. It was noted that it was highly likely that the shaft was used as an offensive weapon, striking and incapacitating the opponent so that they lay prone, after which the halberd would be used in the overarm fashion trialled, delivering the mortal blow (O'Flaherty 2007:430). However, the shaft was not used offensively in the trials, which is unfortunate. It is possible that the blunt force trauma (BFT) from the shaft, and the sharp force trauma (SFT) from the halberd blade could have been delivered to the same area of the skull, in which case the damage inflicted by the BFT would change the head morphology and alter the damage inflicted by the SFT. Furthermore, no information was provided as to the height, weight, or physical capabilities of the wielder; the only information given was that the halberd was wielded with "confidence, rather than brute force" (O'Flaherty 2007:426). However, O'Flaherty's study remains the most comprehensive and robust of the trials undertaken to date, and provides the backbone for the replica Scottish halberd trials in this thesis (Chapters 6 and 7).

3.3 Research Aims

The three previous weapon trials discussed in Section 3.2 indicated the importance of clear research aims, accuracy, reliability and replicability; these are also important in maintaining an objective stance, in line with gender archaeology methodologies. These aims were achieved as follows.

3.3.1 Research Aim:

Primarily, to determine the damage, wear or impacts inflicted on a replica Bronze Age dirk as a result of interpersonal combat, in order to identify similar patterns of damage on the prehistoric assemblage. Secondarily, to determine the capabilities of the Bronze Age dirks to injure or incapacitate combatants and any resulting limitations through the use of proxy data gathered from experiment and analysis of the tissue analogues and a replica dirk.

3.3.2 Accuracy:

The dirk was weighed and measured using calibrated, precision instruments prior to the trials. A skilled martial artist, used to handling and using weapons, was invited to strike the blows on the skeletal material, which was measured using a force meter. Human error and varying degrees of skill were therefore accounted for. The SynBone™ is as accurate an analogue for human tissue as possible. Pre-trial analysis on the blade was conducted with optical microscopes; the skeletal tissue analysis was undertaken by a specialist as part of their Masters dissertation (Downing 2015).

3.3.3 Reliability:

The skeletal experiment was filmed for future reference, and to identify any human error. Using a skilled martial artist as well as a comparative amateur allowed the creation of a range of ‘acceptable’ or expected data points. The SynBone™ is manufactured to be materially uniform. The soft tissue experiment was photographed in full and clearly labelled throughout.

3.3.4 Replicability:

The methodology used in the trials was clearly outlined, and no material was used that could not be easily obtained for further research (excepting perhaps the replica dirk; future work would rely on museum loans or the creation of new replicas). The experiment was carefully documented by film and photograph. It is hoped that the write-up is of sufficient detail and clarity as to allow future work to use the methodology.

3.4 Skeletal Tissue Trials

Interpersonal combat using an edged weapon results in damage to the skeletal and soft tissues, depending on the type and force of blow inflicted. Both types of tissue therefore need to be considered when designing the trials. As an accurate skeletal analogue proved the more difficult to acquire and accommodate (see below), it was decided to undertake the skeletal tissue trials first.

The best analogue for human skeletal tissue that is readily available and not cost-prohibitive are pig heads (*Sus scrofa*), because their frontal plate is of a similar thickness to the human skull. Animal bone is denser that human bone, however, and the suture lines are also slightly different; these factors can affect results from various experimental trials. Furthermore, cranial pig skin is twice as thick and has a significantly thicker layer of subcutaneous fat than human skin, making it an imperfect analogue for live human tissue – one does not attack defleshed bone with the intent to maim or kill, so skeletal tissue experiments must accurately account for the living soft tissue encasing the bone (Pounder et al 2011; see also Figure 3.7 below). One option would be to use deer heads in place of pig heads, as deer have much thinner skin on their crania and are therefore much more analogous to the soft tissue on human heads. However, their skeletal structure is not analogous, as their frontal plate is thicker than human plates, even in young deer. Logistically, acquiring deer heads would prove problematic, even in Scotland, because – unlike pigs and cattle - they are rarely sent whole from estates to abattoirs. Moreover, the deer stalking seasons are very restrictive, spanning 1st July-20th October for red deer[3] (stags) and 1st April-20th October for roe deer (bucks) (www.deerstalkingscotland.co.uk, last accessed 2/3/2015); the replica dirk was used on loan by Perth Museum and Art Gallery in February 2015, the timing of which was incompatible with any of the relevant stalking seasons. Furthermore, as with any animal analogue, the soft tissue degrades very quickly, which limited the timeframe for the experiment and subsequent analysis. Removing the soft tissue from the heads takes eight weeks of carefully-controlled

[3] I am grateful to Dr Laszlo Bartosiewicz, then at the University of Edinburgh, for his advice and guidance in issues with animal tissue analogues.

maceration at a specialist laboratory, resulting in the clean, bleached skull for skeletal analysis. As this part of the analytic process was to be undertaken by a Masters student, allowances also had to be made for conflicting academic schedules. Coupled with the imperfections in material analogy, it was decided that animal heads were not suitable for this experiment.

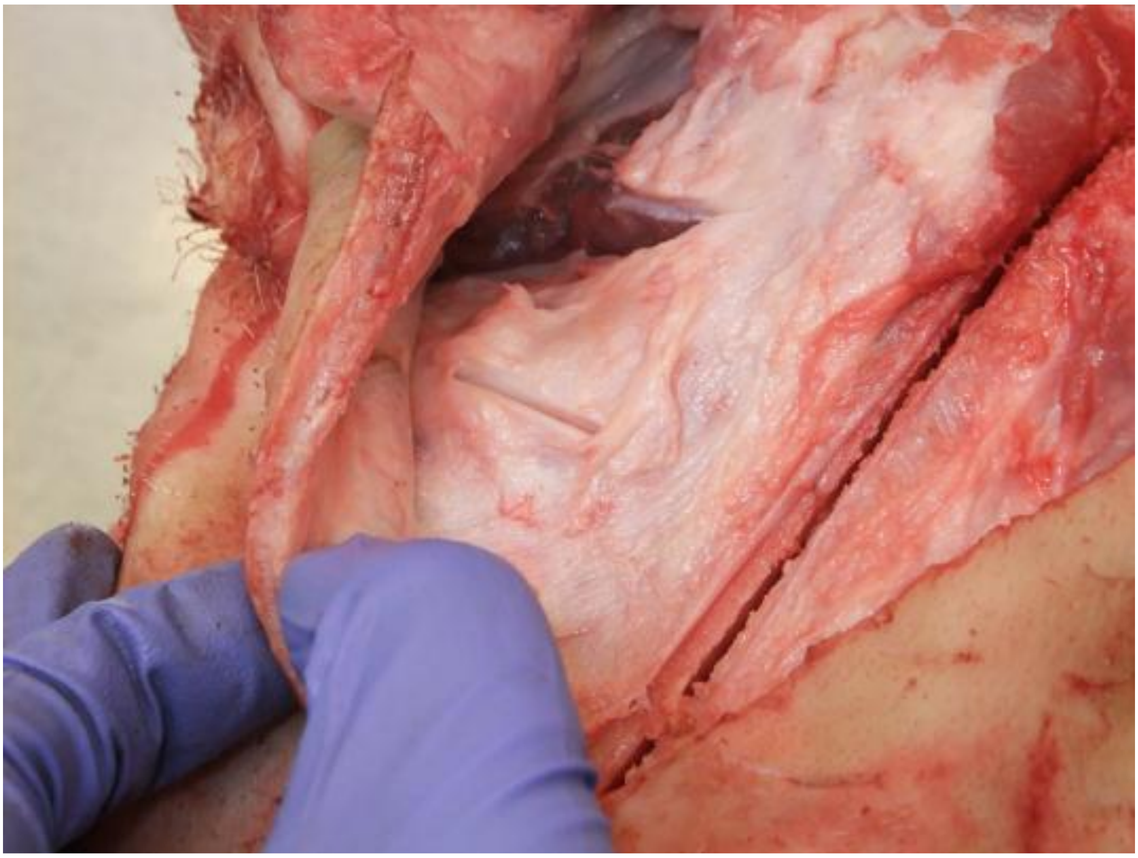

***Figure 3.7** – The thick (c. 7mm) layer of subcutaneous fat on the cranial skin of a juvenile female pig (*Sus scrofa*); this makes the soft tissue significantly thicker than the equivalent layer on a human cranium. Donnellan (2010:55).*

Instead, SynBone™, a synthetic material which mimics human bone and skin, was considered. SynBone™ is formed into either spheres, sheets, or long narrow tubes, which are then filled with ballistic-grade gelatine and covered in a synthetic 'skin' that accurately mimics the thin layer of soft tissue on the skull, and the shin and forearm (depending on which shape is selected). They can then be used in combat or damage trials as near-perfect analogues for human skeletal and skin tissue for experiments such as these (Henwood and Appleby-Thomas 2020). After experimentation, the ballistic jelly degrades over several days and requires relatively immediate analysis, but the synthetic soft and skeletal tissue will remain stable for several months, greatly expanding the post-experimental analysis timeframe. There is no need for maceration, and no ethical considerations to make, as there would be if animal heads were used. SynBone™ is more expensive than pig heads would be, but this is consideration is outweighed by its considerable benefits.

The skeletal tissue trials took place at the University of Edinburgh on 16th February 2015. This was the first day of Innovative Learning Week (ILW), a university-wide initiative in which regular teaching is suspended and specialist events, workshops and practical sessions are run in order to encourage non-traditional teaching and learning methods. As discussed in Section 2.10.2 and 2.11, a major feature of applied queer theory in archaeology is encouraging 'deviant' paradigms and expanding the field through accessibility. The experimental weapon trials are very visually appealing, involve several archaeological sub-disciplines, and showcase a range of practical skills that are rarely covered in university teaching; it was therefore highly desirable to incorporate the trials into an accessible event for the student body as part of ILW.

Six SynBone™ spheres and two long bone cylinders were prepared by M. Donnelly, an Osteoarchaeology MSc(T) student prior to the combat trial. It was expected that each piece of SynBone™ would be struck twice, once by the martial artist, and once by the author. This was intended to create a controlled value for differences in combat skills, which had not been addressed in any of the previous studies. It was theorised that the impacts resulting from the sets of two blows would be consistently different, allowing an equivalency to be derived which could be used in future work, minimising or controlling the difference in impact force between the experimental wielder and the original fighter. This did not, however, occur quite as expected.

Immediately prior to the trials, the replica dirk was examined under a microscope. The initial structure of the experiment involved examining the dirk before and after each trial to record any minute edge damage that could indicate usage, so that similar edge wear could be identified in the prehistoric assemblage. The first photomicrographs were taken at 10x magnification using a Leica DM750P microscope and the Leica MC170HD digital camera, and processed using Leica's LAS Live Image Builder Z software, before any blows were enacted using the dirk.

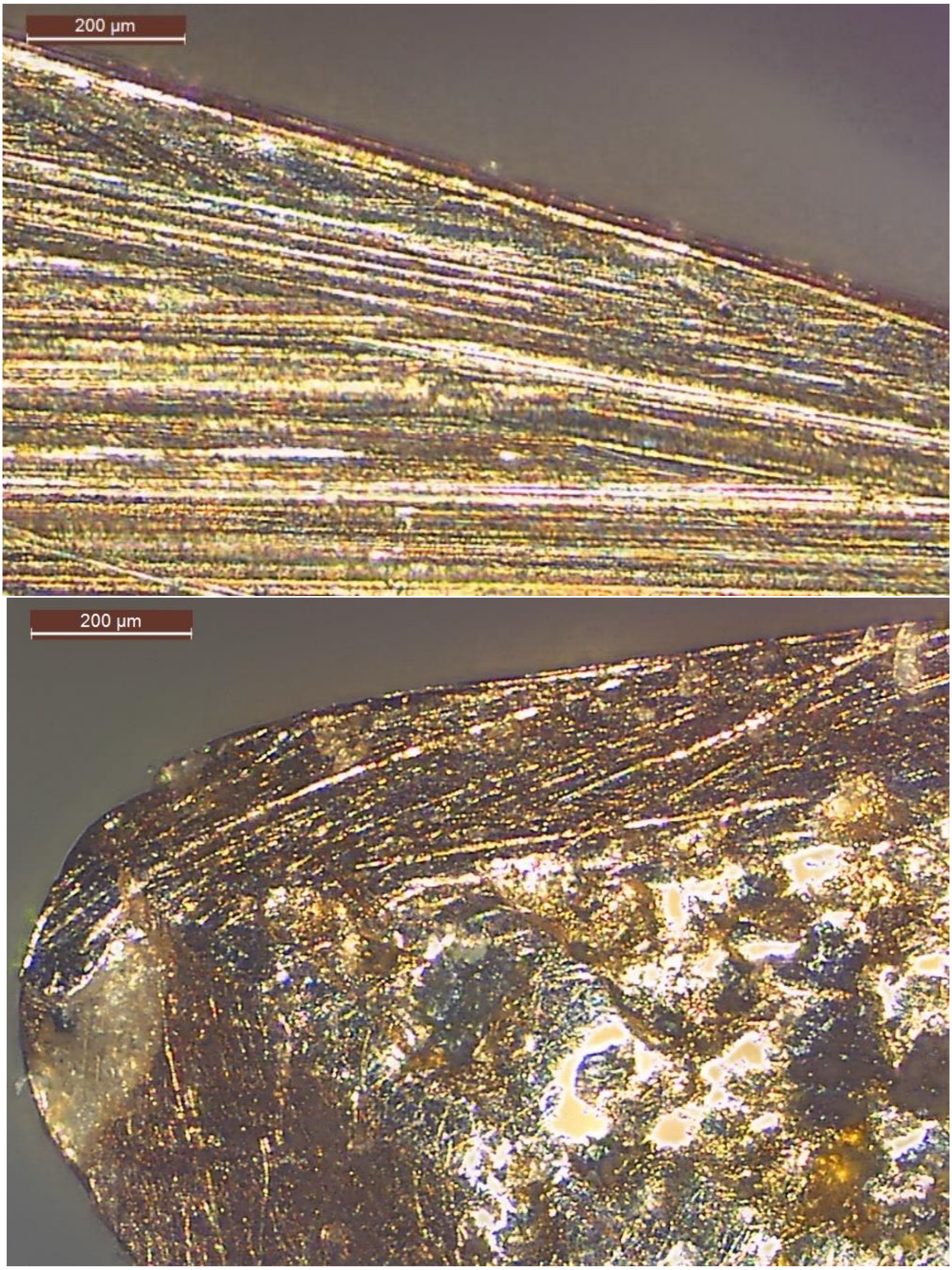

Figure 3.8 *– Photomicrographs showing the microscopic analysis of the edge wear on the replica dirk prior to the experiments. Top: the sharp edge, showing the linear scratches characteristic of sharpening. Bottom: the tip, showing small deformations in the cast towards the midrib and the linear scratches at 45° to the edge characterising of intensive sharpening.*

Immediately following the initial microscopy and before the trials took place, a Vickers Hardness test was done on the replica dirk blade. The Vickers Hardness test measures hardness based on plastic deformation following an indentation of known diameter and force (Shahdad et al 2007). The results are given in Vickers Pyramid Numbers (Hardness Value, or HV), rather than Pascals (though conversion between units is possible). Modern metal manufacturing uses the Vickers Hardness scale, so the results obtained from the replica can be compared directly to values for modern manufactured bronze. Furthermore, the Vickers Hardness test has been widely applied in modern electrical engineering, which has resulted in one particular benefit. Traditional Vickers Hardness testing equipment has consisted of a large, bulky, static machine with large, diamond indenters that, by necessity, leave a large and unfixable dent in the tested material (Giannakopoulos et al 1994). Not only would this be impractical, but the replica would be irrevocably scarred by the process. Innovations in applied hardness testing in electrical engineering have resulted in the development of a small portable hardness tester, easily transportable to the material in question. Furthermore, rather than measuring plastic deformation following indentation, the portable testers meticulously measure the rebound of a calibrated ball bearing which is dropped onto the material from a known height and acceleration. These portable testers are primarily designed for Leeb tests, which use the rebound method, but are calibrated to convert between testing methods, materials and values. The testing equipment used was the HT-1000A; full specifications and calibration can be found at http://grhardnesstester.com/leeb-hardness-tester/specifications-package/ (last accessed 12/3/2015). The Vickers test, administered via this method, is therefore cost-effective, accessible, comparable to a known value set, and – crucially – non-destructive[4].

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[4] I am grateful to Dr Alan Faulkner-Jones, Assistant Professor in Mechanical Engineering at Heriot-Watt University, Midlothian, Scotland, for bringing the portable hardness tester to my attention, and to Mr Richard Kinsella at the Mechanical Engineering Workshop, Heriot-Watt University, for facilitating a short loan of the portable tester.

Figure 3.9 *– The portable hardness tester. http://grhardnesstester.com/*

Ten Vickers tests were done on various areas of the blade – midrib, edges and tip on both sides – and the mean of the results was calculated. The hardness values were remarkably consistent across the blade, especially considering that the dirk had not been annealed by the caster (Neil Burridge, pers. comm.). The average HV was 212, which is within the expected range for bronze forged using modern methods – indeed, it tends towards the much harder end of the array[5]. It should be noted that many of the HVs for modern-forged bronze are calculated from testing thin bronze strips designed for insulation or for use in electrical circuits, rather than thick-cast bronze such as the replica dirk; the range of hardness values calculated from the replica is therefore understandably quite wide, from HV 75 to 250.

5 http://www.diehl.com/fileadmin/diehl-metall/dlc/Beispielordner/Diehl_Metall_Strips_BB50_V2_M-SM.pdf

The first sphere was raised to a height of 1.6m above the ground, to mimic an upright but incapacitated adult. A digital force meter was positioned beneath the sphere, and the whole process was filmed using a digital video camera.

The first blow was delivered by the martial artist. It had been suggested that the most efficient blow with a weapon such as the dirk would have been a strong, sweeping overarm motion, using the blade point-first to stab the opponent at an acute angle (Mark Appleford, pers. comm.). This was enacted, as shown in Figure 3.10.

Figure 3.10 *– The strong sweeping overarm blow being delivered. The Synbone™ sphere is clearly visible, anchored in a circular cardboard sheath and sitting atop the force meter.*

The first blow attempted glanced off the Synbone™, leaving no trauma marks and making the blade 'shiver', which put significant strain on the rivet fastenings and making the whole weapon jump in the wielder's hand. A similar issue arose in O'Flaherty's initial blow using the replica halberd, which caused the researchers some consternation before being ascribed to the wielder's timidity with the unfamiliar weapon (O'Flaherty 2007:427). Given the martial artist's prowess with similar weapons and the force meter readings of 473 Newtons (N), timidity seemed an unlikely explanation; however, the precedent set by O'Flaherty suggested that the wielder simply needed to be more confident in the second blow. The strong, sweeping overarm blow was repeated, with unexpected results.

The second overarm blow was delivered with a force of 912 N and was aimed more at the centre of the Synbone™ sphere to minimise the chance of the blade glancing off the side of the sphere and stressing the rivets. This second blow connected successfully with the sphere, and with such force as would usually seriously damage the skeletal tissue. However, rather than inflict significant damage on the bone analogue, the replica itself bore the brunt of the damage. The sharpened tip failed to fully pierce the bone (Figure 3.13); instead, a 9mm length of the tip bent by almost 90° (as shown in Figure 3.11). Furthermore, the riveted area of the hilt on the upper edge of the blade (i.e. the rivet furthest from the Synbone™, the one facing the ceiling) underwent significant stress, snapping the wood and shearing the underlying metal (Figure 3.12).

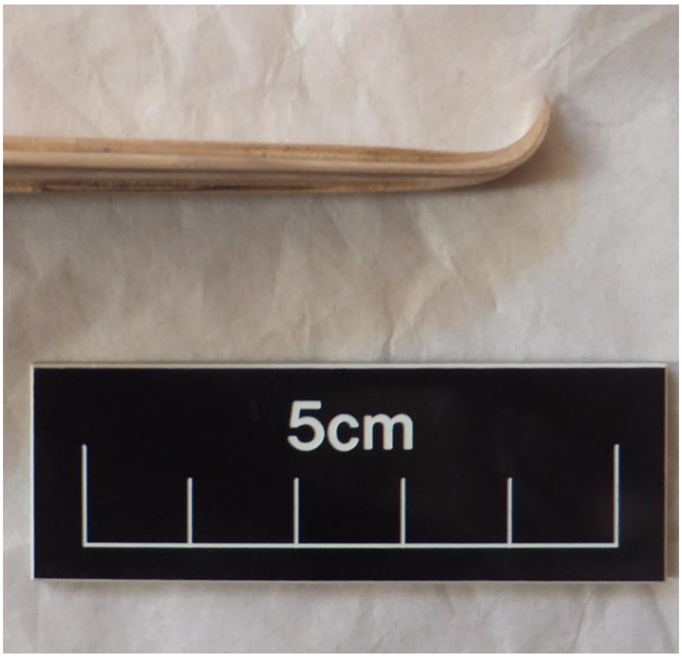

Figure 3.11 *– The area of plastic deformation on the tip of the replica dirk. 9mm of the tip bent almost to a right angle. © Perth Museum and Art Gallery, Perth and Kinross, Scotland.*

Figure 3.12 *– Damage to the rivet and hilt from the connecting overarm blow. The clean linear shear was a thoroughly unexpected result of the trial. ©Perth Museum and Art Gallery, Perth and Kinross, Scotland.*

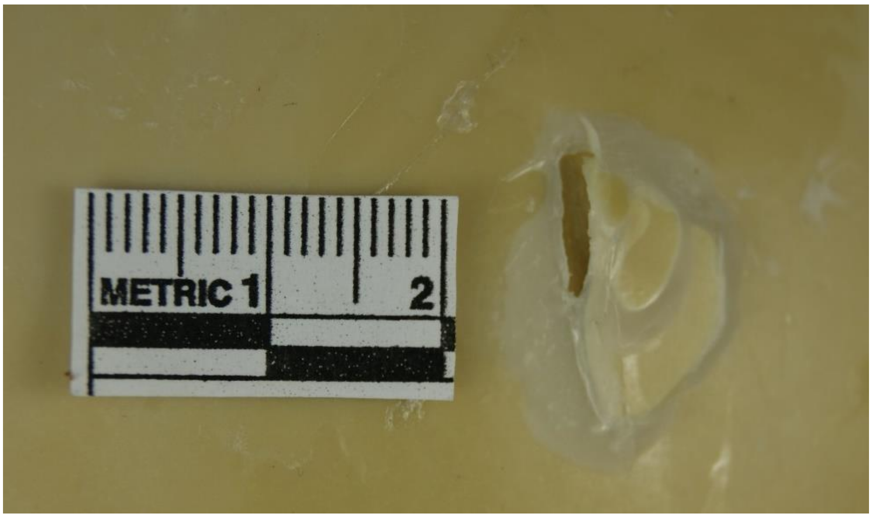

Figure 3.13 *– The small area of sharp force trauma on the Synbone™ from the connecting overarm blow. The blow did not completely pierce the bone; the underlying soft tissue was unmarked. © M Downing 2015.*

The Vickers Hardness Value had suggested that the bronze was more than strong enough to pierce human bone, and the thorough review of Synbone™ as a suitable and effective analogue for human skeletal tissue suggested that the sphere – when struck with a force of over 900N – should have splintered and broken. By taking so many measurements and precautions, it was hoped that sufficient variables had been controlled and accounted for as to have created as ideal a prehistoric combat analogy as possible. This is discussed further in Section 3.6.

Originally, the methodology for this trial required each blow to be copied by the author, to demonstrate the differences between an amateur and a skilled wielder. However, it had also been made clear that the methodology had to be reflexive, in order to immediately adapt to the results. It was therefore decided to not attempt to replicate the connecting overarm blow; the replica dirk had been shown, fairly conclusively, to be incapable of piercing human bone after only two blows designed to deliver sharp-force trauma. The small sample size was regrettable, but the results obtained were of such finality as to preclude further testing at that time. Furthermore, as the replica dirk had been loaned to the author from Perth Museum and Art Gallery, the decision was made to minimise further potential damage and move on to the second part of the skeletal tissue trial.

The scarcity of human remains from the British Bronze Age, particularly in Scotland, when compared to other regions in Europe, means that researchers must often look to the Continent for skeletal evidence for interpersonal combat. The most famous such site is Tollense site in northern Germany (Jantzen et al 2010). Skeletal marks included both blunt and sharp force trauma indicators resulting from spears, arrows, wooden clubs, lances and swords (Brinker et al 2016). The range of weapons used in the combat show that the presence of bronze blades does not supersede the use of blunt and crushing weapons; it therefore seemed prudent to assess whether the butt of the dirk hilt could be used to incapacitate an opponent, akin to using a wooden club. Subsequent discussion with the martial artist showed that this is a common technique among several martial disciplines, and is commonly taught alongside hand-to-hand combat (M. Appleford, pers. comm.).

Given that the two overarm blows had done very little damage to the Synbone™, the blunt force blow was inflicted on the same sphere; the analogue was rotated so that the small area of pierced damage would not affect (or be affected by) the blunt force trauma.

A similar stance to the stabbing blow was adopted. The dirk was held so as to use the butt of the hilt as the impact face, and brought down onto the Synbone™ in a sweeping overarm motion, connecting with the sphere at roughly 20° to the vertical – mimicking a blow to the temple. The force of the blow exceeded 900N; unfortunately, the software which displayed the force meter readings underwent technical difficulties in the middle of the blow, so the final second of the impact is not recorded. However, of the recorded data, the blunt force blow peaked at 908N, which is consistent with the impact of the sharp-force stabbing blows from earlier in the trials.

As with the sharp force impact, the blunt force blow did not significantly damage the Synbone™; the synthetic skin ripped, but the skeletal tissue was unscathed (see Figure 3.14). However, the replica dirk itself did not cope well with the blow. The wooden hilt sheared completely towards one edge, resulting in a large chip dislodging from the hilt. Numerous small splinters also detached from the hilt with some force (Figure 3.15). Fortunately, sufficient precautions had been taken to ensure none of the participants or audience were injured by the splintering hilt.

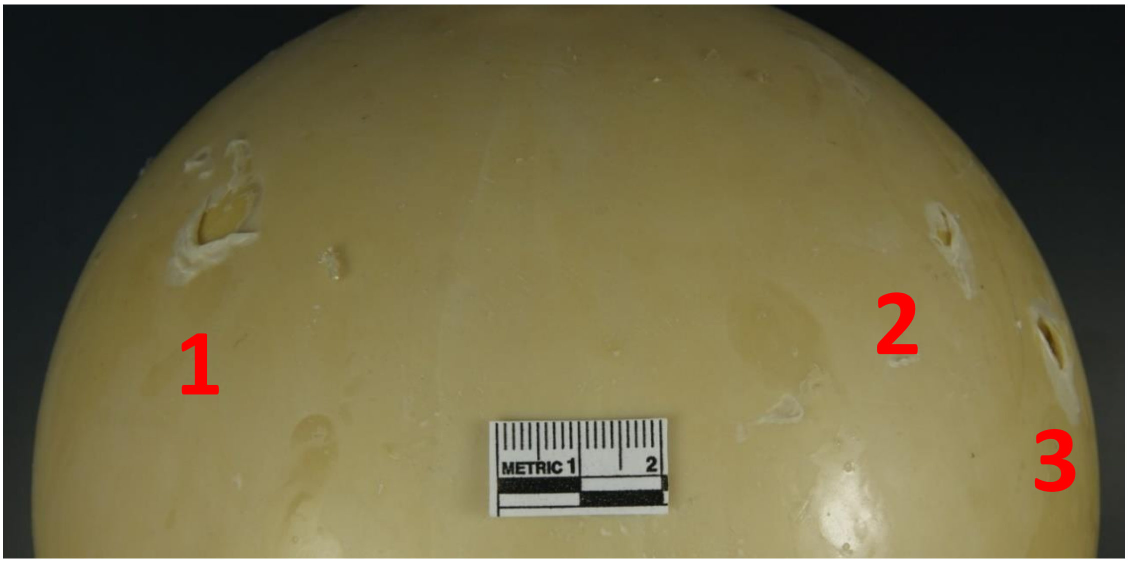

Figure 3.14 *– The Synbone™ sphere showing all inflicted damage from the sharp and blunt force blows. Left to right: 1 - the ripped 'skin' from the third blow, the blunt force impact using the butt of the hilt; 2- the ripped 'skin' from the first blow, the first sharp force impact which glanced off the side of the sphere; 3 - the pierce and flake damage from the second, the connecting sharp force trauma impact which resulted in significant damage to the replica dirk. © M Downing 2015.*

Figure 3.15 *– The hilt, repaired following the blunt force impact. A large splinter could not be reattached, leaving the chip visible in the middle of the hilt. The red outline shows the chunk of hilt which became detached following the blunt force impact; the incised decoration, running against the grain, is also visible. © Perth Museum and Art Gallery, Perth and Kinross, Scotland.*

3.5 Soft Tissue Trials

Having demonstrated that the replica dirk was incapable of damaging human bone, itself becoming significantly damaged in the process, it seemed appropriate to determine whether the dirk was capable of damaging soft tissue. The damage to the replica from the skeletal tissue trials was recorded and repaired[6], and a soft tissue analogue secured.

The synthetic 'skin' ensures that the blow inflicted on the skeletal tissue was of comparable force and shape to one inflicted on human tissue, rather than striking bare bone. However, it is not an ideal analogue for human soft tissue damage. In forensic and ballistic testing, and increasingly in archaeological combat testing (Anderson 2011), pig tissues are used as a substitute for human soft tissue. There are a number of significant issues with the thicker pig skin, particularly the hypodermis, when using porcine tissue as an analogue for the human cranium; this is less of a problem for analogues for the

[6] The wooden hilt was easily fixed using wood glue; I am deeply grateful to Mark Young, the metal technician at Edinburgh College of Art, for cold-hammering the tip back into shape. This proved extremely significant in the analysis and is discussed in Section 3.6.

upper limbs and torso, as humans tend to have thicker skin in these areas throughout the majority of their lives[7]. It would be expected that at least some of the injuries inflicted during interpersonal combat would occur on the soft tissue of the torso, thigh or upper arm. Porcine skin (excluding the subdermal layer of fat in the hypodermis) is remarkably similar to human skin: both are covered with hair follicles, but not with a thick layer of hair; both are tightly attached to the subcutaneous tissues; both have a similar healing process when damaged; a similar cell turnover rate (c.28-30 days); and an almost identical subcutaneous blood supply (Swindle 2008). Pig limbs with a thin layer of subdermal fat, therefore, would be the most analogous, though not perfect, material to human skin. Consequently, a hock – the upper part of a rear leg – and trotter from a freshly-slaughtered pig was acquired from an abattoir through Saunderson's Butchers, Tollcross, Edinburgh, with its skin intact and unaltered. The leg had been refrigerated for approximately 24 hours prior to collection, and the soft tissue trials took place within six hours of collection. The limb weighed 1.54kg and displayed muscle, skin, ligaments/tendons and bone. Most importantly, the maximum dermal thickness was slightly over 2mm, making this an appropriate human tissue analogue.

Figure 3.16 *– The pig limb upon collection from the butcher.*

[7] Skin thickness is maintained until a healthy modern adult reaches their mid-60s; health, lifestyle and age affect the skin's recovery and elasticity capabilities, but not its thickness or extensibility. See Escoffier et al 1989.

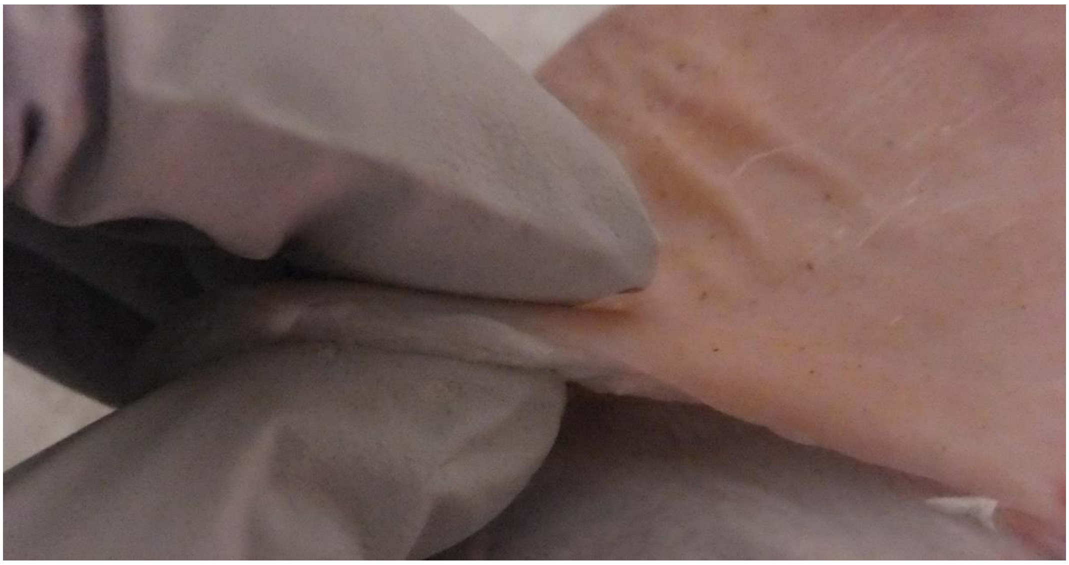

***Figure 3.17** – The much thinner layer of subdermal fat (rolled slightly forward for emphasis); the maximum thickness was 2.4mm. The limb had been scrubbed but not shaved or heat-cleaned; the hairs and epidermis are clearly visible and largely unaffected by slaughterhouse processing.*

The soft tissue experiments were undertaken in a wet room and recorded in full. Due to time constraints relating to the soft tissue processing, and in transporting the tissue from one area to another, it was impossible to facilitate an event similar to the audience in ILW that was enacted for the skeletal tissue experiments. If these soft tissue trials were to be repeated in the future, more effort would be made to include immediate feedback.

The limb was placed on a 1.2m raised platform, to best imitate an upright adult's torso. A series of blows, similar to the range anticipated for the soft tissue trials, was determined and enacted as follows. The objective was to cover a range of movements and to ensure that all faces and edges of the replica dirk were utilised. To this end, the two cutting edges were labelled and each slashing blow was repeated so that both cutting edges were tested. Edge 1 was the edge which had had the rivet stress and metal shear on the hilt; Edge 2 was the other. All blows were enacted by a 1.75m, 80kg, right-handed, female assailant.

Blow 1. A right-handed blow using Edge 1. A swinging overarm slicing action, pulling the edge of the blade towards the assailant along an area of thick muscle on the pig thigh. The resulting incision was 38mm long and 14mm deep, slicing through the thick muscle layer and underlying ligament but making no impact on the bone.

Blow 2. A right-handed blow using Edge 2. A swinging overarm slicing action, pulling the edge of the blade towards the assailant along an area of thick muscle on the pig thigh.

The skin and muscle were not pierced, but instead displayed a deep, V-shaped groove 36mm long and 6mm deep.

Blow 3. A right-handed blow using Edge 1. A swinging overarm slashing action, pulling the edge of the blade towards the assailant along the ankle joint, an area of thin skin and ligament with the skeletal tissue very close to the surface. The slashing impact damaged the soft tissue with a clean laceration 24mm long and 2mm deep, which scored the underlying bone.

Blow 4. A right-handed blow using Edge 2. A swinging overarm slashing action, pulling the edge of the blade towards the assailant along the ankle joint, an area of thin soft tissue with the bone very close to the surface. The slashing impact damaged the soft tissue with a clear laceration, 19mm long, which scored the underlying bone.

Blow 5. A right-handed blow using Edge 1. The blade edge was placed on a forelimb, on an area of thin muscle and skin and thick tendon, and then pulled back to slice the tissue. The skin was cleanly lacerated, and the underlying ligaments were severely damaged. The resulting wound was 46mm long and 4mm deep.

Blow 6. A right-handed blow using Edge 2. The blade edge was placed on a forelimb, on an area of thin skin and muscle and thick tendon, then pulled back to slice the tissue. The skin was cleanly lacerated, and the underlying ligament was severely damaged. The resulting wound was 36mm long and 2mm deep.

Blow 7. An overarm, point-first stab to an area of very thick muscle on the pig thigh. The skin, muscle and ligaments were deeply damaged, but the stab blow glanced to one side when it reached the underlying bone, which remained unscathed. The resulting penetrative wound was 11mm long and 28mm deep.

Blow 8. An overarm, point-first stab to a forelimb area of thin skin, muscle and tendon, with the bone fairly close to the surface. The blow resulted in an incision 6mm long and 2mm deep which lacerated the skin and partially sliced the tendon but made no impact on the underlying bone and failed to completely sever the tendon. The blow skittered and glanced off at an angle when it reached the skeletal tissue.

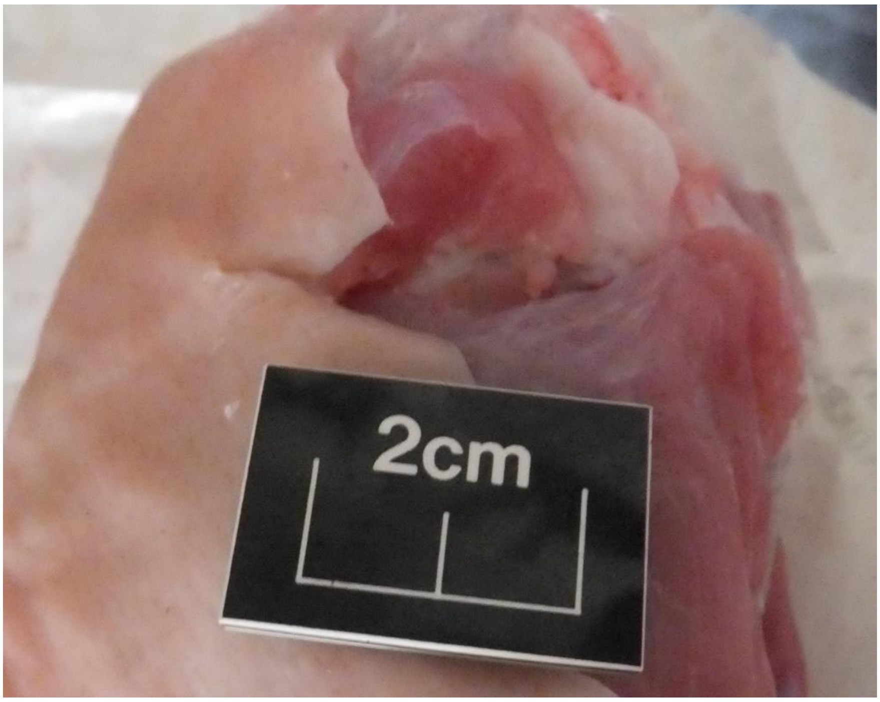

Figure 3.18 *– The incision in the deep muscle tissue resulting from Blow 1.*

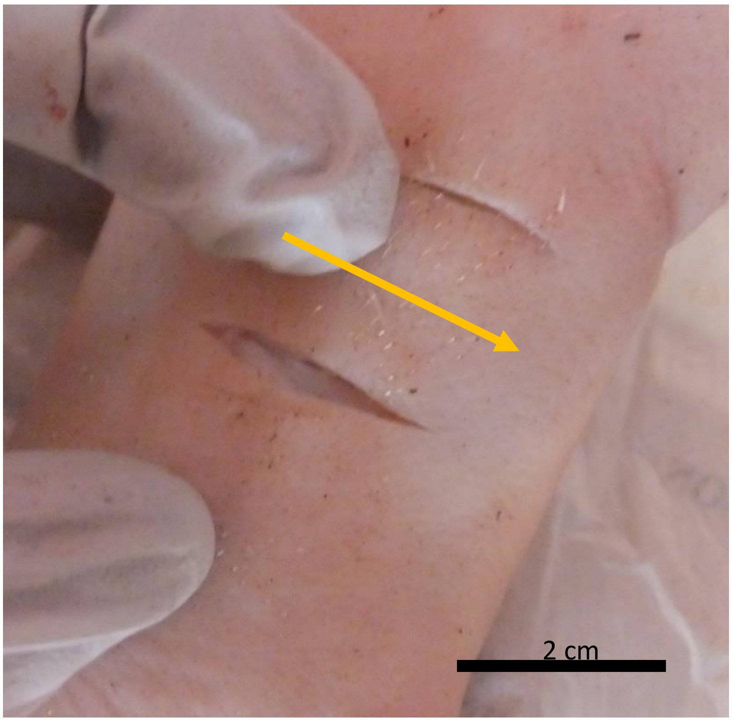

Figure 3.19 *– Blow 4 (top) and 3 (bottom), showing the slight skeletal scoring from Blow 3. The yellow arrow indicates the direction of the slicing blow.*

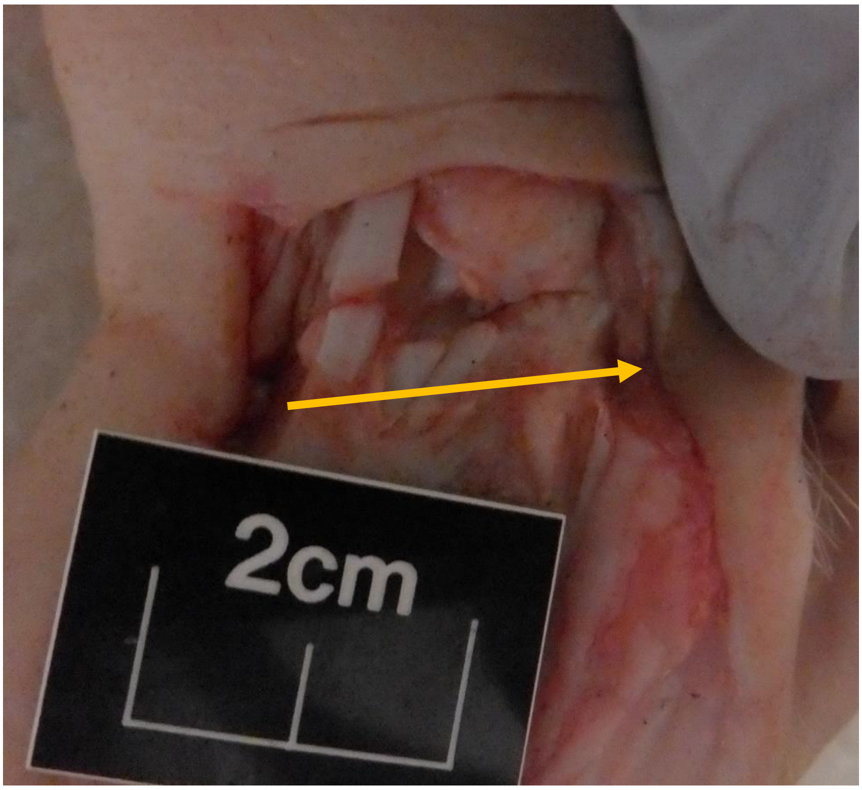

Figure 3.20 *– Blow 5 (top) and 6 (bottom). The dermal layer has been removed following Blow 6 to demonstrate the ligament damage; the dirk has clearly severed the thick tendons. The yellow arrow shows the angle of impact of the slicing blow.*

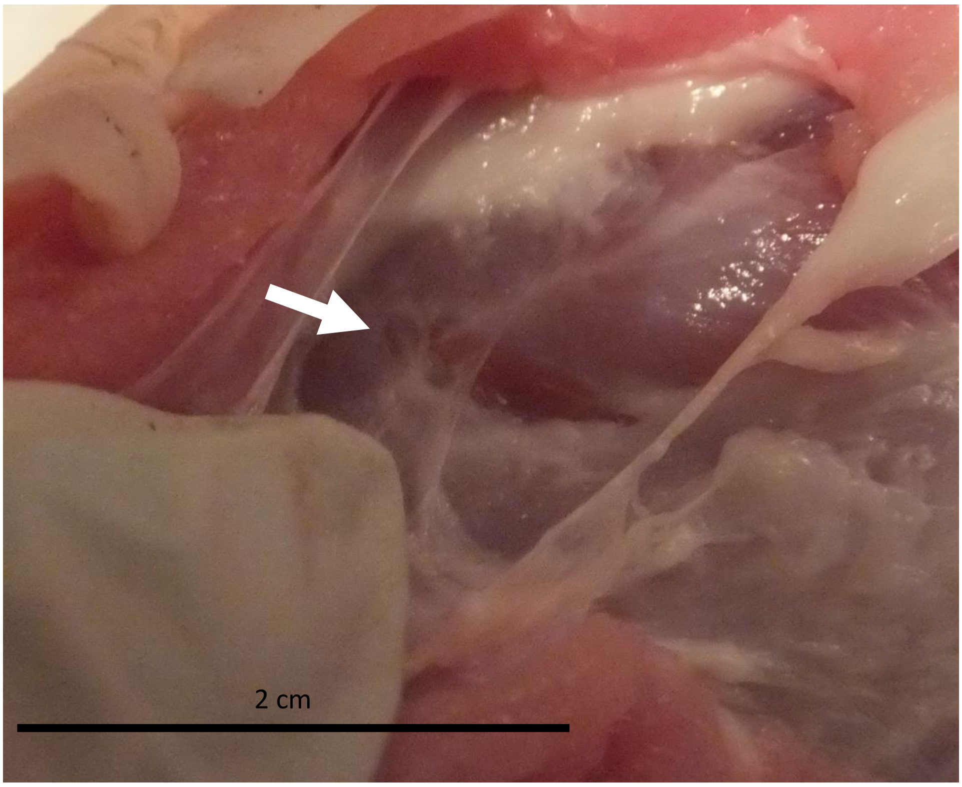

Figure 3.21 *– The deep stab wound (the indicated by the white arrow) resulting from Blow 7; the dermal layer has been removed to show the extent of the muscle damage.*

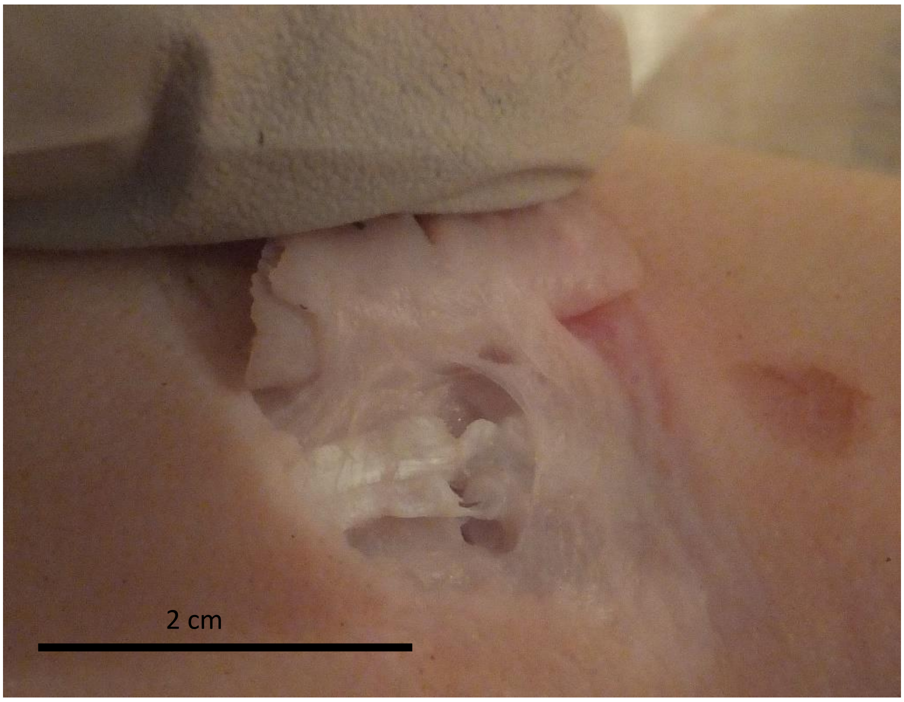

Figure 3.22 *– The shallow stab wound from Blow 8; the dermal layer has been partially removed to show the extent of the partial ligament damage. It can be seen that the ligament was cut by the blow, but not cleanly and not completely severed.*

The results of the soft tissue trials were encouraging. The dirk was shown to be capable of inflicting severe soft tissue damage, slicing through skin, muscle, and tendon in both overarm slashing blows and more controlled slicing blows. The point was also shown to be effective, as the stabbing blows deeply penetrated skin and muscle and damaged ligaments and tendons. The difference in wound sizes inflicted by the two edges can be explained by the different levels of sharpness; both edges of the dirk were sharpened – as equally as possible – upon collection from Perth Museum and Art Gallery, but any sharpening or edge hardening prior to collection was beyond the control of these experiments. Given the consistent difference between the inflicted damage, it is clear that Edge 2 required more sharpening to be as effective as Edge 1.

Furthermore, it is evident that the dirk is not capable of inflicting damage to skeletal tissue. Every blow which came into contact with the underlying bone (Blows 3, 4, 7, and 8) failed to make a significant impact on the bone, and in every case, the dirk 'jumped' in the hand and/or glanced to one side. Combined with the SynBone™ experiments described in Section 3.4, therefore, it is apparent that the replica dirk is not suited to combat blows which would come into contact with skeletal tissue.

The dirk itself was completely undamaged by the soft tissue trials. No visible damage to the edge or hilt was recorded during or after the soft tissue trials, unlike the SynBone™ trials. However, one major drawback in the post-trial analysis quickly emerged. As the damage to the blade of the dirk was repaired between the SynBone™ and soft tissue trials, there was no point in undertaking further microscopy to record minute edge damage. The blade repair involved cold hammering the edges and tip of the blade, leaving characteristic rounded indentations visible to the naked eye, and linear striation edge markings that were only visible under the microscope. Due to time and budget limitations, the repairs were made at the Edinburgh College of Art metal sculpture workshop using an iron hammer and anvil, rather than Bronze Age-appropriate tools. The microscopic marks are therefore the result of modern smithing techniques, rather than the accurate marks that would have resulted from using Bronze Age metallurgical techniques and tools. Undertaking further microscopy would only yield images of the repair marks from the modern techniques, and any useful experimental data would be compromised by the overlying marks to the point of irrelevance. This could potentially have seriously limited the study; however, the small number of blows and the very visible resulting damage to the replica dirk provided sufficient data to warrant the lack of consistent microscopy regrettable but not calamitous.

3.6 Conclusions

The experimental cutting and stabbing trials using soft and skeletal tissue and the replica dirk, based on a novel methodology incorporating applied queer theory, were largely successful. The replica dirk was an accurate reconstruction of the Middle Bronze Age blade from Friarton, in that the metal composition (10% tin bronze) and casting techniques are accurate replications of Bronze Age technology. However, the dirk was hafted using ash, a fairly soft wood. Ash looks attractive, and was chosen because of its ready availability in Cornwall (where the smith is located) as well as its visual appeal, because the replica dirk was primarily intended for museum display. However, future experimental weapon trials, including the experiments using replica halberds detailed in Chapters 6 and 7, would do well to accord the haft wood as much attention as the metal. As far as I am aware, very little research has been done into the difference in hafting in relation to combat capabilities (cf. Molloy and Mödlinger 2020), though data and methodologies examining Neolithic wooden clubs could be a useful starting point (Dyer and Fibiger 2017). The lack of preserved organic hilt material in the Bronze Age assemblage means that the interpretations and publications on Bronze Age weaponry rarely discuss the implications of the hafted weapons. It is very likely, however, that the haft played a significant role in the functionality and significance of the bronze object, both as a weapon and a prestige item. Based on the one intact halberd recovered from Ireland (O'Flaherty 2007:426), and the spread of hard timber-bearing trees in Scotland during the Late Neolithic and Early Bronze Age which neatly corresponds to the distribution of Bronze Age settlement and halberd deposition (Figure 5.1 in Edwards and Whittington 2003:65), a more suitable wood will be used for future experiments, most likely oak. The ontological significance of melding wood with metal has recently been explored by relating the shared generative properties of trees and copper metallurgy, and is particularly interesting given the long object-biographies of the halberds discussed in Section 9.3 onwards (Fahlander 2018).

The research aim of the experimental trials was to determine whether the Friarton dirk, and by extension, many of the similar dirks found across Middle Bronze Age Europe, could be used offensively in interpersonal combat, and whether the resulting combat left any visible traces in the archaeological record, either on the dirks themselves, or skeletally. This was tested in two ways: through the use of Synbone™, the synthetic human skeletal tissue analogue; and using a pig hock and trotter, to mimic various types of human soft tissue. Although the sample size of the Synbone™ trial was much smaller than initially anticipated, these trials conclusively showed that the replica dirk was completely incapable of wounding human skeletal tissue, either through piercing, stabbing, or slashing. The damage to the replica weapon was significant (see below) and sufficient to prevent any further skeletal testing. Only one blow resulted in any significant sharp-force trauma (Figure 3.14), and even that was potentially insufficient to kill an opponent. The soft tissue trials were more successful, showing that the dirk was capable of stabbing and slashing through skin, muscle and ligaments. However, the soft tissue experiments also confirmed that the dirk was completely incapable of damaging bone, and that unwary blows that glanced off bone were much more likely to skitter away and jar the blade, making the blow significantly less efficient. The dirk suffered no visible damage as a result of the soft tissue experiments.

The experimental stabbing trials therefore showed that the Middle Bronze Age dirk could wound an opponent when wielded with enormous skill and expertise, so as not to come into contact with any underlying skeletal tissue. However, to inflict serious damage to the throat or torso, the wielder would have to be in extremely close proximity to their opponent, putting them at serious risk of counter-attack. It is therefore implausible that the dirk was primarily intended as a combat weapon. It is possible that the dirks were used in conjunction with other weapons in interpersonal combat, but it is very unlikely that interpersonal injury was their primary purpose.

Furthermore, despite the high level of damage incurred after using the haft of the replica dirk as part of the offensive weapon, the decision to incorporate as much of the weapon as possible into the trials – not just the metal blade, as represented by the archaeological assemblage – was well-founded. Not only was it confirmed by the martial artist as a fighting method employed by many martial disciplines (M. Appleford, pers. comm.), but the damage inflicted on the replica dirk as a direct result of the haft blow very closely mirrors the damage to the original, prehistoric dirk (Figure 3.23).

Figure 3.23 *– The damage to the replica dirk as a result of the haft blow (top) and the single area of damage to the prehistoric dirk (bottom). © Perth Museum and Art Gallery, Perth and Kinross, Scotland*

The location and angle of the shearing damage on the prehistoric dirk is very reminiscent of the damage on the replica. It would be logical, therefore, to hypothesis that the original Friarton dirk could have suffered the damage in a similar manner as the replica did; that is, by the organic hilt being used to inflict blunt-force trauma on a person or object, putting massive stress on the lowermost rivet and deforming the underlying metal hafting area, and perhaps the organic hilt as well. The rivet on the experimental dirk became very loose following the blow, requiring delicate repair to stop it completely dislodging and becoming lost. The rivet could very easily have been lost if the replica dirk was deposited in the bank or bed of a river; the missing rivet on the prehistoric dirk is therefore consistent with this interpretation. The experimental trials succeeded, therefore, in providing sufficient empirical data to create a narrative for the damage and eventual deposition for the Friarton dirk, which would not have been possible otherwise.

Furthermore, the methodology was shown to be appropriate and effective. The inclusion of applied queer theory led to a more reflexive, adaptive, and inclusive methodology, resulting in accurate and reliable results and a number of applications for future experiments. Research published in the gap between these experiments and the submission of this thesis for examination (2014-2020) did not adequately answer these two specific research aims, and the dirk trials detailed in this chapter, therefore, remain relevant to this study; the limitations and capabilities arising therefrom could not have been anticipated without these experiments – particularly the plastic deformation in the dirk tip, the damage to the wooden handle, and the poor performance of the dirk in the soft tissue trials. Crellin et al (2018) is the most comprehensive methodological study for experimental weaponry published to date, but this still would not have generated the results shown in this chapter, nor would it have helped to refine the audience and tissue analogue elements for the halberd experiments as did these dirk experiments – not to mention the impossibility of using their results in 2014, four years before they were published! Relying solely on extant methodologies was not appropriate at the beginning of this experimental period and remains so in order to facilitate an accurate and above all reliable dataset which can be compared to the extant catalogue record.

The two research aims were therefore completed, and the limits of the dirk's offensive capabilities demonstrated. The damage to the replica dirk could be used to identify similar potential blows in the prehistoric assemblage – bent tips from stabbing bone or similar hard surfaces, and hafting-plate shearing from using the hilt as a blunt weapon. The dirk did not leave sufficient skeletal damage to identify similar damage in the archaeological record.

Chapter 4 – Middle Bronze Age Dirks Found in Scotland: A Comparative Study

The replica dirk experiments described in Chapter 3 showed that the Middle Bronze Age dirk hilt and hafting plate were susceptible to fracture damage, particularly around the rivet holes. The replica was damaged when used offensively, in an attempt to damage a Synbone^{TM} sphere (see Faulkner-Jones 2016, and Section 3.4); the Friarton dirk, on which the replica dirk was modelled, also showed near-identical fracture damage along the hafting plate. The shearing damage pattern is also present across the Scottish Middle Bronze Age (MBA) dirk assemblage; by cross-referencing the experimental and catalogue data, a novel interpretative model for the MBA dirks can be developed.

4.1 Damage

The experiment detailed in the previous chapter, involving the replica dirk and a Synbone^{TM} sphere, resulted in a characteristic pattern of shearing damage across the hafting plate of the dirk which closely mirrored the damage displayed on the prehistoric Friarton dirk (see Figure3.23). The shearing damage on the replica dirk resulted from a powerful overarm stabbing blow to the Synbone^{TM} sphere, used here as an analogue for an adult human skull. I posit that the design of the Friarton dirk (a Group I weapon with multiple grooves, per Burgess and Gerloff (1981)), specifically the wide-set, small diameter rivet holes with a thin bridge of metal on the outside, creates a structurally weak area on the hafting plate which rips and breaks when subjected to pressure. The Friarton dirk was complete and undamaged when discovered, but the hafting plate sheared during its recovery from the river bed (Cowie et al 2011). The prehistoric dirk damage is therefore not necessarily symptomatic of combat usage, but rather a consequence of unusual stress and, potentially, indelicate handling or damage from rocks or stones on the river bed (little information is given on the exact actions resulting in the tear, but the dirk was recovered by a diver, not an archaeologist, so careful recovery protocols may not have been observed – see Longworth 1997). Similar damage patterns displayed by other MBA dirks can, therefore, potentially be ascribed to the infliction of unusually severe stress through striking a hard material – potentially from bone in combat, but also possibly from other materials like stone, animal bone, or frozen earth.

The characteristic damage that this chapter seeks to identify in the prehistoric assemblages is the shear, where the hafting plate displays a linear fracture bisecting the rivet hole.

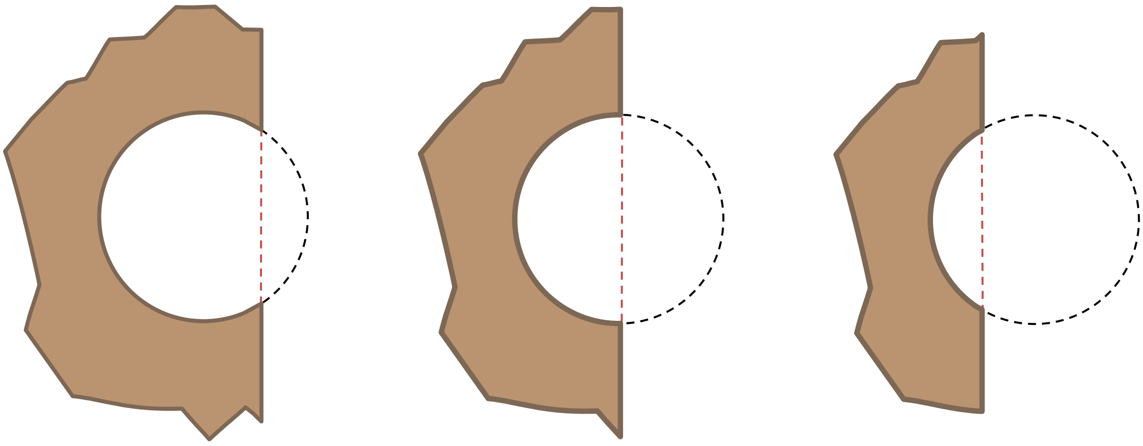

Figure 4.1 *– Diagram of the shear damage identified in the prehistoric assemblage. L-R: acute, horizontal, and obtuse shearing damage.*

Dirks which show clear evidence of shearing display a sharp linear fracture on the hafting plate, where the newly-created terminals (see the notations on Figure 2.9) on the rivet hole do not taper, as with erosion from wear damage, but instead form a blunt edge with right-angled corners. These artefacts are listed as having damage caused by unusual stress (as defined above). The fracture should extend through the hafting plate, resulting in material loss. If the terminals show softening, possibly through taphonomic wear, and the right-angles are no longer unequivocal; if the fracture does not continue as a linear tear into the hafting plate; if the dirk is in very poor condition and has suffered significant edge damage and material loss: in such cases, where linear shear damage is identified but there are mitigating circumstances, then the damage has been noted as possibly resulting from unusual stress.

4.2 Research Aims

The interpretation offered in the previous section suggested that the placement of the rivet holes, close to the edge of the hafting plate, made the weapon susceptible to stress-induced fracture. This can be supported or refuted through comparison with the prehistoric dirk assemblage, in this case through the creation of a select comparative catalogue. The four primary research aims for this short study are therefore:

1. To establish whether the characteristic shearing damage observed on the replica dirk is found in the prehistoric assemblage, and if so, to what extent.

2. To establish whether there are any observable patterns in the frequency of shearing damage, in terms of dirk type, size, deposition location, or state of preservation.

3. To construct a short comparative catalogue, and to identify any obstacles or issues in its construction which may have an impact on the development of the large catalogue of Scottish halberds which will be used extensively later in this thesis.

4. After achieving aims 1-3 inclusive, to demonstrate whether the experimentally-derived data can be compared with catalogue data in order to aid the interpretation of both data sets, and to the development of a set of robust and confident conclusions.

4.3 Comparative Catalogue

The Prähistoriche Bronzefunde (PBF) series includes several volumes on the European MBA dirk assemblage; the most complete and up-to-date corpus of British MBA dirks is Gerloff and Burgess (1981), which includes the English dirks listed by Gerloff (1969) as part of her PBF volume based on her doctoral thesis. Each dirk is catalogued by type, with a short paragraph of text and an accompanying illustration. Due to resource constraints and the size of the Scottish dirk assemblage, it was not feasible to construct a novel catalogue of the Scottish Bronze Age dirks in the manner of the halberd catalogue (see Chapter 5); furthermore, the work described in this and the previous chapter is intended as a support for the work on halberds (Chapters 5-9 inclusive), and not as the primary focus of this dissertation. However, there is scope for it to be developed much further in its own right, and this will be discussed in the Further Work section of Chapter 10 (Section 10.2).

The PBF volume on British and Irish dirks and rapiers (Burgess and Gerloff 1981) comprises the largest source of comparative catalogue data for this chapter; it is, however, 40 years since the assemblage was recorded, and many dirks have been recovered since. There are significant differences in the reporting structures within the constituent nations of the UK; in Scotland, all archaeological objects must be reported under the Treasure

Trove system, regardless of the material from which the object is made[8]. The Treasure Trove Unit publishes an annual report of museum allocations and noteworthy finds[9]. However, the Portable Antiquities Scheme (PAS), instituted by the Treasure Act of 1996, applies to England, Wales, and Northern Ireland and only stipulates the mandatory reporting of archaeological items made from gold, silver or, as of 1st January 2003, base-metal. The reporting of ceramic, stone or other material artefacts is entirely voluntary[10]. Furthermore, Northern Ireland strictly regulates metal detecting: under the Historic Monuments and Archaeological Objects (NI) Order 1995, it is an offence to search for archaeological objects in Northern Ireland without an excavation licence; it is also an offense to bring a metal detector onto a site under state protection, or to remove anything from the protected site without written consent[11]. The Republic of Ireland follows a similar structure: the National Monuments Act of 1930 decreed that any archaeological object, regardless of material, belongs to the state and should be reported within 14 days; excavation and the use of metal detectors are strictly licensed and controlled, as is the sale and export of any archaeological material[12].

With these structures in mind, a tiered system of representative assemblage reporting emerges:

Scotland, where there are no restrictions on seeking stray finds using detecting tools, but where all archaeological objects are reported, evaluated, allocated and published. The published assemblage is therefore representative of recovered Scottish archaeology as a whole, and should not display bias towards one material or item type. The immediate involvement of the Local Authority Archaeologist upon the finder reporting the object means that recovery damage is minimised.

Northern Ireland and the Republic of Ireland, where archaeological investigations are heavily regulated, and the general public are not permitted to seek stray finds. Recovered archaeological artefacts are handled solely by trained and licensed archaeologists, so there is minimal loss of contextual data or damage to the object

[8] See the advice and information listed at www.treasuretrovescotland.co.uk
[9] See www.treasuretrovescotland.co.uk/reports-and-minutes
[10] See the advice and information listed at www.finds.org.uk/treasure
[11] See www.communities-ni.gov.uk/articles/finders-treasure
[12] See http://www.irishstatutebook.ie/eli/1930/act/2/enacted/en/print

by members of the public. However, this does mean that there are far fewer objects discovered and reported every year. There is also no regular publication of recent finds on a national scale.

England and Wales, where there are no restrictions on who can seek stray archaeological finds (outwith Scheduled Monuments and other sites protected by the state). The finder is under no legal obligation to report non-treasure (i.e. non-metallic) finds, though it is encouraged on a voluntary basis by the PAS. A database of finds made by the general public since 1998 is available online, but objects recovered as part of professional archaeological investigations are lodged with the local Historic Environment Record (HER) and are not available to the public; local reporting and accessibility varies greatly between HERs, and has been significantly affected by the recent austerity measures, and further restrictions required to control the Covid-19 pandemic[13]. The published assemblage is therefore highly fragmented and not necessarily representative of the entire English and Welsh assemblages.

Updating the dirk catalogue to reflect discoveries from the last 40 years is therefore problematic, and a significantly bigger task than is feasible for this section (see Section 10.2). However, some steps can be taken to address and include the more recent dirk finds, albeit imperfectly.

Firstly, the Treasure Trove annual reports dating back to 2006 were examined at the library at the National Museum of Scotland, Chambers Street, Edinburgh. Additionally, the annual publication Discovery and Excavation in Scotland was also consulted from the years 1979-2017 inclusive (by optimistically assuming that Burgess and Gerloff (1981) took two years to go from manuscript to published book; there may have been a handful dirks published earlier that have therefore been missed by this range, but not enough to negatively impact or skew the overall dataset), and cross-referenced with the Proceedings of the Society of Antiquaries of Scotland (PSAS) and the RCAHMS/Historic Scotland archives where appropriate; by these methods, the published Scottish dirk assemblage should be accurately represented. Next, the PAS database was searched for dirks and

[13] See http://new.archaeologyuk.org/cuts-to-archaeology-services

rapiers from England and Wales, and any results cross-referenced with the data from Burgess and Gerloff 1981 to ensure that entries were not replicated. Finally, a literature search (using JSTOR and Google Scholar, as well as www.researchgate.net and www.academia.edu) returned results for England, Wales and Northern Ireland, as well as select publications from the Republic of Ireland; these were obviously constrained to dirks and rapiers which had been published in journals and books which had then been made available online. An illustration or photograph is required for each published dirk in order to identify the characteristic shearing damage described in Section 4.4; dirks with no published image were therefore not included in this select comparative catalogue. The scope of this study was constrained by time and resources; there is obviously significantly more work to be done on the Scottish dirk assemblage, potentially including the experimental aspects investigated in this thesis, and will be discussed further in the Future Work section (Section 10.2).

Rather than a complete artefact-specific catalogue (such as the one for the Scottish halberds, detailed in in Appendix 1 and Chapter 5), this select dirk/rapier catalogue serves a different – but no less useful - purpose. Primarily, it is intended to demonstrate comparable examples of the shearing damage observed on the original and replica Friarton dirks, in order to substantiate the interpretation outlined in Section 4.4. It is not intended to be exhaustive, only illustrative. Again, there is evident scope here for expanding this work in future as part of deeper and broader-reaching research projects – see Section 10.2.

The catalogue, as raw data on a Microsoft Excel spreadsheet, is available upon request. The analysis of the raw data is presented in the following sections; the aim was to include sufficient detail so as to preclude the need to include the raw files here.

4.4 Dirks Displaying Characteristic Shearing Damage

Based on the comparative catalogue data, the following frequencies of damage were observed. It should be noted that this represents only the dirks displaying shearing damage, rather than the complete dirk assemblage from the British Isles. For reference, Burgess and Gerloff (1981) list 1,002 dirks and rapiers from Britain and Ireland as of 1979; an educated guess would put the current assemblage (as of 2017) at around 1,050. The damaged blades therefore constitute ~10% of the total assemblage.

Table 4.1 *– Number of dirks and rapiers from the British Isles displaying the characteristic shearing damage discussed in Section 4.4.*

Dirks with shearing damage	Clear damage	Possible damage
	51	57

This can be further broken down by country:

Table 4.2 *– Breakdown of the sheared dirks and rapiers by country.*

	Clear damage	Possible damage
England	20	25
Republic of Ireland	21	19
Northern Ireland	5	6
Scotland	5	3
Wales	0	4

There is also a difference between the frequency of damage between dirks and rapiers:

Table 4.3 *– Breakdown of the sheared dirks and rapiers.*

	Clear damage	Possible damage
Dirks	37	30
Rapiers	11	19
Indeterminate dirk/rapier	3	8

It is apparent that the shearing damage occurs across Britain and Ireland; England and Ireland have higher numbers due to the larger complete assemblage size resulting from more intensive programs of archaeological investigation, mostly as a consequence of infrastructure construction such as roadbuilding. More dirks show the damage than rapiers; I posit that the stress-induced shearing damage occurs more frequently on the shorter blades because there is less material in the blade to absorb the force of the blow. Detailed experimental work would be required to further investigate the parameters causing the damage, and is discussed in Further Work (Section 10.2); for instance, it is possible that the different ways of wielding dirks and rapiers, or the difference between slashing and stabbing, also plays a role in determining whether a stress fracture is created or not. Furthermore, it is possible that there is a non-combat use for dirks and not rapiers which could cause the damage – butchery, for instance, or leather working (although specialised tools for specific tasks such as leatherworking are attested from the very early Bronze Age, so this is not as likely a cause (Sofaer et al 2013:483)).

As noted above, ~10% of the dirks in the whole assemblage display the shearing damage observed from the replica experiment; it is therefore reasonable to conclude that stress-induced fractures were a recognisable form of breakage in the Bronze Age, though by no means present on the majority of the dirks.

The chronologies proposed by Burgess and Gerloff for each Group, followed in this chapter and throughout this thesis, rely heavily on continental comparisons and typological dating (1981:15-9, 43-6, 60-1, 106-9); however, it does indicate that rapiers were fully developed and in circulation by the Middle Bronze Age, based on Group III rapier associations (Burgess and Gerloff 1981:60) and Group IV rapier design developments (Burgess and Gerloff 1981:106-7). Dirks continue to be manufactured and circulated during this period, and their butt and rivet designs are reflected in their contemporary rapier forms. The number of damaged dirks/rapiers are shown by Group (which represent broad chronological changes), below.

Table 4.4 *– Breakdown of clear and possible damage on dirks and rapiers, sorted into Groups (following Burgess and Gerloff 1981).*

	Clear damage (dirk)	Possible damage (dirk)	Clear damage (rapier)	Possible damage (rapier)
Group I	6	4	2	0
Group II	17	14	1	2
Group III	1	2	3	15
Group IV	10	10	11	10

Table 4.4 shows that there is not a clear pattern of increasing or decreasing shearing damage over time. Groups II and III include a sub-category of weapons with damaged butts, which account for the spikes in possible rapier damage (Group III) and all dirk damage (Group II). The increase in rapiers being manufactured and circulated as the Bronze Age progresses is mirrored in the gradual increase in damaged rapiers in Groups III and IV, even when allowing for the Group III damaged weapon sub-category. Groups II and IV account for the majority of the damaged dirks, as well as the majority of the

weapons showing clear damage; most of the specific examples listed below are therefore drawn from these Groups. The examples given are divided by damage type: acute, horizontal and obtuse (see Figure 4.1). For comparative reference, Table 4.5 shows the proportions of each damage type across the select assemblage. Where multiple rivet holes have been damaged, each one has been counted separately; there are therefore more instances of damage than there are weapons. The following subsections are intended to illustrate some of the clearer and/or better-preserved examples of Bronze Age dirks and rapiers displaying the characteristic shearing damage.

Table 4.5 *– Breakdown of the types of damage displayed by the Bronze Age blades. To recap: acute damage results in a circumference gap of <89°, obtuse damage results in a gap >90° <179°, and horizontal damage covers 180° and over.*

	Clear damage	Possible damage
Acute	5	14
Obtuse	38	20
Horizontal	35	55

4.1.1 Examples of Acute Shears

Acute shearing results in a 'gap' in the rivet hole circumference of <90° (see Figure 4.1). The damage inflicted on the replica Friarton dirk is an example of acute shearing (see Figure 3.12). Acute shearing is the least common type of shearing damage observed in the prehistoric blade assemblage, as demonstrated by Table 4.5, and is more prevalent as "possible" damage than "clear" (discussed further in Section 4.5). There are a handful of clear examples of acute damage in the select catalogue, however, some of which are discussed here. The Group II blade with a damaged butt from River Shannon, Ireland (Museum of Dublin acc. W.149) (Burgess and Gerloff 1981 Plate 34, no. 276) is one such blade; the right rivet hole shows a small fracture which extends into the hafting plate. The hafting plate itself is very damaged, showing extensive material loss, but the blade itself is in very good condition.

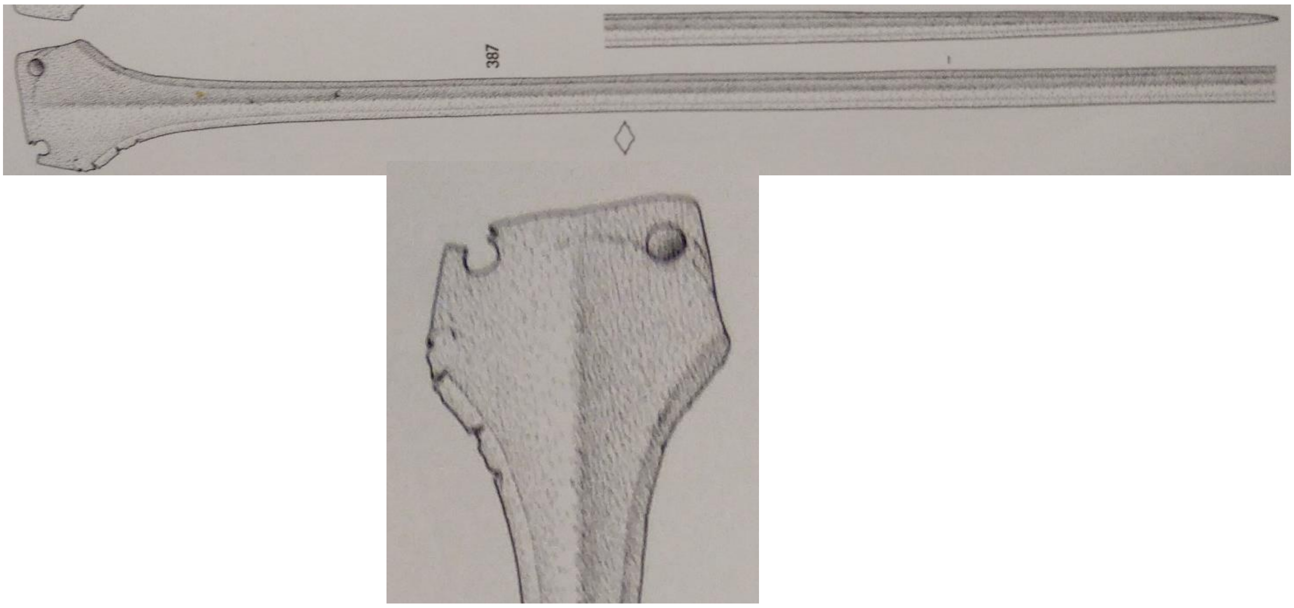

Figure 4.2 *– The Type Lissane rapier from Ireland. Burgess and Gerloff 1981 Plate 50, no. 387.*

Acute damage is also present in the rapier assemblage. A Group III Type Lissane rapier from Ireland (Museum of Dublin acc. 1897.46) (Burgess and Gerloff 1981 Plate 50, no. 387) (Figure 4.2) shows an acute shear on its left rivet hole. This type of rapier is characterised by a very long thin blade and a short, squat hafting plate with the rivet holes bored extremely close to the plate edge – many of the Type Lissane rapiers show shearing damage to the rivet holes, as the thin metal bridge is particularly susceptible to stress-induced fracture and distortion. A more extreme example is given by the adjacent Type Lissane rapier, also from Ireland (British Museum acc. 47.5020.5) (Burgess and Gerloff 1981 Plate 50, no. 390) (Figure 4.4), which shows an acute shear on its left rivet hole and a horizontal shear on its right. The narrow metal bridges have both succumbed to a stress fracture; the long thin blade is also snapped in two, although this was most likely not the result of the same blow as caused the damage to the hafting plate because the fracture lines are at right-angles to each other, indicating two different impacts.

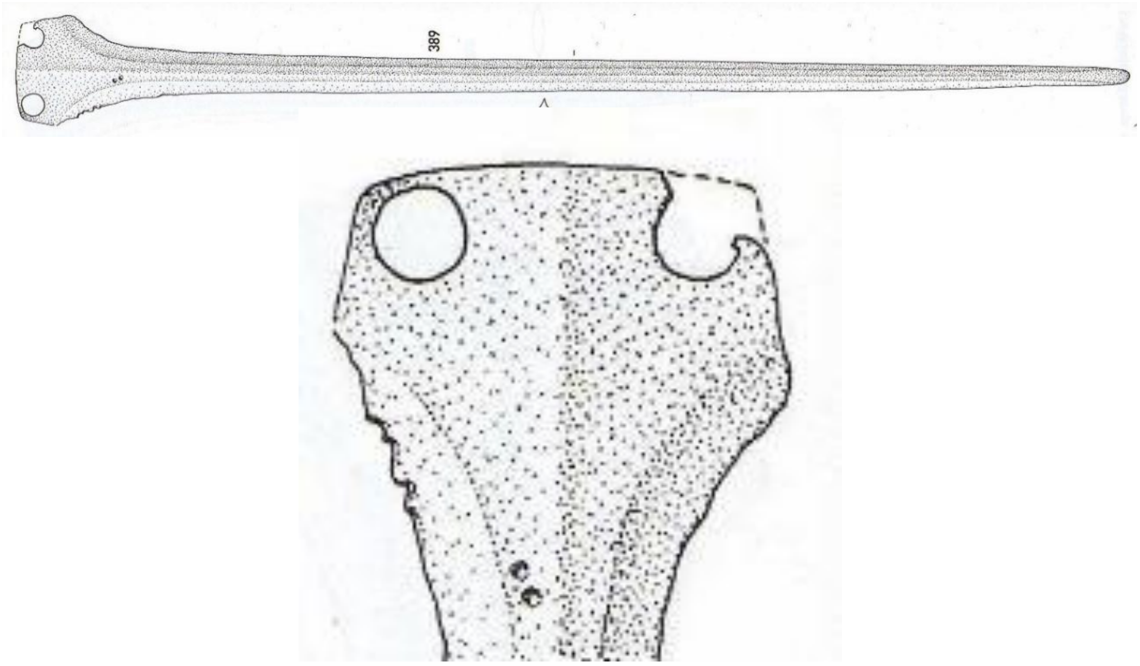

Figure 4.3 *– Type Lissane rapier from Ireland, with the hafting plate enlarged to show the acute shear and hypothesised shape of the original butt. Burgess and Gerloff 1981 Plate 50, no. 389.*

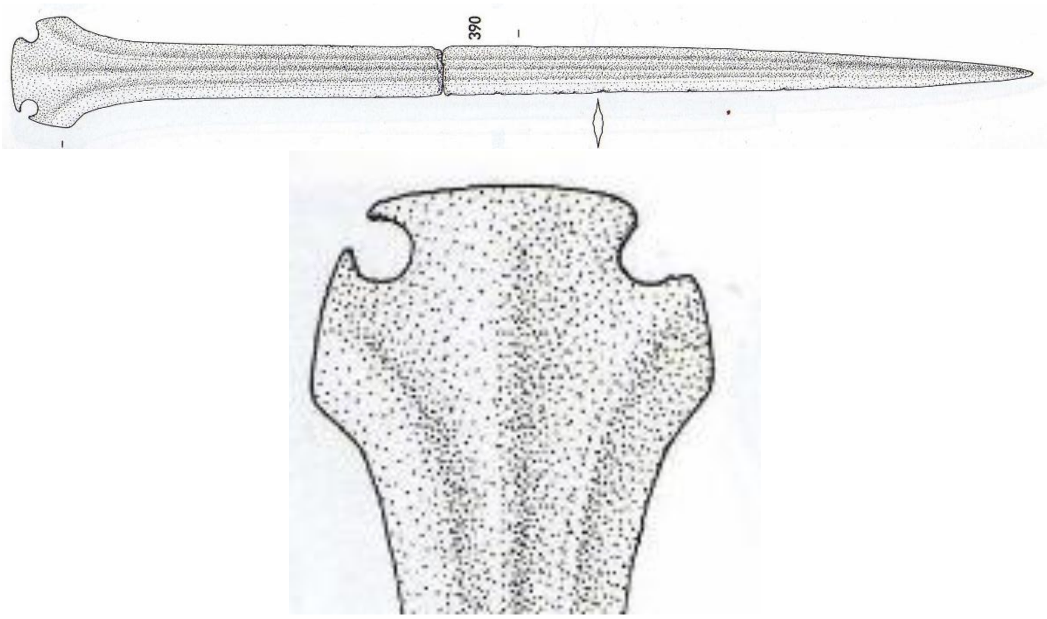

Figure 4.4 *– Type Lissane rapier from Ireland, with the hafting plate enlarged to show the acute shear (left) and possible horizontal shear (right). Burgess and Gerloff 1981 Plate 50, no. 390.*

One example of a possible acute shear is one of the rapiers from the Talaton hoard, Devon (British Museum acc. 71.608.3) (Burgess and Gerloff 1981 Plate 54, no. 412) (Figure 4.5). The rapier is in very poor condition: the blade itself is heavily pitted, and has been broken into four pieces prior to deposition. The hafting plate shows significant material loss to one side; the other side contains a rivet hole displaying a potential acute shear. However, the terminals are folded and bent, which is not necessarily consistent with the stress-induced shearing: it is for this reason that the shear is listed under possible, rather than clear, damage.

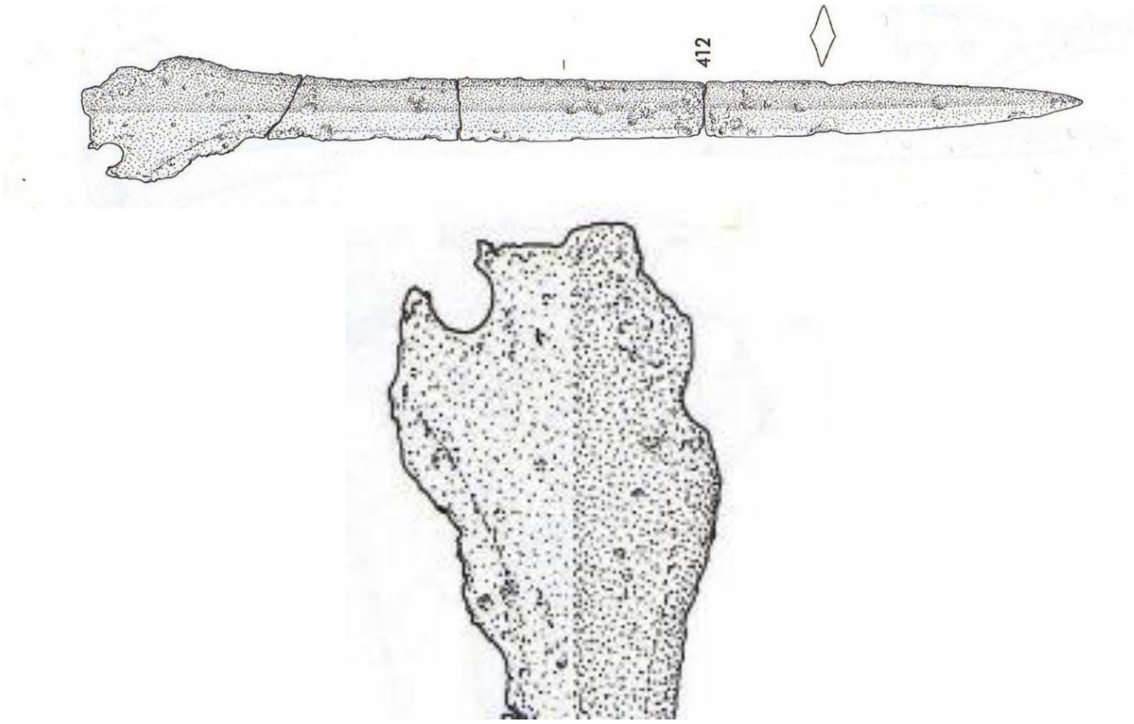

Figure 4.5 *– One of the rapiers from the Talaton hoard, which is in visibly poor condition. The enlarged hafting plate below shows the possible acute shear on the left rivet hole; the significant edge damage and bent terminals are clear. Burgess and Gerloff 1981 Plate 54, no. 412.*

4.1.2 Examples of Obtuse Shears

Obtuse shearing results in a large gap in the circumference of the rivet hole, larger than a right angle but smaller than a horizontal shear (91-179° - see Figure 4.1). Obtuse shears are the most common type of clear damage observed in the select catalogue (see Table 4.5). Some of the clearer examples are discussed further in this subsection.

A rapier from Edenderry, Co. Offaly, Ireland (University of Cambridge, Museum of Archaeology and Ethnology acc. M.C.99177) (Burgess and Gerloff 1981 Plate 58, no. 443) (Figure 4.6) displays an excellent example of an obtuse shear on its left-hand rivet hole, and a borderline obtuse/horizontal shear on its right. Although the tip of the rapier blade is missing, the artefact is otherwise in good condition, and the hafting plate shows minimal material loss – the damage to the rivet holes can therefore be confidently ascribed to stress-induced fracture, rather than post-depositional taphonomy.

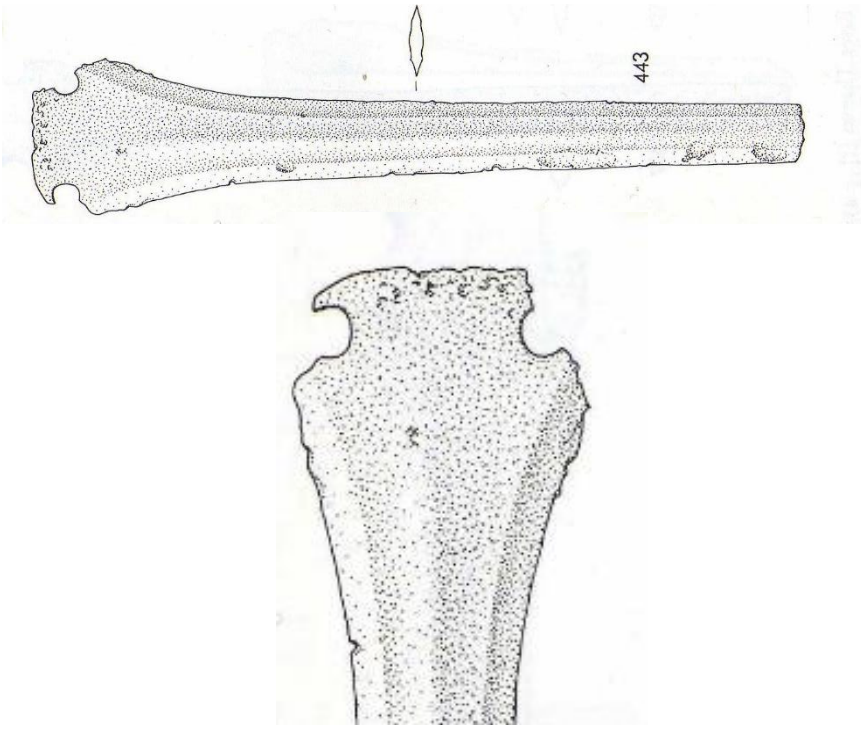

***Figure 4.6** – The partial rapier from Edenderry, with the hafting plate enlarged below to show the two obtuse shears on both rivet holes. The rapier is – other than the missing tip – in good condition. Burgess and Gerloff 1981 Plate 58, no. 443.*

A dirk from Chatham Reach, Kent, of a similar size and weight to the Friarton dirk, displays another excellent example of an obtuse shear on the right-hand rivet hole (British Museum acc. 71.10-2.6) (Burgess and Gerloff 1981 Plate 12 no. 85) (Figure 4.7). The left rivet hole has ripped but the circumference is intact; it is possible that the rip was caused by the same blow which inflicted the adjacent shear. The dirk itself is in excellent condition, displaying no edge damage or pitting.

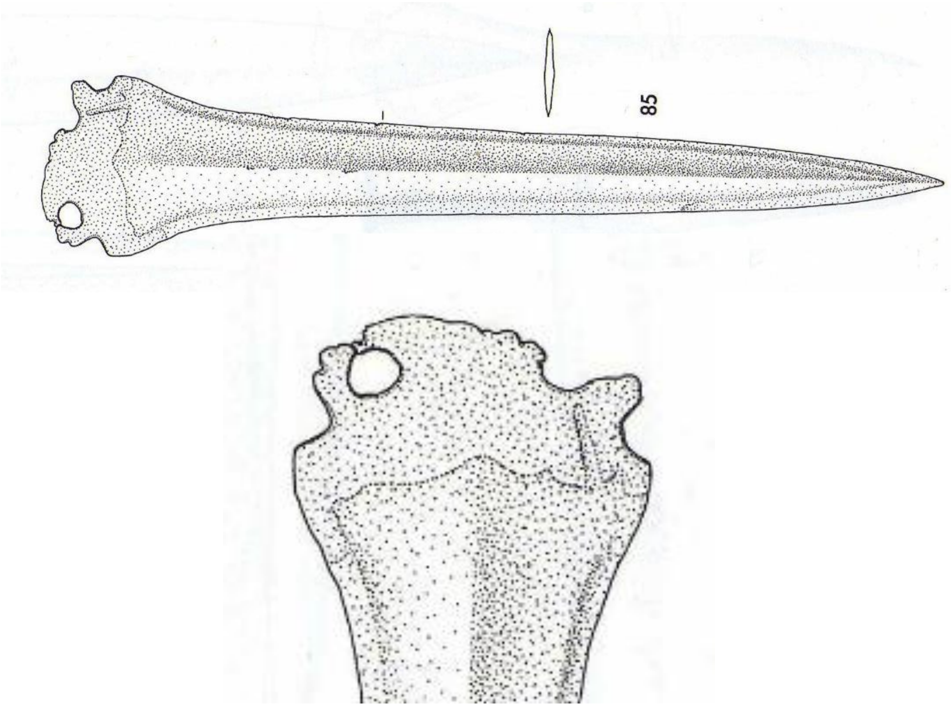

Figure 4.7 *– The dirk from Chatham, Kent, with the hafting plate below showing the obtuse shear on the right-hand rivet hole. The dirk is in excellent condition and is a similar size and type as the Friarton dirk detailed in Chapter 3. Burgess and Gerloff 1981 Plate 12 no. 85.*

A third example of clear obtuse shearing is given by the slender dirk (listed as a short rapier by Burgess and Gerloff) from Cowpen, Northumberland (Great North Museum: Hancock acc. 1901.10) (Burgess and Gerloff 1981 Plate 26, no. 195) (Figures 4.8 and 4.9). The dirk is in excellent condition, with a clear obtuse shear on the left rivet hole. The shear extends into the hafting plate, where the bronze has folded along the linear fracture line. The right rivet hole is intact and displays no damage or pitting, consistent with the rest of the blade. This pattern of damage is therefore very similar, almost identical (save the small fold), to the damage inflicted on the replica Friarton dirk; it follows that a similar powerful overarm blow using the dirk to connect to a hard, dense material could have caused the damage to the Cowpen dirk.

Figure 4.8 *– File image of the Cowpen dirk (no scale) from the Hancock Museum, Northumberland, showing the bevelling around the midrib. © Tyne and Wear Archives & Museums*

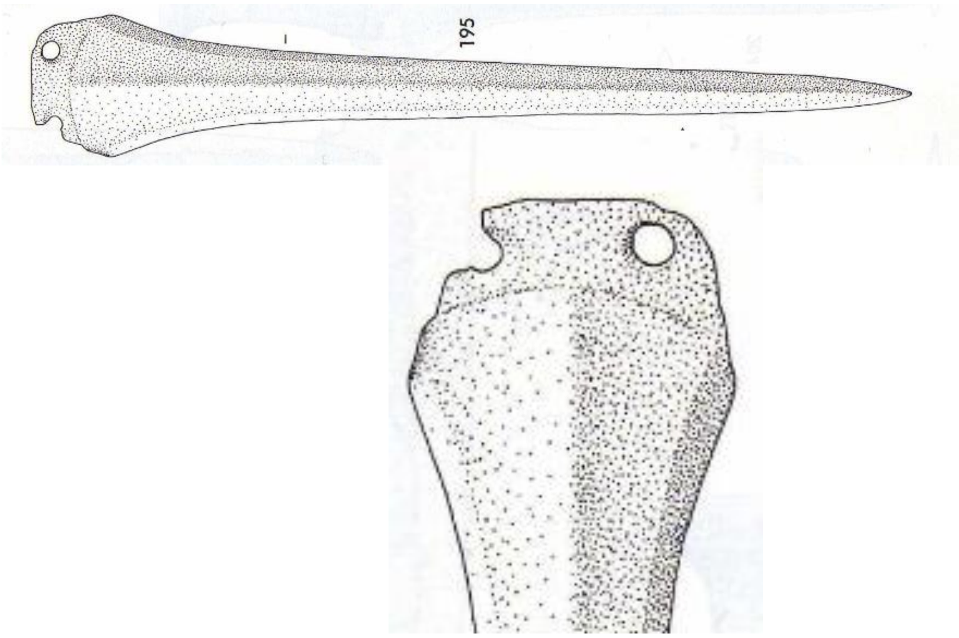

Figure 4.9 *– The dirk from Cowpen, Northumberland with the hafting plate shown below. The left rivet hole shows a clear obtuse shear. The dirk is in excellent condition, free from damage save the single shear on the hafting plate. Burgess and Gerloff 1981 Plate 26, no. 195.*

A rarer Scottish example is the dirk from Monybachach, Kintyre (Kelvingrove Museum) (Figures 4.10 and 4.11), which was recovered in 1988 during an excavation of three cist burials, and was found in association with a jet spacer plate necklace and six stone flakes (the human remains had decayed away in the acidic soil) (GMRC catalogue 1988). Pre-conservation photographs show a clear obtuse shear to the empty rivet hole. It is very likely that there is also an acute shear in the second rivet hole, given the angular flake of metal that has broken off the hafting plate (visible on the photograph below in Figure 4.10); however, as the rivet remains in situ in the photograph, the hypothesised acute shear is listed as possible, not clear.

Figure 4.10 *– Archive image of the hafting plate on the Monybachach dirk, prior to conservation. The obtuse shear is visible on the bottom rivet hole; the upper, with the rivet in situ and the accompanying flake of broken metal, is a conjectured acute shear. The dirk has since been cleaned and is currently on display in Kelvingrove Museum. ©CSG CIC Glasgow Museums Collection.*

Figure 4.11 *– Archive image of the Monybachach dirk. Even pre-conservation, it can be seen that the dirk is in excellent condition, which supports the interpretation that the hafting plate damage is the result of unusual stress. ©CSG CIC Glasgow Museums Collection.*

“Possible” obtuse shearing damage is ascribed with the same stipulations as possible acute shearing: where the artefact is in very poor condition, casting doubt on the intentionality of the rivet hole damage; where the terminal ends have rounded with taphonomic wear; and where the shearing damage to the holes is accompanied by non-characteristic damage such as folding, metal distortion or pitting. An example of a possible acute shear with accompanying non-characteristic damage was given in Section 4.1.1 from a dirk from the Talaton hoard; here is shown an example of a possible obtuse shear, uncertainty because of the extremely poor preservation of the artefact. The dirk (Figure 4.12) was also part of the Talaton hoard in Devon (Royal Albert Memorial Museum and Art Gallery, Exeter acc. 315) (Burgess and Gerloff 1981 Plate 54, no. 414), and so can be compared with the above-mentioned rapier (see Figure 4.4). As shown below, the long dirk (or short rapier) is in very poor condition, with heavy pitting and edge damage, and extensive material loss to the hafting plate. Regardless, both of the rivet holes show indications of obtuse or horizontal shears – however, the poor condition of the artefact precludes a conclusive identification.

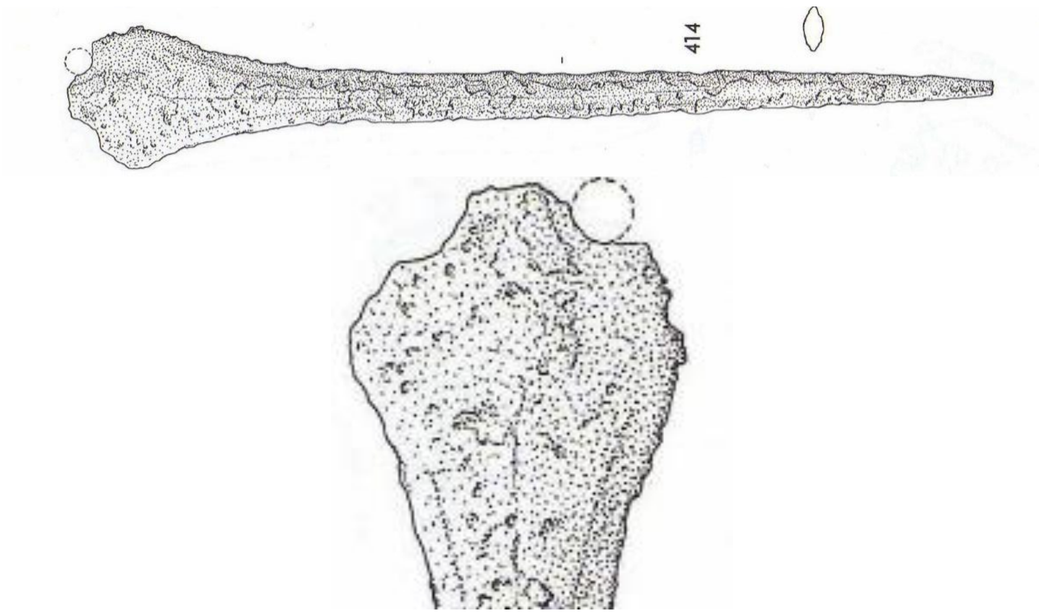

Figure 4.12 *– One of the dirks from the Talaton hoard, Devon (see also Figure 4.5), with the hafting plate shown in more detail below. The dirk is in very poor condition, with heavy pitting all over its surface and notable edge damage. Using the reconstruction hypothesised by Burgess and Gerloff in the illustration, possible horizontal or obtuse shears can be inferred on both rivet holes. However, the poor condition of the blade precludes further interpretation. Burgess and Gerloff 1981 Plate 54, no. 414.*

4.1.3 Examples of Horizontal Shears

Horizontal shearing results in significant damage to the rivet hole, leaving less than half of the hole’s circumference intact (see Figure 2.9). A horizontal shear results in the loss of the rivet, rendering the dirk/rapier non-functional. Horizontal shearing is the most common type of damage observed in the select catalogue, and there is also a high incidence of clear horizontal shears (see Table 4.5).

There are numerous examples of dirks and rapiers displaying horizontal shears. For instance, both rivet holes on the rapier from Keelogue Ford, Co. Galway, show clear horizontal shearing (National Museum of Ireland acc. W 117) (Burgess and Gerloff 1981 Plate 69, no. 528) (Figure 4.13). The rapier is otherwise in good condition – there is a small area of pitting on the lower half of the blade itself, consistent with its deposition in the River Shannon. This does not, however, undermine the stress-induced fracture interpretation.

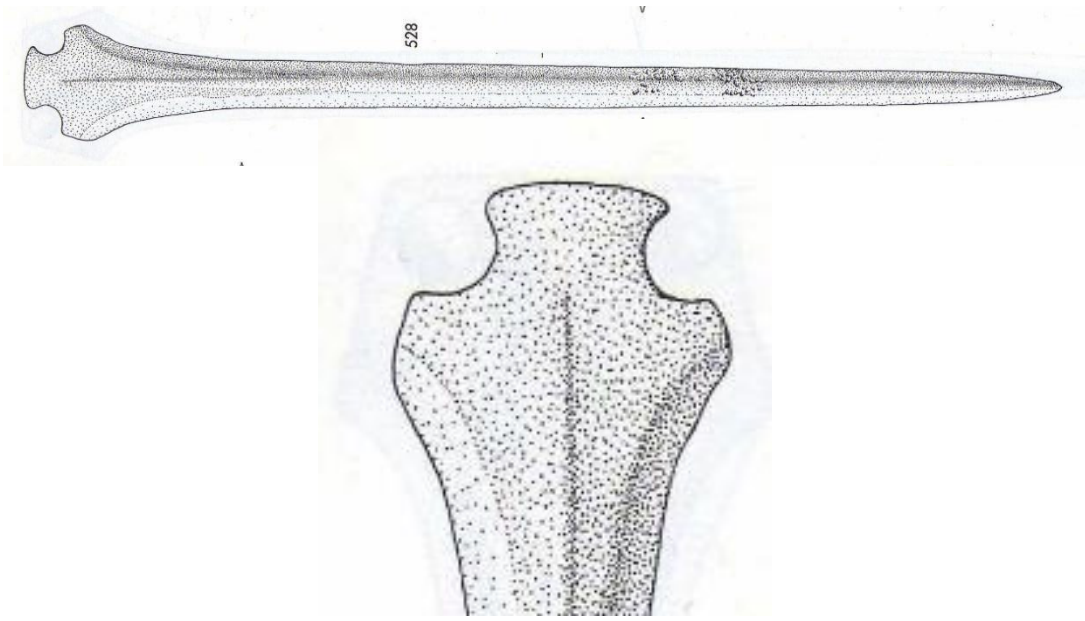

Figure 4.13 *– The Type Cloontia short rapier (or long dirk) from Keelogue Ford, with the hafting plate enlarged below. The illustrator[s] have reconstructed the original outline, shown faintly around the edges of the extant hafting plate, based on well-preserved rapiers of the same type. Both rivet holes show clear horizontal shears. Burgess and Gerloff 1981 Plate 69, no. 528.*

A dirk from Morebattle, Roxburghshire (NMS acc. DJ 28) (Burgess and Gerloff 1981 Plate 67, no. 541) provides one example from Scotland (Figure 4.14). The dirk blade itself shows a very uneven profile, indicating either a poor-quality mould or cast or, more likely, substantial material loss. The blade surface is quite pitted, and it appears that much of the hafting plate material is also missing. However, despite the loss, the two rivets holes both show horizontal shearing damage.

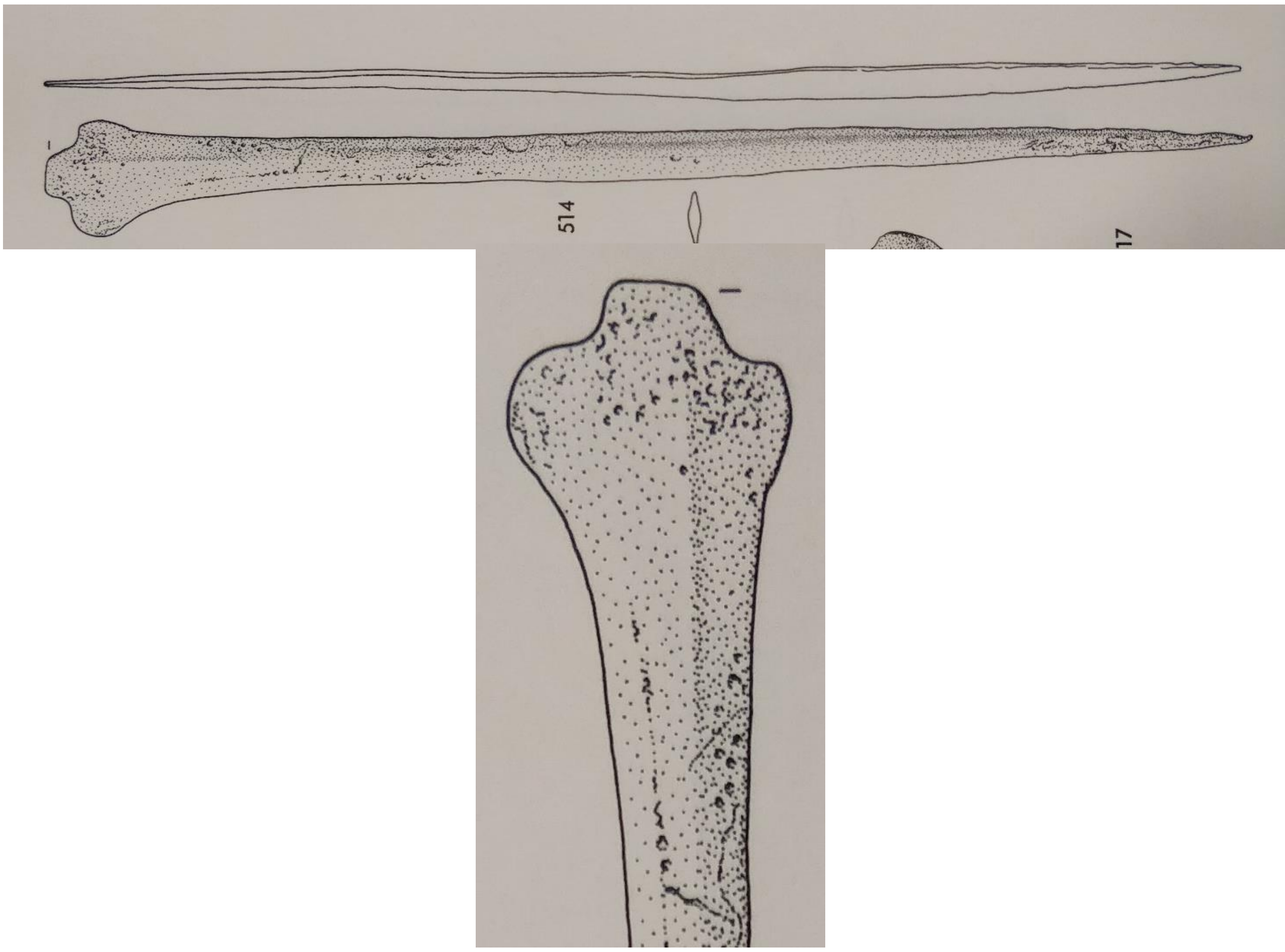

Figure 4.14 *– The Morebattle dirk, with the hafting plate enlarged. Burgess and Gerloff (1981), plate 67 no. 514*

A second Scottish example can be seen on the rapier from Dalbeattie, Kircudbrightshire (British Museum acc. WH 1236) (Burgess and Gerloff 1981 plate 51 no. 394) (Figure 4.15). This long rapier has a very well-preserved blade, displaying minimal pitting and edge damage, and very little material loss. The hafting plate is slightly pitted and both extant rivet holes show clear horizontal shears with very sharp terminals; the notching along the edges of the top of the blade strongly resemble the V-shape notches indicative of intentional damage to the blade (O’Flaherty et al 2011:42; see also the discussion at the end of Section 5.4). Both rivet holes show unequivocal examples of horizontal shearing damage, and the linear fractures aligning in different directions indicate that there were at least two powerful blows enacted with the rapier, resulting in the two episodes of shearing damage.

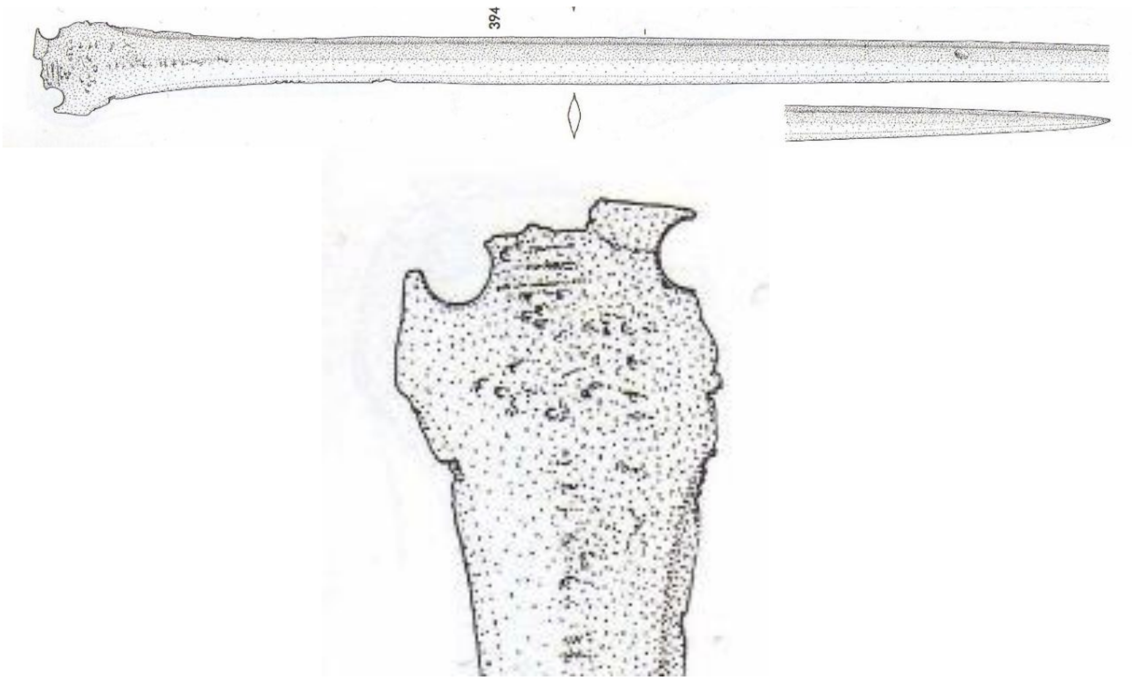

Figure 4.15 – The type-find rapier from Dalbeattie, Kircudbrightshire with the hafting plate enlarged below. Both rivet holes show clear horizontal shears, with sharp terminals and no folding or distortion – despite the relatively poor edge condition of the rest of the rapier. Burgess and Gerloff 1981 plate 51 no. 394.

Horizontal shearing damage is the most extensive (in terms of proportion of damage to blade) type of damage observed in the assemblage; it follows that the blades displaying horizontal shearing are heavily damaged, and also that heavily damaged blades may have poorly-preserved hafting plates. These factors make the ‘possible horizontal shear’ the largest of the six categories of damage described by the select assemblage (see Table 4.5), but also the most problematic in terms of distinguishing between stress-induced fracture damage resulting in a shear, and post-depositional taphonomic processes. The only Scottish dirk showing a possible horizontal shear is a poorly-provenanced blade from Midlothian (NMS acc. DJ 27) (Burgess and Gerloff 1981 Plate 87, no. 674) (Figure 4.16). The dirk is, unusually, in excellent condition, with a fine tapering blade, bevelled edges and an angular hafting plate. The horizontal shearing on both of the rivet holes is not typical of the type – the shear on the left hole has resulted in an unusual angle not seen on other horizontal shears, and the right hole has softened, rounded terminals which could indicate taphonomic wear rather than stress-induced fracturing.

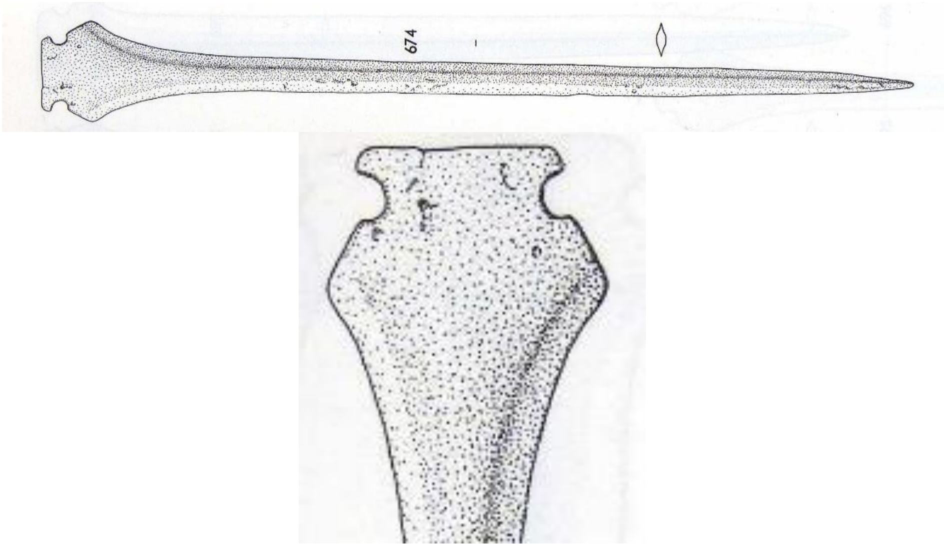

Figure 4.16 *– The long dirk from Midlothian with the hafting plate shown in more detail below. Both of the rivet holes show possible horizontal shears; however, the terminals are rounded and softened, which could indicate that the damage is the result of post-depositional taphonomic wear rather than stress. Burgess and Gerloff 1981 Plate 87, no. 674.*

4.2 Conclusions from the Analysis of the Early/Middle Bronze Age Dirk

Fracturing the replica dirk hafting plate by using it to inflict a powerful overarm blow onto a human skull proxy was not the ideal result predicted for the replica dirk experiment. However, it opened a new and unexpected avenue of research which would not have been possible without the experimental data: comparing prehistoric damage patterns to observed experimental outcomes. The select catalogue described in this chapter represents the range of prehistoric damage across the known dirk assemblage; as noted above, it is estimated that – given the currently available data – approximately 10% of the British dirk assemblage shows clear or possible evidence of shearing damage.

The work in this chapter demonstrates the importance of a reflexive approach to experimental work: an unexpected outcome should be embraced, not lamented, and the research strategy adapted accordingly. It also highlights the importance of gathering primary experimental data when working with a weapon type which has not previously been tested; relying on extant studies could unintentionally close off these potential avenues of specific research. Selecting for specific results, or prioritising one mode of knowledge over another, reflects on individual author bias and limits the audience and, by extension, the applicability of the work to other fields of research (Olesen 2011:129-30), and is not indicative of good science (Arjona and Lennen 2015). It also shows the importance of a robust catalogue for comparative analysis. The select catalogue included in this chapter was never intended to be representative of the dirk assemblage as a whole, only of the dirks showing the characteristic shearing damage that was the focus of this short study, which was appropriate for the study's research aims (Section 4.2). Comparing the experimental and catalogue data has shown that the shearing damage was common on dirks and rapiers in the Early and Middle Bronze Age, but was by no means present on the majority of the blades – 10% of the assemblage indicates that the shearing would have been a known and recognisable issue for the smiths and wielders, but not an especially frequent occurrence. There is no correlation between a specific dirk or rapier type and the shearing damage, nor even a particularly striking pattern when comparing dirks and rapiers themselves (Table 4.5), nor with the diameter of the rivet hole and the shearing. There is an observable increase in the frequency of damaged blades in Groups III and IV; however, the sharp increase in the number of blades showing possible damage in Group III is due to the inclusion of the sub-group 'Weapons with damaged butts' (Burgess and Gerloff 1981:56-9), which account for 13 of the 'possible damage' entries, mostly rapiers. Furthermore, Group IV comprises more than half of the blades catalogued by Burgess and Gerloff (519 of 980 weapons), and – assuming that the 10% estimate of damaged dirks applies across the entire assemblage – will therefore contain the largest proportion of blades showing shearing damage. There are noticeably fewer examples of acute shears, noted in Section 4.1.1: one possible explanation for this could be that a stress-induced fracture creates a linear shear in the hafting plate, making for a much wider gap in the rivet hole than 90°; as observed in the experimental damage on the replica Friarton dirk. An acute shear could be caused either by a less powerful blow, or by the material properties of stronger, less brittle copper blades – it is possible that a lower arsenic content, or a cooler casting temperature, could create more resilient hafting plates and smaller shears. Further experimental work would be required to test this hypothesis. Based on this short study, I suggest that the shearing damage is not caused by a design or manufacturing flaw in the dirks, but rather is an issue of softer copper being unable to withstand powerful blows, regardless of the shape or weight of the blade. This would account for the presence of damaged blades across the whole assemblage, as well as the lack of observable patterns in sub-types, weights, shapes, rivet hole diameter, deposition patterns etc. Further work could be undertaken to test this theory: a wider range of replica dirks could be used to establish the importance of arsenical copper, or inclusions such as lead or tin to make bronze. X-Ray Fluorescence (XRF) testing could be done on the prehistoric blades to establish whether there is a correlation between composition and damage; this would of course have to include testing the undamaged blades as well. For instance, copper and bronze develop similar post-depositional patinas, making it difficult to distinguish between prehistoric bronze and copper artefacts; it can also be difficult to distinguish between tin-copper bronze, and copper which has be tinned on the surface to make it shiny (Nicholas and Manti 2014:2) XRF testing would indicate whether an object is made from copper, or copper alloy. This would be significant because the addition of tin makes bronze significantly harder and more durable than copper, and would therefore presumably show a different, less extensive range of damages; establishing a correlation between known bronze objects and specific damage types may help in identifying other bronze artefacts without the need to XRF test entire assemblages; patterns of distribution could also be inferred, as could networks of trade and exchange.

The comparative analysis of the Early and Middle Bronze Age dirks described in this and the previous chapter was never intended to be the final word on the subject. As well as demonstrating the frequency of stress-induced shearing in the prehistoric assemblage, the comparative analysis also allowed for the testing and refining of research techniques which will feature in the second part of this thesis: the study of the Early Bronze Age halberd. The experimental tests with the replica dirk established the validity of experimental weapons testing, as well as providing an excellent opportunity to test the human tissue proxies, laboratory space, general set-up of the trials, and the feasibility of opening the tests up to an audience. Issues with the replica weapon itself could be addressed – such as the soft wood used to haft the dirk blade by the smith, Neil Burridge, which could be replaced with a harder wood for the halberd handle. The select catalogue of damaged dirks used in this chapter, although suited to the narrowly-focussed research aims specific to this smaller study, would not be an appropriate model for the halberd catalogue discussed in the next chapter. Because the results of experimental weapons tests cannot be confidently guessed beforehand (as demonstrated by the sheared replica dirk), the halberd catalogue needs to be as comprehensive, accurate, and reliable as possible. The methods used for its construction are therefore very different to the approach taken in this chapter, and are discussed further in Section 5.1.

To summarise, the data collected in this chapter demonstrates that the dirks and rapiers of Early and Middle Bronze Age Britain were frequently but not overwhelmingly used to inflict powerful blows onto a hard surface, possibly (but not necessarily) dense bone. Dirks that were damaged in this way were not repaired, but were deposited in the earth, rivers, lochs, and burials with the shears intact, although the wooden haft may have been repaired so that the damage to the underlying metal was not so obvious to an observer. The work in this chapter also provided valuable experience in the issues and challenges in designing and performing the larger replica experiments, and constructing the catalogue for the Scottish halberd assemblage, which form the rest of this thesis and provides the bulk of the data for the novel interpretative model proposed in Chapter 9. The importance of a secure, accurate and representative dataset based on reflexive collection methods has been demonstrated here; it will therefore be the primary focus of the halberd catalogue construction detailed in the following chapter.

Chapter 5 – Constructing the Halberd Catalogue

With regard to the Scottish halberds, two things became immediately apparent upon review of the literature review. Firstly, the lack of a comprehensive, accurate and up-to-date catalogue was hindering Scottish halberd studies (last recorded by Coles 1968-9 and Schmidt and Burgess 1981, compared to the more recent work in Iberia in Brandherm 2003). Secondly, the research gap between artefact studies and work on modelling, interpretation, and hypotheses persists, despite recent work by O'Flaherty (2002, 2007) and Dolfini (2011). No analysis has been published on the Scottish halberds since their previous cataloguing by Schmidt and Burgess (1981), save for the short paper reprovenancing the Poltalloch halberd to the Channel Islands (O'Connor et al 2009). This has led to a preponderance of the top-down paradigm, wherein theories are formulated and the supporting artefactual evidence then found, rather than theory developing from a close analysis of the artefacts themselves (see, as one example from many, Kristiansen (1999), where the presupposition of a warrior aristocracy leads to the association of specific weapons and grave goods not otherwise connected geographically or typologically, and the many artefacts and sites which are not explained in the model are ignored and/or dismissed).

A focus on detail and the primary utilisation of objective evidence are two of the basic tenets of feminist theory which apply to archaeology (Rubio 2011:24), being mindful of the questions asked and data collected, so as to avoid the pitfalls of the culture-history paradigm of the last century (Shennan 2000). Shennan made the case for a return to Victorian values – specifically, to the values of Sherlock Holmes. Fahlander (2013:638) identifies the problems with cultural and regional history models as resulting from the forced application of models derived from the top-down approach, much as Inspector Lestrade approaches a crime scene. Fahlander (2013) argues instead for a renewed focus on artefacts, clear communication in recording and publishing data, and the bottom-up approach, much as Sherlock Holmes approaches a case - and with significantly higher success rates than his top-down paradigm colleague Lestrade. Consider the following from *A Study in Scarlet*, originally published in 1887.

> "“You don't seem to give much thought to the matter in hand,” I said at last, interrupting Holmes's musical disquisition.
> “No data yet,” he answered. “It is a capital mistake to theorize before you have all the evidence. It biases the judgement.””

Conan Doyle 2009:27

The bottom-up approach proposed by Fahlander (2012:147) has been successfully applied to skeletal remains, where each individual body was considered separately in order to examine the intersectionality between the body, material culture and prehistoric ideology. (Applying it to the weapon assemblage not only allows for both a feminist and queer reading of the artefacts, but also enables a more reliable, robust and innovative set of interpretations.

As such, one of the primary goals of this study was to construct an accurate and coherent catalogue of all Scottish halberds, in order to avoid making mistakes in interpretations based on inaccurate published (or unpublished) data. In addition, this catalogue addresses the lack of a comprehensive study on the Scottish halberds, and fulfils the Scottish Archaeological Research Framework (hereafter ScARF) research recommendations 1.4:1 and 2 for one specific grouping within the metal assemblage.

1.4.1. " Further work is required on intellectual history and the provenance of the artefacts to provide the historical context to archaeological understanding for this period";

1.4.2. "Archival material, whether antiquarian, scientific (e.g. SEM) or previously sliced up artefacts, constitutes a valuable resource that would benefit from reanalysis." [14]

5.1 Methodology

O'Flaherty's doctoral thesis (2002) was largely based on his analysis of all extant Irish halberds, which he had [re-]recorded at the beginning of his research. This involved visiting various museums and collections across Ireland and recording the halberds onto a standardised form, as well as taking high-resolution photographs. From this, he was able to confirm the applicability of Harbison's (1969) typology of these implements, and offered a theoretical fifth halberd type specific to Ireland; these consisted of comparatively slender, sharp-pointed halberds with very wide midribs occupying more than 50% of the total blade width (O'Flaherty 2002:87). He also devised a basic but effective metric: by dividing the length of the blade by its thickness, a measurement

[14] All recommendations from the Scottish Archaeological Research Framework, www.scottishheritagehub.com/content/scarf-bronze-age-panel-report

O'Flaherty (2008) termed 'stoutness' is derived which helped to differentiate between Harbison's (1969) four types. By re-recording the halberds onto a standardised form, clear comparisons could be drawn and the existence of the theoretical fifth type could be proposed and supported by the data. As such, his cataloguing methodology was effective and was therefore the framework upon which the Scottish halberd recording methodology was based.

The information fields in the Scottish halberd catalogue were designed with several fundamental guiding principles, each of which are discussed in their relevant sections. These are: comprehensiveness; accuracy; reliability; accessibility; and objectivity.

5.2 Comprehensiveness

As it is intended to form the backbone of a large section of this thesis, the catalogue must be as comprehensive as possible. Though initially intended to cover the Scottish halberds only, the writer judged it was important that the catalogue includes all accessible British halberds – as a comparison, O'Flaherty (2002) covered the sizeable Irish assemblage. The Scottish work could be undertaken fairly straightforwardly because there are surprisingly few English and Welsh halberds and the majority of the blades are held in the national museums, making access relatively straightforward. Having Welsh and English halberds to compare to the Scottish set provides a counterpoint to perspectives dominated by Irish comparanda (such as Schuhmacher (2002)) and offsets the abundance of Irish blades. Two halberds from Wales, held in small local museums (Carmarthen and Caernarvon) proved difficult to access: as Needham (forthcoming) includes these in his Welsh halberd catalogue, it was not felt necessary to include them in this study, as the six halberds in the Amgueddfa Cymru / National Museum of Wales, Cardiff, provided sufficient data for the purpose of this thesis.

Similarly, several Scottish halberds are held in small museums now operating under recent budgetary constraints rendering their collections difficult to access as a consequence; the Marischal college collection in Aberdeen, for instance, has largely been put into storage and the reduction of curatorial staff means access is restricted by their availability (Shona Elliot, pers. comm). Where access to the halberds has proved impossible due to time and resource constraints, or by the museum collections being held in central closed storage during museum refurbishment, staff have provided detailed images and measurements. The six halberds recorded by their relevant curators are:

- Halberds 1880.3 and 1880.4, both in Dunrobin Castle Museum, Sutherland.

- Halberd A.1962.3 from Kelvingrove Museum, currently held by Glasgow Museums Resource Centre (GMRC), Glasgow

- Halberd 1989.206 from the Falconer Museum, Forres

- Halberd ABHER:2017.011 from Banff, currently held by Aberdeenshire County Museum Services (ACMS), Mintlaw. This halberd was subjected to XRF analysis at the University of Edinburgh at a late stage in the PhD programme; the catalogue entry is based on information and photographs provided by ACMS at an earlier date.

- Halberd GLAHM C.1914.320 from the Hunterian Museum, Glasgow.

Time and resource constraints prohibited the production of hand-drawn ink illustrations of each halberd as part of the procedures undertaken in compiling the new catalogue, as is usual for cataloguing (Burgess and Gerloff 1981). The Trecastell halberd was illustrated beautifully in full colour by T. Daly (Needham et al 2015:6); during the cataloguing visit to AC/NMW, the author met Mr Daly and discussed the time and resources required to produce such high-quality illustrations: it took him several weeks to produce the Trecastell image, following several years of archaeological illustration training. This was clearly not feasible for this thesis: instead, high-resolution digital photographs were taken of each blade, covering both faces, surviving rivets and, where appropriate, a profile shot. Line drawings were also made, using these photographs and Adobe Illustrator, to supplement the plates. The author considers that the use of well-lit digital photographs of the halberds, supplemented by basic line drawings, is preferable to the graphic convention of using illustrations only (as with the *Prähistoriche Bronzefunde* series, hereafter PBF) as it reduces the element of unconscious bias in the catalogue, further discussed in Section 5.6.

Each blade was weighed, and measurements were made using RSO Pro 160mm Spring calipers across every area of the blade (Figure 5.1) not just length (as is the case with the PBF catalogue (Harbison 1969)). The Scottish halberds have been noted as being narrower and lighter than their Irish counterparts (Coles 1968-9), so taking more detailed measurements allowed a greater degree of comparison with the other Scottish blades, as well as with the other European examples. It also meant that any halberds fitting O'Flaherty's theoretical fifth type, with its unusually wide midrib, could be identified (O'Flaherty (2002)). A freehand sketch was made to record surviving rivets, areas of intentional damage, decoration and any other distinguishing feature. Traces of decoration, areas of damage, the presence of corroded bevelled edges and evidence of re-sharpening were identified using microscopy where available, or a high-power magnifying glass where microscopes were not kept by the museum.

5.3 Accuracy

All measurements were taken with the same sets of plastic-tipped digital callipers – one Vernier and one outside set. Both sets of callipers were re-calibrated before each halberd was recorded. As noted above, measurements were taken from the same points on each halberd to maintain continuity and allow accurate comparisons. Weights were taken using each museum's own scales, as scales accurate to two decimal places do not travel well; zero-error calibrations were made on each scale using 100g and 500g weights prior to their use. Photographs were taken in the best available light, using lamps and spotlights where available, and cover both faces of the halberds because corrosion levels are often different, especially on blades recovered from hoards. The line drawings were developed in Adobe Illustrator using the measurements, photographs, and scale-drawings made on site using graph paper.

5.4 Reliability and Standardisation

All weights are recorded in grams and all measurements are in millimetres. All photographs were taken with a 10cm scale bar for reference; the exceptions being any close-up photographs of rivets and areas of damage, which have a 5cm or 2cm bar, clearly labelled, as appropriate. All line drawings have a 10cm bar.

In order to facilitate repetition or testing of the data at a future date, all of the data was collected using a standardised methodology. A copy of the form below was used to record each halberd, regardless of any previous cataloguing or publication. A quick sketch can be made (top right box) and is intended for reference and for noting areas of specific interest, such as visible notching or significant corrosion, and for noting the numbering system used for any rivet holes present.

Accession number ________________

Museum ________________________

Date accessed ___________________

Type (Harbison) __________________

Single/hoard _____________________

NGR/provenance _________________

____

Context_________________________

____

Material (if known) _______________

Image, showing damage, re-sharpening and rivets

BLADE

Weight _________________________

Length ___________ (blade)______ (h.p) ______ Width _______ Thickness _____

Midrib width _______ length________ Point _______ Stoutness (l/t)_____________

Edge condition: ___________ Impacts: _______________ Sharpened? __________

Heft (w/l) ____________ Condition _____________________________________

Decoration ____

HAFTING PLATE

Shape _____________ Width________ Thickness__________

Rivet holes: _____ d______ Arranged___________ Condition_________________

Rivets in situ: ______ Overall L________ Stud L_______ Stud d.___ Head d.______

Any further comments

Each measurement and weight was double-checked by the writer at the time of recording. Specific measurements (in bold) were taken at the same point on each halberd, detailed on the diagram below. The width was measured where the midrib began, and the hafting plate width at the widest point of the whole halberd.

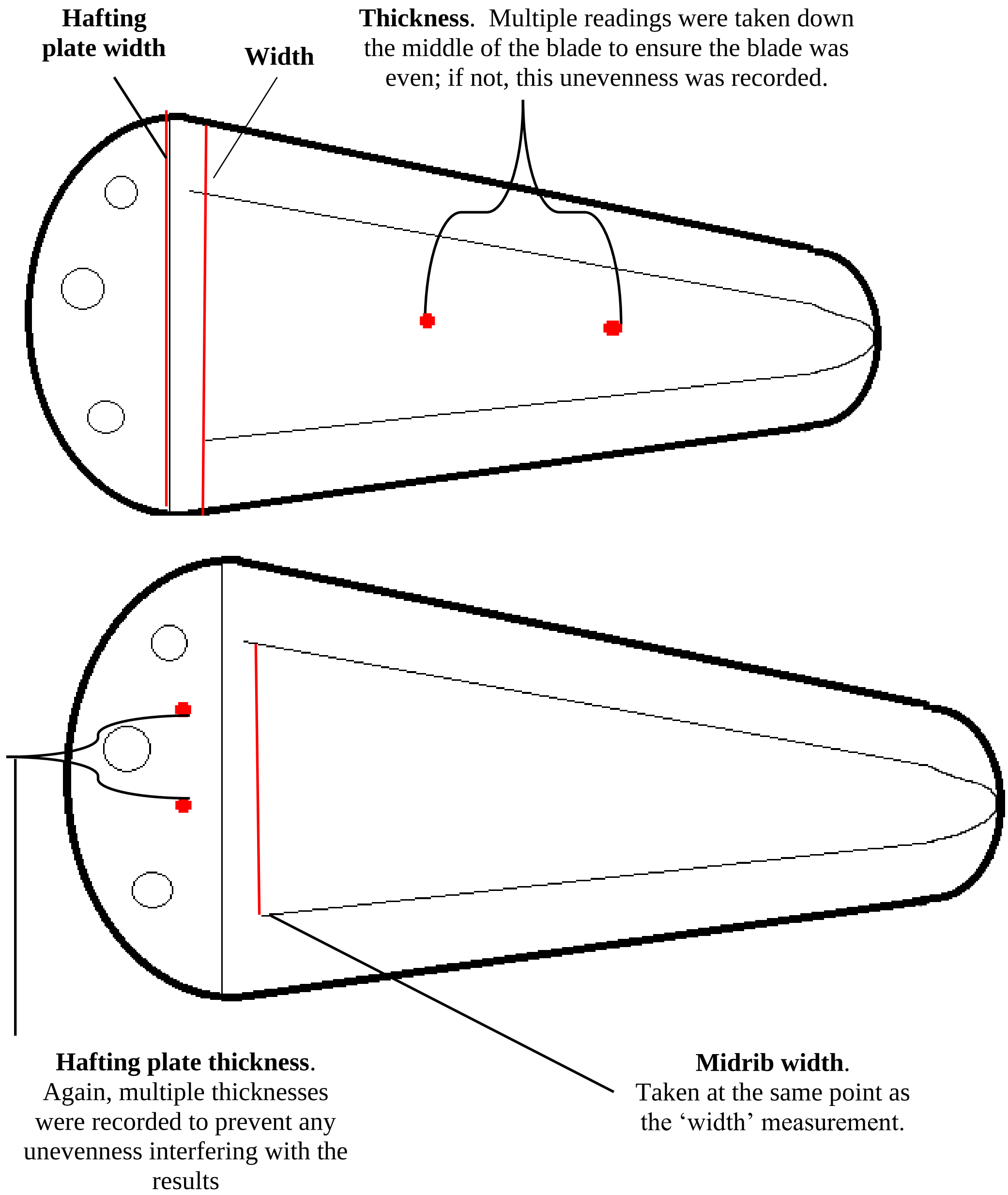

***Figure 5.1** – Diagram of the terms used in the descriptions of halberds in this thesis, and of the specific areas of the halberds which were recorded (red lines).*

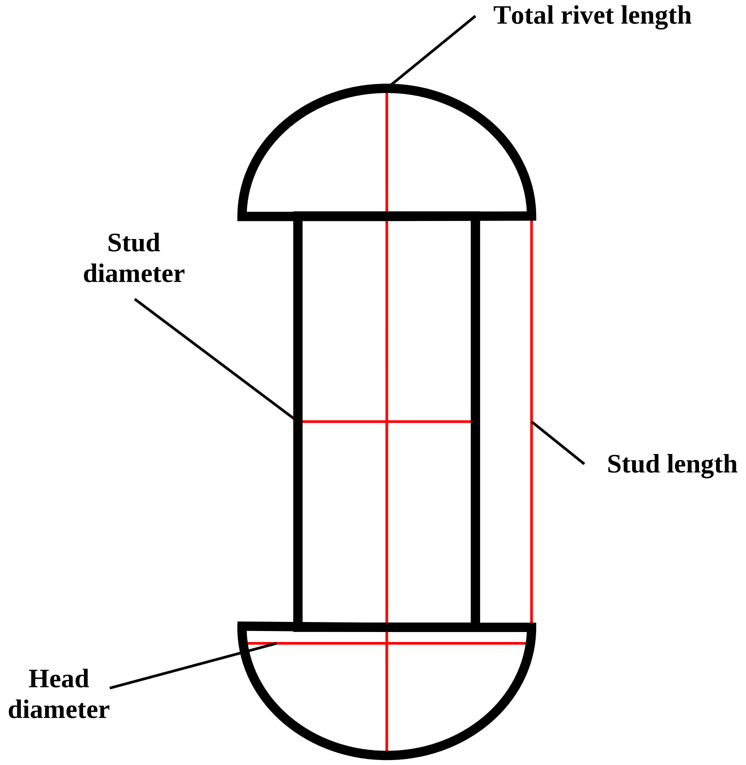

Figure 5.2 *– Diagram of the terms used in this chapter, and of the specific areas of the in situ rivets which were recorded (where possible) (red lines), ensuring a consistency of data recording across the assemblage, and to facilitate future methodological replication or adaption.*

Rivets were also extensively recorded. Some rivets were deformed in such a way, or in such poor condition, so as to preclude the measurement of the stud length and/or diameter. In these cases, a note has been made on the relevant record.

The blade width measurements were taken at the same point on every halberd, where the midrib began. Where the midrib began higher on one edge than the other, the point closest to the hafting plate was used. O'Flaherty (2002) posited that a subset of the Irish halberds displayed an abnormally wide midrib, which occupied more than a third of the total blade width. A further measurement was therefore included to assess the width of the midrib compared to the total blade width. To achieve this, the midrib and blade widths were compared and the ratio of one to the other converted into a percentage, calculated accordingly [(midrib width / width) x100]. A small number of halberds display flared midribs, which occupy a greater proportion of the blade width at the widest point of the blade than the other point. A single entry for proportion of the blade occupied by the midrib would therefore be misleading, and the mean proportion derived from two measurements would not be accurate (see Figure 5.1; multiple width measurements were taken for the halberd in Figure 5.3, for instance, which displays a pronounced flair at the plate-end of the midrib). In these cases, the midrib and blade widths were re-measured at a minimum of one other point on the blade's length, usually half-way down the extant blade, and the percentage again calculated; if these differed significantly from the initial calculation, the difference was recorded in the 'Any Other Comments' section.

Figure 5.3 *– Halberd 22.178 from Pontrhydygroes, Ysbyty Ystwyth, Ceredigion, held by the National Museum of Wales. The midrib has a pronounced flare (white bracket), where it goes from occupying 37% to 72% of the total blade width. © NMW.*

O'Flaherty's (2002:86-9) proposed 'stoutness' value, relating the length of the blade to its thickness, was recorded for each halberd and to help to establish whether Harbison's (1969) typology could be supported using this value. The Irish types fell into four distinct groups based on their stoutness value; these accorded neatly with Harbison's (1969) four categories (O'Flaherty 2002:89). Given that Harbison's (1969) categories were not as applicable to many of the Scottish halberds, using the stoutness value could aid in typing some of the halberds which were more difficult to classify.

A second value was also included, called 'heft', which relates the weight of the blade to its length. Upon initial examination of the halberds held by the British Museum (whose stores were the first ones visited as part of this project), it became apparent that some of the Scottish halberds felt much heavier and more unbalanced in the hand than their Irish counterparts. Dividing the weight of a halberd by its length produces a quantifiable number that could then be used to compare the relative heft of a blade, rather than the very woolly and unscientific method of going by feel. This did not involve taking any additional measurements, only dividing the weight by the length, and the value calculated helped to demonstrate the range in robustness in the blades.

As noted in Section 5.2, the photographic record minimises the human error encountered in illustration; this was of particular importance to this study, because much of the subsequent interpretation and modelling relies heavily on accurate records and detailed artefactual analysis. Accurate photographs and simple line drawings were of particular importance as there was neither time nor money to undertake advanced training in traditional archaeological illustration; furthermore, many of the halberds have already been illustrated in the PBF series (Harbison 1969).

It was often difficult to ascertain whether individual halberds had been sharpened, but attempts were made to discern this for every blade. Where possible, close analysis of the blade edges using microscopes was undertaken; otherwise, a magnifying glass had to suffice. The physical evidence for re-sharpening presents as very small, very fine scratches running towards the blade edge at a slight angle, and not distributed parallel to the halberd edges or the midrib. Parallel scratches are considered to be indicative of polishing the finished blade or of post-recovery cleaning, and not of re-sharpening (Dolfini 2011); experiments have shown that grinding and polishing leave a distinctive pattern of scratches and striations running parallel to the blade's edge, whereas sharpening results in tight clusters of short lines along the edge of the blade (Dolfini 2011:1038).

Evidence for re-purposing or repairing the blade presents as joint marks, where the blade has had a small section of metal replaced and its intersection with the original blade is apparent as an irregular trace in the metal surface – usually the tip – or as irregular hairline seals, where the blade has been heated and hammered to seal cracks (Dolfini 2011:1038). This level of analysis was only possible where the blades had not been cleaned post-recovery; certain visible evidence for repairs to the blade sometimes survives cleaning, but the overlaying scratches can cause confusion, so extra care was taken in these cases. Furthermore, not every museum had microscopes available for use; only the National Museums of Scotland and Wales had microscopes available where the halberds were stored. In the other museums, a powerful magnifying glass (×15-×20 magnification) was used, but this was obviously less suitable for the task and more reliant on external light conditions than microscopy. Recording erred on the side of dismissing questionable evidence as taphonomic, rather than assuming repairs and re-sharpening had taken place if the evidence was less than convincing, particularly given the extremely poor state of preservation of most of the halberds.

Microscopy was also used to check the halberd blades for evidence of impacts and edge damage. The difference between non-specific post-depositional decay and damage, and intentional damage, can usually be identified using the patina: impacts marked by the same patina as the rest of the blade are generally pre-depositional in origin, whereas impacts with lighter or no patina are taphonomic, either as a result of the deposition matrix or from post-recovery conservation. Furthermore, in the case of intentional damage, the difference between that sustained in combat and deliberate destruction for ritual or other reasons can be investigated. Following experiments by O'Flaherty et al (2011:42), U-shaped impacts are interpreted as combat damage, where this is the product of the halberd being struck by a similar blade when both blades are in motion. V-shaped impacts are interpreted as the result of intentional destructive damage to the blade, where the blade is struck by another blade *when stationary and cushioned*; for instance, if the impacted blade is braced against a rock face. It is hoped that by using the V- and U-shaped terminology, any confusion arising from the difference between 'dents' and 'notches' (the preferred terminology in O'Flaherty et al (2011)) will be avoided.

5.5 Accessibility

The catalogue is presented as a series of data and images. The data are presented as tables so as to minimise uninviting lists of numbers. Each halberd is afforded its own entry, where images and data are presented side-by-side. Unlike the separate description and illustrative plate format favoured throughout PBF monographs (see, for instance, Harbison (1969)), this unified format facilitates readier comparison between halberds and does not require the reader to flit back and forth between sections to examine a single blade. All of the original recording sheets are filed safely with the author and are available for cross-referencing, if required; they will also be deposited with the Archaeological Data Service (ADS) and the University of Edinburgh library. Furthermore, the raw data has been tabulated onto a spreadsheet included at the end of this thesis on a USB. It is hoped that the catalogue might be made available for publication after it has been presented at *viva*.

5.6 Objectivity

The essential principle of queer theory in archaeology is to recognise and minimise bias wherever possible (Rubio 2011:24). This is manifested in several ways in the catalogue development.

The standardised recording sheet (Section 5.4) ensures that the same data are recorded for every halberd, ensuring that well-preserved or unusual blades are not given undue prominence or more damaged blades are overlooked. Similarly, the photographs were taken according to a template: both faces of the halberd were recorded, followed by the hafting plate if it was unusual or particularly damaged, and then a profile view of any surviving rivets. Consistency across the record helps to minimise the impact of author bias, as also discussed in relation to accuracy.

The amount and detail of information as to a halberd's recovery varied from artefact to artefact, depending on the time and circumstance of discovery and acquisition by the museum. Where possible, museum holdings were consulted in order to ascertain the circumstances of the find, and any information about the weapon's post-recovery biography, such as ownership, any abrasive cleaning, or invasive diagnostic work such as compositional analysis, was recorded onto the sheet. These data were then sought on the halberd itself, such as examining the edges with a magnifying glass or microscope to look for evidence of sharpening.

The existing catalogue and/or museum holding information also included whether a halberd was recorded with a hoard association, and whether that association was presumed or in doubt. This too could be sought on the halberd itself. A hoard association was supported using corrosion pattern analysis: copper and bronze corrode when exposed to water in soil; therefore, a blade with heavy corrosion on one face and little corrosion on the other face has been protected, to an extent, from contact with the waterlogged soil. This protection could have been from a rock face or a root system, or an organic covering such as a bag or box, so markedly uneven corrosion does not automatically imply association in a hoard with other copper alloy objects. However, there are a handful of occasions where corrosion patterns on separate blades match, strongly indicating that the objects displaying these similarities had spent a long period together underground; it does not, however, preclude multiple deposition events, where the hoard accrues over time rather than by all of the associated objects being deposited simultaneously. For instance, the Castell Coch hoard from Cardiff contains a halberd which shows clear corrosion patterns, where the area protected from the water by overlaid objects is much less corroded than the exposed metal above it (Figure 5.4).

Figure 5.4 *– Halberd 84.83H.2 from Castell Coch, Cardiff, held by Amgueddfa Cymru/ National Museum of Wales. The lower area of blade was protected by the second halberd in the hoard, and is in much better condition that the upper section which was exposed to the soil (white dotted line) . © AC/NMW..*

5.7 Typology

The typology used for basic reference is Harbison's (1969) four-type system based on Irish type finds; see Section 2.7.3 for a full explanation. They are briefly recapped here:

Type Carn: asymmetrical, copper, rounded hafting-plate, three rivets in a triangle formation

Type Cotton: asymmetrical, copper, bevelled edges and two grooves on each edge, three rivets in a triangle formation

Type Clonard: short blade, copper, squared and shouldered hafting plate, four rivets in a square formation

Type Breaghwy: symmetrical bronze blade, bevelled edges, squared and shouldered hafting plate, minimum of three rivets (usually more) arranged in an arc formation

O'Flaherty's proposed fifth type (2002), a narrow blade with an unusually wide midrib (>50% of the total blade width) which was repeatedly noted in the Irish assemblage, was also found within the Scottish assemblage and noted accordingly as **O'Flaherty Theoretical**. Although proposed almost two decades ago and upheld by some of the Irish halberds, his fifth type has not been widely sought after in subsequent European work (eg. Brandherm 2003).

Based on analysis of the halberds from Scotland, Wales and England, a sixth theoretical type is proposed in addition to Harbison's (1969) four established types and O'Flaherty's (2002) further proposed Irish type. This type (termed Group Tom na Brataich and discussed in greater detail in Section 8.7; see also Figure 8.20)is characterised by a heavily modified hafting plate, one which could not support the blade upon hafting and has rendered the halberd unfit for offensive wielding. Often, though not always, halberds in this category can be identified due to their being almost textbook Type Breaghwy except for their unusual hafting plates; their heft values are also often unusual, averaging 1.07 compared to the overall average of 1.21; of the 19 Group Tom na Brataich halberds, five have heft values of <1.0. The material loss from the damaged hafting plate skews the weight measurement and subsequently derived values. It could therefore be considered a secondary modification of Type Breaghwy, but I would disagree: although in many cases the modification has rendered it difficult to type the halberds, there are at least two that are more similar to Type Carn than Breaghwy (NMS X. DJ 10 from Langalbuinoch, Bute, and NMS X. DJ 13 from Lanarkshire; one of the Auchingoul halberds, NMS X. DJ 35, could also have been a Type Carn). Halberds with complete but unbored hafting plates are also included in this theoretical category. This new type is noted here for clarity; it is discussed and justified in much greater detail in Section 8.7 following the analyses of the experimental and catalogue data for the halberd assemblage.

The Bronze Age in particular has a wealth of catalogues, ceramic and lithic as well as metal, and even an artefact so restricted in spatial and temporal range as the halberd has a variety of catalogues and typologies (Irish halberd types were distinguished by O'Riordain (1936); Harbison (1969); central European by Brandherm (2003 and 2004); Brandherm's works also include catalogues, along with Coles (1968-9), Schmidt and Burgess (1981) (both of the Scottish halberds); O'Flaherty (2002) (Ireland), with a recent Iberian catalogue from Risch et al (2017)). Indeed, a newly-proposed typology covering the Welsh halberd assemblage was published during this project (Needham et al 2015).

However, there is very little discussion as to what the typologies actually mean; the PBF is a towering work, but there is very little, if any, discussion outside of the introductions to the typologies (e.g. Burgess and Gerloff 1981:1-4). Sørenson (2015) summarises her response to the plethora of cataloguing and relative dearth of analysis:

> "I question whether 'applying typologies' has simply become a matter of identifying similarities and differences without reflecting on why this matters and in which ways it matters, and why we select these rather than other similarities and differences. Has typology become a trope, in the sense of a commonly recurring device, a cliché, but lost its power as a tool to think with?"
>
> Sørenson 2015:85

She also notes the implicit assumption of relatedness when order is imposed, particularly in Bronze Age studies where there are so many catalogues and typologies, and the lack of reflective analysis as to why we arrange and present data the way we do (Sørenson 2015:88). By examining our first principles and the fundamentals of catalogue construction, we can not only avoid adding yet another uncritical artefact list to the growing body of catalogue literature, but could also discover different research paths or analytical aspects within our own work; in essence, the aims of a queer archaeology and fully in line with the objective, non-normative research aims built into this project. This is discussed further in Section 5.10.

5.8 Rivet Hole Recording

Damage to rivet holes was assessed on the five-point scale established by O'Flaherty in his thesis (2002:146-7), where 0 is an intact hole and 4 is the barest impression of a hole; . This has recently been applied to a wider selection of BA metalwork and proven effective (Knight 2020), and will therefore only be augmented by the addition of a sixth category required by the Scottish halberd assemblage, where the rivet hole has been incompletely punched.

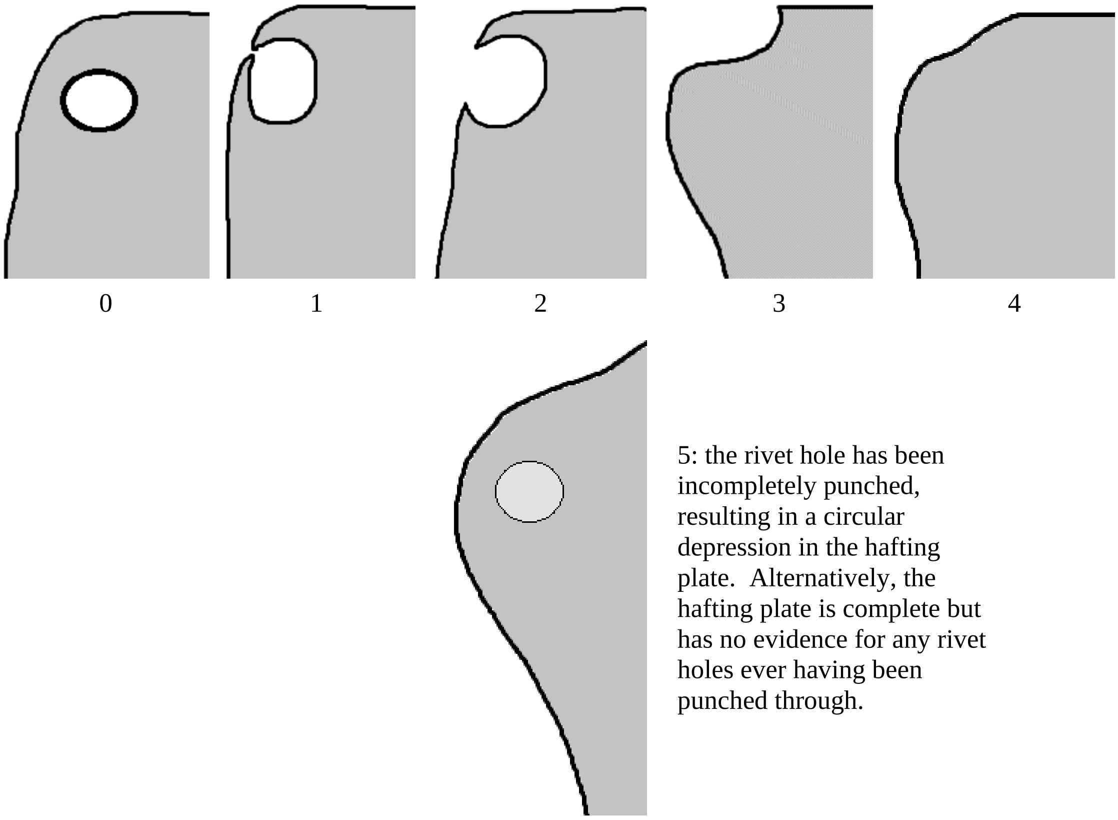

Figure 5.5 *– Scale for assessing damage to rivet holes. Adapted by the author from O'Flaherty's 0-4 scale (2002:146-7) with the addition of #5, which is specific to the Scottish halberds.*

5.9 Locational Information

National Grid References (NGRs) were recorded where possible. Upon the request of various museums[15], NGRs which are known accurately to six or eight figures are referred to in the main body of text here as a maximum of four figures (i.e. accurate to 100m). This is to prevent undesirable investigation of likely hoard sites and destroying the matrices and contexts of any remaining prehistoric metal artefacts; this is also the standard practice of the Treasure Trove team in Scotland, for the same reason (no findspot information is published in the TT reports; see www.treasuretrovescotland.co.uk/reports-and-minutes). The full NGRs are recorded on the database included with this theses, and will be lodged with ADS. The NGRs in the catalogue interspersed with single asterisks (e.g. AB 12* 34*) denote six figure NGRs which have been artificially truncated for publication, and the catalogue NGRs with double asterisks (e.g. AB 12** 34**) denote eight figures which have been redacted. Place-names have been recorded as found in the

[15] Adam Gwilt, Principal Curator of Prehistory at the Amgueddfa Cymru / National Museum of Wales made this request regarding the Welsh halberds; during all subsequent museum visits curators were asked whether they would prefer a 4 figure NGR to be quoted, and all concurred; the records in this project have therefore been adapted accordingly.

museum holdings; the shire or county attributions follow the pre-1975 county divisions, prior to the Local Government (Scotland) Act of 1973.

5.10 Layout

The layout of the catalogue differs from the style of the PBF (Harbison 1969) in a number of ways. As with the PBF, the halberds are presented by type: first Type Carn, followed by Types Cotton, Clonard, and Breaghwy, and then the halberds that do not fit into Harbison's (1969) categories, the Welsh Tonfannau types, and then Group Tom na Brataich, ending with the two halberds which are in such poor condition as to preclude classification. However, unlike the PBF, no consideration is made in regards to geographical find location; rather, halberds are arranged within their type by the clarity or security of the type. This means that the halberds which can be clearly fitted within a type are shown first, to demonstrate what the type 'should' look like; usually, this means the better-preserved halberds (though not necessarily; the Tom na Brataich type find is in poorer condition than the following entry, WG 2061 from Culloden, but demonstrates the type best). These are followed by the halberds which were a little more difficult to categorise, either because of poor preservation, or because the halberd shares features with several types, or is missing key indicators of a specific type. This arrangement was selected for several reasons. Significantly, this method makes space for the halberds which are more difficult to categorise, the blades which show characteristics of several types or none, which can be fitted securely in between types. Listing by find-spot, as with the PBF, would be problematic for several of the Scottish halberds, as they have no secure or specific recorded findspot; NMS X. DJ34, for instance, is from the Borders – possibly. Furthermore, ordering alphabetically by findspot often relies on modern place-names, ignoring any potential similarities in the style, method of manufacture, or suggestion of usage that would not (necessarily) be reflected in the find-spot's geographic location; the type of find-spot, for instance in a river or on a mountaintop, would perhaps relate more to the artefact type, but these factors are not considered when listing alphabetically by place-name, and very often not recorded or known. The catalogue has been laid out as the author judged best to support the work presented in this thesis; prefaced by a full Table of Contents, the halberds can be searched by area as well as Type.

Chapter 6 – An Experimental Investigation into the Efficacy of an Early Bronze Age Halberd as an Offensive Combat Weapon

The catalogue of all of the Scottish halberds created as part of this work (see Appendix 1 and Chapter 5) is itself a useful research tool for wide analyses of the Scottish halberd assemblage as a whole; however, it was never intended to be the sole method of investigation into Early and Middle Bronze Age weaponry in this thesis. Experimental testing with the replica dirk yielded significant empirical data that could be considered against extant catalogue data (see Section 3.2), and the application of a similar methodology to the experimental and catalogue data for the Scottish halberds will be further explored in this chapter.

6.1 Weapon-Inflicted Damage and the Law

Existing studies do not provide an unequivocally coherent or collective methodology, resulting in conclusions of varying replicability and reliability. The most useful studies in terms of replicability or usable methodologies for this project usually relate to medico-legal aspects of trauma, and are strictly governed by the Daubert Standard (in the US) or the Council for the Registration of Forensic Practitioners (CRFP) (in the UK), both of which are frameworks determining whether experimental forensic evidence can be admissible in court. Similar frameworks are in place across Europe.

The most significant existing experimental study as relates for this research is O'Flaherty (2007), on the capabilities of a replica Irish bronze halberd.. O'Flaherty's study (2007: 423) involved the creation of a replica halberd based on an 'average' of 69 Irish Type Cotton halberds from the Early Bronze Age, resulting in a 'typical' Type Cotton halberd representative of the majority (74%) of the Irish halberd assemblage.

***Figure 6.1** – The replica halberd used by O'Flaherty in the trials. Based on a large number of Irish Type Cotton halberds, this replica can be considered as representative of the majority of the Irish halberd assemblage. O'Flaherty (2007:424).*

Hafting the halberd in oak was also a carefully considered choice; the recovery of the halberd from a bog at Carn, County Mayo – the type find for the Type Carn category – is the only published halberd to be recovered with its haft intact in Britain and Ireland (O'Flaherty 2007:424)[16]. The Carn halberd was affixed to an oak haft, and rock-art depictions of halberds from across Europe were consulted in order to determine the length and thickness of the handle. Post-casting treatments such as annealing, cold-hammering, and sharpening were considered but ultimately not enacted, because it would be very difficult to control the extent to which the treatments would affect the blade[17]. Observations on the Scottish halberd assemblage indicate that post-casting treatment varied widely from halberd to halberd, seemingly without reference to the type, size or complexity of the halberd: the large and elaborate Culloden halberd (British Museum WG 2061) has no post-casting treatment at all, whereas the smaller – but no less elaborate – halberd from Tom na Brataich (West Highland Museum WHM1520) shows significant post-casting sharpening and annealing. Both halberds are Group Tom na Brataich and were found within the Highlands, 100km apart – the most direct route being down the natural valley floor containing Loch Ness and Loch Lochy, an easily navigable two-day walk for an able-bodied adult. Therefore, while this approach was suitable for the relatively more uniform Irish halberd assemblage, this would not be an appropriate approach for the replica Scottish halberd experiments.

6.2 Halberd Experiment Methodology

This study will obviously reflect the existing work by O'Flaherty (2007). In his experiment, a replica halberd was designed and created based on a large number of 'typical' Irish halberds, all Type Carn, in order to be as representative of the prehistoric blades as possible. This is not an appropriately reflective method for the Scottish halberds, as will be discussed in Section 6.3.1, but worked well with the Irish assemblage. The

[16] A halberd from the Wales/England border was recovered as a single find from inside a cairn monument as part of a developer-led project. It is Type Breaghwy, made from arsenical copper with three rivets holding its wooden hilt still in situ. Held by the National Museum of Wales/Amgueddfa Cymru at Cardiff, AMS dating and a full analysis are being undertaken by (Needham et al 2015). Until this, the Carn halberd was the only published hafted halberd from Britain and Ireland.

[17] Detailed descriptions of the dis/advantages of post-casting treatments are given in Section 6.3.5

halberd recovered from a bog in Carn, Co. Mayo (the type find for Type Carn) was deposited with its haft intact; the oak shaft was preserved in the bog and remains one of only three halberds found with intact hafts in north-west Europe (see Figure 6.62). The halberd from Altnamacken, Co. Armargh was found in a sticky clay matrix with its wooden haft in situ, but this disintegrated when the halberd was removed from the earth (Flanagan 1966:95, Figure 6.3). The third hafted halberd is the blade from Trecastell, recently published (Needham et al 2015). This small copper Type Breaghwy blade was found with its wooden haft intact, which was analysed and found to be of the family Pomoideae (which includes rowan, pear, maple and hawthorn), and yielded an AMS date of 2700-2200 BCE (Needham et al 2015:8-11). O'Flaherty's (2007) replica was hafted using the Carn halberd as a primary point of reference, augmented by depictions of halberds in rock art across Scotland and Scandinavia (see also Section 6.3).

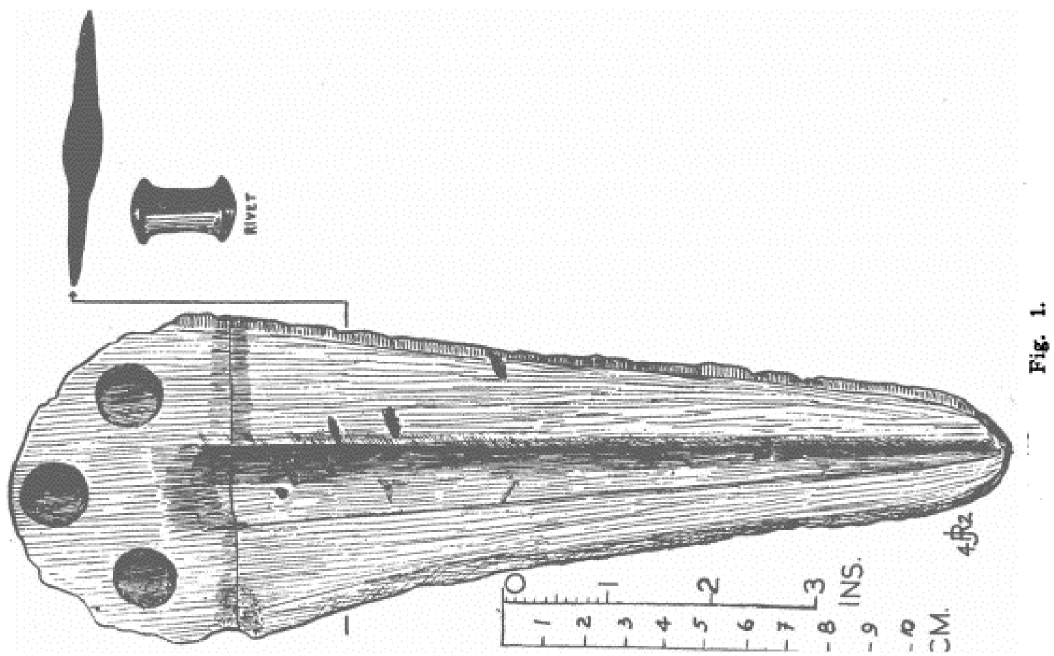

***Figure 6.2** – Raftery's illustration of the Carn halberd (termed 'halbert' in his paper), the only halberd recovered in Europe with its shaft surviving. Unfortunately, the shaft was not illustrated, but was recorded in some detail through text and measurements. Raftery (1942:55).*

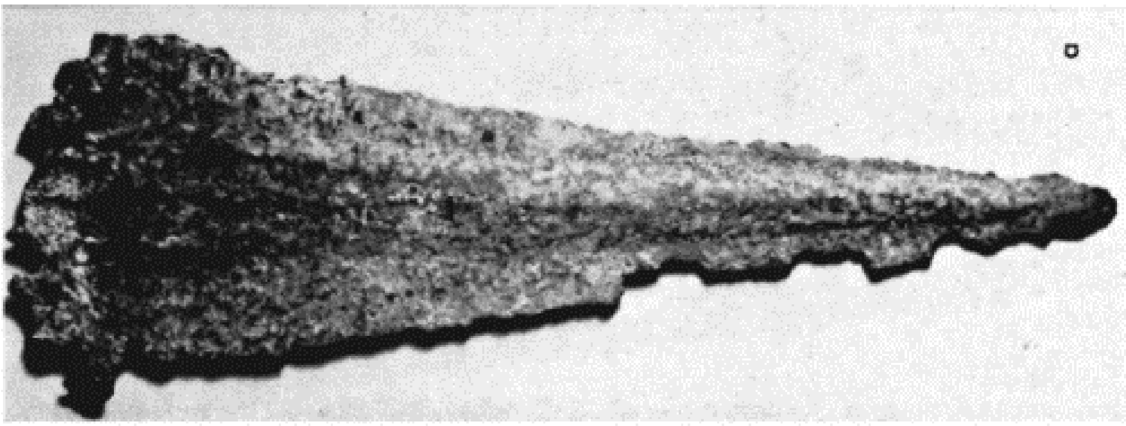

Figure 6.3 *– The halberd from Altnamacken, Co. Armargh. The halberd was found with its wooden haft, though this did not survive removal from the clay matrix. The halberd is in surprisingly poor condition, considering the organic material's survival. Flanagan (1966: Plate 1).*

Figure 6.4 *– The Trecastell halberd. Needham et al (2015:6)*

As discussed in the literature review, halberds have been ascribed several practical and symbolic functions. One of the most common areas of debate has been whether the halberds were efficient and effective combat weapons. O'Riordain (1937:241) surmises that "while there can be no doubt that in its origin the halberd was a practical weapon, it is also evident that in the main it is a non-utilitarian object which served as an emblem of authority". However, this is then qualified by an assumption that the halberd would immediately become detached from the haft due to its weight and the position of the rivets, close to the edge of the shoulder of the hafting plate. Similar assumptions can be seen throughout much of the literature as regards weapon technology and use – Osgood (1998:13), for instance, maintains that it is easier to wield a sword, and the inflicted blows become more effective and accurate, when one places a finger over the ricasso (the small notch often seen in between a sword's hilt and the main blade). However, experimental work by Kristiansen (2002:319-32) demonstrated that placing a finger in the ricasso leaves the digit highly exposed to incoming blows from one's adversary, and was therefore highly unlikely to have been a feature of Bronze Age combat. The need for controlled experimentation when investigating weapon function and use is therefore clear. Any experiment must be reliable, answer specific research questions, and be accurate, in order to be considered scientifically valid and produce useful, precise data. Based on the critiques of previous studies, the resources available as part of the project, and the specific research framework of the thesis, the following methodology was developed.

6.2.1 Reliability

The reliability of an experiment is based on its replicability, the breadth and relevance of its sample size, and whether the results fall within acceptable parameters (i.e. with minimal margins of error, in a recognisable pattern, or where outlying data can be explained or justified (Golafshani 2003:598)).

This chapter provides sufficient explanation and detail for the experiment to be replicated for reliability, and the choices made to control the variables explained and justified for academic clarity and rigour. The extensive discussion and justification of the choices made should allow any follow-up research, or future researchers in similar fields, to adapt and alter the work done here with relative ease. Opening the trial up to an audience – as with the dirk experiment (Section 3.4) – could also aid its replicability, as the spectators could mimic the setup and blows in their own future research, if so desired. The experiment was also filmed, and the digital video file is available as part of the supplementary information. Transparency in method is important to the planning and justification of any future work, as well as to identify and minimise any latent bias within this current project (Rubio 2011:24).

The primary focus of this project is the replica halberd and the blows it is capable of inflicting. Three identical halberd blades were cast by Neil Burridge, using the materials and techniques described below. Multiple blades were cast because the experiments with the replica dirk showed that extensive damage could occur to the weapon during the experiment, potentially curtailing the trials unexpectedly or before sufficient data could be collected. Multiple blades mean that a damaged blade can be removed from the haft and taken away for analysis, having been replaced by an identical but undamaged copy. The haft itself could also be damaged during the experiment: the ash handle of the replica dirk suffered severe damage, splintering along the grain of the wood, losing chips around the hafting plate where the impact stress was greatest, and splitting a large section of the handle away completely (Section 3.4). To this end, two handles were used (see Section 6.3.6 below), both made from oak. One had the halberd blade riveted on, making it difficult to replace either the blade or the handle if damage were to occur. The other handle had nuts and bolts affixing the blade, making it easy to replace a damaged blade or to remove an undamaged blade from a damaged handle. Two Synbone™ spheres and two long bones were used as the human tissue proxy (Section 6.3.7, below); each sphere is large enough to accommodate at least three blows, more if the weapon is ineffective and imparts little damage. This is a sufficient number of blows to determine whether the weapon is effective or not, one of the main specific research questions of the experiment.

The results of the experiments are discussed in Section 6.7. As there has not yet been any published experiment using replica weaponry on Synbone™, there are no known extant acceptable parameters with which to compare the results from this project.

6.2.2 Specific Research Questions

The fundamental hypothesis informing the design of this experiment is that the Bronze Age halberd in Scotland is a functional weapon, but only under specific circumstances that render it unsuitable for mêlée combat. This hypothesis can be broken down into two main specific research questions:

Is the halberd capable of inflicting debilitating injury to the human tissue proxy? (i.e. is the halberd a *functional weapon*?)

If the halberd is capable of inflicting damage, can it be used to inflict a range of blows using a variety of movements reminiscent of hand-to-hand combat, or does the halberd only function, or function best, in a restricted set of circumstances?

These two specific research questions are fundamental to the model developed in Chapter 9, and therefore to the integrity of this thesis as a whole. Furthermore, there are several additional research questions that can be investigated during this experiment, which would expand the body of research if investigated, but would not jeopardise the project if not. These are:

What are the advantages and limitations of using a replica weapon for combat simulations?

What are the advantages and limitations of using human tissue proxies in combat simulations?

Does an audience positively or negatively affect the experiment itself, and is there any effect on the methodology or the write-up?

What considerations must be made for using a non-archaeologist to wield the replica? Should a non-specialist be told about the theories and methodologies underpinning the experiment to better inform their movements, or would that introduce bias?

How can non-traditional recording methods, such as video, be used to enhance the research?

6.3 Accuracy

(Note: much of this section uses information from unpublished experimental results and personal experience of experts who may not have published their results via traditional academic journals or manuscripts. This is a key issue with highly skilled personnel who are not (necessarily) affiliated with a university or research group, reflected by Queer Theoretical approaches to ensure that voices traditionally excluded from academic research are sought and included (c.f. Browne and Nash 2010). Citations have been provided where possible and appropriate, and communication with the experts for further clarification is encouraged; contact information is included in footnotes where relevant, and collectively in a delineated section at the end of the Bibliography.)

The accuracy of an experimental weapons trial relies on a precision-made replica and the exactitude of the combatant enacting the blows.

6.3.1 Designing the Replica

The halberd commissioned by O'Flaherty (2007) was a composite of several Irish finds, averaged out to create a 'typical' Irish Type Carn blade. The size of the Irish assemblage and the relative uniformity of the Irish Carn halberds made this a logical and appropriate decision, resulting in a replica that accurately represented the Irish assemblage. However, this was not an option for the Scottish replica for several reasons. Primarily, the range of halberd types in Scotland, wherein all four of Harbison's (1969) types are represented, as well as a significant number of the Group Tom na Brataich proposed in Section 8.7. To take an average of such a range of halberds would blur the categorical boundaries and not accurately represent the whole assemblage. Furthermore, the range of state of preservation is very large, from the very well preserved (such as the Culloden halberd in the British Museum (WG 2061)) to the barely identifiable (such as the Hillton of Aldie halberds in Perth Museum and Art Gallery (PMAG 1972 209 and 310)): the significant material loss from the poorly-preserved halberds would alter the average weight and size of a 'typical' Scottish blade, rendering such a composite inaccurate. Instead, a replica of a single, well-preserved halberd of a secure typology was commissioned. The Tom na Brataich halberd is held by the West Highland Museum in Fort William, Invernesshire (WHM 1520), and was found at Achingoul, a few kilometres north of Fort William. The halberd is in a good state of preservation, with use-wear edge sharpening marks suggesting that it was used in combat (unlike, for instance, the nearby halberd from Culloden which indicates no post-casting treatment at all). The Tom na Brataich halberd was the first halberd examined to prompt the idea of the hafting plate being conserved after damage; expertise disguised as intuition, as the halberds from the larger museum collections in London, Edinburgh and Cardiff had all been examined by the time the West Highland Museum was visited: the Tom na Brataich halberd could be considered the type-find for this feature. The pattern of corrosion suggests that the halberd was deposited in a watery, though not waterlogged, matrix, and it is very likely that the halberd was covered in an organic wrapper, the gradual disintegration of which led to the increased corrosion on one face[18]. One rivet remained in situ, suggesting that the halberd was originally deposited with its haft intact. Moreover, the arrangement of rivet holes strongly supports the multiple-episode model proposed in Section 8.4, and the experiments here provided an ideal framework in which to test the utility and function of the halberd after multiple episodes of riveting.

Detailed diagrams, several scale photographs, and the full table of weights and measures were collated for the Tom na Brataich halberd, and sent to Neil Burridge, a smith who specialises in casting using prehistoric metallurgical technology. The mould was made based on these data, and a successful test cast was made in late March 2015. Compositional analysis has not (yet) been performed on the Tom na Brataich halberd, so the ratio of tin to copper is unknown. Instead, a mix of 12% tin to 88% copper, also referred to as 12% bronze, was used; this is also the composition used for the replica Friarton dirk, improving the reliability of comparable data between the two sets of experiments. Much of the EBA bronzes from Scotland are as yet untested through XRF and their specific compositions are unknown; where a bronze material has been noted in museum catalogue listings, it is done so through the presence of bronze disease, or copper is assumed to be the default and listed with a question mark (see Appendix 1). The bronze alloy used to create the replicas used in this study is in line with the handful of compositionally analysed bronze items from Scotland and northern England from the Early Bronze Age, prior to the widespread inclusion of lead (Rohl and Needham 1998). The best-case scenario would obviously have been to have done XRF analysis on the Tom na Brataich halberd and cast the replica in the same material; as this was impossible due to time and resource constraints, using a bronze alloy known from the EBA in Scotland and proven to be an effective material by the dirk experiments in the previous chapter was a logical second choice.

6.3.2 Casting: Fuel and Furnaces

Insofar as the casting is concerned, there is a balance to be struck between prehistoric accuracy and commercial viability. Some experimental work has been undertaken to establish some possible methods for prehistoric metallurgy (see Coghlan and Case

[18] The Tom na Brataich halberd is catalogued in Appendix 1, and discussed at length in Section 8.7.

1957:96). Bronze Age metallurgy, however, has left a very light archaeological footprint when compared to the slag heaps from iron processing during the Iron Age (Stetkiewicz 2016:63). The scanty evidence for metal processing in Britain could be due to a recovery bias, in that excavations aren't targeting Bronze Age metal production areas; it could be that the bronze objects were being manufactured close to the copper and tin extraction sites, and the manufacturing evidence would therefore not be dispersed across Britain; it could also indicate that copper and bronze smithing was more ephemeral, and has therefore not left a significant trace in the archaeological record. Consider Gordon Childe's (1930, 1958) 'peripatetic smiths', with their portable greenwood crucibles, charcoal fires, and small toolkits; these would not leave many archaeological traces. Experiments with various fire-making and metallurgical methods have suggested a few models for Bronze Age casting. Temperatures of up to 1200°C have been achieved in a wood-fired hearth using bellows on a large heap of embers, but it proved difficult to reach and sustain this temperature. It seems much more likely that charcoal was used, which burns hotter than wood – hot enough to smelt the raw metal ore, as well as annealing and casting (Munoz 2019)[19]. A hearth would be sufficient for annealing copper and tin, and there would be no need for a large enclosed furnace, as are found for iron smelting throughout the Iron Age; however, charcoal is produced in an enclosed, oxidising environment such as a furnace or charcoal pit. Simon Timberlake of Butser Ancient Farm (Chalton, Hampshire) has suggested a set-up whereby a wood-fired reducing furnace is used to make charcoal, which is then burned at the top of the furnace in a more controlled fashion to anneal the metal[20]. Indeed, he has found that it is much easier to make a larger item by melting smaller quantities of copper in this way, rather than melting all of the metal at once by burying a lidded crucible in hot coals and then using bellows to maintain a high temperature throughout. Fergus Milton, also of Butser Ancient Farm, has also noted that the alloyed bronze melts at a slightly lower temperature than copper or tin individually, and alternative fuels such as animal dung or peat would reach the required temperature: experiments in Ireland using peat, and in India using dried dung, have both proved successful. Open or semi-open furnaces using charcoal, peat, dung, or wood, are

[19] I am grateful to Simon Timberlake and Fergus Milton, both of whom have undertaken extensive experiments into the controlled use of fire in prehistory at Butser Farm, and who have been very helpful and forthcoming with information and their own experimental results as relate to Bronze Age metallurgy.

[20] Pers. comm. Simon Timberlake, Cambridge Archaeological Unit, University of Cambridge (simon.timberlake@gmail.com)

highly ephemeral and would therefore leave very little mark on the archaeological record. Mr Burridge used a charcoal fire in a modern hearth to melt the bronze.

6.3.3 Casting: Crucibles

There is slightly more archaeological evidence and fewer theoretical possibilities for crucibles than for fuel. Experimental casting using a charcoal furnace showed that it takes around 20 minutes for a crucible of bronze to melt[21]. Wooden, even greenwood, crucibles would therefore not be suitable for bronze annealing, because the length of time that the crucible would be exposed to the heat of the furnace would compromise its structural integrity. Conversely, stone crucibles would be too effective in insulating the metal from the heat of the furnace, and would not be suitable either. There is archaeological evidence to suggest that ceramic crucibles were widely used in the pre-Roman Iron Age and earlier in metallurgical prehistory, as they maintain the correct balance between durability and conductivity (Lamm 1973 from Bronze Age Sweden; Spratling 1979:130 for Iron Age Dorset – despite the age of these papers, they remain useful comparanda for Scotland when read critically). Experimental reconstructions have indicated that even the roughest pottery crucible, made with a thick temper of grog and straw, could be used for one or two successful casts before cracking; more refined pottery and greater care used in the crucible's manufacture can result in a crucible that can be used for upwards of two dozen separate episodes of casting or annealing[22]. The replica halberd was cast using a modern ceramic crucible, of the type which is widely commercially available[23]; the modern crucible has not changed significantly in either form or material since the introduction of metallurgy to Britain (Spratling 1979:130; the site discussed by Spratling, Gussage All Saints, is an early Iron Age site in Dorset, England, but many of the findings are relevant to this study, particularly given the lack of an equivalent site study from the Bronze Age.)

6.3.4 Casting: Mould

The final controllable variable in the casting is the mould. Mould technology developed rapidly in the Bronze Age, allowing the creating of progressively more elaborate and complex objects. The most basic casting technique uses an open stone mould, into which

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[21] Pers. comm. S. Timberlake

[22] Pers. comm. Fergus Milton, Butser Ancient Farm (fergus@fingerbutser.com)

[23] A range are available at https://www.cousinsuk.com/category/crucibles-salamanders-stirring-rods (last accessed 8/8/16); there are several other suppliers in the UK.

the molten copper is poured and left to cool (see Figure 6.5). Open cast moulding requires significant post-cast hammering and shaping before the final blade is ready for use, as the resultant cast object is very thick and rough around the edges. Flat axes were cast using open stone moulds (Schmidt and Burgess 1981:52). The early appearance of halberds in Britain would have meant that open stone casting was used to create at least the initial wave; indeed, a small halberd open stone mould was recovered from Llanwyddelan Bridge, Powys, held by Amgueddfa Cymru/ National Museum of Wales, which has halberd-shaped indentations on three of its four sides.

Figure 6.5 *– One face of the carved stone mould from Llanwyddelan Bridge, New Mills, Newton, Powys, held by AC/NMW (accession number NMW 7926H).*

However, open mould technology places severe limitations on the kinds of objects that can be cast. It is difficult, if not impossible, to cast a midrib or bevelled edges using open moulds because the finer detail cannot be accurately carved into the stone, and the thickness of the cast object can only be controlled through extensive post-cast hammering: in addition to taking many hours of skilled labour, hammering can seriously weaken the final object, as discussed in the next section. Closed moulds can be made from stone, clay, metal, sand, and cuttlefish bone, though the latter two are not (yet) attested in the Bronze Age (Boutoille 2012:9; this could be because they have not survived, or either because they were not used). Ceramic moulds provide a much finer final cast than stone, with the cast object requiring much less post-casting treatment (indeed, the Culloden halberd [British Museum, acc. WG 2061, Appendix 1] has not undergone any post-casting hammering or edge sharpening at all; this may reflect its primary purpose as non-offensive, rather than an intentional benefit of finely-tooled ceramic casting). Ceramic moulds also facilitate the creation of midribs, sockets, bevelled edges, and finer tips (Garbacz-Klempka et al 2015). The mould is made up of two ceramic plates which, when fitted together, make a hollow space into which the molten metal is poured. The resulting cast object is significantly more elaborate and closer to being finished than the equivalent cast from an open mould.

Figure 6.6 *– The test cast. The rough edges are clear, as is the excess flange at the tip, where the molten bronze was poured into the mould.*

Figure 6.6 shows the first cast of the replica halberd by Neil Burridge. The rough edges can be seen, as can the bevelling, the midrib and the curve of the blade. The flange at the tip is where the molten bronze was poured into the top of the mould, forming a plug of bronze that needs to be melted off the final blade. It should be clear that a halberd of this (relative) complexity could not have been made using an open mould.

The mould for the replica halberds was made from clay, and was designed using scaled photographs, diagrams and line drawings of the Tom na Brataich halberd. The first cast, shown in Figure 6.6, was weighed and measured, and then compared to the equivalent weights and measures from the Tom na Brataich halberd (allowing for a small amount of material loss on the prehistoric halberd through corrosion and bronze disease). This ensured that the replica was as close a copy as possible, and that the photographs and diagrams had been interpreted accurately. Mr Burridge first cast several initial test halberds to establish whether the mould was viable (i.e. whether the resulting halberd was of sufficient length and thickness to not bend or break post-cast), as the Tom na Brataich halberd is thinner than the swords and axes that Mr Burridge is more used to making. The mould was found to be suitable for casting, and the three halberd blades for replica testing were cast, the first of which is shown in Figure 6.5. The replica halberd's weights and measures (the metal blade only, excluding the wooden haft and handle) are as follows:

Table 6.1 *– Measurements of the replica halberd blade, before it was hafted.*

Total length	242mm
Midrib length	206mm
Hafting plate length	37mm
Maximum width	72mm
Maximum thickness	5mm
Weight	306g

6.3.5 Post-casting Treatments

The question of post-casting treatments was complicated. Post-casting treatments fall into three broad camps: hammering, annealing, and sharpening. Hammering involves hitting the cast object with a smooth blunt hammerstone or metal hammer; the cast object is sometimes heated beforehand, called warm or hot hammering (depending on the temperature), and cold hammering is done on the cast object at room temperature. Hammering results in a stronger metal, because it reduces the number of deformations, or stress points. However, if the material is hammered beyond its elastic (i.e. reversible) limit, a plastic (i.e. irreversible) deformation occurs, seriously weakening the object and leaving it very vulnerable to fracture (Degarmo et al 2003:60). In non-ferrous metals such as copper and bronze, cold-hammering is the norm because the elastic limit is very low; hot-hammering will very quickly break through the elastic limit and seriously compromise the structure of the cast item[24]. The whole object can be hammered, or specific areas, like the edges or the hilt, can be targeted for strengthening. Annealing is a

[24] Pers. comm. Mark Young, Metalwork Technician and Deputy Head of Technical Services, Edinburgh College of Art. Mr Young was kind enough to mend the tip of the replica Friarton dirk after it was damaged during the experiment detailed in Chapter 3.

process whereby the cast object is rapidly heated to beyond its crystallisation temperature and allowed to slowly cool; non-ferrous metals cool best in the air, rather than being quenched in water. Copper reaches this temperature when it glows white and 'dances' in the crucible, as observed by Mr Burridge. Pouring molten metal into a mould is therefore a form of annealing. Annealing can be used to 'reset' fractured or overworked metal after hammering, if required (Bray and Pollard 2012). Annealing increases the ductility and malleability of a metal, making it easier to work and shape, but seriously decreases the hardness and strength of the object; hammering is often subsequently required to rectify the annealing-induced softness (Verhoeven 1975:326). Sharpening is the most straightforward of the three processes: a whetstone is used to remove the ragged edges of the moulded object, and to sharpen the edges if the object is to be used as a blade. Sharpening leaves distinctive diagonal scratches at 45° to the edges of the blade, which are visible under a microscope (Dolfini 2011; see also Figure 6.7 below showing the post-casting sharpening scratches on the replica Friarton dirk).

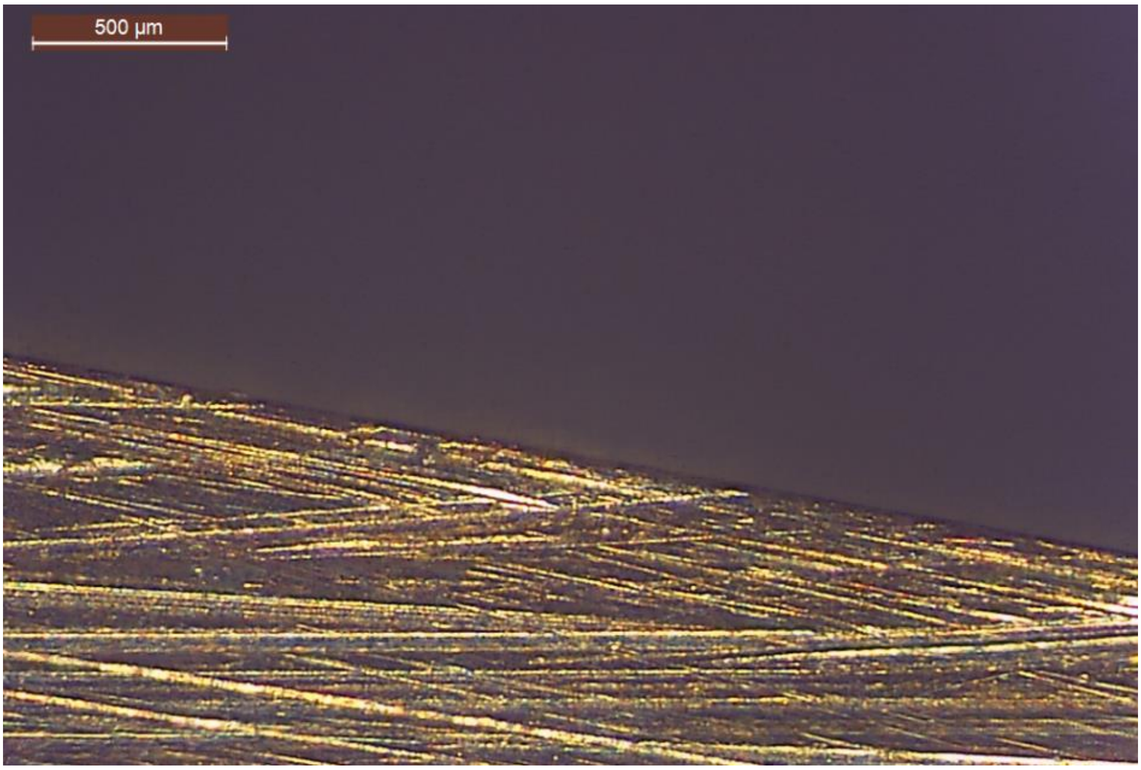

Figure 6.7 *– Microscopy image of the replica Friarton dirk edge, showing the long diagonal scratches associated with sharpening.*

It should be clear, therefore, that inexpert treatment of the replica could result in a weapon which is significantly stronger or weaker than its prehistoric counterpart; stress lines or fracture faults could appear in a poorly-hammered replica, or weakened edges from over-sharpening. O'Flaherty (2007:424) did not subject his replica halberd to any post-casting treatment, so as "to avoid argument about the appropriate level of post-casting treatment and its implications for the performance of the blade during trials". However, the Tom na Brataich halberd showed some evidence for hammering, and although the edges were not in perfect condition, there was some indication that they had been sharpened at least once. The author therefore asked Neil Burridge to cold-hammer the replica halberds, and to sharpen the edges to a cutting face.

6.3.6 Hafting the Halberd

As noted above, there are only two known examples of halberds with some of the haft still attached: the type find from Carn, County Mayo, which was recovered with its entire oak handle (haft and shaft) still intact (Raftery 1942:55); and the recent find from Trecastell, Powys, which had some of its Pomoideae haft intact (Needham et al 2015:4). The haft of the Altnamacken, County Armargh, halberd was destroyed when the halberd was lifted from the soil (Flanagan 1966, 95-6).

The continental northern European halberd assemblage includes a number of halberds with metal hafts (Wüstermann 1995); these are considered to be skeuomorphs of the local wooden-hafted halberds, rather than a technological innovation in their own right (Needham et al 2015:11). Because they are not found in Britain or Ireland, it would not be appropriate to consider a metal haft for the replica in this project. Their presence should be noted, however, as a possible avenue of future research.

There are two methods of hafting a halberd using wood: a solid-back, and a split haft. The solid-back haft involves carving a recess into the solid haft head into which the metal blade is slotted, and then anchored into place with three or more rivets (O'Flaherty 2002). This is the method by which the replica of the Carn halberd was hafted, though there is some question as to its accuracy (Needham et al 2015:12) (see Figure 6.8, below). A split haft sandwiches the metal blade between two loose pieces of wood, which are then riveted together and bound with thick cloth, twine or wooden pegs; there is very little organic evidence for hafting remaining in the European assemblage, so reconstructions vary according to the archaeologist's interpretation. The three conjectured methods of hafting using a split haft are shown below in Figure 6.9. Further discussion of solid versus split hafting is given in Section 8.3.

Figure 6.8 *– The reconstruction of the Carn halberd in the National Museum of Ireland. The halberd has a solid-back haft. Needham et al 2015:12.*

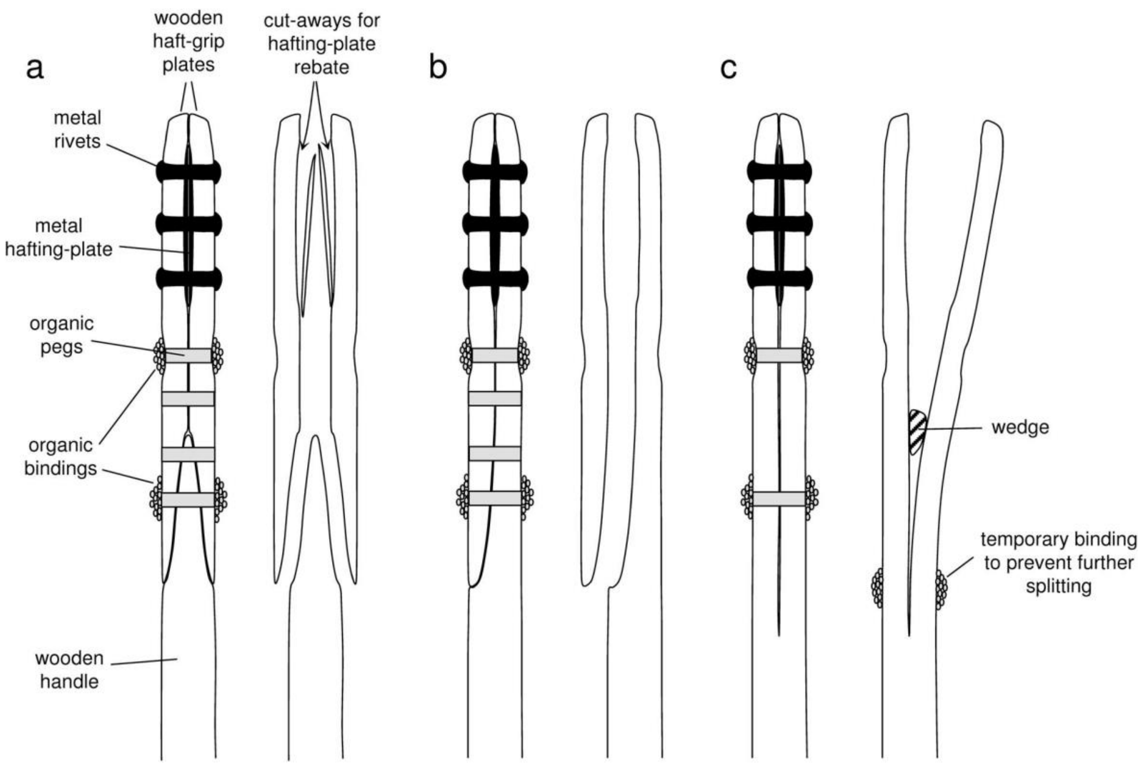

Figure 6.9 *– Three methods of split hafting. A: two disparate plates. B: one separate plate. C: split and wedge haft. To my knowledge, there are no replicas using split hafting techniques. Needham et al (2015:15).*

The largest body of evidence for hafted halberds is the representations thereof in rock art across northern and western Europe. Some of these have been discussed frequently in the literature; two such are shown in Figure 6.10. These hafted halberds are shown as being held aloft by human figures, in a performative display or as an act of aggression. The image from Mont Bego shows halberds with very long shafts, several times the length of the person wielding it, whereas the Foppe di Nadro image shows the halberd hafted onto a much shorter shaft. A lesser-known but equally significant representation can be found on the 'halberd pillar' from Ri Cruin, Kilmartin Glen, Argyll and Bute (Needham and Cowie 2012). There is very little evidence to suggest that petroglyphs were intended to be purely representative, however, so there must be some (subjective) element of interpretation when translating the images into a reconstruction.

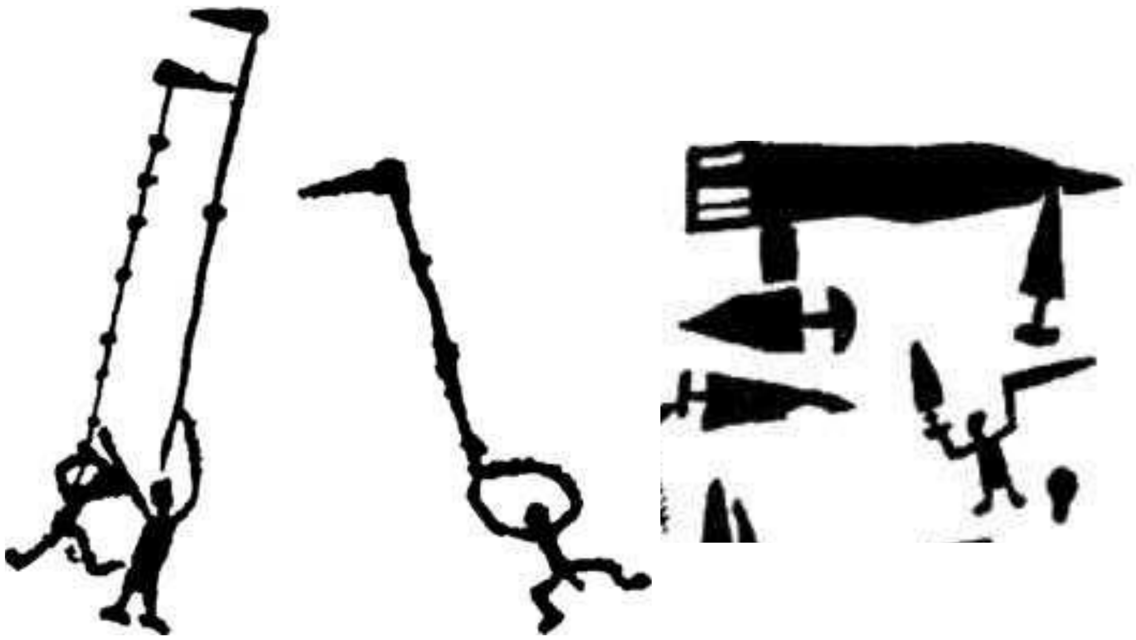

***Figure 6.10** – Left: Rock art from Mont Bego depicting figures wielding hafted halberds above their heads, which show knots or protrusions on the handles; whether these are literal or figurative representations remains unknown Right: A detail from rock art at Foppe di Nadro, showing a small person dual-wielding a halberd and a short sword or dirk. The figure is surrounded by depictions of weaponry, including what could be a large halberd (top) and dirks, daggers, or short swords (O'Flaherty 2007, after Abelanet 1986),*

Figure 6.11 *– Plaster cast of the Ri Cruin halberd pillar. The halberd blade is at the far left of the long handle. Needham and Cowie (2012:91).*

Given the rock art representations, and the experimental success of the hafted replica by O'Flaherty (2007), a similarly proportioned handle was commissioned by the author. Neil Burridge made the first handle (Handle 1) using white oak, in part to experiment with various bolts and rivets to haft the blade. This handle was finished using a metal grinder, leaving a very coarse and textured finish to the wood. The slot for the halberd was bored a little too wide, so the final haft left the blade slightly loose. The blade was not riveted in place; instead, three nuts and bolts were used to secure the halberd. Obviously, this is not a prehistorically accurate hafting method; given the extent of the damage to the replica dirk (Section 3.4), having a method of replacing a broken blade with an unbroken one would prolong the experiment and remove the need to have a metalworker on-site to remove the rivets to free the damaged blade, and then to haft and rivet the new blade.

Figure 6.12 *– The first halberd handle (Handle 1) made from white oak, prior to hafting the blade. The yellow scale bar represents 1m.*

Figure 6.13 *–Handle 1, made by Neil Burridge, after hafting the blade. The nuts and bolts used to affix the blade to the handle can be seen.*

A second handle (Handle 2) of the same dimensions was then commissioned from Peter Driver at PMD Bespoke Joinery, also to be made from white oak. The hafting slot was bored slightly narrower, making for a tighter final haft, and the halberd blade was riveted in place for greater accuracy.

Figure 6.14 *– The riveted halberd blade and the haft of the second handle (Handle 2).*

Figure 6.15 *– The second halberd handle (Handle 2) with riveted blade (metre scale bar).*

The handles were identical in length and width; their measurements are shown in Table 6.2. Handle 2 was slightly heavier due to the narrower hafting slot, but not significantly (>1% difference in weights).

Table 6.2 *– Measurements for the oak handles, excluding the metal blade.*

Total length	896mm
Haft head length	113mm
Maximum diameter (handle)	51mm
Maximum diameter (haft head)	31mm
Weight	Handle 1: 742g Handle 2: 749g

The second handle was made smooth, and the wielder had no issues with gripping the handle or having it slip out of control. The blunt-force trauma blows using the handle as a club were inconclusive (discussed in detail in Section 6.6), but there is scope for future research here, with foci including: using prehistoric woodworking tools to craft the handle, and their effects on the handle's usability; the effects of using various species of wood; the best way of hafting the blade; the effects of soaking the hafted blade in water for at least an hour before use, causing the wood to swell and make the blade more secure; the effects of using a shorter handle, < ~500mm; and whether incorporating knots or handholds into the handle, as possibly shown in Figure 6.9, improves its combat performance or renders the weapon more ergonomic.

6.3.7 The human tissue proxy

A faithful combat recreation requires an accurate proxy for the human victim, otherwise the painstaking research and effort spent in creating the replica halberd would be undermined by sub-standard experimental materials. A more detailed discussion of material choices is explored in Sections 3.4 and 3.5. For ballistics and weapon trials, there are three options for the testing material: cadavers, animal tissues, or synthetic analogues. Human tissue poses a huge infection risk, to say nothing of the monumental legal and ethical issues, and is very difficult to obtain (using cadavers for weapons testing is illegal in the UK); furthermore, rigor mortis and bone hardening makes it very variable in consistency and viscosity rendering it, ironically, a poor imitation of live human tissue (Smith et al 2015:427). Animal tissue is much easier to source, but similarities to human tissue vary enormously from species to species, and there is not a single suitable animal proxy for the human cranium (Smith et al:427). Polyurethane, sold under the brand name Synbone™, is a synthetic human bone substitute that performs in a very similar manner to human tissue in ballistics trials (Thali et al 2002), particularly when ordnance, or ballistic, gelatine is used to mimic the soft tissue in the cranium (Kneubuehl and Thali 2003:45-6; Smith et al 2015:429). For the experiments with the replica halberd, and for the dirk trials covered in Chapter 3, Fluka brand Type 3 ballistic gelatine was used. Synbone™ is quickly and easily obtainable in various quantities and shapes, and the samples are identical due to the mass-production process (www.synbone.ch). This uniformity is an advantage, in that any results or variation from experiments using Synbone™ can confidently be ascribed to something other than compositional anomalies in the testing material. However, more complex ballistics models investigating specific trauma patterns in human bone have found that the variability in human bone composition (the specific ratios between hydroxyapatite crystals and the collagen fibril matrix, not to mention the alignment of the fibril matrices) is impossible to replicate using Synbone™ (Smith et al 2015:432-4). For a relatively simple ballistics test, such as using the replica halberd, and with this research focus concerning the impact on the halberd itself, rather than the specific patterns of skeletal damage, Synbone™ is a sufficiently accurate human tissue proxy. Two long bones (generic bone Ø 30mm, 5mm thick wall, product number PR0105.G) and two spheres (5mm thick wall, product number PR0112.G), both covered with rubber 'skin', were prepared using ordnance gelatine (Fluka Type 3) for the first set of experiments; the final experiments described in Section 6.8 were also enacted using two 5mm rubber-skinned spheres prepared using ordnance gelatine.

6.3.8 Wielding the Halberd

This section has accounted for the accuracy of the replica itself and the human tissue proxy; however, it is also up to the combatant to replicate the range of movements and blows as accurately as possible. Fortunately, the experiments undertaken by O'Flaherty (2007) provide detailed explanations of suitable and unsuitable movements, creating the baseline for this experiment with the prone opponent; the gaps identified in O'Flaherty's work with different ways of using the halberd, including using the handle as a blunt weapon and testing the weapon against an upright opponent, are covered in Sections 6.6 and 6.8 respectively. Furthermore, as discussed in Section 4.5, part of the rationale driving the replica dirk experiment (detailed in Chapter 3) was to trial several different methods of wielding a prehistoric weapon, and to address issues and problems that arose during the trials in order to refine the halberd experiments ahead of time. However, unlike the replica dirk experiments, there is some evidence to suggest how the halberds were wielded in prehistory: petroglyphs from Mont Bego, France, and Foppe di Nadro, Italy, include representations of figures holding hafted halberds over their heads (Figure 6.10).

These depictions were noted by O'Flaherty, who used them to design his own (highly successful) replica halberd experiments (O'Flaherty 2007). A similar set-up was therefore chosen for this experiment.

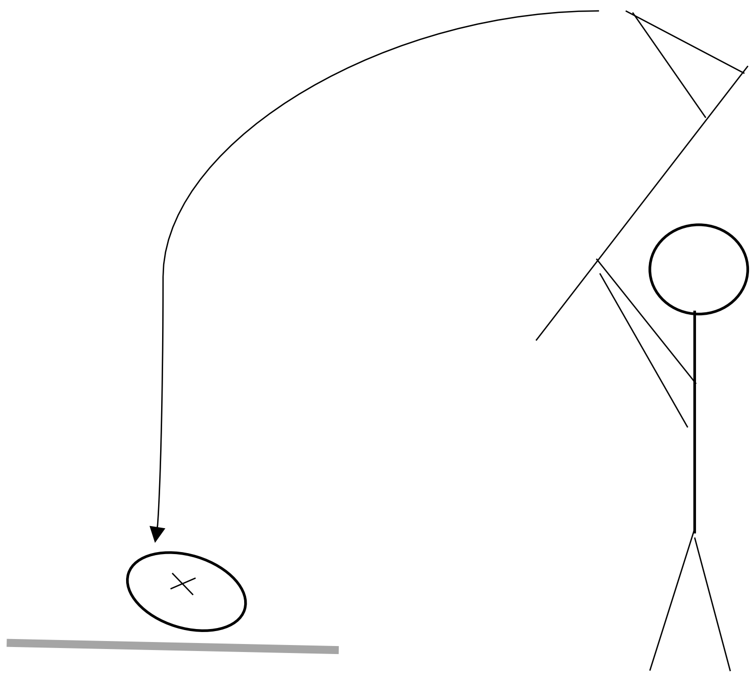

Figure 6.16 *– Simplified representative diagram of the overarm motion used to hit the Synbone™ spheres with the halberd.*

As with the dirk experiments, the actual number and style of blows was intended to be reflexive and adaptive, to accommodate the unknown effects on the halberd blade and haft, and the Synbone^{TM}.

As with the dirk experiments, consideration must also be made for the wielder of the weapon. O'Flaherty's experiment (2007) indicated that wielding the halberd required no small skill, and significant upper-body strength (lighter, less confident blows made the blade flex and jar (O'Flaherty 2007: 246)). As the overhead blow requires both hands, there is no issue of ambidexterity, or a right-handed bias, as there was with the dirk. To control for gender and height variables, two wielders were nominated: a man (1.8m tall, 86kg mass) with some martial artist training and developed upper-body strength, and a woman (1.72m tall, 95kg mass) with less martial arts training but more developed core strength; the assumption is that the wielder must have been fit and able-bodied, given the overarm type of blow inflicted with the halberd. Further study with a range of wielders could include investigation into wielding one-armed, perhaps, or seated.

6.4 Halberd Replica Experiment

The experiment was performed in the Osteoarchaeology Teaching Lab in the Department of Archaeology, University of Edinburgh, on Friday 23rd September 2016. Every blow was recorded in photographs and on video (video clips are included on the USB at the end of this thesis).

6.4.1 Audience

Opening the replica dirk experiment (Chapter 3) out to an audience proved to be very successful in terms of audience engagement, and explaining each step to the educated but non-specialist onlookers ensured that the experiment was clearly thought through and as accessible as possible. Furthermore, the subsequent question and answer session provided some interesting and novel perspectives on the experiment, some of which informed this final write-up. The halberd experiment was therefore designed to be enacted before an audience. However, as this experiment took place during a teaching week (unlike the dirk experiment, which took place during Innovative Learning Week when regular teaching was suspended), it would not have been appropriate to advertise the trial to the public or the wider university student body. Instead, the experiment was advertised to the student body, both under- and post-graduate within the Archaeology department; faculty members were also encouraged to attend. This did limit the audience pool to archaeology staff and students, rather than the wider public, which meant that there was generally a greater degree of archaeological knowledge and expertise than with the dirk experiment. On the one hand, this meant that the audience was more critical of the methodology and set-up, and therefore asked more specialised questions than did the wider public; on the other, there was less need to thoroughly explain each stage, and therefore an arguably less rigorous examination of the methodology and materials than with the dirk experiment. This has been ameliorated by the extensive documentation and analysis presented in this chapter, particularly the long discussion on the many aspects of accuracy which were considered (Section 6.3).

6.4.2 Enacting the Experiment

O'Flaherty(2007:426) noted that the greatest potential for damaging the blade occurred when swung tentatively. The wielders were therefore encouraged to try some target practice before attempting to damage the Synbone™ spheres, to get a feel for the weight and reach of the hafted halberd, as well as to improve the aim and accuracy of the blow. An apple was placed on a fabric-covered foam pad on the floor, and the first (male) wielder was invited to practice his aim on this soft and small target. Within a very few (<5) blows, the wielder had greatly increased his confidence in aiming, and it had become clear that the lack of ridged handholds on the handle would not present any issues with grip or slippage. It also became apparent that the halberd was capable of causing significant punching damage when wielded with confidence. This process is shown in Figure 6.16.

Figure 6.17 *– The wielder's target practice using the replica halberd. Left: the results of the first on-target blow. Right: the almost inevitable result of the second on-target blow. The foam pad was also punctured (red arrow); this indicated that the halberd's penetrative power was greater than initially expected.*

Encouraged by these early results, the first Synbone™ sphere was set up, held in place by a cork ring and secured on top of a large piece of padding, 25cm thick. The spheres themselves are 19cm in diameter, meaning that the uppermost area of the sphere was raised 44cm off the ground.

The first halberd to be used had the blade riveted into the haft head (Figure 6.14 and 6.15). The halberd was wielded as diagrammed in Figure 6.16. The blow landed slightly off-centre on the sphere, but not sufficiently astray that it glanced to the side: it resulted in a clean deep punch to the sphere, easily cleaving through the bone and into the ballistic gelatine inside. The skeletal damage presented as a large flake of detached bone, with a smaller flake fragmenting from the larger. The first impact is shown in Figure 6.18.

Figure 6.18 *– The first blow using the riveted halberd on the first Synbone™ sphere. The large detached flake is clear, with the smaller flake fragmenting from its uppermost edge.*

The sphere was rotated until the damaged area was hidden, and the second blow was made. Perhaps buoyed by the success of the first blow, the wielder struck the sphere more forcefully on the second pass, resulting in a deep puncture that was much further away from the centre point. The force meter used in the replica dirk experiment could not be used for the halberd experiment. If it were placed directly on the floor, the thick padding would have rendered the reading unreliable. If it were placed on the padding, directly underneath the bone, the uneven surface would have rendered the force readings inaccurate, and there would have been a significant risk to the force equipment and computer cables, as well as to the halberd blade. Relying on video footage and personal impressions of the forcefulness of the blows is obviously not ideal, and this should be addressed in any future research. The deep puncture was located off to one side, far from the centre point, perhaps as a result of the increased force of the blow. The skeletal damaged presented as another large detached flake. A jagged linear incision extended beyond the limit of the flaked piece, where the halberd blade had penetrated the sphere very deeply: the narrow tip had punched a hole, creating the flaked fragment, and the widening blade continued to slice through the bone beyond the original incision. These are shown in Figure 6.19.

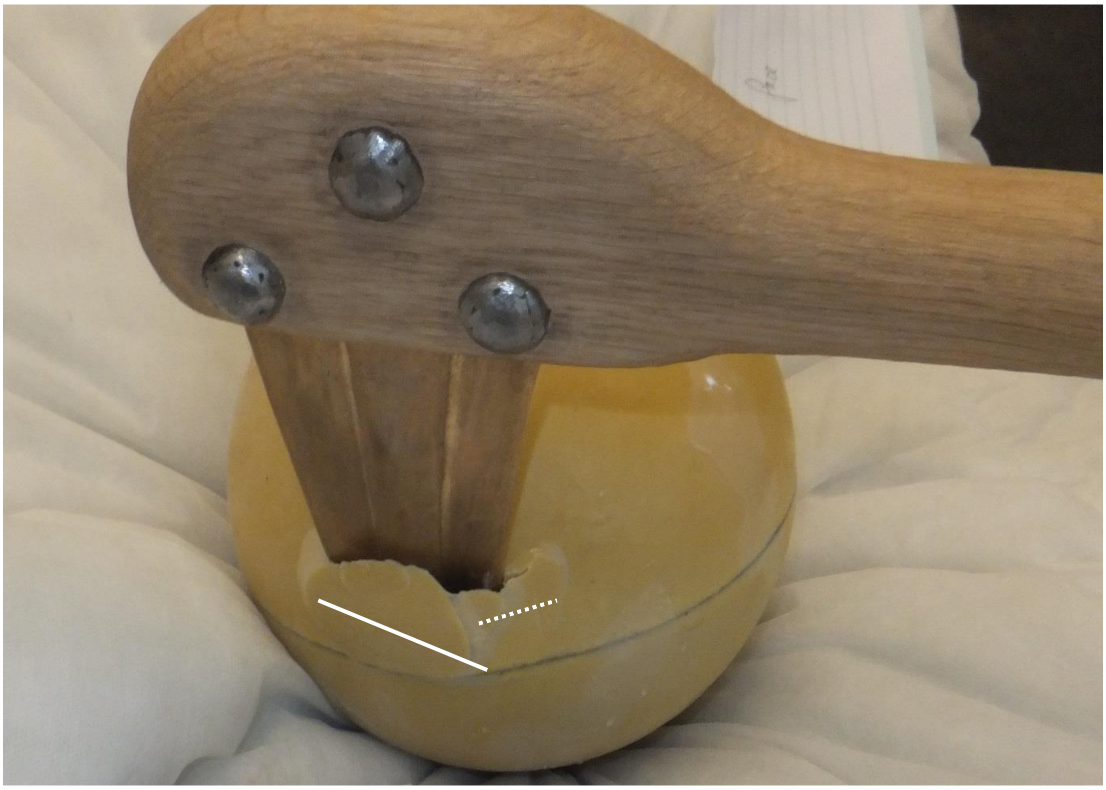

Figure 6.19 *– Damage inflicted by the second blow. The solid white line indicates the extent of the flake, caused by the punching impact of the tip. The dotted white line indicates the jagged linear incision, caused by the widening of the blade as the weapon continues downwards into the sphere.*

Although the first and second blows did very similar types and severities of damage to the Synbone^{TM}, only the second blow had any noticeable effect on the halberd itself. When removed from the Synbone^{TM}, it was noted that when viewed in profile, the halberd blade had been bent by 12°, deforming it into a curve that began approximately halfway up the length of the midrib (Figure 6.20). As the blade is riveted onto the handle, it cannot easily be removed, so any damage to the hafting plate will remain unknown unless the weapon is first dismantled. This deformation is further discussed in Section 8.2.

Figure 6.20 *– The 12° bending deformation of the first replica halberd after the second blow, with the original straight line of the blade indicated by the black dotted line.*

The Synbone^{TM} sphere was again rotated so that the damaged areas were not face-up, and a third blow was delivered. Again, the confidence and force with which the blow was delivered meant that the blade punched cleanly through the bone to a depth of 128mm, causing a very large flake to detach completely from the sphere, held in place only by the outer layer of rubber 'skin'. The damage to the Synbone^{TM} sphere now covered its entire surface area, leaving no undamaged areas left for further blows. Upon extraction from the sphere, the halberd blade was again checked for further bending deformation. It can be seen (Figure 6.21) that the blade had indeed been bent by a further 4° by the third blow, making a total profile deformation of 16° after the three blows, and the author decided to end this phase of the experiment and move on to the second sphere and the second halberd.

Figure 6.21 *– The 16° profile deformation following the third blow. This damage was deemed sufficient to have addressed the specific research questions, and this halberd was not used in any of the further experiments.*

Figure 6.22 *– The third blow with the first halberd. The large flake can clearly be seen to have completely detached from the sphere, and the thin rubber skin has stretched to accommodate the movement.*

The second Synbone™ sphere was set up in exactly the same manner as the first, held in place by a cork ring and secured on top of a 25cm thick piece of padding. The second halberd was used for this sphere; this halberd had nuts and bolts holding the blade and haft together. Although this was not remotely prehistorically accurate, it did mean that if the blade sustained damage sufficient to prevent any further blows, it could be replaced with the third (and final) replica blade with relative ease and the experiment could continue.

The first blow of the second set of experiments produced virtually identical results as the first set. The halberd punched cleanly through the bone to a depth of 148mm, lacerating the sphere and causing a large fragment to shear away, with a second, smaller fragment coming away from the larger piece (Figure 6.24).

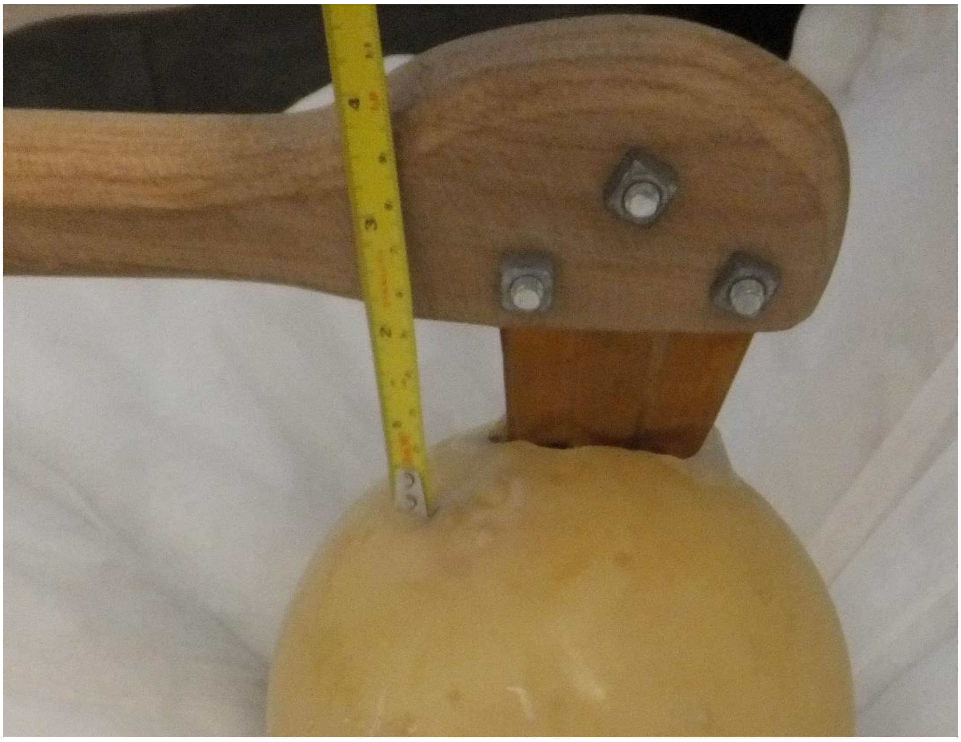

Figure 6.23 *– The clean puncture made by the first blow.*

Figure 6.24 *– The two fragmented pieces of Synbone™ resulting from the first blow.*

The halberd was retrieved from the sphere and checked for any damage or deformations; no instances of distortion, bending, or edge rifling were found anywhere along the blade.

Two further blows were made using the second halberd, both with very similar results as the first. In both cases, the halberd cleanly punctured the Synbone™, creating large flaked fragments with secondary flakes; in neither case was the blade damaged or bent by the impact.

Figure 6.25 *– Puncture and flake damage from the third blow using the second halberd.*

The fourth and final blow caused the most damage to the Synbone™ of the experiment. The damage did not present as a large fragment with a smaller secondary flake, as seen in the previous blows; rather, it created a very large lateral fracture, running almost the whole diameter of the sphere – effectively cleaving the sphere in half.

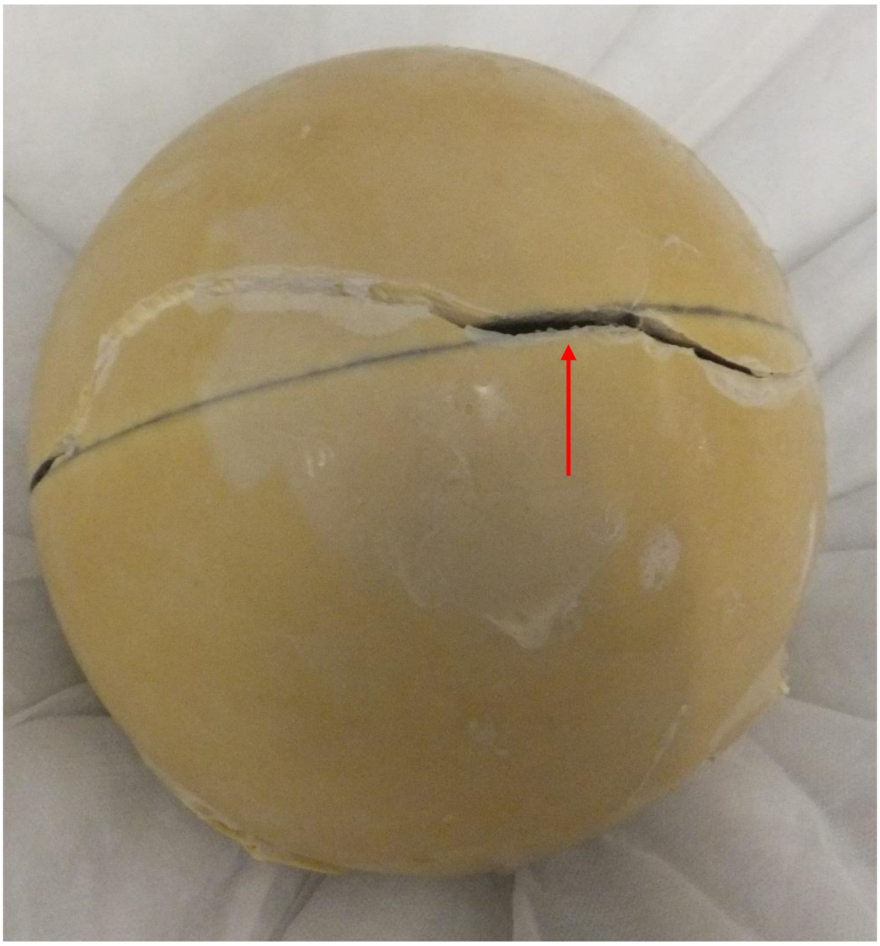

***Figure 6.26** – The lateral fracture resulting from the fourth blow with the second halberd. The red arrow shows the entry point of the blade. The fracture can be seen curving sinuously across the dark blue suture line.*

The Synbone™ spheres are made of two polyurethane hemispheres sealed together with a resin-based glue. The glue is exceptionally strong, and should – theoretically – not have any great impact on the accuracy, or structural integrity, of the Synbone™ as a human bone proxy; this issue has not yet, to my knowledge, been addressed in the literature. However, the change in material (from polyurethane to glue) could feasibly create a fault-line on the spheres, mimicking the sutures found on a human cranium (visible in Figure 6.26 as the dark blue line spanning the circumference of the sphere). It is possible that the fourth blow landed in sufficiently close proximity to the suture to crack it open, resulting in the unusual damage pattern. The entry point of the blade is visible on Figure 6.26, the straight incision indicated by the red arrow. That being said, although the fracture is linear, it does not follow the suture the whole way around the sphere; rather, it curves above and below the suture in almost a sine-wave pattern (also visible on Figure 6.26). It is unclear, therefore, whether this is a materials issue relating to the glue forming the suture line, or if this is instead an accurate representation of what would happen to a human cranium if the halberd were to puncture a cranial suture. Given the existing literature on the Synbone^{TM} and the conclusions that the proxy is highly accurate for wider-scope[25] ballistics testing, such as this experiment (Thali et al 2002, Kneubuehl and Thali 2003), I am inclined to conclude that the linear fracture is an accurate representation of a human cranial fracture. A similar fracture was observed in an animal (bovine) bone proxy in one ballistics test and was attributed to a high-velocity, high-energy impact (Rickman and Smith 2014:1483). It is reasonable to conclude, therefore, that this type of fracture only appeared on the seventh and final blow of the experiment because the wielder had become increasingly confident and competent through practice, resulting in a very assured and powerful blow, capable of causing this level of damage.

The wielder noted after each of the four blows that the halberd blade was quite difficult to extract from the sphere. The blade sunk ~15cm into the spheres with each blow, and each removal involved two people – one to hold the sphere down, and one to carefully pull out the blade. Were we not concerned about recording the damage from each blow, the wielder could have used their foot to hold down the sphere; either way, however, the movement is time-consuming and messy. This is noted at this juncture as it has a bearing on the development of the interpretative model in Chapter 9; it also informed the long bone experiments discussed in Section 6.5.

The second halberd blade was checked for bending deformation after every blow. Despite the similarity of blows with the first halberd, which bent significantly, the second halberd did not deform in this way. This could either be the result of the nuts-and-bolts riveting, or due to the increased confidence and power of each blow as the wielder becomes more experienced and accustomed to the weapon; these are the only differences between the two sets of experiments. However, the second halberd blade did not emerge unscathed from the trials. After the third blow, the wielder noted that the blade felt loose in its hafting socket. The nuts were tightened using a small wrench before the fourth blow, but they did not feel particularly loose. As shown above, the fourth blow was the most powerful, and

[25] The accuracy of Synbone^{TM} can decreases slightly at the (optic) microscopic level, or narrow-scope testing; this, however, is not an issue for this experiment, as the primary focus is the efficacy of the weapon rather than the fine detail of the specific tissue damage. Scanning Electron Microscopy increases the accuracy of the proxy, but is not widely available. Kneubuehl and Thali (2003), Rickman and Smith (2014)

the wielder again felt that the blade had become loose in its socket. As this fourth blow was the last one using the second halberd, the blade was removed from the haft and examined. A small amount of damage was discovered on the hafting plate: the central rivet had deformed its hole, enlarging the hole diameter and narrowing the (already quite thin) bridge of metal, making it difficult to tighten the rivet securely to the haft (Figure 6.26).

Figure 6.27 *– The second halberd blade after all four blows. The narrow, deformed metal bridge on the central rivet hole is indicated by a red arrow. The superficial discolouration of the bronze is due to the natural oils and resin in the oak handle.*

This is consistent with results from a large use-wear analysis of Irish halberds, which found that the back of the hafting plate was the area most vulnerable to damage (O'Flaherty 2002:149, 156). As the first halberd was riveted onto the haft, removing it to check for similar damage would in itself damage the blade; it is consequently unknown whether this rivet hole deformation is an inevitable result of using the halberd in combat, or whether it could be avoided by accurate riveting rather than by using nuts and bolts. The first halberd did not become loose in its socket during any of the testing, however, so it is unlikely that hole deformation occurred at any point, or the resulting looseness would have been noted. This finding partly answers one of the secondary research questions (Section 6.2.2) regarding the accuracy and applicability of replica weapons to archaeological research: the replicas are very useful, providing that they are as accurate as possible. Shortcuts to make their manufacture or use easier for the researcher (such as bolting the blade in place for ease of replacement) can compromise the results or introduce unwanted variables in the methodology.

6.5 Long Bone Experiments

The cranium proxy tests conclusively showed that the halberd was capable of inflicting mortal injury on an immobilised or prone opponent, in line with the precedent set by O'Flaherty (2007) and in answer to the first specific research question (Section 6.2.2). However, this mode of combat is very different to the hand-to-hand combat of mêlée conflict, whether between two or two hundred combatants (Jontzen 2010:430). The overarm swing, favoured by both the wielder in this study and in O'Flaherty's trial (2007), leaves the combatant's entire body highly exposed and easily targeted by a close-range dirk or short sword; the hafted halberd is too heavy to be wielded one-handed with accuracy and power, so the combatant cannot protect themself with a shield or buckler. It is possible that a shorter haft could be used alongside a shield (cf. Kristiansen 2002): this would be a very interesting focus for future work. The size of the hafted halberd and the long swing required to make a powerful blow mean that the halberd is not a quick weapon – a mobile opponent would have a few seconds to dodge or move (discussed in further detail in Section 7.4), and extracting the blade from a successful blow took time and finesse (Section 6.4.2), leaving the wielder vulnerable and exposed. The second research question concerns the applicability of the halberd to mêlée combat, as well as the controlled (or even the ubiquitous 'ritualised') combat simulated with a prone opponent. Incapacitating an opponent would remove the issue of dodging the powerful overarm blow. To disable an armed opponent, either their legs or arms must be rendered useless. Leg damage was selected for experimental simulation, on the basis that an immobile opponent would best result in the prone body simulated by the trials with the Synbone^{TM} spheres.

Two Synbone^{TM} generic long bones were prepared using ballistic gelatine; the filled polyurethane long bones therefore have the same material properties as the spheres (Section 6.3.7). The long bones were 30mm in diameter, with 5mm thick walls (the same wall thickness as the spheres) and were 265mm long. The bones were affixed to a desk leg using foam padding and medical tape so that the top of the bone was 490mm above ground level, which was as close to mimicking a mobile adult human's shin as could be managed with the materials and equipment available. It did, however, mean that the bone was fixed firmly in place and had an immovable base behind it: a real human shin is not generally strapped to a thick metal pole. Any connecting blow to the Synbone™ would therefore make a deeper cut or puncture because the impact would be inelastic (see O'Flaherty et al 2011 for an excellent example of the difference in damage between elastic and inelastic impacts on a metal edge; the principle holds for human tissue).

Figure 6.28 *– The long bone affixed to the desk using foam padding and medical tape; the wielder is demonstrating the sweeping horizontal blow used to mimic disabling an opponent.*

Buoyed by the success of the sphere experiments, the wielder took several non-contact practice swings to become accustomed to the different motion (Figure 6.27). Because of the damage to the hafting plate of the second halberd, the long bone tests were done with the first (accurately riveted) halberd, the bending deformation having been fully recorded beforehand.

Four blows were enacted using a horizontal, sweeping motion to attempt to pierce or break the bone. However, despite all four blows landing on target, the only incidents of inflicted damage were small lacerations of the rubber skin, and smaller (1-2cm), very shallow lacerations to the bone itself, which were all but invisible to the naked eye.

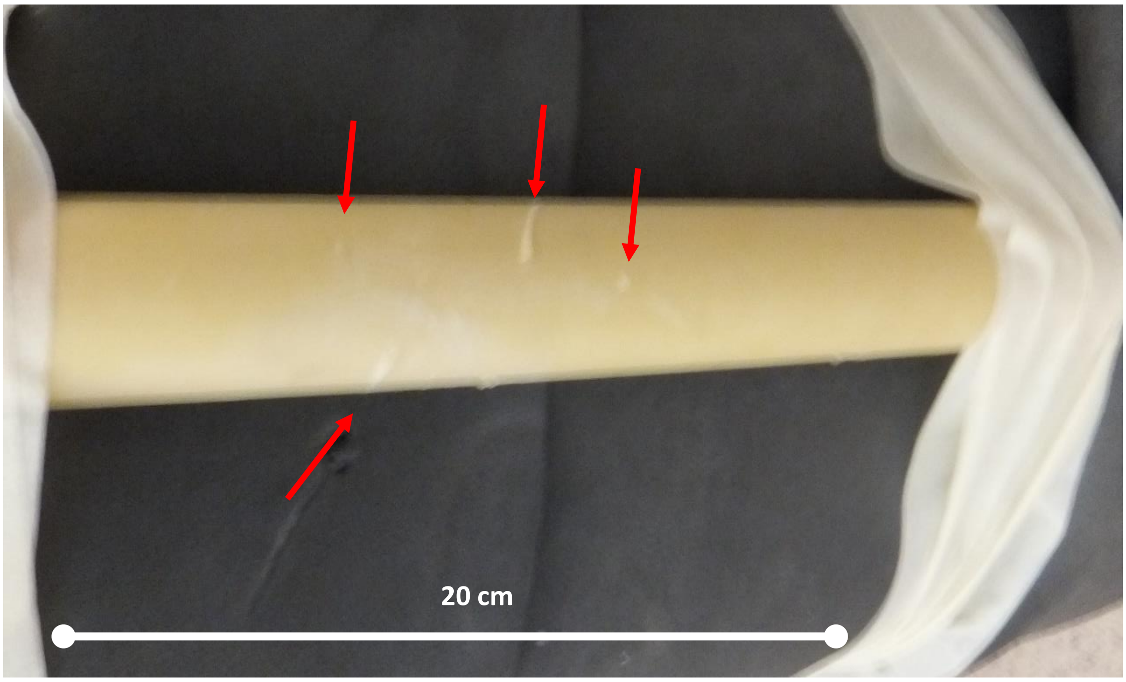

Figure 6.29 *– The four shallow lacerations resulting from the four horizontal blows; indicated by the red arrows, the damage is minimal and is quite difficult to see.*

Clearly, the halberd was not designed or intended for this kind of blow. The sweeping motion made it very difficult to aim accurately, even with practice. Without the momentum from an overarm swing, and without the wielder's weight and upper body strength behind it, the horizontal blows were not forceful enough to cause any meaningful (incapacitating) damage. Interestingly, a fifteenth-century text on the use of the pole-axe – a close approximation of the Bronze Age halberd – derisively notes that "long handled swinging strokes were easily countered and not greatly admired" (Angelo 1991:115). The swinging, scything strokes were shown experimentally to be inefficient and difficult to aim; historic literature concurs, and this section of the trial was concluded. Accordingly, the second long-bone was not used in testing these swinging blows because it was evident that the halberd was not suited to this motion and made no notable impact. However, an incapacitated opponent remains the most likely victim of a halberd's blow, as the efficacy of the blade in damaging the Synbone™ spheres showed. Another method of disabling an opponent would be through blunt-force trauma, which could be tested using the resources from this experimental set-up.

6.6 Blunt Force Trauma

Halberd research has tended to focus on the metal blades, because these survive and constitute the archaeological record. However, as noted in Section 6.3.6, the handle was by far the largest constituent part of the halberd, and it would have been highly unlikely for its offensive capabilities not to have been considered; research on the Thames Beater and on Native American blunt weaponry has shown the varied offensive capabilities of this kind of weapon (Eren et al 2016, Dyer and Finiger 2017). O'Flaherty (2007:430) noted that rock-art depictions of halberds often included a bulbous terminal (Figure 6.10 and 6.29); metal-hafted halberds from western and central Europe, interpreted as skeuomorphs of the more common wooden handles (Needham et al 2015:16), also have a flare or protrusion at the base of the handle (Horn 2014:63, see also Figure 6.30). Experimentally, it has been shown that a straight, smooth handle does not hinder the grip or security of a powerful overhead or sideways blow (Section 6.4); the wide terminals could therefore be used to trip an opponent, or to provide a wider clubbing surface if the handle were to be used as a blunt-force weapon, like a club.

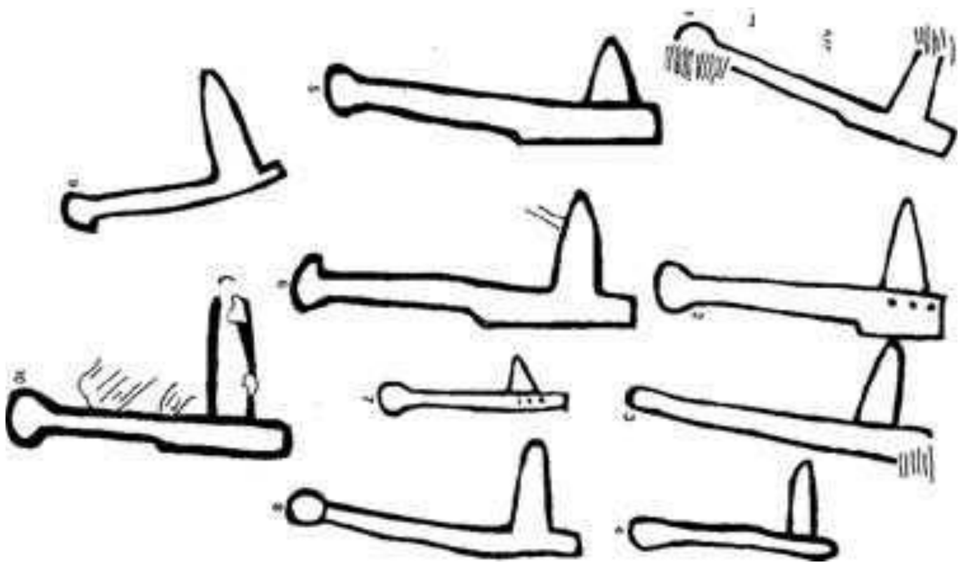

Figure 6.30 *– Rock art showing halberds with bulbous handles from the High Atlas Mountains, Morocco (O'Flaherty 2007:430, after Chenorkian 1988).*

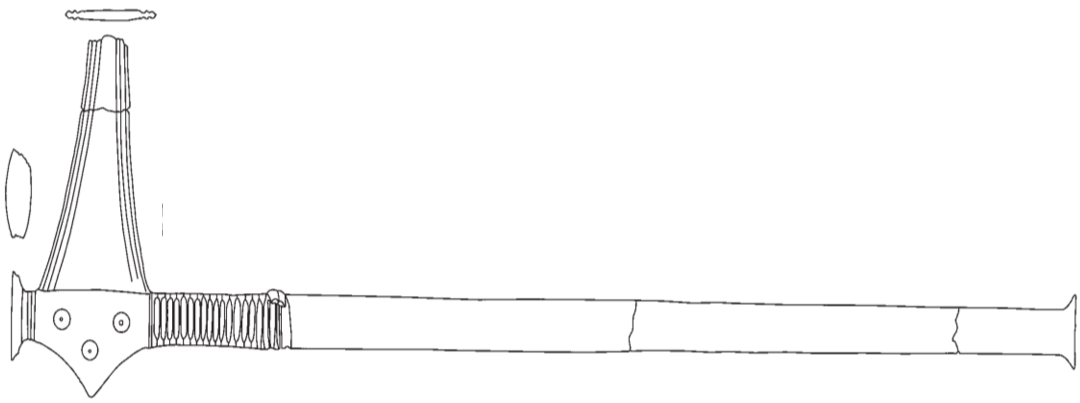

Figure 6.31 *– A metal-hafted halberd from Glasin, Germany, with a flared handle base. Horn (2014: Plate 53).*

The second Synbone^{TM} long bone was therefore used to test whether the hafted halberd could be used as club with sufficient force to break the rubber skin on the proxy, or even to cause the radiating fractures typical of blunt force trauma injuries in humans (Moraitis et al 2008).

The Synbone^{TM} was again affixed to a secure desk leg using foam padding and medical tape, at a maximum height of 490mm above ground, so as best to mimic an upright adult human's shin. The clubbing motion involved the wielder bringing the handle from shoulder-height down across the body, and following the motion through to make contact with the 'shin'. Immediately, however, the wielder had great difficulty: the halberd blade flexes in the socket, and it is difficult to club with enough force to break the Synbone^{TM} skin without the blade flashing very close to the wielder's face and ears. Three attempts were made with the upright Synbone^{TM} and the diagonal cross-body club motion, but none of the impacts inflicted any damage at all, and there was increasing concern for the wielder's safety: this section of the experiment was deemed unsuccessful, and halted accordingly.

Figure 6.32 *– The first attempt at a blunt-force trauma test; the blade can be seen close to the wielder's shoulder and elbow, which caused some safety concerns. Image courtesy of Prof. Ian Ralston.*

The Synbone^{TM} was repositioned flat on some of the padding used for the spheres, 150mm above floor level. Although this was not the best analogue for an upright able-bodied opponent, it did allow for a more forceful (and safer) clubbing blow to be tested, to give some indication of the handle's capabilities as a blunt weapon. The experimental setup is shown in Figure 6.33. The resulting connecting blow was a much safer and more powerful impact; there remained, however, several limitations with this test which are discussed below.

Figure 6.33 *– The second experimental blunt-force trauma setup, with the long Synbone^{TM} tube flat on the floor padding, and the connecting forceful vertical clubbing blow.*

With this arrangement of bone and padding, and a linear vertical clubbing blow that did not involve bringing the halberd across the body, the wielder was able to make one very powerful clubbing blow to the bone (shown in Figure 6.33). However, as the Synbone^{TM} was not secured to the padding, the force of the connecting blow caused the bone to shuck and bounce away from the point of impact, severely reducing the transmitted force from the impact. Consequently, no visible blunt-force damage was inflicted by the halberd handle.

The long Synbone^{TM} was reset on the padding, and taped down at each end using medical tape. A second vertical clubbing blow, identical to the preceding one, was inflicted on the bone. Again, the Synbone™ bounced away from the point of impact, despite the medical tape. No visible damage was recorded on the bone; neither of the blunt-force impacts had even broken the rubber skin. The limitations of the test were recognised as being too restrictive, and the test was concluded.

6.7 Interim Results

The blunt-force trauma tests were too limited to draw robust conclusions. It was evident that the long Synbone™ tubes were not suited to testing the clubbing blows; if a skeletal proxy were to be used to test the blunt-force capabilities, a sphere would be better because it provides a much bigger surface area and can be securely positioned on a cork ring, make it much less likely to bounce or shuck away from the impact. However, it is unlikely that the hafted halberd – a long weapon with a sizeable, very sharp, blade at one end – would have been suited to this type of use. The clubbing capabilities are assumed to have been used to incapacitate or disable an opponent, to render them prone on the ground so that the halberd blade could be used as a killing strike. It is improbable, therefore, that the clubbing blow would have been aimed at the head: easily dodged or ducked, such a blow would also have left the wielder vulnerable to attack, and avoiding the blade as it passes over the shoulder and by the head and neck would also have required a lot of skill and training. The long bones were therefore the most appropriate human skeletal tissue proxy in the circumstances; that no damage was inflicted should not be seen as a limitation of the weapon, but of the experiment. Although breaking the bones in the ankle, shin or shoulder would incapacitate an opponent, inflicting soft-tissue damage, particularly to the abdomen, would also render someone prone or stunned, and could not be tested within the experiments designed and reported here. Similarly, although the sphere experiments conclusively showed that the halberd could inflict mortal injury to the cranium, specific positions for the victim and attacker were required. During the sphere experiments, it was postulated that a similar overarm blow inflicted on an upright opponent would also cause mortal injury, because the blade would target the neck, shoulders and upper torso. It was further speculated that such a blow could utilise the edges of the halberd blade to drag the weapon through an opponent's torso, inflicting a much larger amount of damage than the clean, in-and-out puncture of the blade in the Synbone™ spheres[26]. A soft-tissue proxy would be necessary to establish the extent of the handle's blunt force capabilities, and whether the edges of the blade could be used to enlarge a sharp puncture wound to inflict more damage.

6.8 Experiments on an upright opponent

6.8.1 A note on circumstances

The following section addresses some of the questions inferred from the experimental data gathered from the preceding sections in this chapter. It will be immediately apparent that these final Synbone experiments were conducted under very challenging conditions: these tests were undertaken in February 2021 during the third full lockdown in Scotland, in my garden rather than the university laboratory or clean room (as with the soft tissue experiments), with my partner and daughter present rather than a skilled audience and range of wielders. This is not, however, to suggest that the data obtained were compromised as a result, only that there were several uncontrollable variables which under easier circumstances would have been addressed and controlled more fully. The weapon and Synbone were the same as were used in the previous experiments in this chapter, and the soft-tissue experiments detailed in the following chapter: the issues arose in accessibility and audience engagement, though the data resulting from this was nevertheless very valuable (see Section 6.8.5).

6.8.2 Rationalisation

The skeletal trauma experiments discussed in this chapter were all designed to mimic a prone opponent; the halberd is capable of causing mortal injury to someone lying or kneeling on the ground. This is upheld by rock art depictions of wielders brandishing a halberd over their heads; not a pose designed for melee combat in close quarters. The wielders in the previous experiments in this chapter concurred, noting that the overhead swing felt powerful but took time to line up properly, and that they felt very exposed: they also noted that the blow could be easily deflected or hindered by people pushing,

[26] This transpired during mid-experiment conversation between the author, Prof. Ian Ralston, and Andrew Barlow, all of the University of Edinburgh, and Joe Jones, a researcher at The University of Kent, Canterbury.

snagging, or otherwise interfering with the halberd as it makes its long arc over the wielders head and down onto the target, further reducing its efficacy as a melee weapon.

The data gathered so far suggested that the halberd would not fare well as a melee combat weapon, and that inflicted damage would be increase proportional to the increase in relative height difference. To substantiate these phenomenological findings, two further Synbone spheres were prepared and placed on a frame at 1.6-7m above the ground, to simulate a standing human (see Figure 6.8.1 for further detail). Although the spheres would not duck, dodge or react like a living human would, this arrangement is sufficient to establish whether the halberd could be effectively wielded in melee combat.

Figure 6.8.1. The Synbone sphere on the frame, with a 2m scale for reference. Measuring from the flagstones, the sphere is 1.6m (5ft 3in) from the ground; stepping down and measuring from the grass, the sphere is 1.75m (5ft 9in) from the ground.

6.8.3 Testing melee combat: negligible relative height difference

All of the blows in this section were inflicted by a male wielder, 1.78m (5ft 10in) tall. Bronze Age adult men in the Mediterranean were 1.66m tall on average, with women at a much shorter 1.52m (Hermanussen 2003); northern European people have been shown to be consistently taller than their Mediterranean counterparts by 1-2cm from the Neolithic period onwards (Cox et al 2019). The frame supporting the Synbone spheres is therefore appropriate to the average Bronze Age human when measured from the flagstones (1.6m), as well as providing a method of assessing what damage can be inflicted by a wielder of the same height as their opponent (measuring from the grass, 1.75m).

The first blow was inflicted by the wielder standing on the grass, so that the Synbone was at the height of the head of a 1.75m adult standing upright and there was therefore no relative height difference between wielder and target. The wielder immediately had a problem with lining up the blow; visible in Figure 6.8.2, securely holding the halberd handle with hands around 30cm apart creates a twist in the shoulders. The wielders' bodies had straightened out by the time the halberd blade hits the floor in the previous experiments, so this twist was not noted until now; however, when the halberd is being aimed at a much higher target, the wielder's body is still angled, making aiming more difficult. As a result, the first blow, as shown below, went wide and missed the sphere.

***Figure 6.8.2.* The first blow, with no relative height difference: the halberd blade can clearly be seen missing the target.**

The second, more forceful blow from this angle was more successful, making contact with the sphere and piercing the rubber skin to around 11mm, though inflicting only shallow damage (<1mm) to the bone analogue itself. Although blood loss and sepsis should not be discounted, this damage is a far cry from the mortal injury capable of being inflicted by the halberd on a prone opponent.

Figure 6.8.3. The second blow with no relative height difference. Note the acute angle of impact between the blade and sphere due to the higher target.

Figure 6.8.4. Damage inflicted by the second blow with no relative height difference. The rubber skin has been pierces, and the miniscule damage to the underlying bone is visible on the right of the cut.

A third further blow again connected with the sphere, delivered with all of the force the wielder could manage. Again, a small amount of damage to the rubber skin (11mm) and negligible skeletal damage (a 2-3mm pierced indent) was inflicted.

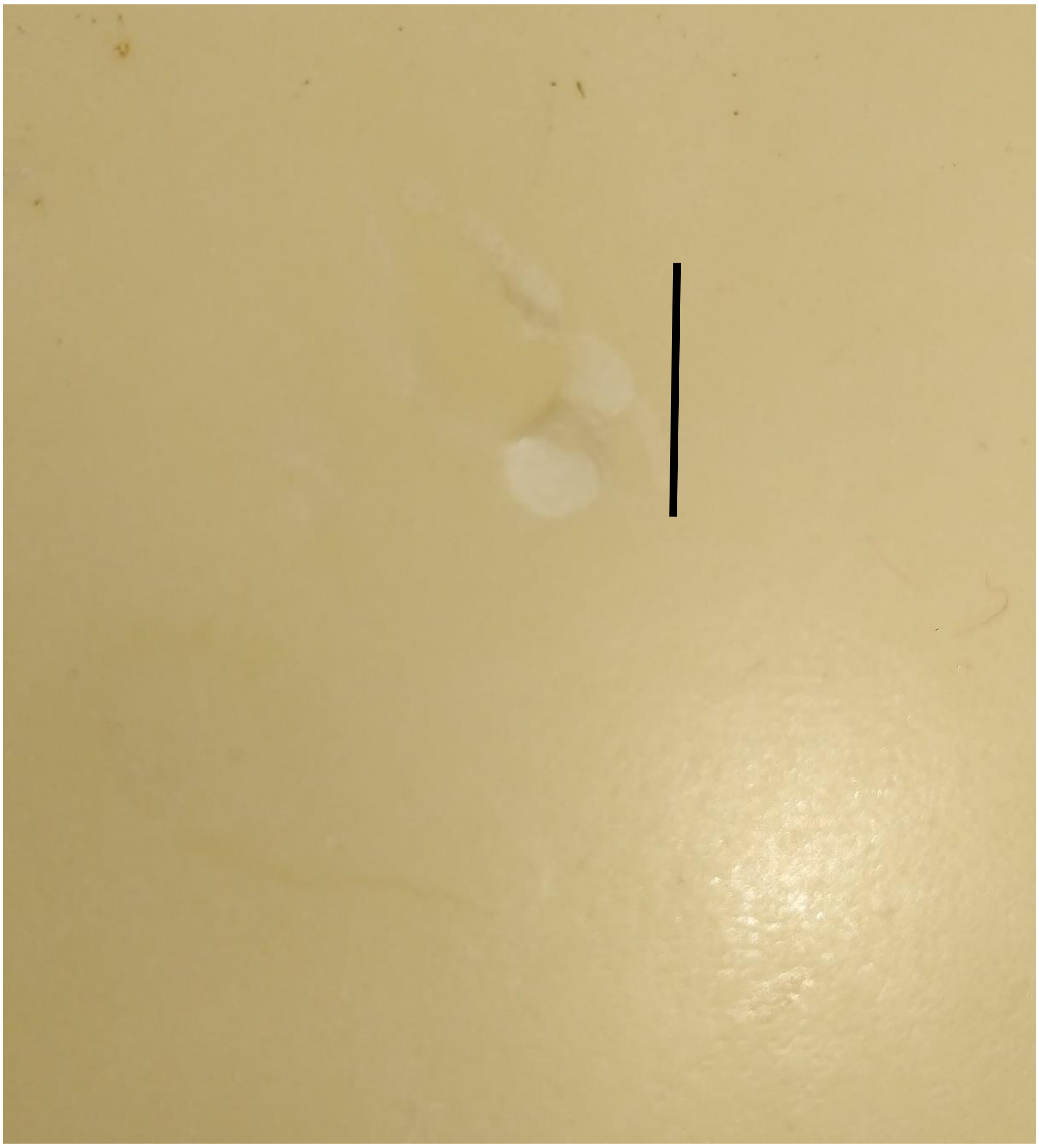

Figure 6.8.5. Damage inflicted by the third blow with negligible height difference. The piercing damage to the skeletal material is visible at the bottom, with ripping or slicing damage to the rubber skin radiating upwards. Scale bar is 10mm.

6.8.4 Testing melee combat: 10cm relative height difference

The second sphere was then placed on the frame and the wielder moved to the flagstones, creating a relative height difference of 10cm. Three further blows were made by the wielder, who reported it slightly easier to aim at the lower target: all four blows connected with the Synbone, inflicting superficial damage each time.

Figure 6.8.6. The wielder positioned on the flagstones demonstrating the blows in this section; the relative height difference (10cm) between the target and wielder can be seen.

Figure 6.8.7. The first blow with a relative height difference; a small (<10mm) superficial bone flake has been detached, but blow has not pierced the skull completely

Figure 6.8.8. The second blow with a relative height difference; very similar to the first blow, another small flake (10mm) has been detached but the blow has again failed to pierce the sphere completely.

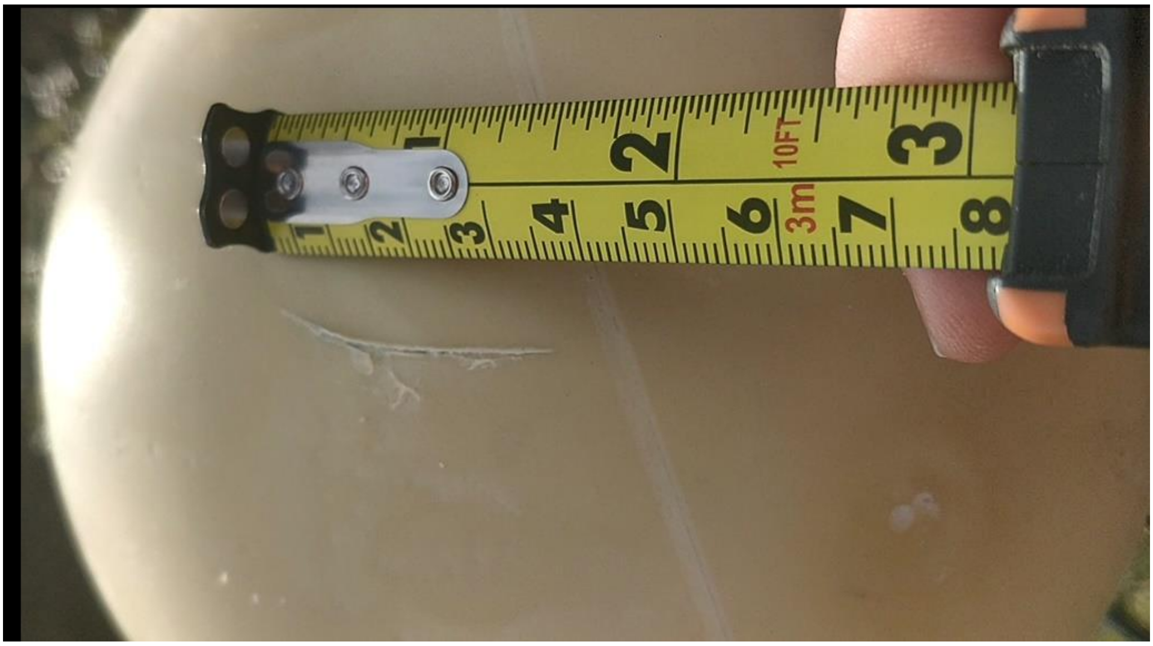

Figure 6.8.9. The third and final blow. This blow caused no damage to the skeletal material but did slice the rubber skin in a 35mm long scratch.

These three blows produced similar levels of damage: slicing skin and on two, detaching small superficial bone flakes. Enacting a blow from a slightly higher vantage point has caused more damage, but the level of harm is again a far cry from the decisive mortal injuries seen in the preceding sections. In melee combat, an upright opponent would certainly be disadvantaged by these injuries through dizziness, blood loss, pain, and potentially obscured vision. They would not, however, be incapacitated, and this is crucial in modelling how the halberd can be used most effectively. The long blows made by the wielder leave their torso, legs and the back of their neck and head extremely exposed; the two-handed grip leaves no hand free for a shield or defensive dirk. Even in one-on-one combat against an opponent capable of fighting back, the halberd does not inflict enough damage to compensate for the vulnerabilities it creates. The handle on this replica halberd is 1m long, but this does not keep the wielder at a safe distance from their opponent – the images above show that the wielder has to come within arm's reach of an upright opponent to land a secure, accurately-aimed blow, well within range of a counterstrike. The potential for using the halberd to inflict debilitating blows to the shoulders or torso of an upright opponent is discussed at length in the next chapter, where soft tissue analogues are used. The experiments with an upright opponent here, however, show conclusively that the halberd is not suited to melee combat against an opponent capable of retaliating.

6.8.5 Further experiments regarding relative height differences

It is worth noting at this stage that there is a correlation between damage inflicted and the relative height difference between wielder and opponent, determined by the angle of impact. The closer the angle of impact to 180°, the greater the inflicted damage. Even the small difference of 10cm between the grass and flagstones tested here resulted in a visible, ~10° change to the impact angle and a consequent small increase in inflicted damage.

Figure 6.8.10. The difference in impact angles between the grass (left, no relative height difference) and flagstones (right, 10cm relative height difference), measured from the halberd tip long the midrib against the impacted surface of the Synbone.

The point is belaboured here because the angle of impact on a prone opponent, as seen in the previous sections, is almost 180° and the inflicted damage is severe. The different wielders could be a factor here – that stronger people did the prone opponent experiments, and that the impact angle is not the significant variable. One final unexpected experiment in this section should serve to disprove this and indicate the primary importance of relative height differences.

As noted at the start of Section 6.8, these experiments were conducted at home during the third major lockdown of the coronavirus pandemic in Scotland; as such, I used these experiments as an opportunity for homeschooling and non-traditional audience engagement with my daughter, who was remote learning in Primary 1 at the time. She helped us set up and record the experiments described above, and once I thought I was finished, had a turn with the halberd on the undamaged underside of the second Synbone sphere.

Figure 6.8.11. Non-traditional audience participation, or balancing homeschooling with work.

Ada is 1.3m tall, 5 years old, and no more or less strong than an average 5 year old would be. After a few practice swings with the halberd, mimicking the experimental blows inflicted on the spheres by her father detailed above, and getting used to the feel of the weapon, she made two distinct blows that connected with the sphere at a 180° angle both of which dealt significant, lethal, damage. Fortunately, I was able to record the second blow as it was happening.

Figure 6.8.12. The second of the two unexpected final blows of the experiment; although the camera angle is head on, rather than in profile, nevertheless the halberd blade (inset) can be seen to have pierced the Synbone and sunk into the cranium by several centimetres and caused a long lateral fracture. The damage from the first of the unexpected final blows can be seen to the left of the blade.

Needless to say, this was not one of the hypothesised outcomes of this section of experiments, but working within a reflexive and adaptive framework informed by queer theory, data is data and the results stand. The halberd is capable of inflicting mortal injury when wielded by someone who is *significantly taller than the target.* Prior training, upper body strength, weapon aptitude, or intent to kill are not the significant factors in determining lethal damage, but relative height difference is.

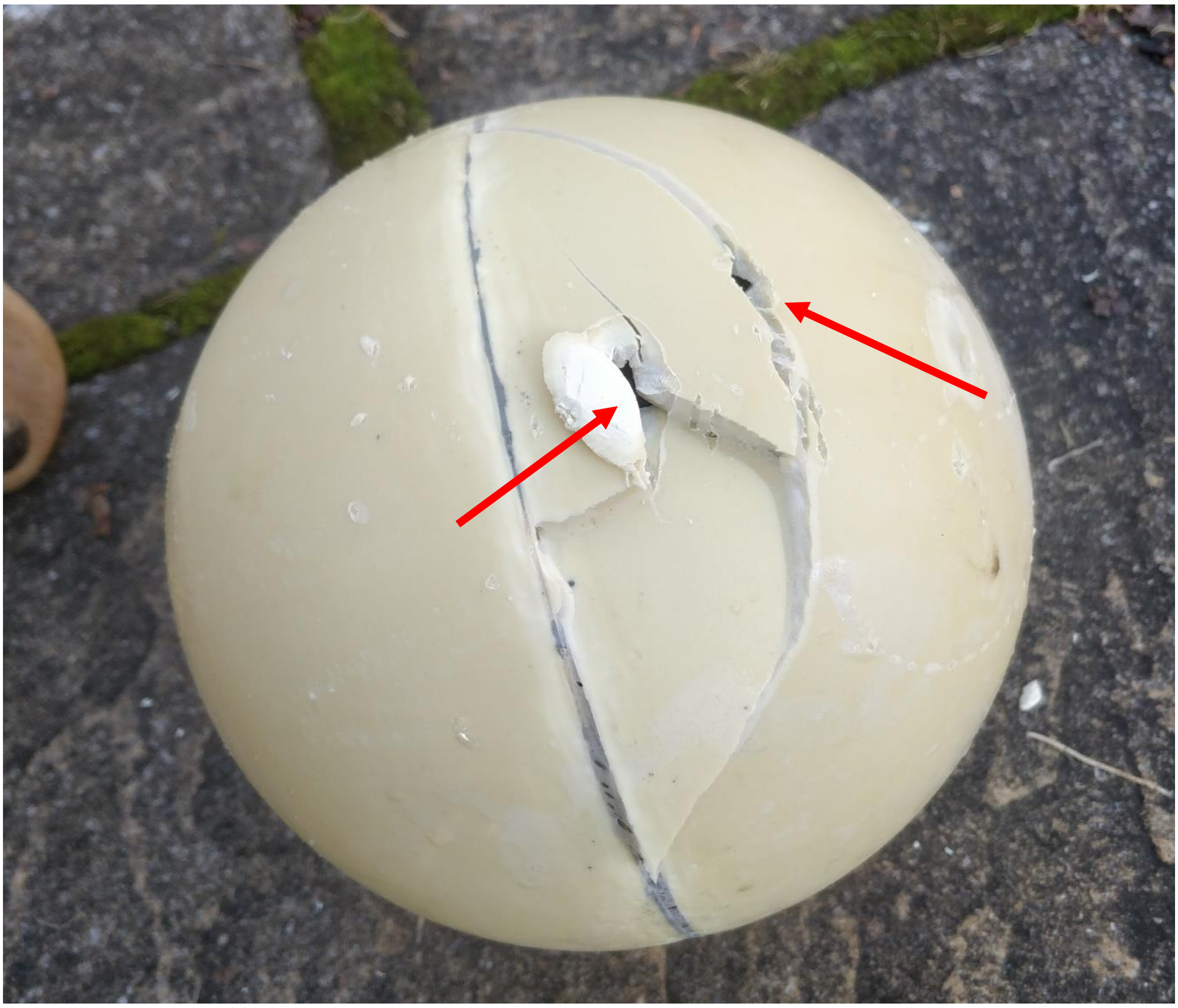

Figure 6.8.13. The two piercing blows inflicted by my daughter (red arrows) and the resultant lateral fracture from the second blow.

6.8.6 Interim conclusions

The first two sets of experiments with the Synbone placed on a 1.6m-1.7m frame to represent a standing adult human showed that the halberd is not an ideal weapon to use offensively in melee combat against an opponent capable of fighting back for two main reasons: it leaves the wielder very vulnerable to counterattack, and does not inflict significant damage when used as a punching blade. The small 10cm relative height difference was shown to make a demonstrable difference to the severity of damage and the ease with which it can be inflicted; further experiments with my daughter showed conclusively that the halberd is a devastatingly effective weapon when wielded by anyone when there is a significant height difference between wielder and target. This should be taken literally: there is therefore no reason why someone could not wield the halberd while seated if their opponent was prone, so being able-bodied is not a prerequisite for dealing mortal damage. Nor should age be assumed: my five year old is not particularly strong yet dealt severe damage, and we can thus infer than old age or other physical weakness would not prevent effective wielding also.

Chapter 7 – Soft Tissue Experiments Using The Replica Halberd

The preceding chapter demonstrated that the replica halberd was capable of inflicting significant damage on a human skeletal tissue proxy, particularly on a prone and immobilised opponent or when there was a pronounced height difference between wielder and target. The halberd could have been used to render the opponent thus by targeting the opponent's torso and limbs, as described by the second specific research question for this and the preceding chapter (Section 6.2.2). In order to establish the capabilities and limitations of the halberd in inflicting debilitating but not necessarily mortal injury, a further experiment was undertaken, this time using soft tissue.

7.1 Rationale

The Synbone™ experiments provided a number of perspectives on the use and limitations of the replica halberd. It was shown that the halberd was unquestionably suited to damaging the Synbone™ spheres, whether hitting the spheres on the floor (or only raised by 250mm). To render the opponent prone and immobilised, so that an effective blow to the cranium could be delivered, the opponent should be injured to such an extent as to prevent them moving away (assuming that the opponent was fully mobile beforehand, and not disabled in any way). Blunt-force experiments using Synbone™ long bones and the halberd haft proved unsuccessful in that no significant damage was caused, but the halberd blade could have been used to inflict non-fatal injuries to the torso and limbs to incapacitate an upright fully mobile opponent, resulting in them collapsing and lying prone and still on the ground, when the cranial blow could be inflicted more readily and with less danger to the wielder. A soft-tissue experiment was therefore designed to test this hypothesis, by mimicking an upright adult human's torso as accurately as was feasible. Soft tissue-specific research questions are:

(1) Is the halberd capable of inflicting debilitating injury to the soft tissue that would render the victim immobilised and prone on the ground?

(2) Is the halberd capable of inflicting potentially fatal injury to the soft tissue? This would involve being able to 'drag' the blade downwards after impact, elongating and opening up the wound and causing sufficient bleeding to kill an opponent.

This second question also addresses the interpretation of the halberds as being capable of scything or hooking damage (Brandherm 2004:322, Horn 2013:108), where the long edges of the blade are assumed to be sharp enough to slice through muscle, connective tissues, and possibly even bone (the mechanisms of the inflicted damage). This mode of use is proposed here as a counterpoint to the 'punching', point-first incision favoured by O'Flaherty (2002) and Dolfini (2011), and which was utilised in the experiments in Chapter 6. The experiments in this chapter are an appropriate medium by which to test the halberds' potential as scything weapons, as well as punching.

7.2 Human Soft-tissue Proxy

The replica dirk experiments discussed in Chapter 3 included a discussion on the merits of using pig flesh as a proxy for human tissue (Section 3.5). Two salient points are:

While porcine hypodermal layers tend to be thicker than human, this is less of an issue for the torso and upper limbs, where human skin thickens.

Porcine skin is very similar to human skin in terms of its attachment to subcutaneous tissue, healing rates, subcutaneous blood supply, and hair follicle structure and density.

Furthermore, an adult pig torso is only slightly smaller and less dense than an adult Bronze Age human of average height – height estimates from Bronze Age skeletons in Britain range from 1.66-1.71m, slightly shorter than a modern adult human male (1.78m), and the torso's mass and density would therefore be more comparable to a large pig (O'Donnabhain and Lozada 2014:68).

Although pig bone is generally thicker and denser than human bone, which could be an issue in this experiment, this is much less significant in the case of pig and human ribs. Pig and human rib bones are broadly analogous: both are similarly constructed of a thin outer layer of cortical bone surrounding a core of red bone marrow, which consists mainly of hematopoietic tissue (a dense red spongy material that produces red blood cells) (Bibrair and Frenette 2016). Porcine ribs have a thicker outer layer of cortical bone than humans, which could negatively affect the outcome of the soft tissue tests. Furthermore, porcine ribs are attached to the spine through long, thick costal cartilages; the upper seven ribs (sternal ribs) have particularly long costal cartilages compared to the rib bone, almost one third of the rib length. This is a much higher proportion of cartilage to bone in the sternal ribs than in the equivalent portion of humans, and although the costal cartilage can be very hard, it is not structurally comparable to bone (University of Guelph Department of Animal Biosciences 2017, *Breakdown of porcine anatomy*, University of Guelph, viewed 1st February 2017, <http://www.aps.uoguelph.ca/~swatland/ch2_1.htm>). Damage to the porcine costal cartilage is thus not an accurate analogue for damage to a human rib bone. Care must therefore be taken to test weapon damage to the porcine rib bone itself, which, if it is observed, indicates that the halberd would be equally as capable of damaging human rib bone. Furthermore, because the pig limb was successfully deployed as a human tissue analogue to test the replica dirk (Section 3.5), this sustains the case for using porcine soft tissue as an analogue for human tissue.

Two pieces of pig tissue were selected to best represent the range of tissue types found in an adult human torso. A neck and shoulder joint, with scapula, spine (atlas to T2 vertebrae inclusive), sternum and upper four ribs intact, and a belly piece with all twelve ribs intact, were considered suitably to replicate soft tissue damage to a human torso. These pieces were brought to room temperature, 36 hours after slaughter, prior to their use in the experiments. As this experiment took place in early January, these body parts had a much thinner subdermal fat layer (4mm) than at other times from the increased energy expenditure over the cold winter period, thereby minimising the issue of human epidermises normally being thinner than those of pigs.

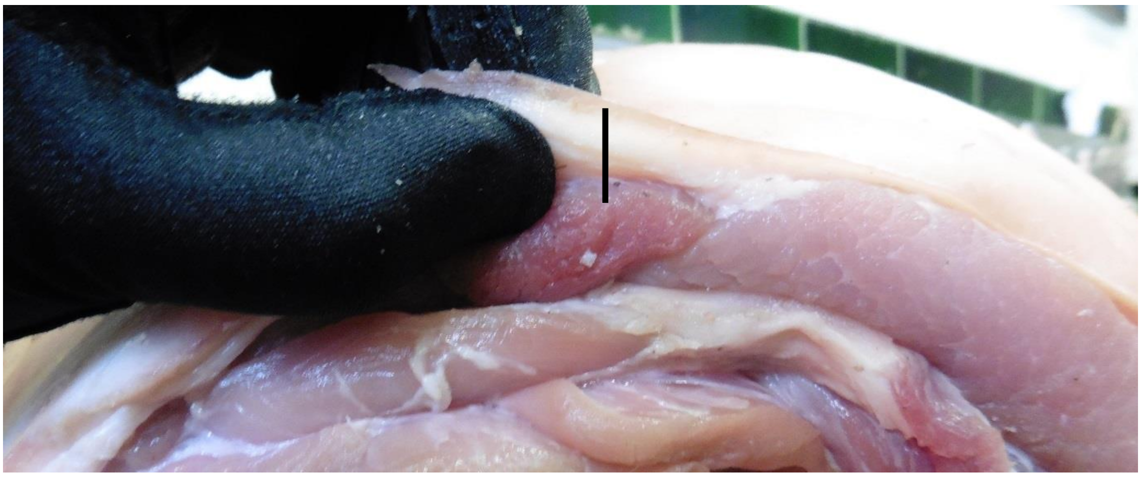

Figure 7.1 *– The thin (4mm) epidermal layer on the shoulder and neck joint piece of porcine tissue; this is a close analogue to human tissue. The black bar represents 1cm.*

The shoulder joint was placed on a thick wooden butcher's block, 900mm high, as it was too difficult to securely suspend on a hook due to its shape.

Figure 7.2 *– The pig shoulder/neck joint on the butchers' block before any blows were inflicted; the atlas vertebrae are visible at the top of the joint.*

The belly piece was suspended on a meat hook so that the top of the piece was 1.7m above the ground, accurately to reflect an upright adult human opponent. Because the belly piece was butchered by splitting the pig in half from neck to pelvis, it offered in due course the opportunity to establish the internal damage inflicted by the halberd, a unique prospect in this study, and – to my knowledge – in any published replica weapon test to date. Using the belly piece meant that it is possible to see whether the blade was capable of piercing the ribcage and puncturing a lung, for instance.

Figure 7.3 *– The pig belly and ribcage suspended from a meat hook, 1.7m above the ground. The thick rib bones comprising the sternum can be seen in cross-section at the top of the piece.*

7.3 Soft-tissue Experiments

During the interval between the skeletal and soft tissue experiments, the replica halberd blades that had been bent and deformed upon impact with the Synbone™ were cold-hammered straight (see also Section 3.5). Despite the modern iron anvil and hammer used by the technicians at the metal workshop in Edinburgh College of Art, on balance, the author concluded that an inauthentic repair was preferable to not undertaking the soft tissue trials, or attempting them with a weapon which was already damaged at the outset. There were neither time nor resources available to investigate and procure a stone anvil and hammerstone to maintain as close an analogue with the EBA as possible. The same reasoning underpinned the halberd repairs; furthermore, it would be much more difficult to identify similar profile deformation damage occurring during the soft tissue experiments on an already-bent blade.

The soft tissue experiments took place at the butcher's storage area[27] on 11th January 2017. The two meat pieces had been removed from refrigerated storage 12 hours previously, and both registered an internal temperature of 10°C, slightly cooler than room temperature and much cooler than normal human body temperature (~37°C), but warm enough to ensure that the sub-dermal fat layer had softened to a closer approximation of living human skin. The cool temperature was necessary to prevent the tissue from spoiling or rotting – a necessary compromise between academic research and food hygiene standards. The shoulder joint was the first piece to be tested, because it had come out of refrigeration first. As shown in Figure 7.2, the shoulder joint was placed on a wooden block 900mm above the ground; relative to the halberd-wielder, this height mimicked a kneeling adult opponent. The wielder (for all blows unless otherwise stated) was a right-handed woman, 1.7m tall, weighing 85kg.

The first blow to the shoulder joint was aimed at the area of thick muscle by the nape of the neck, avoiding as much of the thick bone as possible. The blow was the same swinging overarm motion as described and used in Chapter 6. The halberd successfully damaged the joint, inflicting a 6.5cm deep blow which severed tendons, connective and soft tissues, and scraped the edge of the scapula. There was no way of dragging the blade downwards to extend the wound, because the halberd was incapable of damaging the large, dense scapula.

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[27] J Proctor Butchers, 1 Kents Bank Road, Grange-over-Sands, Cumbria LA11 7HF

Figure 7.4 *– The shoulder joint after the first blow.*

The halberd was much easier to remove from the porcine tissue than from the Synbone^{TM} spheres, although this may have been because the blade did not penetrate the muscle tissue quite as deeply as it had the Synbone^{TM}. As expected, the thick animal bone hindered the progress of the blow and prevented the wielder from using the long halberd edges to cut through the softer tissues.

The second blow was aimed slightly higher up the joint in order again to avoid the thick scapula. This resulted in a much deeper penetrative blow (~15cm), predominantly through thick muscle. However, even with the full weight of the wielder on the halberd, the long edges of the blade were not capable of slicing through the tissue, and no ‘dragging’ or severing damage could be inflicted. Furthermore, the depth of the blow meant that the tip and edge of the blade scraped the scapula, which snagged against the long edge and caused damage to this part of the blade (Figure 7.6). The flaking material loss on the edge of the halberd is seen in the archaeological record, but could also be ascribed to post-depositional taphonomic processes, such as damage by shifting stones or hard roots (NMW 84.83H.1, ABDUA 19677, BM 1905 1106.3).

Figure 7.5 *– The second blow, which penetrated 15cm of the soft tissue (mostly muscle). It can be seen that the wound was not extended downwards; the incision is not any wider than the blade.*

Figure 7.6 *– The small U-shaped notching edge damage caused by the replica blade snagging on the scapula.*

The two blows to the shoulder joint had thus shown the capabilities and limitations of the halberd with thick soft tissue and animal bone. It was not possible to use this joint for a further blow: the area of dense muscle and absence of bone around the shoulder and upper back which was chosen as a human soft tissue proxy was not large, and the two inflicted blows were placed far apart enough to keep the resulting damage as separate impacts. There was not enough space left to enact a third blow without hitting bone and/or having the incisions overlap. The shoulder joint was therefore set aside, and the long torso piece was set up.

As shown in Figure 7.3, the second soft tissue analogue was a long (750mm) piece incorporating the ribcage, sternum and abdomen of a pig, butchered laterally (neck to pelvis). The pig abdomen did not contain any skeletal material, thus offering a large area of soft muscle and connective tissue on which to experiment, with particular reference to whether the halberd's long edges could slice through soft tissue, elongating the wound, as identified in Research Aim 2 (Section 3.3.1). The meat piece was suspended from a meat hook set at a height of 1.7m, and was designed to mimic the torso of an upright adult human; it was also able to swing freely upon impact – unlike the supported shoulder joint, and the cushioned Synbone^{TM} spheres and long bone (Sections 6.4.2 and 6.5).

The third blow of the halberd (the first blow to the suspended belly piece) was aimed into the abdominal soft tissue, avoiding the ribcage and sternum. The blow completely penetrated the thick muscle and connective tissue, and the long edge of the blade sliced 9mm downwards into the flesh as a result of the lateral drag force of the blow. If the pig had still been completely intact, the tip of the blade would have punctured some of the internal organs including the liver and stomach, making this a potentially fatal blow.

Figure 7.7 *– The third blow. Left: the complete penetration of the abdominal muscle by the halberd. Right: the incised damage. The 9mm of drag damage is clearly visible at the bottom of the wound, where the angle of incision changes as the halberd blade was dragged downwards.*

The fourth blow, however, was less impressive: the belly piece, suspended from a hook and hanging away from the wall (Figure 7.7) was pushed backwards from the force of the impact, resulting in a glancing blow that sliced through the epidermis and sub-dermal fat layer, but made no impression on the thicker muscle and connective tissue below.

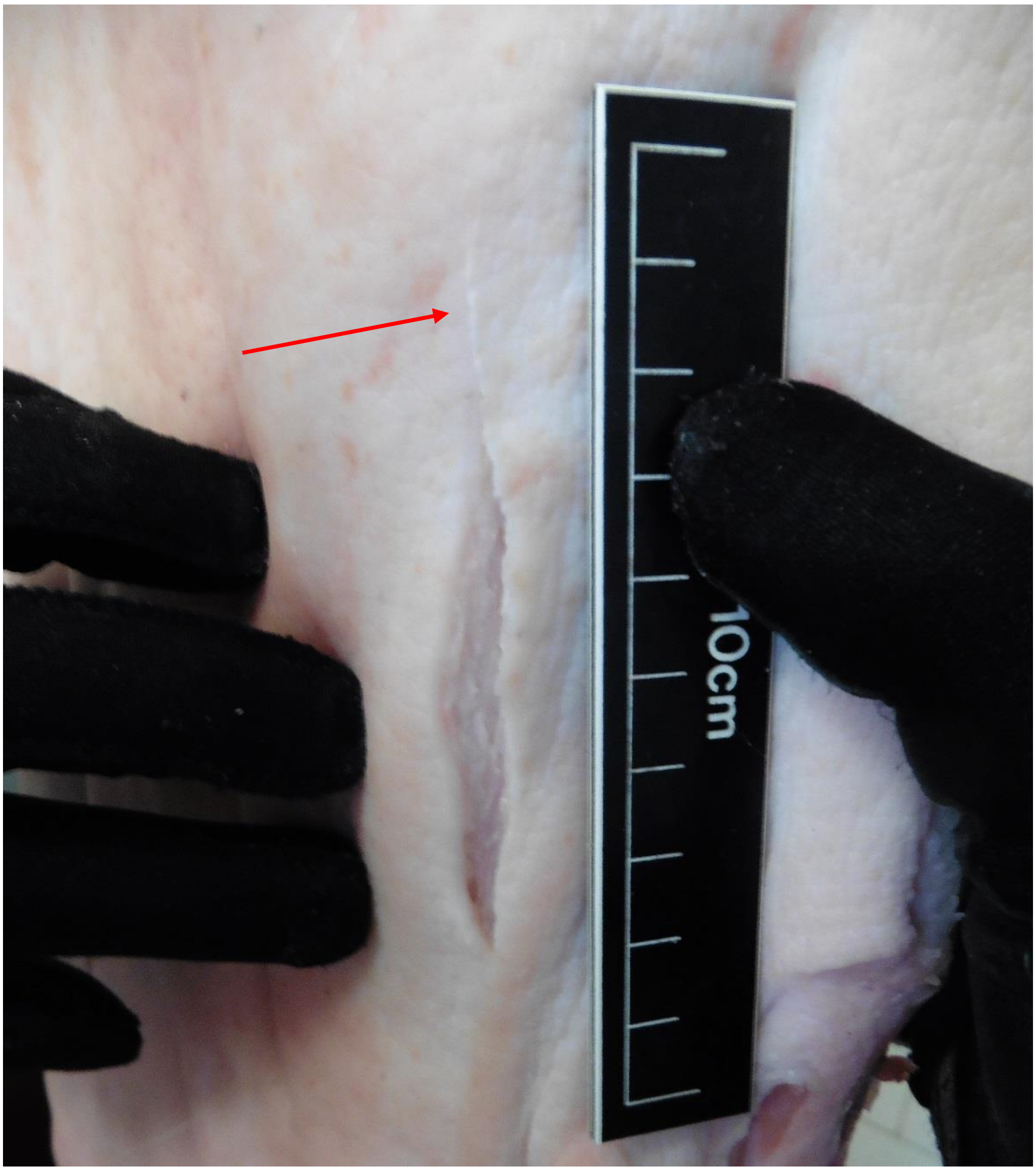

Figure 7.8 *– The fourth blow, which failed to penetrate the muscle and connective tissue. The epidermis and sub-dermal fat layer were sliced open. The scratch (red arrow) shows where the tip of the blade only scraped the skin, resulting in a glancing, superficial blow.*

The fifth blow, however, yielded more positive results. Aimed at the sternum, this blow severed the thick cartilage and dense connective tissues in the middle of the ribcage, although once again the blade snagged and caught on the rib bones. The long edge of the blade also caused a significant amount of damage when dragged downwards, almost doubling the length of the inflicted wound in the process. Interestingly, it was not contact with a rib bone that stopped the downwards trajectory of the halberd edge, but the dermal layer: as seen in Figure 7.9, the skin has wrinkled and folded at the bottom of the incision, the additional thickness preventing the blade from continuing downwards. This supports the preliminary findings discussed in Section 6.7, that the halberd is best suited to deliver powerful punching blows where the damage is inflicted through the tip of the blade, and is less suited to slicing damage inflicted by the edges. This may also account for the lack of evidence for extensive edge sharpening and re-sharpening on the prehistoric blades: if the primary focus is on delivering punching blows, the damage to the blade and areas requiring mending or upkeep would be the hafting plate and rivets, not the edges. This will be discussed in much greater detail in Chapters 8 and 9. Although – or perhaps because of – the extensive damage to the thick cartilage in the area of the ribcage and sternum, the halberd blade suffered noticeable profile deformation (Figure 7.12), similar to the deformation resulting from the Synbone^{TM} sphere experiments (Section 6.4.2). As shown by the skeletal tissue experiments, this does not render the halberd unusable, but does put stress and strain on the rivets and hafting plate (Figure 6.26).

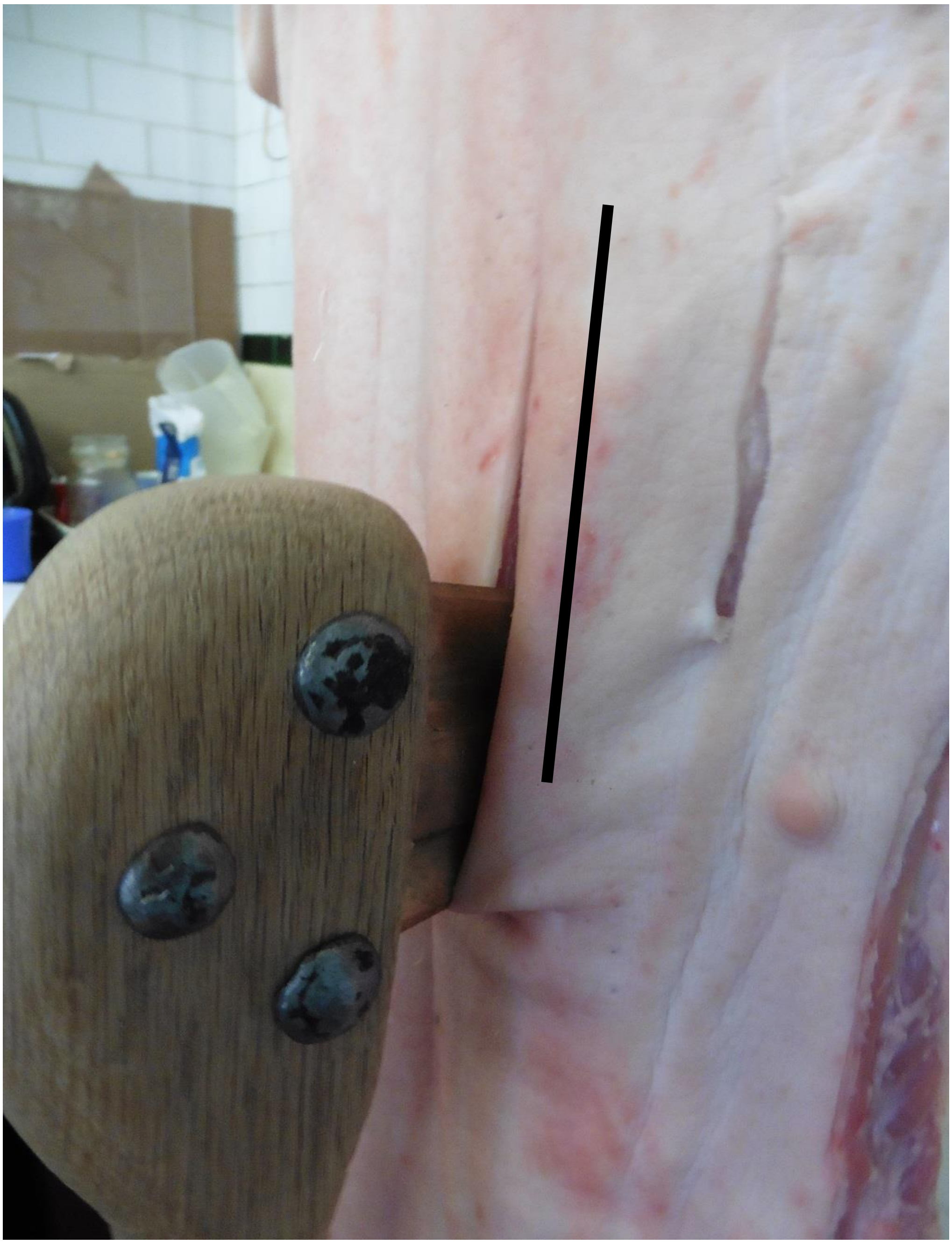

Figure 7.9 *– The fifth blow, showing the extensive slicing damage and the wrinkled skin preventing further drag. The superficial damage from the fourth blow is visible to the right. The black scale bar represents 10cm.*

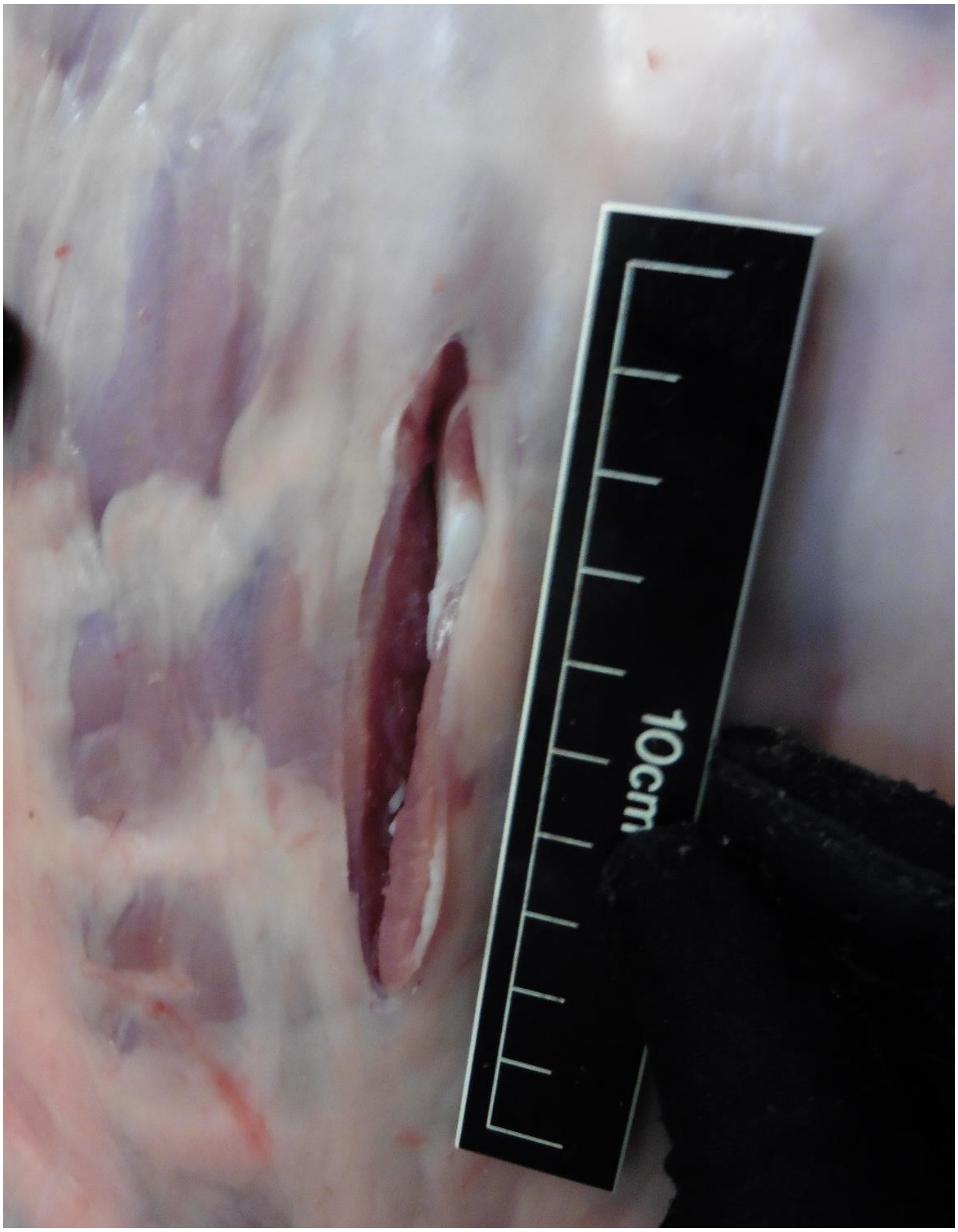

Figure 7.10 *– Internal view of the damage inflicted by the fifth blow. Areas of both thick cartilage and connective tissues are visible, having been cleanly severed by the halberd.*

Figure 7.11 *– The halberd blade in situ following the fifth blow. It is obvious that were the internal organs present, this blow would have punctured the lung inside the ribcage, and possibly the stomach and/or liver depending on the angle of impact.*

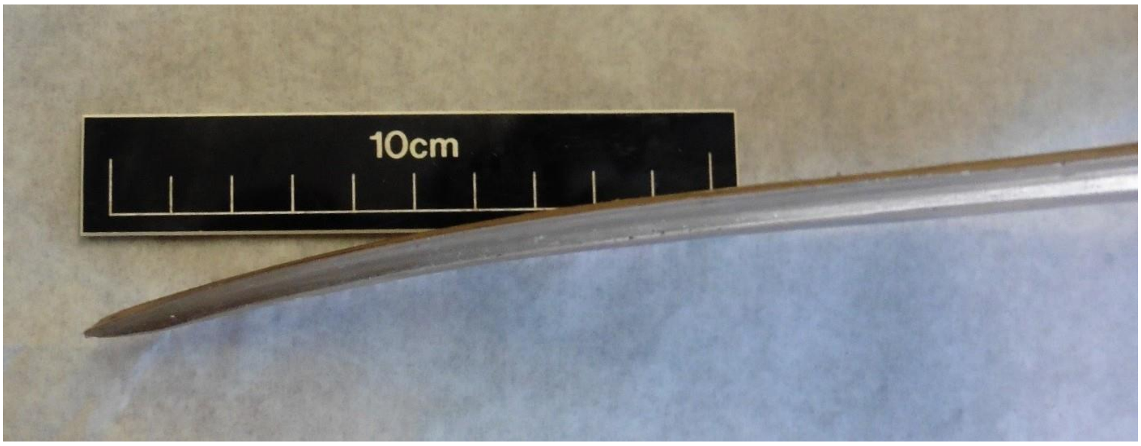

Figure 7.12 *– The 9° profile deformation of the halberd following the fifth blow.*

As noted above, the initial wielder who had inflicted all of the blows thus far in this soft tissue trial was 170cm (5 feet 6 inches) tall. Given the ongoing difficulty in cleaving pig bone with the halberd in this first part of the experiment, compared with the success in damaging the Synbone^{TM} when it was attacked from above, the author posited that a taller assailant would have more success in breaking through the rib bones of the suspended pig carcass. Accordingly, a second wielder was chosen: male, 1.9m tall (6 feet 2 inches), weighing 110kg (with significantly developed musculature; the second wielder's job involved a lot of heavy lifting, and he had established significant upper body strength as a result). The second wielder had no experience in fighting, martial arts, or in using an axe or similar implement; he thus represents a strong but unskilled assailant (as opposed to the first wielder, who was skilled but not strong).

The sixth blow was the first time that the second wielder had used a hafted blade; it was therefore not expected to land perfectly on target, nor to inflict the greatest possible amount of damage, because the wielder was adjusting his grip and getting a feel for the way the weapon moved. Furthermore, as I did not have an anvil and hammer to hand during the soft tissue experiments, the profile deformation illustrated in Figure 7.12 had not been hammered out, which could affect the blow as well. In the skeletal experiments, contrastingly, the initial tests (Figure 6.16) allowed the wielder to get used to swinging the halberd; this was however not an option for the soft tissue experiments, so allowances had to be made for the sixth blow. Accordingly, although the sixth blow was aimed at the mid- to lower-ribcage, it in fact connected with the upper ribcage/clavicle area, where the ribs are predominantly thick costal cartilage rather than bone (see Section 7.2). Therefore, although the blow penetrated the joint to a depth of 5.5cm, severing all of the thick connective tissues with which it came into contact, no conclusions could be drawn as to its efficacy on human bone from this blow. The sixth blow resulted in a long wound, slicing through the epidermis, sub-dermal fat layer, and upper layers of thin connective tissues at the top of the wound, and only severing the muscle and thicker connective tissues at the bottom of the blow (Figure 7.15). The sixth blow was successful in making the wielder much more confident in his strength and aim thereafter, as well as in producing useful data.

Figure 7.13 *– The sixth blow; the blade has landed high up on the belly piece, among the upper ribs/clavicle area of the pig.*

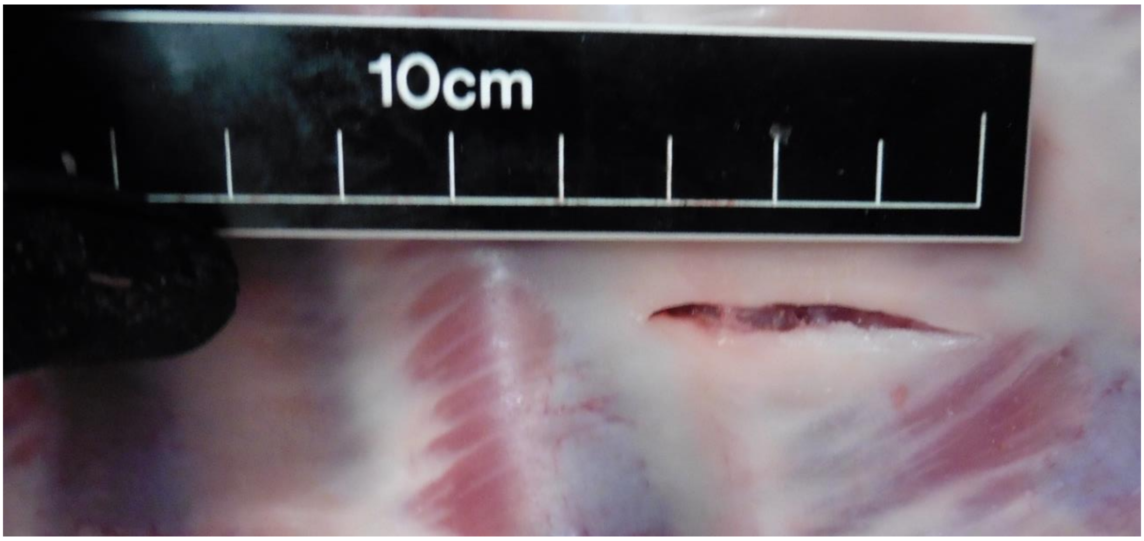

Figure 7.14 *– An internal view of the damage caused by the sixth blow; the thick vertical bands of costal cartilage can be seen, one of which has been punctured by the blow.*

Figure 7.15 *– The wound inflicted by the sixth blow (the black scale bar represents 10cm). The superficial damage can be seen at the top of the wound, where the dermal layers were sliced open, but the underlying musculature and connective tissues were not damaged.*

The second, taller wielder also inflicted the seventh blow. Following the results from his first attempt, the wielder on this occasion stood slightly closer to the tissue, meaning that the blow was struck almost vertically to the hanging belly piece, mimicking the angle of impact in the skeletal tissue experiments that delivered the most damage due to maximum comparative height difference (see Sections 6.4 and 6.8.5). The wielder also felt more confident and assured, and delivered a much more powerful and forceful blow than previously. The blow landed in the middle of the ribcage, severing the thick cartilage of the upper ribs, the muscle and connective tissues, and breaking one of the rib bones. Because of the more vertical angle of impact, the blow also created some dragged damage where the long blade edges sliced downwards through the soft tissues; however, the long edges of the halberd were not able to damage skeletal tissue, so the dragging damage ended upon contact with bone.

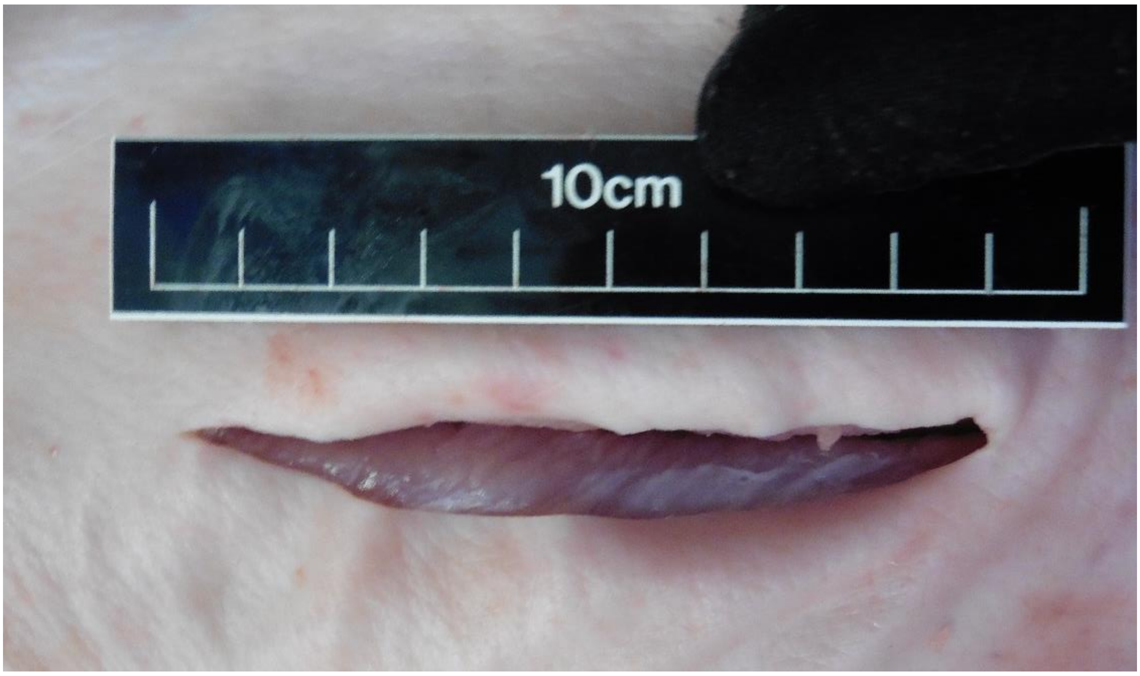

Figure 7.16 *– The wound resulting from the seventh blow. The dermal layers and thick layer of muscle and connective tissues have been completely severed. A small amount of drag damage is visible at the very bottom of the wound, where the angle of incision changes slightly.*

Figure 7.17 *– The seventh blow. The angle of impact is visibly more inclined than previous blows, this is a product of the trajectory of the halberd blade due to the taller wielder.*

Figure 7.18 *– The rib bone broken by the halberd blade; the halberd damage is the right-hand edge, indicated by the arrow (the left is a butchery mark produced by a cleaver, and made when removing the rib from the soft tissue piece for recording). The halberd blade damage to the rib is also shown in the lower image. The outer cortical layer and dense inner hematopoietic red bone marrow is visible on the right of the upper image, as well as in cross-section below.*

7.4 Conclusions from the Soft-tissue Experiments

The soft tissue experiments were successful in conclusively answering the two research objectives identified in Section 6.2.2; whether the halberd could cause soft tissue damage sufficient to immobilise an opponent, and to inflict fatal injury through elongating a punched wound causing bleeding and/or sepsis. To clarify, in the experiments described in the previous section, a fatal blow was one which penetrated the ribcage or abdominal muscle so that >3cm of the halberd blade protruded into what would be the abdominal cavity, puncturing the lung and/or causing major damage to the internal organs, not to mention internal bleeding by severing blood vessels (Byard et al 2002:15-16).

The first objective was designed to establish whether the halberd could be used as a weapon to inflict both soft and skeletal tissue damage. Rendering an opponent prone and incapable of moving much is vital in being able to inflict serious damage to the cranium: the Synbone™ experiments showed that the halberd could potentially cleave a human skull in two, but only if the victim was lying flat on the ground and was relatively immobile, as the head is a small target and the punching blows cannot be re-directed once begun (Section 6.4.2). This was tested against an upright target and again shown to be true; the angle of impact on a standing opponent is too acute to deliver pronounced piercing damage, and the swinging blow is too difficult to aim accurately (and, one should assume, all too easy to dodge) (Section 6.8.6). The soft tissue experiment showed that an upright adult wielder could use the halberd to sever thick dermal layers, muscle and connective tissue with little physical effort, prior training, or experience; none of the wielders in any of the halberd experiments had any combat training, and no particularly developed upper body strength, but all were capable of delivering incapacitating blows with the replica. Inflicting deep wounds with the halberd into muscle and tendons would severely compromise the opponent's mobility and dexterity: the two blows to the shoulder joint did sufficient soft tissue damage to have immobilised the limbs on the human analogue, and the repeated blows to the ribcage and abdomen would have punctured internal organs and caused serious muscle damage and blood loss on the human analogue. A single blow can penetrate multiple organs; a single stab wound can puncture a lung and stomach, and nerve and tendon damage can permanently disable limbs, cause facial palsy, and sight loss (Swann et al 1985:34). Given the depth that the blade penetrated the ribcage and upper torso (Figure 7.17), extracting the halberd after each blow took time and some effort; much as with the Synbone™ experiments, this would have left the wielder exposed and vulnerable to attack in melee combat. However, the extent of a single blow to the abdomen would severely weaken an opponent by this level of soft tissue damage, even in the heightened psychological state hypothesised for aggressors (see Section 2.9.1, Molloy and Grossman 2007:192). It would not be unreasonable to suggest that a trained fighter could have aimed a single halberd blow to the shoulder or thigh with the intention to disable a specific limb, as the two relatively inexperienced and wholly untrained wielders in this soft tissue experiment managed to land five of the seven blows on target, and to inflict significant damage to the pig carcass with each blow.

The soft tissue experiments also answered the second research objective, albeit with more caveats than in the case of the first. The seventh blow demonstrated that it is possible to inflict a fatal blow using the halberd to a human torso as well as to the head, but that several variables could instead result in a serious, but not fatal, blow. While internal organs in themselves would have offered some resistance to a penetrating blow, an injury of this magnitude to the pig tissue would represent fatal harm to the human counterpart. Sepsis and haemmorhage would have compounded the injury; if damaged or cut open at any point, the superior mesenteric artery, which supplies blood to the upper and lower intestines, will cause shock and fatal haemmorhage (Swann et al 1985:34). A study of 318 stab wound patients in Glasgow showed that even with modern medicine and swift intervention, 25 of the patients died from haemmorhage, punctured lungs, or haemothoraces (where blood fills the pleural cavity), all resulting from a single deep blow to the abdomen (Swann et al 1985:35). Without modern emergency medicine, the mortality rate would be much higher. Noting this, from the experiments described in this Chapter, three of the seven blows inflicted on the soft tissue (the third, fifth and seventh blows) penetrated >3cm deep into the suspended abdomen tissue piece; these would very likely represent fatal injury. The shoulder piece had too much dense connective tissue and bone to accommodate the infliction of a deep, fatal wound in this sector of the body – however, the subclavian and common carotid arteries are located in the shoulder and neck respectively, and if punctured, would result in substantial, potentially fatal, blood loss. This would be particularly relevant in combat when the opponent was in Condition Red and has a correspondingly higher blood pressure; debilitating blood loss is less of an applicable theory to ritualised performative and/or judicial violence.

The soft tissue experiments showed that a fatal blow to the abdomen would be most likely delivered if the wielder were close (within 1m, or arm's-reach) to the victim, and if the wielder was noticeably taller than their opponent. Having the angle of the blade closer to 45° to the vertical causes a much deeper, more powerful blow which is capable of breaking rib bone (cf. the seventh blow), whereas the blows which were closer to 45° to the horizontal, while capable of inflicting deep damage to muscle and connective tissues, were not able to break bone. This corresponds to the interim results detailed in Section 6.8.6, where the angle of impact is directly correlated to the inflicted damage, and a literal child was shown to be capable of using the halberd to deal fatal damage when the angle of impact was close to 180°. Interestingly, little research has so far been conducted on the effects of the halberd handle – which of various wood species, for instance, was deployed; or the length and shape of the haft. A shorter handle could potentially facilitate a quicker, more efficient blow, or it could render the blade useless without the power and momentum of a longer swing. This would certainly be worth considering for follow-up research.

The experiments also showed that the drag damage inflicted after the initial puncture was much less significant than expected. The halberd is not suited to long, deep gash wounds, because the long edges of the blade are not capable of slicing through very thick connective tissue or bone. The blows resulting in drag damage and an elongated wound (the third, fifth and seventh blows) only displayed ~1cm of dragged damage, a very small increase in the size of the wounds – which with this halberd are between 6 to 8cm without drag damage, depending on the depth of blade penetration. Secondary, drag damage is therefore not a major factor in inflicting a fatal level of soft tissue injury.

Finally, the soft tissue experiments demonstrated that the halberd is not generally capable of inflicting incidental damage to bone; that is, although the seventh blow broke a rib bone with the initial impact of the blade tip, more usually the long edges of the halberd blade snag (blows one and two) or the blade bends (fifth blow) on indirect contact with bone. If the bone is not fractured or broken by the halberd tip, the experimental results indicate that it will not be damaged by the long edges of the halberd blade or by dragging damage; rather, the bone may damage the blade edges. This issue is discussed further in the next section.

7.5 Conclusions from the Replica Halberd Experiments

The replica tests reported in Chapters 6 and 7 represent an extension and progression of the experiments undertaken by previous researchers in the field, most notably O'Flaherty (2007), Anderson (2011) and Molloy (2007, 2009), and are an exploration of hypotheses proposed by Dolfini (2011), Coles (1968-9), and Schuhmacher (2002) on the halberd's perceived unsuitability as an offensive weapon. The reliability and accuracy of the experiments were established in Sections 6.21 and 6.3 respectively.

The soft and skeletal tissue experiments both showed that the Scottish Bronze Age halberd was capable of being used as an effective combat weapon, inflicting serious debilitating injury to both of the human tissue analogues, and potentially fatal injury from shock, haemmorhage, sepsis, and haemothorax. Having the second soft tissue carcass piece (the abdomen) hang freely from a meat-hook during this project showed the importance of considering the experimental set-up. The fourth blow struck in this experiment glanced off the tissue piece because it was suspended and thus free to move, much as an upright human would shy away from an attack. Affixing the tissue analogue to a secure surface, as with the shoulder joint, may yield more impressive experimental results, but it could be considered inaccurate in the sense of not duplicating real-world behaviours and this circumstance could potentially undermine the results obtained – for instance, by having the halberd inflict deeper and more severe damage to the shoulder joint, or severing thick cartilage or bone in a way which would not be analogous to intrahuman combat.

The Synbone^{TM} sphere experiments were particularly successful in demonstrating the capabilities of the halberd under specific combat circumstances. These spheres have garnered a large body of literature supporting their suitability as a human tissue proxy (e.g. Kneubuehl and Thali 2003, Moraitis et al 2008, Brewster 2013, Rickman and Smith 2014), and the inflicted blows clearly and unequivocally demonstrated that the halberd could cause major damage to a human cranium. Using the Synbone^{TM} instead of pig or sheep crania as proxies removed the issue arising from the deployment of denser animal bone, noted in O'Flaherty (2007), and thus improved the accuracy of the experiment in replicating the likely impact on a human skull. The damage inflicted to the Synbone^{TM} spheres would undoubtedly have proved fatal, demonstrating that the halberd could be used to kill an opponent – providing that they were immobilised and prone, and the incoming blow was inflicted as close to perpendicular as possible. The halberd would be more than capable of delivering a similarly severe blow to an upright combatant, but the wielder might not be; given the small target area of a human head, and the fact that the halberd is not a small or light weapon and does not allow for much mobility or dexterity in the wielder, the issue would be in the wielder aiming and landing an injuring or fatal blow, especially if the victim can dodge or duck out of the way, as demonstrated in Section 6.8. Both the skeletal and soft tissue experiments showed that extracting the blade following a successful blow took time and left the wielder open to counterattack; aiming a blow at an upright combatant and having it miss the head but embed in the shoulder or neck may prove fatal for the combatant, but puts the wielder at a decided disadvantage in melee combat.

Conversely, the Synbone^{TM} long bones proved to be a poor choice as human tissue proxy for this type of experiment. They were difficult to secure to the padding and desk legs, meaning that the resulting positive experimental data is open to accusations of inaccuracy and experimental variation; a human leg is not usually strapped upright, immobile and cushioned, against a steel pole during combat, and the set-up was therefore not as close to a combat simulation as could be hoped. Furthermore, although the sphere experiments demonstrated the need to first incapacitate an opponent, breaking long bones is not the only way – and certainly is not the most efficient way – to disable someone's limbs. The soft tissue experiments showed that the halberd could sever thick muscle and connective tissue, as well as arteries, with much less effort and skill than would be required to damage the long bones themselves. The reflexive approach was very useful in this instance: although the long bones did not work as a human tissue proxy in this experiment, a soft tissue shoulder and neck analogue was substituted and the interpretation adjusted accordingly. In future work, based on the experiments reported in these chapters, animal tissue would be chosen over Synbone™ long bones as the better analogue for experiments such as these, despite the structural differences between human and animal anatomy. Alternatively, more setups could be devised to better utilise the long bones, such as using free-standing clamps to keep them upright but not cushioned or immobilised.

Maintaining a flexible and reflexive approach within the soft and skeletal tissue experiments was beneficial in the soft tissue experiment, when the second wielder inflicted the last two blows. The unexpected importance of relative height of the wielder to opponent was demonstrated by the second wielder, most notably in the observed characteristics of the seventh blow, and was not one of the anticipated experimental results. This was mirrored in the final set of blows described in Section 6.8, which were inflicted by a five year old; what began as play and a home-schooling opportunity yielded valuable data as to the primary importance of the angle of impact, reflecting and reinforcing the conclusions drawn from the soft tissue experiments – namely, that an unskilled wielder can, under specific circumstances, inflict fatal damage using the halberd. The application of a methodology based on queer theory was demonstrably effective in maintaining high standards of objectivity and rigour, and in yielding unexpected but very valuable data, discussed further in this section. The multi-use, multi-focal viewpoint model proposed in Chapter 9 is a much more obvious development of the applied queer theory approach, but its suitability in informing experimental protocols should not be overlooked. The published article based on the dirk experiments (Faulkner-Jones 2016, bound in at the end of this thesis) further discusses the application of queer theory in deriving experimental methodologies, and can be summarised here. The focus on empirical objective research should drive the production of reliable data, the analysis of which is done with a clear view on latent bias (Dowson 2000). In terms of deriving experimental methodology, collecting primary data through reflexive experimentation, minimising latent gender bias in using multiple wielders, and ensuring accountability by recording and clearly communicating the procedures and results are all influenced by queer theory (Faulkner-Jones 2016:2).

Relating to the application of queer theory to experimental archaeology, the importance of an audience was also demonstrated by the skeletal and soft tissue experiments, as well as by the earlier dirk experiments (Chapter 3, Faulkner-Jones 2016). The skeletal experiment (Sections 6.4.2, 6.5 and 6.6), undertaken in the University of Edinburgh Osteoarchaeology Teaching Laboratory, was most suited to observation by the under- and post-graduate community within the university, particularly within the department of Archaeology. Staff were also invited to attend. Consequently, the audience feedback was much more informed than might be expected from a broader demographic mix, as all were archaeological researchers (though not necessarily in Bronze Age Scotland, weaponry, or experimental techniques). Questions and suggestions were invited, but they did not materially alter the results of the experiment. The audience did, however, help to keep the experiment accurate (as each stage was explained by the author and critiqued or questioned by the audience), as well as to facilitate multi-viewpoint recording of each blow. There was, however, an unprompted audience comment that the long handle and overarm blow made for an impressively tall silhouette, and that ribbons or cords tied to the handle would catch in the wind, especially if the combat episode took place outside. The depiction of a beribboned halberd was suggested by Needham and Cowie (2012) as an interpretation of the incised halberd stone pillar from Kilmartin, Argyll. The performative element of interpersonal combat had been noted previously (O'Flaherty 2007), and it was interesting to see how an audience responded to, and recognised the theatricality of, the performance of the experiment. For instance, the light levels in the room changed during the course of the experiment as the afternoon progressed, and several of the audience members commented on how it altered the appearance of the halberd, especially when it was raised overhead before delivering a blow; one person commented on how it would potentially flash and catch the eye from a great distance, widening the visibility for the audience even further than the immediate onlookers, which had not occurred to the author at any point until then.

Conversely, the soft tissue experiment was performed in a very different public space, behind a butcher's counter in full view of the customers and passers-by. As such, the questions and comments proffered were of a very different nature than the previous experiment, though no less valuable. The audience required much more basic information, such as what the halberd was, why we were attacking pig tissue, why the blade and handle were shaped and hafted as they were, and why the blows were inflicted overarm and not in a horizontal sweeping motion. Explaining the experiment to a non-specialist audience ensured that the first principles were sound, and that each stage of the experiment was carefully considered and enacted. It also meant that people became involved with archaeology who might otherwise have been marginalised or unengaged by traditional outreach programmes; indeed, many of the audience questions referred to archaeology in popular culture, most commonly *Indiana Jones* and *Time Team*, being their only experience with archaeological research. Audience participation was therefore mutually beneficial and is to be encouraged wherever possible. The final set of SynboneTM experiments had constraints resulting from the pandemic lockdown, but still managed to incorporate non-traditional audiences (an engineer and a child) whose engagement with the experiment resulted in valuable data – that the halberd can inflict mortal injury when wielded by a child, firmly disproving the idea that these were weapons only usable by a skilled warrior (cf. O'Flaherty 2002).

The soft tissue and skeletal experiments resulted in useful data for the interpretation of the halberd as an effective combat weapon. As noted above, both sets of experiments demonstrated that the halberd could be used offensively, and was capable of inflicting debilitating and potentially fatal damage on a human opponent. None of the three wielders across both halberd experiments had any combat experience, but this did not prevent any of them from inflicting serious injury with the weapon. However, as the blade snagged on rib bones and the scapula during the second and fifth blows in the soft tissue experiment, the blade became damaged – bending in profile, and creating small V-shaped notches in the blade edge. The profile deformation can be attested in the archaeological record (see Section 8.2), but the poor preservation of the Scottish halberds precludes any meaningful edge-wear analysis, preventing the secure identification or rejection of halberd combat usage in prehistory. Consider the great strides made in halberd studies by Dolfini (2011), where edge damage on Italian copper blades (mostly daggers and halberds of various types) could be identified as specific results of a wide range of pre- and post-depositional practices, and the data used to inform interpretations of the weapons' usage and biographies.

Careful combat training would be required to inflict a serious blow to the torso without snagging on bone – either by avoiding the skeleton completely, or by targeting specific areas of the body with sufficient force and the correct angle of entry to break the bone, as demonstrated by the seventh blow in the soft tissue experiments. This would prevent the edge notching to the blade, and also makes it easier to extract from the victim, which has been noted many times above as a serious hinderance in melee combat. The experiments showed that a fatal blow could be inflicted to the cranium with relative ease to an immobile, prone opponent, but also that to use the halberd to incapacitate an opponent without damaging the blade takes a greater degree of skill and finesse than any of the wielders had in these experiments. Someone other than a skilled fighter could therefore use the halberd to inflict the final, fatal blow to the head, but the weapon does not lend itself to effective combat use by an untrained fighter without incurring damage to the blade. The people using the halberds offensively are discussed in much greater detail in the next chapter, in which the conclusions from these experiments must be borne in mind.

Further evidence supporting the interpretation that the halberd was not designed primarily for melee or hand-to-hand combat was produced by both tissue experiments, but more clearly by the Synbone™ sphere trials. The overhead blows inflicted substantial injury, and the halberd blade sank deep into the ballistic gelatine in the spheres, designed to mimic the material properties of human brains. The blows were so successful, however, that it was quite difficult to remove the blade from the spheres. Both hands were required to pull the blade out of the sphere, and sometimes the sphere itself had to be anchored by the wielder's foot (or the foot of a willing audience member) before extracting the blade. The time and dexterity required to extricate the halberd from a deep blow during a melee would leave a wielder at substantial risk of further attack, with little means of self-defence. Indeed, wielding the halberd itself is not particularly suited to combat between more than two people: it requires two hands, preventing the use of the leather buckler shields attested during the period (Molloy 2009); the overarm blow leaves the wielder's torso and back exposed; the blows take longer to inflict than stabbing with a dirk, for instance, particularly if the time and finesse required to free the blade from a deep wound are included; the most damaging blows are caused by the tip of the blade, a very small area which could potentially be dodged or deflected.

To summarise: the halberd is shown here to be capable of inflicting debilitating and potentially fatal injuries, depending on the wielder and their intention, but is limited in its applicability to melee combat. Various human tissue analogues were shown to be effective in replica weapon testing, and the resulting data can be treated as both reliable and accurate. The data gathered in Chapters 6 and 7 can be used alongside analysis of the prehistoric halberd assemblage to form the basis of an interpretative model to re-evaluate the role of the halberd in Bronze Age Scotland, which will be discussed in the next chapter.

Chapter 8 – A Biographical Study of the EBA Halberd in Scotland

The two previous chapters demonstrated that controlled experimentation with the replica halberd yielded valuable data on how it could be used offensively. The experimental halberd blade however sustained slight damage in that the lower half of the blade bent slightly following blows to dense bone. This data can be used in conjunction with an analysis of the halberd catalogue (Appendix 1), to formulate a novel interpretative paradigm for the halberd in EBA Scotland.

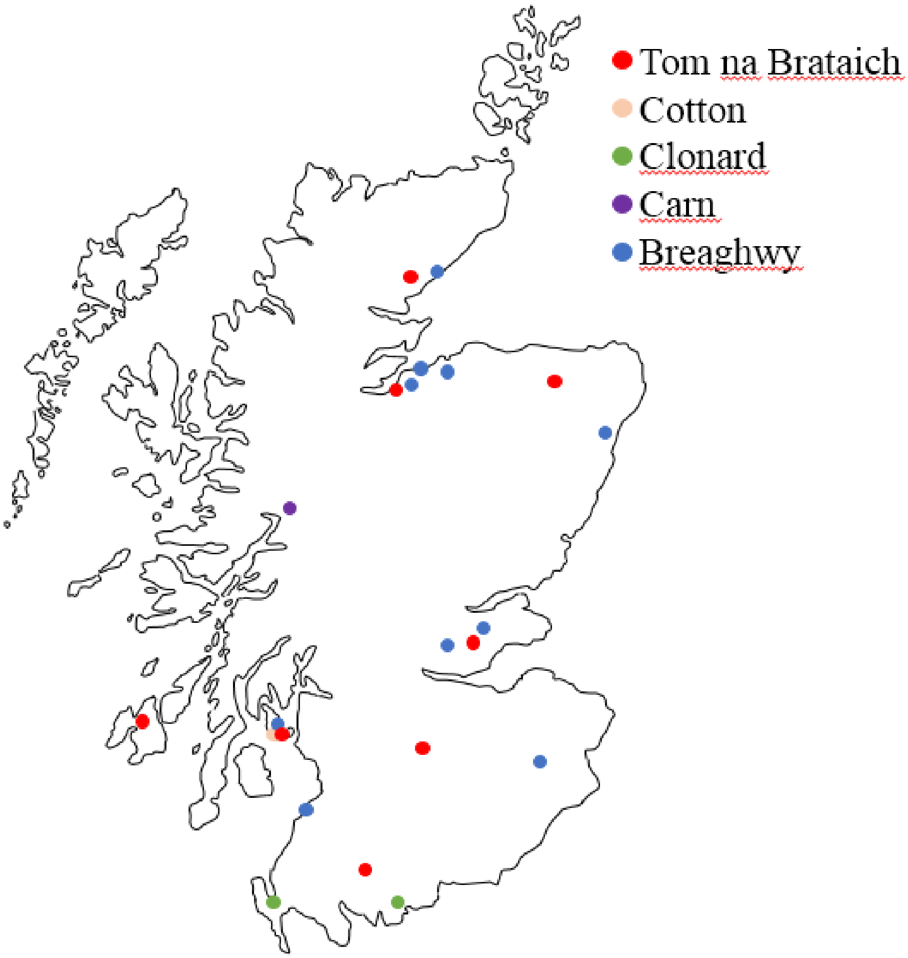

Figure 8.1 *– Distribution map of the Scottish halberds discussed in this Chapter.*

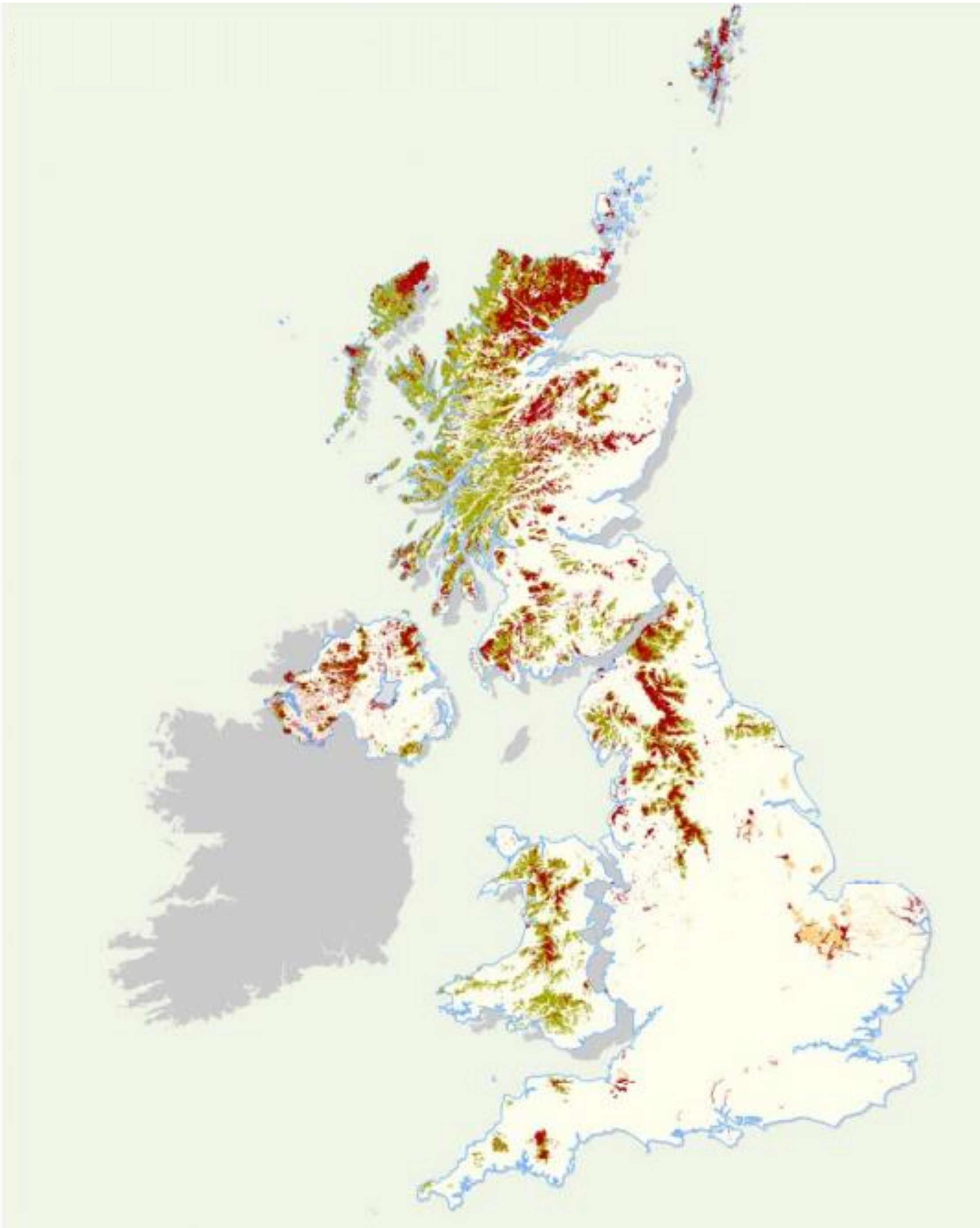

Figure 8.2 *– Peat soil coverage in the UK; the red areas are the most dense peat coverage. Joint Nature Conservation Committee, 2011.*

8.1 Catalogue Analysis

The creation of an accurate, up-to-date catalogue was an important first stage of this research, to update and expand the existing recording in Coles (1968-9) and Schmidt and Burgess (1981); although useful in demonstrating the size and state of preservation of the Scottish halberds, little meaningful analysis would have been gained by the catalogue's creation alone. The corpus was primarily intended as a tool for further, more detailed study. A typological and artefact analysis is presented here; when correlated with the results from the experimental trials, a full reassessment of the halberds can be made. As the British halberd assemblage is not large (~75 blades), it was possible to collect the data and take photographs for the majority the of items included in this study. Collecting all of the analytical data first-hand where possible, even where weights and measures were available in existing catalogues, ensured that all conclusions or assertions drawn are based on standardised and thus reliable, accurate data, collected using a methodology designed to eliminate unconscious bias and recording errors (Section 5.6). Any issues or inaccuracies are therefore specific to this study, any errors should be consistent and controllable within the study, whereby any impact they have on the resulting data is the same for every catalogue entry and should not produce outliers or have an statistically significant effects.

The catalogue (Appendix 1) comprises two data sets: the halberd listings, which includes illustrations, photographs, measurements, and observations for each halberd; and the database, an Excel spreadsheet containing all of the raw data for each halberd, the initial dataset from which quantitative analyses can be made. The database is a useful starting point from which to establish the scale and scope of the British halberd assemblage.

A total of 50 halberds were re-recorded by the author, representing the British assemblage. Five halberds, inaccessible to the current author due to access restrictions in the holding museum or collection, were recorded using already-published data from extant catalogues. These are:

- the two blades from the Baile-nan-Coille hoard held in a private collection in Dunrobin Castle, Sutherland (1880.3 and 1880.4, Appendix 1 (hereafter A1) pg. 126 and 163);

- a halberd of unknown provenance in the Hunterian Museum, Glasgow (GLAHM B.1914.320, A1 pg 123);

- one of the Auchingoul hoard halberds in Banff Museum (ABHER:2017.011, A1 pg 42);

- a halberd from Culbin Sands, Aberdeenshire, in the Falconer Museum in Forres (1989.206, A1 pg 67).

Throughout this chapter, reference is made to the Scottish assemblage and the British, or whole of Britain, assemblage. These are defined as follows:

- The British assemblage is all of the halberds recorded during the course of this study, from Scotland, Wales and England; it consists of 50 artefacts.

- The Scottish assemblage is the halberds which have a secure findspot in Scotland; it also includes two for which there is no secure provenance (GLAHM B.1914.320 in the Hunterian Museum, Appendix pg. 123, and NMS X. DJ 8 in the National Museum of Scotland, Appendix pg. 142). These two halberds show sufficient similarities with the other Scottish halberds to be grouped with them (see Appendix entries for further details). The Scottish assemblage consists of 35 halberds.

One of the Scottish assemblage halberds is held in the British Museum and tentatively provenanced to the coastal village of Haverigg, Cumbria (WG 2060); it is included in this grouping for the following reasons. Firstly, the provenance is not secure; it is possible that the halberd was recovered from further north (several halberds have recently been reprovenanced, so this is not improbable; see Brandherm and O'Flaherty 2001, O'Connor et al 2009, Radivojević et al 2019). Secondly, lead isotope tests show that its composition is very similar to the Scottish halberds (Rohl and Needham 1998); Haverigg's coastal location makes it accessible to communities further north via the sea (Crumlin-Perderson 2010), and a network of trade and communication existed during the EBA as evidenced by the presence of Ross Island copper objects in Britain (Coghlan and Case 1957). Thirdly, it is the only halberd found outside of Scotland that includes the characteristic damage present on the majority of Scottish halberds which is discussed below in Section 8.6. Fourthly, as the modern political boundary of Scotland only came into existence in 1746 with the annexation of Berwick into England, strictly circumscribing a 4,500 year old assemblage by a 250 year old line on a map when the archaeological data supports the halberd's inclusion does not seem reasonable. The entry is clearly delineated on the spreadsheet by a pale-yellow highlight, and its inclusion should be borne in mind during the discussions of the Scottish assemblage.

One final halberd which was recorded by the author but not included in the catalogue or on the spreadsheet, NMS X.HPO 18, is held by the National Museum of Scotland. It is included at the end of the Excel spreadsheet for reference, but not included in Appendix

1 here as it is not relevant to this study, despite appearing in Coles' (1968-9) catalogue and in Schmidt and Burgess (1981); its omission here is intentional. It is listed in the Museum catalogue as being from the Poltalloch estate near Kilmartin Valley, Argyll and Bute, but has since been re-provenanced to the Channel Islands (O'Connor et al 2009). The halberd is a Type Carn and is much more reminiscent of the Alderney/Northern France halberds than the Scottish or Welsh assemblages, and as such is not included in the breakdown of the British or northern British assemblages in this study.

Table 8.1 *– Comparative mean/average values between the recorded halberd assemblage from the whole of Britain, and those from Scotland.*

	Whole assemblage	Scotland
Weight	344.1g	336.5g
Length	255.9mm	251.8mm
Width	77.1mm	77.1mm
Thickness	6.6mm	6.6mm
Hafting plate length as a % of the total blade length	11.79%	10.9%
Heft	1.28	1.21
Stoutness	38.75	40.6

Table 8.1 shows that the halberds in the Scottish assemblage are slightly lighter, shorter, wider, and less dense (the heft value relates weight to length) than the British assemblage as a whole; these differences are not, however, statistically significant. This could be a reflection of the generally poorer state of preservation and higher incidence of material loss (see Table 8.2) of the Scottish halberds, mainly due to the more acidic peat soil; it could also be related to the breakdown by Type of the halberds (Tables 8.3 and 8.4). Marked differences can be noted in the proportions of the blades, where Scottish halberds show, on average, smaller hafting plates relative to their blade length than the British assemblage as a whole, despite the halberds being on average of comparable size; the Scottish mean length is for instance less than 1% different from the British mean halberd length. This is discussed further in Section 9.3.

Table 8.2 and Figure 8.3 show that the Scottish assemblage overall is in slightly worse condition than the British assemblage: all of the eight halberds that display 'Very Poor' levels of damage (whereby over 75% of the blade surface shows corrosion, material loss, heavy patination, edge rifling, or any other pre- or post-depositional damage, to such an extent that secure classification could be made difficult) are from Scotland. Similarly, all seven of the ‘Poor’ halberds (blades presenting damage across 50-75% of their surface, or with significant material loss, but not poor enough to prevent classification) also come from Scotland. Although the damage is not statistically significant compared to the wider UK assemblage, it is worth noting in terms of regional patterns in conditions of recovery: many of the halberds were found in peat soils, which are acidic, causing heavy patches of bronze disease and corroding the exposed edges. Scotland has the largest area of peat soil within the UK (Figure 8.2). Similarly, many of the halberds were deposited in waterlogged soils, increasing the rate of development of bronze disease and creating a heavy dark patina (Oudbashi 2018). However, there is a smaller possibility that the damaged halberds were curated, mended, or valued outwith their combat capacities, rather than melted down and recycled, and that the survival of damaged halberds is indicative of an intentional choice made by Bronze Age communities, and not merely the result of taphonomic processes; this theory will be discussed in more detail in the interpretative model proposed in Chapter 9.

Harbison’s (1969) types are largely distinguished by the number and arrangement of the rivet holes. When examining the Scottish halberd assemblage, some difficulty in classifying the artefacts was anticipated because of the expected conditions. Scotland has large swathes of peat soils and wetlands, neither of which provide ideal preservation conditions for copper or bronze. The maps in Figures 8.1 and 8.2 show that (where the findspot is known), halberds in Scotland were often deposited in areas of dense peat soil resulting in patination and bronze disease. This was certainly the case for some of the assemblage, but the extent of the damage discussed in this chapter goes beyond post-depositional taphonomy. Evidence for profile deformation (Section 8.2), multiple episodes of riveting (Section 8.4) and the removal or repairing of the hafting plate (Sections 8.5 and 8.6) cannot be attributed solely to the depositional matrices; these are discussed further in the proposal of a new halberd type in Section 8.7, below.

Table 8.2 *– Comparison of the overall conditions of the halberds. Very good: damage covering <25% of the total surface of the halberd. Good: damage to 25-50% of the halberd. Poor: damage to 50-75% of the halberd and/or significant material loss that does not preclude classification. Very poor: damage to >75% of the halberd and/or sufficient material loss to preclude secure classification.*

	Whole assemblage	Scotland
Very good	10 blades, 20%	4 blades, 11%
Good	24 blades, 48%	15 blades, 43%
Poor	8 blades, 16%	8 blades, 23%
Very poor	8 blades, 16%	8 blades, 23%

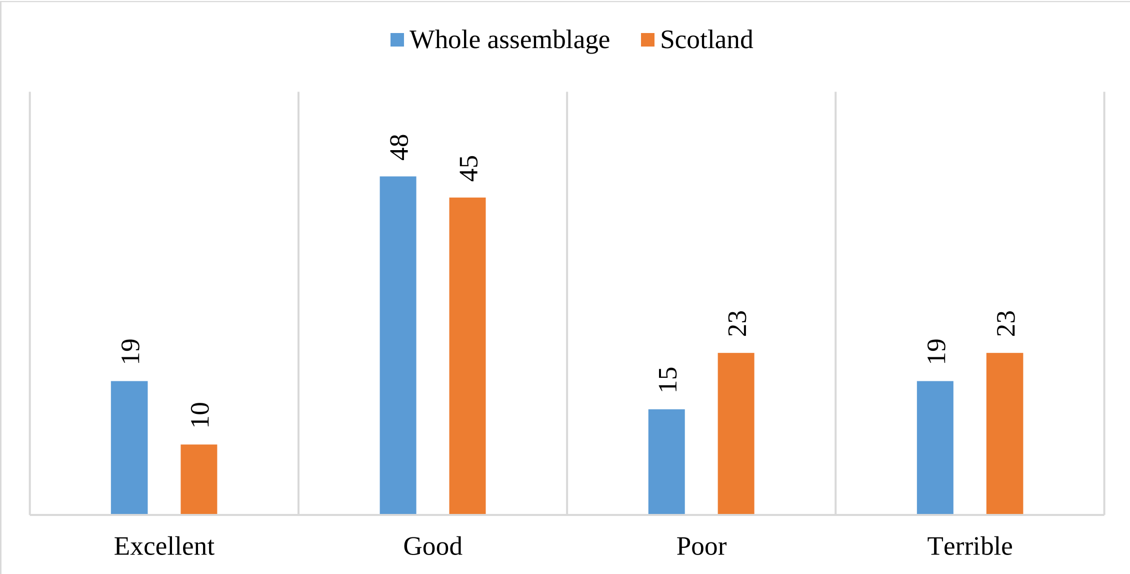

Figure 8.3 *– Graph showing the relative percentages proportions of preservation categories of the halberds from the whole of Britain, and the Scottish subset.*

The following sections will follow a similar methodology to the one adopted in Chapter 4 which compared the experimental damage exhibited by the replica dirk to the artefact damage recorded in the PBF. The halberd catalogue (Appendix 1) was examined as a whole, in order to identify any patterns or data sets which could be used to inform an interpretation. Outlying halberds which did not easily fit into Harbison's (1969) typology could then be compared to similar halberds from other museums. Much as the damage to the replica dirk was used in Chapter 4 to inform what was sought in the existing dirk catalogue, data gathered from the experimental work using the replica halberds, detailed in Chapters 6 and 7, was used as an initial point for analysing the halberd catalogue (Appendix 1). The data derived from the comparison between the experimental results and the catalogue was then used to propose an additional Type to complement Harbison's

(1969) schema (Section 8.7), as well as to inform the interpretation discussed in Chapter 9.

8.2 Profile Deformation of the Halberd Blade: Experimental and Catalogue Data

A result from both the skeletal and soft tissue halberd experiments (Chapters 6 and 7) was that when viewed in profile, the replica halberd had deformed slightly – a total of 16° by the end of the experiments – in the lower part of the blade, following particularly powerful blows to the hard bone. This can be seen in Figure 8.4. As demonstrated in Section 4.4, comparing experimental damage to the damage present on the prehistoric blades can give some indication as to their use and the prevalence of the characteristic damage. Therefore, the halberd catalogue was first examined for instances of lower blade deformation. As indicated by the experiments, the plastic deformation, or bending, in profile was not inflicted intentionally, which separates this damage out from the deliberate folding seen in BA metalwork as part of the ritual decommission process (cf Knight 2020:4).

Three halberds from across the British Isles demonstrated similar profile deformation. The most pronounced of these is a stout halberd from Roscrea, Co. Tipperary (British Museum acc. no. 1854.0714.214), where the lower part of the blade is bent 15° to the norm (Figure 8.4). [As this halberd was recorded in O'Flaherty (2002) and is Irish, not British, it is not included in the catalogue in Appendix 1.]

Figure 8.4 *– The halberd from Roscrea, Co. Tipperary, Ireland, which is bent by 15° from the norm (British Museum acc. no. 1854,0714.214) ©British Museum.*

Two longer halberds also show similar profile deformation, though neither are as pronounced as the Roscrea blade. The Galloway halberd in the National Museum of Scotland (acc. no. NMS X.DJ 5) (Figure 8.5) and the halberd from Hundleton, Pembrokeshire (National Museum of Wales/ Amgueddfa Cymru acc. no. 2006.3H) (Figure 8.6) both show profile deformations of 7°.

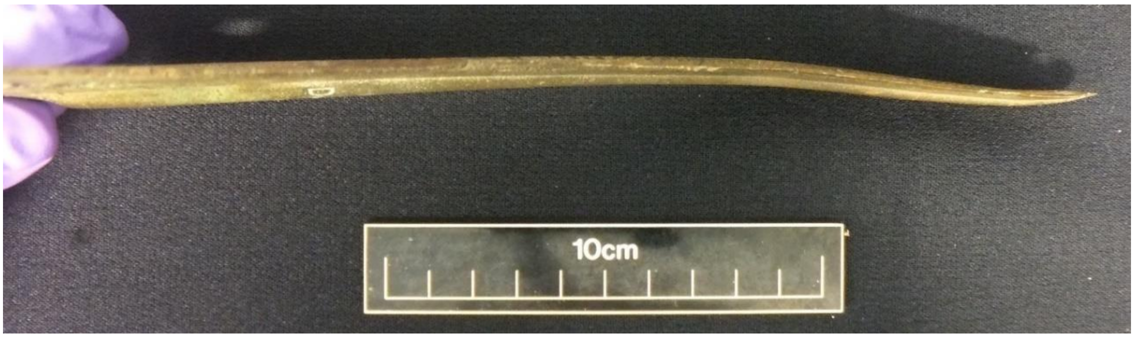

Figure 8.5 *– The Galloway halberd, held in storage at the National Museum of Scotland (NMS X.DJ 5), is bent by 7°. © NMS.*

Figure 8.6 *– The halberd from Hundleton, Pembrokeshire (NMW/AC acc. no. 2006.3H), which is also bent by 7° from the norm. © National Museum of Wales/Amgueddfa Cymru.*

These three halberds all show bending deformation from the middle of the blade, extending out towards the tip. The Rosecrea halberd (Figure 8.4) shows the most pronounced angle, but this could be related to its shorter blade, and there being less material to absorb the force of an impact. The experimental data is consistent with the prehistoric data, suggesting that these three halberds could have all used to deliver an overhead blow onto a very hard object, possibly but not necessarily human skeletal material, which has demonstrably resulted in the deformation seen on all four prehistoric and replica blades. This does not preclude other explanations for the profile deformation, but does offer one theory that is supported by empirical data.

Two further halberds show profile deformation, though not as clearly analogous to the replica damage as the three shows above. The first of these is possibly part of the Baile-nan-Coille hoard held in Dunrobin Castle, but the association is insecure. The halberd (held by the Kelvingrove museum, acc. no A.1962.3) (Figure 8.7) shows a slight deformation of 5° on the lower part of the blade, beginning at the middle, very similar to the deformation on the three previous halberds but a few degrees less pronounced. The two other halberds from the Baile-nan-Coille hoard in Dunrobin Castle do not show any evidence of profile deformation, which neither helps nor hinders the association with this blade.

Figure 8.7*. The halberd from Dunrobin Castle (held by the Kelvingrove Museum, acc. no A.1962.3), which is possibly part of the dispersed hoard from Baile-nan-Coille. The halberd shows a profile deformation of 5°.*

The second halberd showing potential profile deformation was part of a hoard recovered on Islay, and is on display at the National Museum of Scotland (acc. no. NMS X.DQ 45) (Figure 8.8). Although showing a deformation of 9°, only the tip of the blade is bent, rather than the whole lower half as with the previous examples.

Figure 8.8 *– Above: the bent tip of the halberd from Islay (NMS X.DQ 45). Below: the associated hoard of damaged bronzes, with the halberd at the bottom. The white arrow indicates the beginning of the profile deformation, much closer to the blade tip than in the other halberds noted in this section. © NMS.*

The damage incurred during the skeletal and soft tissue experiments is therefore similar to the damage in the prehistoric assemblage. As with the comparative dirk catalogue, the damage is not widespread throughout the assemblage – four blades from Britain, plus one from the Republic of Ireland. Of the four British blades, three are from Scotland. Because this is such a small sample, it would be irresponsible to place undue emphasis on its distribution; however, this does possibly suggest the halberds were being used differently in Scotland. None of the halberds recorded for this study showed any signs of repair to the blade itself (the hafting plate is a separate matter; see Sections 8.3 through 8.6); however, the poor state of surface preservation could obscure or obliterate lighter repair marks. Hammering a bent blade straight would be done cold because of copper's low plasticity (M. Young, pers. comm.; Bray and Pollard 2012); this leaves no compositional trace, and very shallow surface marking.

However, there is one halberd in the recorded assemblage with features which could be interpreted as evidence for a repaired deformation. A halberd from the Snab of Moy, Forres, held by the Falconer Museum (acc. no. 1978.206) (Figure 8.9) shows significant damage to the hafting plate but is in otherwise good condition. There are several large lateral tears or rips across the midrib on both faces of the blade, at the point where many of the profile deformations noted in the previous examples began, which are visible on Figure 8.9 and more obviously on the line drawing in its entry in the catalogue (Appendix 1). These tears are highly reminiscent of the damage on the replica dirk following the Synbone experiments (see Section 3.4). When the bent tip on the replica dirk was repaired using cold hammering, the outer face of the curve (indicated on Figure 8.10) showed very similar tears, where the metal had stretched with the deformation before being hammered back into shape. The inner face of the curve showed similar, smaller tears, where the bent copper was stretched back flat under the hammer; the Forres halberd shows tears on both faces, with more on one than the other. It would therefore be viable to propose that the Forres halberd underwent a similar process, where a major profile deformation caused the copper or copper alloy to stretch and tear, resulting in a crack when hammered back flat. However, because there is no precedent for this damage in the wider assemblage it must remain speculative – but arguably, it is quite convincing as one of many possible explanations, but this one supported by empirical experimental data.

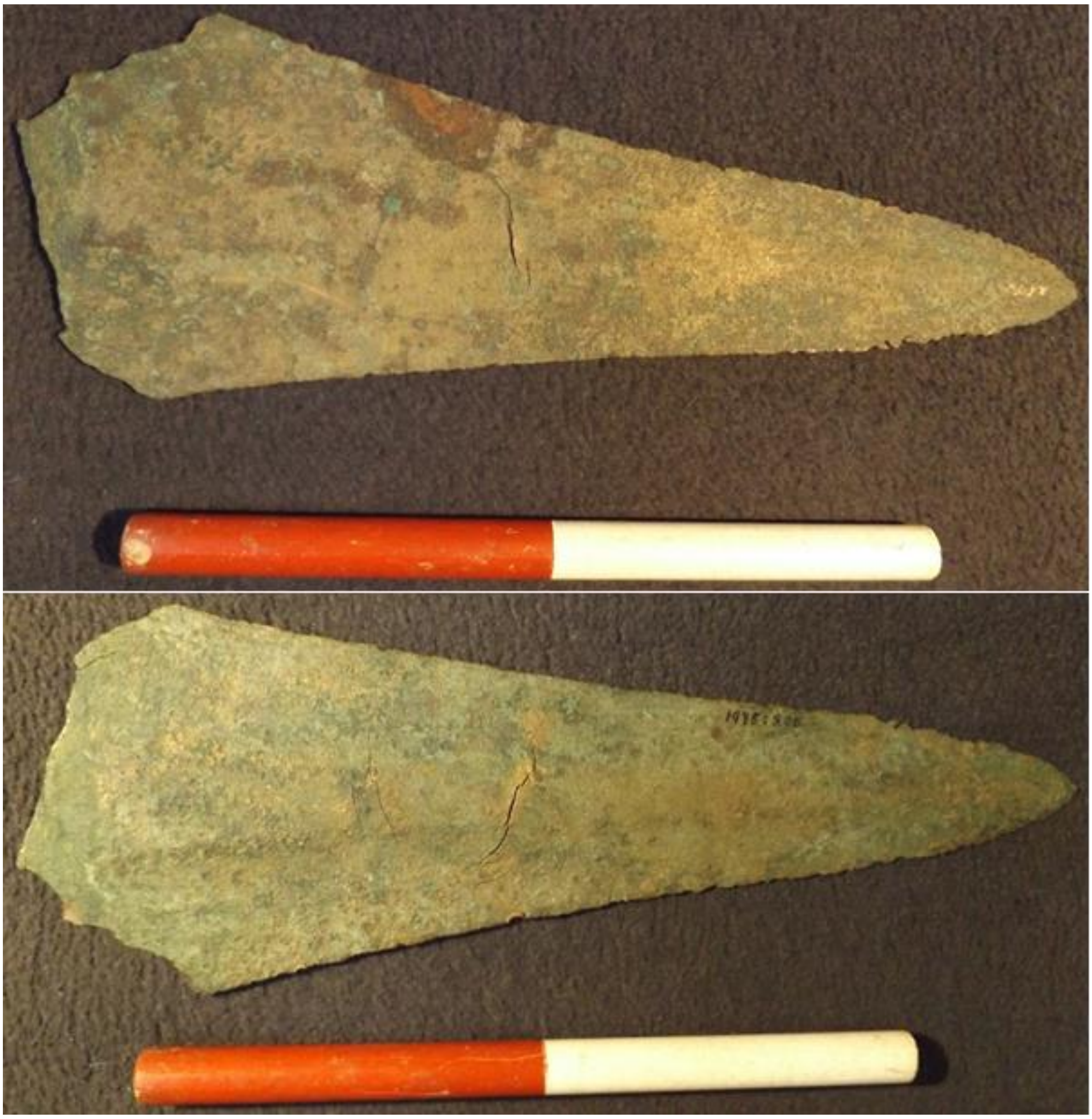

Figure 8.9 *– Both faces of the halberd from Snab of Moy, Forres (Falconer Museum, acc. no. 1987.206). The cracks across the midrib are visible on both images. The measuring rod represents 10cm. Photo © Falconer Museum, provided by Anne Owen.*

Figure 8.10 *– The bent tip of the replica dirk following the Synbone™ experiments described in Section 3.4. The white arrow indicates the 'inner face' of the curve, which when hammered flat, produces smaller and/or fewer stretch tears. The black arrow indicates the 'outer face' of the curve, which produces larger and/or more stretch tears immediately the bending deformation occurs. © Perth Museum and Art Gallery, annotations author's own.*

One further halberd shows evidence for lateral surface tears which could indicate mended bending damage. A cist burial from Dalgety Bay, Fife, yielded a large dagger or small halberd with three rivets in situ. The blade shows a lateral tear around two-thirds of the way down the blade, comparable to the extent of the profile deformation given in the earlier examples in this section. It is possible that this tear is the result of a bent blade being hammering back flat.

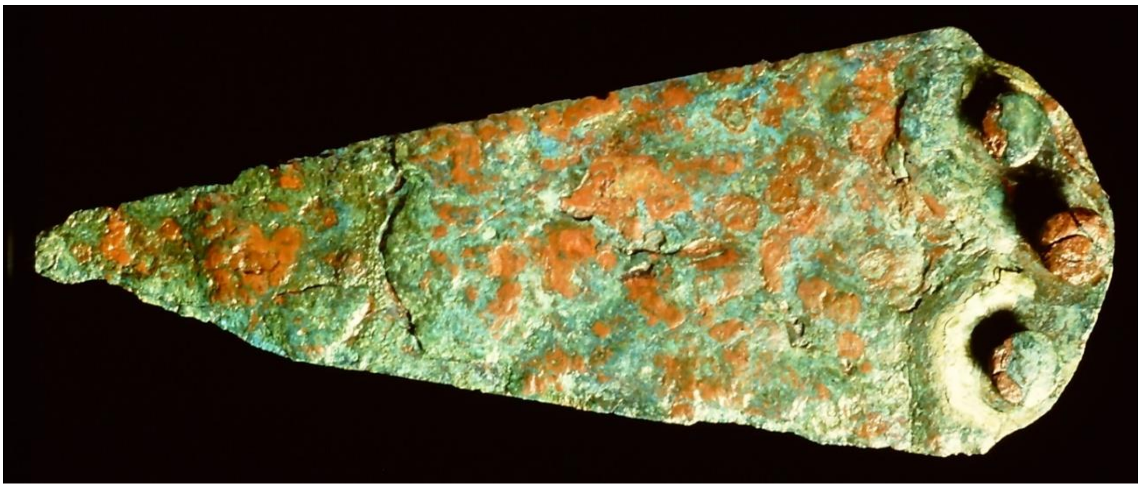

Figure 8.11 *– The Dalgety Bay dagger/halberd. The lateral tear is visible, running across the midrib. © Fife Council Archaeological Unit.*

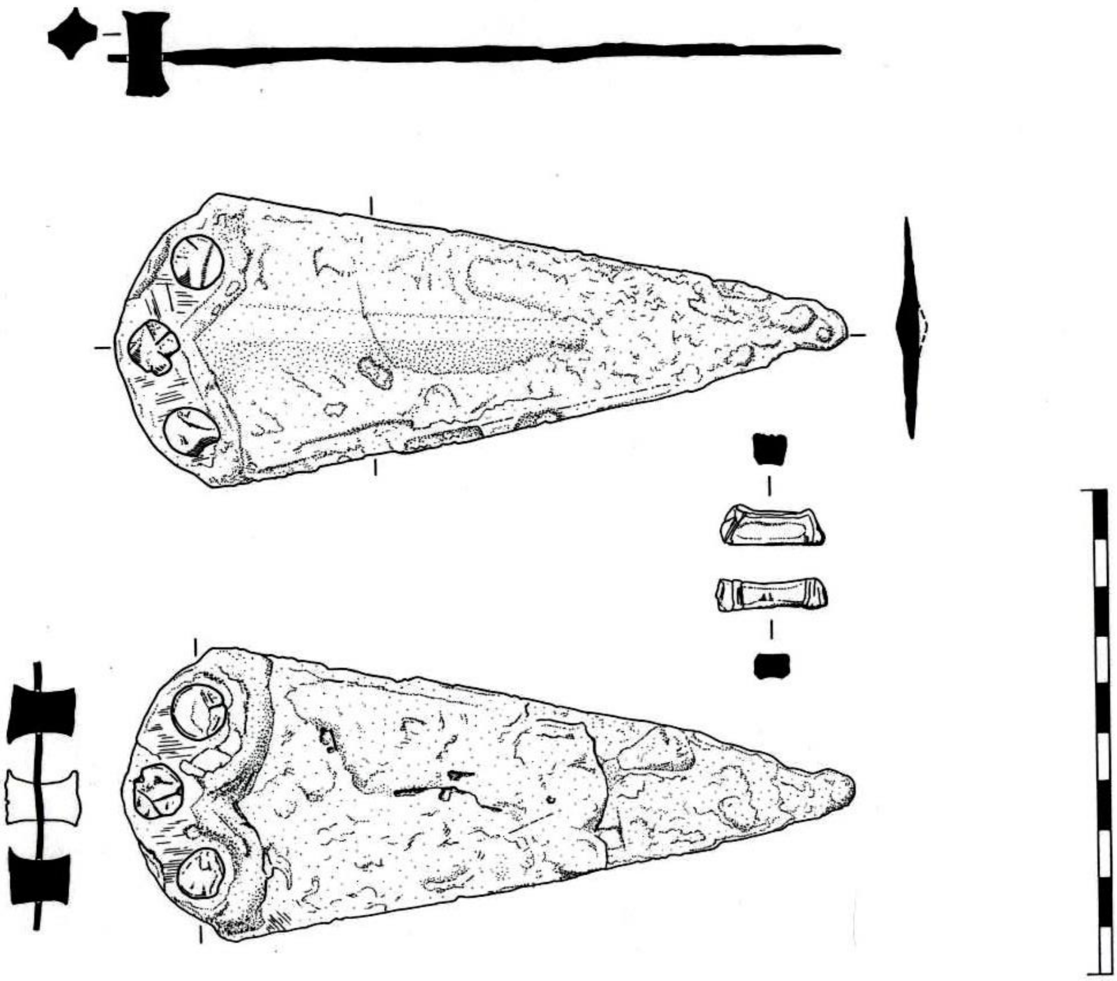

***Figure 8.12** – Scaled illustration of the Dalgety Bay blade from the excavation records. © Fife Council Archaeological Unit.*

8.3 Comparing Instances of Damage to the Hafting Plates and Rivet Holes

In his doctoral thesis, O'Flaherty(2002:142-3) posited that the central rivet hole suffers the most stress when the halberd is used. In his model, the haft is solid-backed, and the blade is inserted into a socket in the wood; the rivets anchor the blade in place, but do not need to anchor the wooden haft in place as well. When used offensively, the solid back of the haft therefore absorbs the entire force of the blow, leading to the increased incidence of cracking and damage of the central rivet hole seen in the Irish assemblage (O'Flaherty 2002:143). However, Needham et al (2015) argue instead that the hafts were 'split', where two separate pieces of wood sandwich the hafting plate, the whole thing held together by the rivets (2015:12). They argue that the rivets therefore play a much bigger structural role in keeping the hafted halberd together; split hafting is also used for Middle Bronze Age dagger/dirk hafting in Wales and England, so its use in hafting halberds is taken as a precedent (Needham 2015:15). The impact on the rivet deformation or damage is not noted, however. Diagrams are provided in Section 6.3.6.

Identifying instances of damage to the central rivet holes in the Scottish halberd assemblage in particular (the Welsh having been examined by Needham (forthcoming and Needham et al 2015)) would therefore lend support to the solid-back hafting interpretation, and also give some indication that the hafted halberds were indeed being used offensively. A lack of central rivet hole deformation would not disprove the solid-back hafting interpretation, but would indicate that the halberds were not being used offensively. The catalogue was examined accordingly, but only one possible instance of O'Flaherty's (2002) central rivet hole damage could be identified. This was on the halberd from Haverigg in Cumbria (British Museum acc. no. WG 2060), where the two inner rivet holes show more damage than the two outer (Figure 8.13).

***Figure 8.13** – The halberd from Haverigg, Cumbria (British Museum acc. no. WG 2060). The two central rivet holes show the most damage, in line with O'Flaherty's findings from the Irish assemblage.*

The Haverigg halberd is included in the Scottish assemblage in Table 8.1 and Table 8.2, but there are no other examples of halberds with the central rivet hole[s] being the most damaged in the rest of the assemblage, so extrapolating a connection to the Irish findings would be unwarranted. However, there was a high incidence of unusual hafting plate features in the Scottish assemblage which were not explained by either of the hafting interpretations proposed by O'Flaherty (2002:142) or Needham et al (2012:12-16). The assemblage data does not therefore uphold or negate either interpretation. The relatively poor state of preservation precludes a secure interpretation of damage related to offensive use through the method proposed by O'Flaherty (2002:143). However, in terms of the hafting plate itself, the Scottish assemblage showed a remarkable tendency towards very small, very thin plates which often showed a profile distortion similar to that observed in the lower blade (Section 8.2). There are several instances of halberds with hafting plates which are markedly thinner than the main blade; a blade from the New Machar hoard is a particularly good example. This halberd (Marischal College acc. no. ABDUA 19677) is in good condition, but the hafting plate does not extend the full width of the blade, and is only 1.1 mm thick (compared to the blade thickness of 8.1mm). The plate also shows a profile distortion and unusually small rivet holes (slightly smaller than 5mm in diameter), the second-smallest observed on any of the recorded halberds in this study and particularly unusual considering the size and weight of the halberd 28cm long and 378g respectively). The Arieland Moss halberd (NMS X.DJ 41) has slightly smaller holes (slightly smaller than 4mm in diameter), but is a much narrower, lighter blade than the New Machar hoard halberd. Small rivet holes are discussed in further detail in Section 8.4, below.

Figure 8.14 *– One of the halberds from the New Machar hoard (Marischal College acc. no. ABDUA 19677); the hafting plate is unusually narrow, short, and thin, and the rivet holes are particularly small for the size of the blade.*

One other halberd shows similar pronounced distortion in the hafting plate, although it is not as noticeably thin, and the rivet holes are not unusually small. Glasgow Museums Resource Centre (GMRC) holds a halberd on behalf of Kelvingrove Museum (acc. no. A.1962.3) which is listed in this study as part of the Baile-nan-Coille hoard based on the following deduction. Coles (1968-9) attributes it to the Baile-nan-Coille hoard in his illustrated list which forms the main body of his work on Early Bronze Age Scottish metalwork, with the two other associated halberds held by Dunrobin Castle, Sutherland (Coles 1968-9:38). However, in the tabulated catalogue at the end of his paper, Coles lists all three Baile-nan-Coille halberds as being held by Dunrobin Castle, and this (GMRC) halberd as coming from 'Scotland?' (Coles 1968-9:88). The Royal Commission for the Ancient and Historical Monuments of Scotland (RCAHMS) does not have a listing for the GMRC halberd, but notes that the third Baile-nan-Coille halberd was 'lost by the finder'[28]; it is highly possible, therefore, that this halberd is the 'lost' third blade. One of the two halberds in Dunrobin Castle (acc. no. 1880.4) shows a very similar patina on its lower half, further supporting the hoard association.

[28] https://canmore.org.uk/site/6615/balnacoil-hill

Figure 8.15 *– The halberd held by the GMRC on behalf of Kelvingrove Museum (acc. A.1962.3), provenanced as being part of the Baile-nan-Coille hoard. Although a typical size and shape, the hafting plate shows significant profile distortion. © CSG CIC Glasgow Museums Collection.*

However, the most unusual feature of the Scottish halberd assemblage to the extent that it could be considered usual (see Section 8.7) is the evidence for multiple episodes of riveting, with conservation of the damaged hafting plate material.

8.4 Evidence for Multiple Episodes of Riveting

The catalogue analyses have indicated that the Scottish assemblage shows some evidence for offensive usage, but does not support or reject some of the recent interpretations as to their combat use offered by researchers working elsewhere in the British Isles as to the halberds' function (O'Flaherty et al 2011, Needham et al 2015). The examination of the images and numerical data collected in this study does, however, offer an interesting alternative interpretation. Many of the Scottish halberds show evidence for multiple episodes of riveting; crucially, instead of smoothing or removing the damaged area[s] of the hafting plate, the newer rivet holes are bored into the extant damaged plate, sympathetic to the older, damaged holes. Retaining the damaged area means that the newly hafted halberd becomes much more unstable and more complicated to haft, as the new rivets sit much closer to the body of the blade and cannot distribute the weight and stress of the halberd as well as the original rivets could. It is therefore possible that the Irish and Welsh assemblages also contain halberds which were re-riveted – but they contain very few examples where the older material was conserved (exceptions are given below).

Multiple riveting episodes are indicative of the halberds being in use for a relatively long period of time. The experimental trials with the replica halberd in Ireland (O'Flaherty 2007) and with the replica Scottish blade (Chapters 6 and 7) showed that the blade itself underwent very little damage as a result of offensive use. The trials also showed that the hafted halberds were fully capable of being used offensively without the rivets working loose or the hafting place shearing or fracturing (*contra* O'Riordain 1937:241, Harbison 1969, Vankilde 1996:75); the experiments in Chapter 6 showed that poor hafting led to stress on the hafting plate; Handle 1 was removed so the damage to the blade could be examined, and although Handle 2 could not be removed without destroying the replica, any stress-induced damage to the blade did not prevent it being used offensively. However, it was noted that an inexpert blow with the Irish halberd caused the blade to "shiver", stressing the rivets and causing the weapon to "jump" in the hand (O'Flaherty 2007:426); this was not noted in the experiments with the Scottish replica, but the imperfect hafting in Section 6.4.2 did cause very minor damage to the hafting plate. With extensive (and potentially inept) use, it is possible that some halberds would require new hafts if they were hafted and damaged in this way. The experiments detailed in Section 6.8 with a child wielding the weapon, arguably the most inept person to use the halberd possible, did not cause any significant haft damage. A comparison could however be made with the unexpected damage incurred during the stabbing trials using the replica dirk, where a standard overarm stabbing blow resulted in shearing damage to a rivet and surrounding haft (Section 3.4).

However, a monolithic offensive use explanation is insufficient for the gathered data. For instance, the very first museum assemblage recorded for this study included a halberd from Culloden, Invernesshire (British Museum acc. no. WG 2061). The Culloden halberd is – unusually for Scotland – in exceptional condition, with almost perfect edge preservation, minimal patination, and no material loss.

***Figure 8.16** – The Culloden halberd (British Museum acc. no. WG 2061). The elaborate pattern of rivet holes is immediately obvious. © British Museum.*

Because the Culloden halberd is exceptionally well preserved, edge-wear analysis could be performed. Unexpectedly, the halberd showed no edge-wear at all: not only were there no indications of offensive usage, but the blunt rounded edges have not been worked, hammered, hardened, sharpened, or annealed. The total lack of post-casting treatments means that it would be highly unlikely that this blade was ever used offensively, because the edges and tip are soft and blunt.

This makes the unusual pattern of rivet holes even more interesting. The Culloden halberd has an elaborate hafting plate with nine rivet holes, alternating large and small. The rivet holes are exceptionally well preserved, all rating 0 on the survival scale (see Section 5.7). Although there are no rivets remaining in situ (given the state of preservation, it can be reasonably assumed that the halberd was deposited unhafted), some inferences can be drawn. Firstly, the rivet holes are too closely spaced for effective hafting. Calculations based on the recorded halberds with rivets in situ indicate that the rivet caps or heads are between 25% and 32% wider than the diameter of the rivet – one halberd from the Tonfannau hoard (NMW/AC acc. no. 33.209/1) has caps 79% wider than the rivets. Using the conservative 25% diameter increase, the larger rivet holes on the Culloden halberd would require rivet caps of at least 11.2mm diameter, and the smaller holes would need caps of 5.5mm. The holes are too closely spaced to accommodate securely-capped rivets in every hole simultaneously; they must therefore have been designed for either insecure decorative rivets, or indicate separate episodes of riveting. Supporting this latter interpretation is the deformation on one of the outer, larger holes. The adjacent small hole has pushed the soft metal into its neighbour, deforming the circle (see Figure 8.17). A deformation of this extent could only have occurred if there were no rivets present in the holes at the time, and if the larger hole had already been bored.

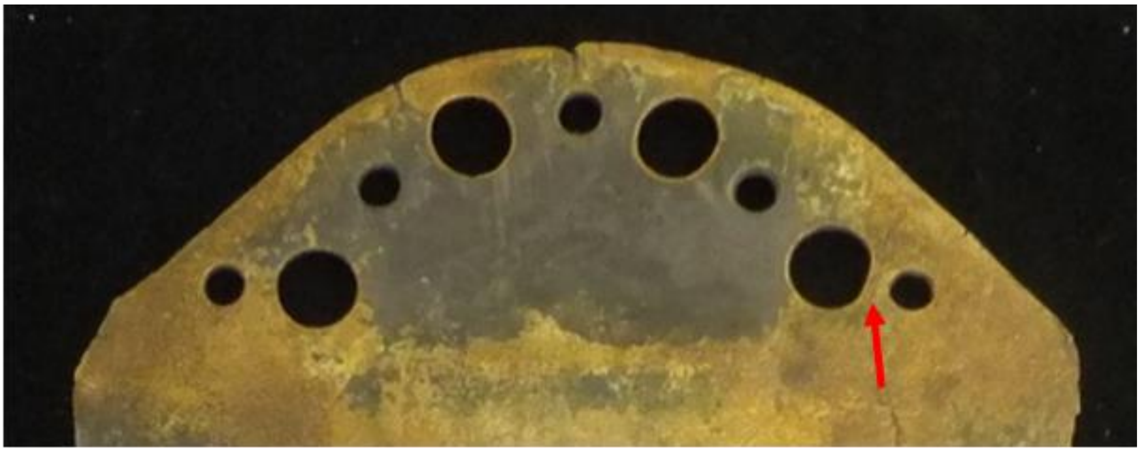

Figure 8.17 *– Detailed view of the hafting plate and rivet holes on halberd WH2061 from Culloden. The darker area in the centre could be remnants of the original patina. The red arrow indicates the area of deformation of the larger rivet holes, caused when the smallest hole to the right was subsequently bored. © British Museum.*

It is possible that this halberd was never intended for offensive use, and the security of its rivets would not have been as high a priority as its appearance or symbolic function (see Section 8.7 below). There are several parallels within the Scottish assemblage, however, which suggest that a secondary episode of riveting using smaller rivets was a recognised stage of the Scottish halberd's life cycle, and not 'just' an aesthetic function.

For instance, a halberd from Galloway held in the NMS (acc. no. NMS X.DJ 5) shows clear evidence for re-riveting. The blade is in fairly good condition (the notch in the tip was taken during compositional analysis, and is not prehistoric), with a very narrow midrib and ogival tip. The hafting plate has been almost completely destroyed; however, two small rivet holes have been bored into the blade body itself, suggesting that the halberd was re-hafted (possibly as a dagger, rather than a halberd – see the discussion in the following sections) following damage to the hafting plate.

Figure 8.18 *– The Galloway halberd (NMS X.DJ 5). As noted above, the circular notch near the tip was caused by post-recovery compositional analysis; the edges are otherwise in fairly good condition. © NMS.*

The hafting plate shows evidence of two, possibly three, episodes of riveting. One large (~11mm) shallow rivet hole remains on the edge of the hafting plate (indicated by the white dashed line on the right – Figure 8.19, below). It would not be unreasonable to reconstruct two equally sized, equally spaced holes, in keeping with similar Type Carn and Breaghwy examples (indicated by the yellow dashed lines on Figure 8.19). These would represent the first episode of riveting. An interim episode of rivet boring could be hypothesised, represented by the orange dashed circle on Figure 8.19. The extensive material loss in this area, so out of keeping with the preservation of the rest of blade, and the broken metal bridge on the adjacent intact rivet hole both suggest the presence of a second rivet hole. The final, third episode resulted in the two smaller intact holes, ~1cm into the length of the midrib.

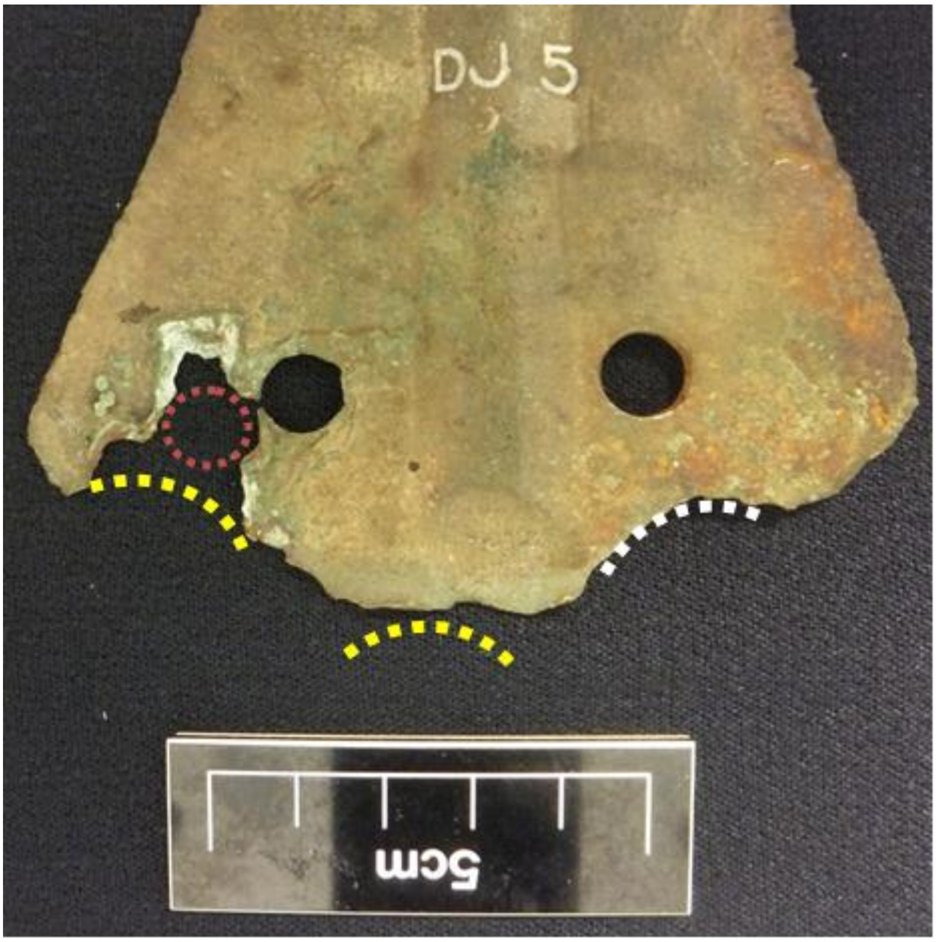

Figure 8.19 *– The hafting plate of the Galloway halberd (NMS X.DJ 5). The white dashed line indicates the surviving shallow rivet hole from the first episode of boring; the yellow dashed lines are suggested placements for two other contemporary holes, based on similar Type halberds. The orange dashed circle indicates the placement of a hole bored during a second riveting episode. The intact holes represent the final episode. © NMS.*

The placement of the two intact rivet holes is reminiscent of the Middle Bronze Age omega-hilted daggers (Gerloff 1975), though the wide shape of the hafting plate and the narrow midrib (occupying 14% of the blade width) make an uncomplicated interpretation unlikely. The conservation of the damaged hafting plate material suggests that the re-hafting was not purely functional: re-shaping the plate would provide a simpler, more secure haft. The retention of damaged original material during successive episodes of hafting should be noted for consideration throughout this section, particularly when its retention would make shaping and affixing the later hafts or handles more complicated.

The Tom na Brataich halberd, held by the West Highland Museum (WHM) (acc. no. WHM 1520) is by far the best example of secondary hafting found in the assemblage. This halberd was the basis for the replica cast, detailed in Chapter 5. The halberd was recovered at Tom na Brataich, Auchindoul, approximately 12km north-east of Fort

William, and is a Type Carn blade. One edge shows significantly more wear than the other, but the blade is otherwise in good condition. The flaking and notching on the more damaged edge, as well as the disparity in material loss between the edges, suggests that the Tom na Brataich halberd was used offensively, which could have contributed to the damage observed on the hafting plate. This differentiates this blade from the two previous examples – the Galloway halberd showed no evidence for combat usage, and the lack of post-casting treatments means that the Culloden halberd could not have been effectively used offensively.

Figure 8.20 *– The Tom na Brataich halberd (WHM 1520). The rivet remaining in situ has been sympathetically placed to the damaged holes in such a way as to require multiple episodes of hafting; see Figure 8.21 for a closer view. © West Highland Museum.*

The hafting plate of the Tom na Brataich halberd, however, is not typical of Type Carn, nor of any halberd Type yet published. There are three clear, if damaged, rivet holes spaced in an equilateral triangle around the plate, the left-most of which is notably smaller than the two others. A small curved notch could represent a fourth, heavily damaged hole of similar small diameter. The only undamaged rivet hole (and still containing the rivet) is placed further into the hafting plate, out of alignment with the other four holes (see Figure 8.21). Furthermore, the cap on the surviving rivet is of sufficiently wide diameter to preclude a capped rivet existing simultaneously in the small rivet hole on the left – it is too wide – paralleling the evidence from the Culloden halberd. If the rivet holes are divided into two sets based on their size, it can be seen that the three largest and most complete holes are further away from the edge of the hafting plate. The two smaller rivet holes on the left of the plate are significantly smaller in diameter, and in worse condition than the three larger holes. It could therefore be suggested that the smaller holes represent the first episode of riveting, and that there were more small holes bored around the edge which have since been either lost or enlarged into the larger holes. Again, the damaged hafting plate material has been conserved and the secondary rivet holes have been bored sympathetically to the originals – possibly, in the case of the two larger empty holes, overlaying and expanding the original holes.

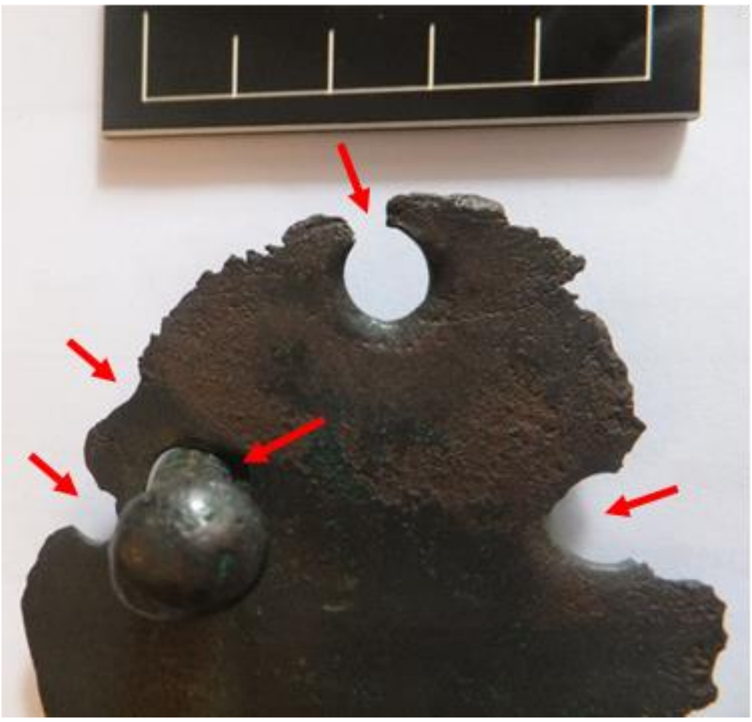

Figure 8.21 *– The hafting plate of the Tom na Brataich halberd. The five identifiable rivet holes are indicated by the red arrows, one of which has the rivet in situ. © West Highland Museum.*

The best-preserved New Machar halberd (ABDUA 19677) (Figure 8.22) also shows very small rivet holes on an exceptionally thin hafting plate; the evidence suggests that these are the result of a secondary episode of hafting, following extensive damage to the hafting plate. The halberd is one of the heavier blades recorded in this study – 378g – and its rivet holes some of the smallest. Without experimental testing using an accurate replica, any interpretations should be qualified; however, based on the profile deformation and 'juddering' blow of the replica halberd during the skeletal trials (Chapter 6), I would suggest that this New Machar halberd would not have been capable of inflicting combat damage or for offensive use if it were hafted using such slender rivets, and such a thin hafting plate, without incurring substantial structural damage. The hafting plate shows some possible indications of tearing, which could have resulted from an attempt at offensive use (Figure 8.22). The yellow dashed line on Figure 8.22 indicates the limit of the hafting plate, which would have been covered by the wooden haft, and by extension delineates the visible section of the blade. Note how close the rivet holes are to the body of the blade: if the halberd were to be hafted, there would be an extremely narrow bridge of wood left between the rivet cap and the edge of the shaft. Again, without experimental testing, its suitability for combat remains hypothetical, but an evidence-based interpretation would be that such a narrow bridge of wood would be prone to splintering and warping under pressure.

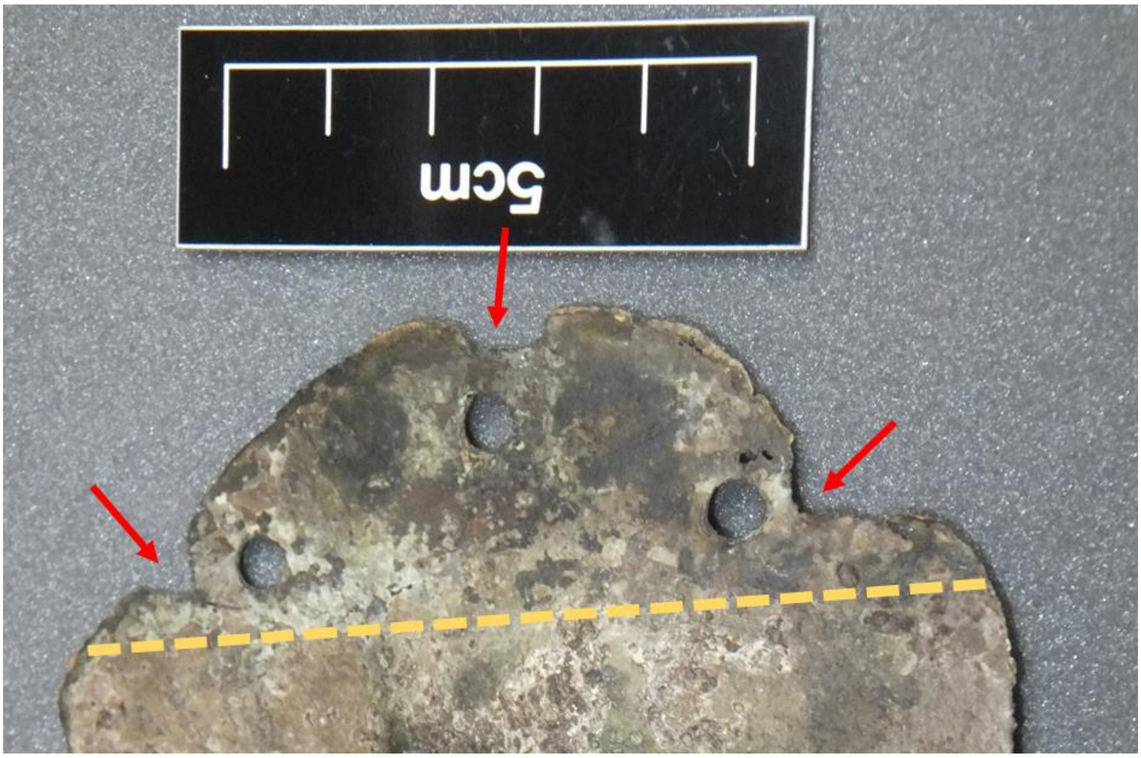

Figure 8.22 *– The most complete halberd from the New Machar hoard (ABDUA 19677). The red arrows indicate the worn rivet holes from the first episode of hafting. The left-most arrow could be a worn rivet hole, or it could be a stress rip from usage while the halberd was hafted; as such, it has not been included as a rivet hole in the catalogue. The yellow dotted line indicates the extent of the hafting plate, based on thickness. © University of Aberdeen Museums Collections Centre (Marischal College).*

The second comparatively complete halberd from the New Machar hoard (ABDUA 19678) displays a similar pattern of wear on its hafting plate. Very small rivet holes lie very close to the middle of an unusually snub, short hafting plate. The intact rivet hole measures 5.0mm in diameter, much smaller than would be expected for a blade of its length and weight (258mm and 355g respectively) based on comparison to the other halberds in the catalogue. Again, it seems unlikely that this hafting plate, when riveted to a wooden shaft, would have withstood the stresses and tension of a full impact (c.f. O'Flaherty 2007:437); however, experimental testing would be required to test this assumption. The similarities in taphonomic damage between these two New Machar halberds (ABDUA 19677 and 19678) suggest a single episode of deposition; the significantly worse preservation of halberd ABDUA 19679, which is assumed to come from the same hoard, suggests that it was a separate deposition. Furthermore, the similarities in anomalous hafting plate features – the small rivet holes, edge wear and thin plate – suggests that similar processes were enacted on the blades before they were deposited.

Figure 8.23 *– The second (largely) intact halberd from the New Machar hoard (ABDUA 19678). There is significant wear to the edge of the hafting plate, but along with the intact rivet hole on the left, two – possibly three – worn rivet holes can be identified on the right. Significant post-depositional environmental damage to the blade precludes further analysis. © University of Aberdeen Museums Collections Centre (Marischal College).*

One of the more exciting examples of secondary riveting is found in the heavily damaged hoard from Langalbuinoch, Bute, held in storage by the NMS (acc. nos. NMS X.DJ 9, 10, 11 and 45). Each of these four halberds shows an unusual hafting plate, and their deposition together strongly suggests that the processes resulting in their re-riveting, usage, and eventual deposition were the result of a shared cultural syntax – similar to the New Machar hoard. Shown together in Figure 8.24, they are then discussed briefly as individuals.

Figure 8.24 *– The four halberds comprising the Langalbuinoch hoard, all held in storage by the NMS. L-R: NMS X.DJ 45, NMS X.DJ 9, NMS X.DJ 10, NMS X.DJ 11. Even at this scale, the similarities in hafting plate damage can be seen. © NMS.*

The first of the Langalbuinoch halberds examined here (acc. no. NMS X.DJ 11) displays clear evidence for re-riveting. Here, two damaged circular rivet holes represent the first episode of riveting, and the second episode is indicated by a malformed hole in the middle of the hafting plate. This hole has either been inexpertly bored or punched, or else deformed after boring by stress and pressure exerted on both sides of the hole. Given the lack of stress lines, fracturing, or indications of pressure deformation elsewhere, inexpert boring would be the more confident explanation. It is possible that the hole was intended for an oblong peg or staple, rather than a rounded rivet, but this is unsupported by any evidence and has no parallel, to my knowledge, in any of the European halberd assemblages.

Figure 8.25 *– One of the halberds from the Langalbuinoch hoard (NMS X.DJ 11), with the two damaged and one oblong rivet holes shown. © NMS.*

The hafting plate warrants further discussion. The two semi-circular rivet holes (on the right as shown on Figure 8.26) are not reflected in any way by corresponding holes on the left half of the hafting plate. Given that halberds are hafted (broadly) symmetrically, this suggests that the two surviving semi-circular rivet holes are themselves not the results of the first episode of riveting; alternatively, this halberd could have been hafted asymmetrically, leaving the blade looser in its socket. In either case, the asymmetrical hole placement is very uncommon in the halberd assemblage as a whole.

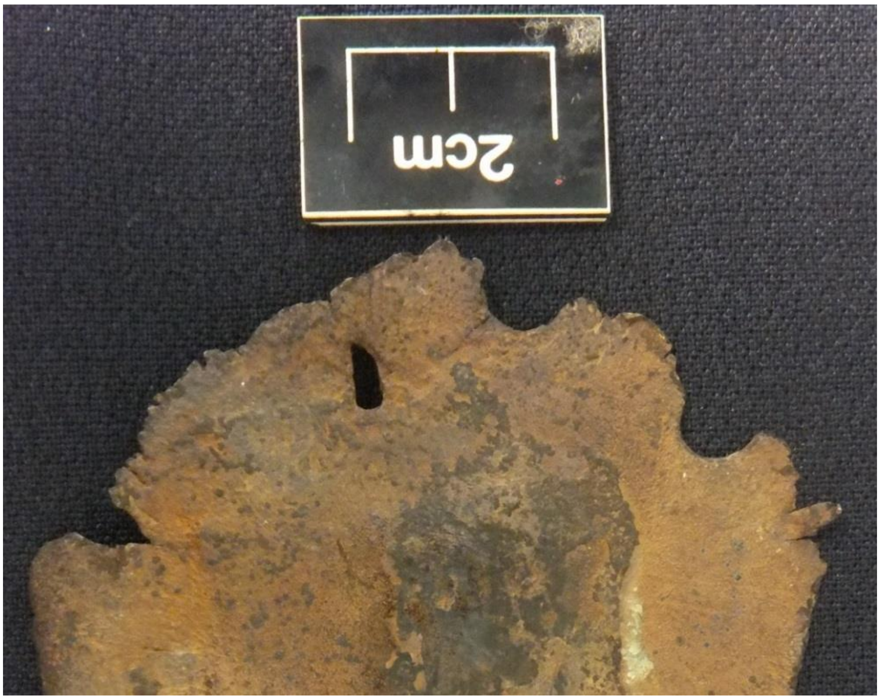

Figure 8.26 *– The hafting plate on the Langalbuinoch halberd (NMS X.DJ 11). The two semi-circular rivet holes on the right of the blade are not mirrored by corresponding holes on the left. The malformed oblong hole is visible on the left. © NMS.*

The second of the Langalbuinoch halberds (NMS X.DJ 10) is in by far the worst condition of the group. The blade has suffered extensive material loss to the edges and hafting plate, so much so as to preclude any attempt at traditional classification. However, one undamaged rivet hole survives, providing sufficient evidence for this halberd's inclusion in this section. The hole has been bored in the centre of the hafting plate, along the midline of the blade, and is very close to the midrib limit. This hole has clearly been bored after the hafting plate – and by extension, any original rivet holes – had undergone major material loss, and therefore represents a secondary episode of riveting.

Figure 8.27 *– The second of the Langalbuinoch halberds (NMS X.DJ 10). Its poor condition is immediately obvious; so too is the central placement of the single surviving rivet hole. © NMS.*

The third and largest Langalbuinoch halberd (NMS X.DJ 9) is in better condition, but still shows significant material loss from one side in particular. Again, the intact, undamaged rivet hole (condition 0) is not mirrored by a corresponding, symmetrically placed rivet hole on the opposite side of the hafting plate. Furthermore, the placement of the central, damaged hole is very close to the edge of the plate, and the suggestion of a third, significantly damaged hole on the far right edge of the plate could indicate that the most intact hole is a later addition as a result of re-hafting following damage, in line with the other associated halberds from this hoard.

Figure 8.28 *– The third of the Langalbuinoch halberds (NMS X. DJ 9). The halberd shows significant material loss to one edge, but not on the other. © NMS.*

The fourth and final of the Langalbuinoch halberds (NMS X. DJ 45) has been the worst affected by bronze disease, and is covered in an almost rusty patina, thick enough to obscure the midrib. Again, as with NMS X.DJ 9, one edge displays significantly more material loss than the other. Although heavily damaged, the hafting plate shows clear evidence for a secondary episode of boring rivets. The smallest and most intact (condition 1) rivet hole has been bored deep into the plate, very close to the blade body, and away from what is clearly the original edge of the hafting plate with wide, open rivet holes (conditions 3-4). The damaged material of the hafting plate has been retained and the newer hole placed sympathetically to the sinuous original edges.

Figure 8.29 *– The fourth Langalbuinoch halberd (NMS X. DJ 45). The thick patina obscures all of the original surface, including the defined outlines of the midrib. The most intact rivet hole can be seen on the hafting plate, as can the original, damaged edge. © NMS.*

All four Langalbuinoch halberds show evidence for secondary episodes of riveting; three (excluding NMS X. DJ 9) indicate that the secondary holes are much smaller than the originals. This is upheld by the Culloden halberd (Figure 8.16 and 8.17), the Galloway halberd (Figure 8.18) and one of the New Machar hoard halberds (Figure 8.14, if the unusual hafting plate is taken as evidence for secondary riveting). This observation is upheld across two further halberds from Scotland, though neither are without interpretative issue. The first, from Portmoak Moss, Kinrossshire in the NMS (NMS X.DJ 2, Figure 8.30), has one intact rivet hole which is smaller than the others (5mm in diameter, compared to the 7mm on the larger holes). However, the placement of the small hole makes for a difficult interpretation: slightly misaligned with the four other partial holes, the small hole occupies the space where a larger (7mm) hole would be expected. There is no evidence that the metal has been reworked, no signs of annealing or patching, which would have suggested that a larger hole had been filled in and then the smaller hole re-bored. The halberd is included here as an example of non-functionally small rivet holes and as a candidate for possible secondary riveting, but it should be interpreted with care.

Figure 8.30 *– Halberd NMS X.DJ 2 from Portmoak Moss, Kinrosshire. The small intact rivet hole (second from top) is visibly smaller than the others. © NMS.*

The final example from the recorded assemblage is the better-preserved part of the Baile-nan-Coille hoard, held by Dunrobin Castle Museum, Sutherland (acc. no. 1880.3). The halberd is in generally fair condition, although bronze disease has pitted the surface of the blade. The hafting plate shows four, possibly five, open rivet holes, and one intact hole bored closer to the midrib, sympathetic to the damaged holes (Figure 8.31), representing a secondary episode of riveting. This intact hole is significantly smaller than the others. (This halberd was not recorded in person; the Dunrobin Castle manager kindly sent the below image, as the Museum is without a permanent curator.)

Figure 8.31 *– One of the Baile-nan-Coille halberds in Dunrobin Castle Museum (acc. no. 1880.3). The smaller secondary rivet hole can be seen at the top of the hafting plate. © Dunrobin Castle Museum.*

One further debatable example is a halberd in the NMS of unknown Scottish provenance (NMS X.DJ 7). The halberd is in very poor condition, with significant material loss from the hafting plate and extensive edge damage. However, the hafting plate does present one small (4mm) circular indentation, which could be interpreted as an unusually small rivet hole from a second boring episode following damage to the blade. However, the exceptionally poor state of preservation precludes a secure interpretation; it is included here because of the similarities to the above-mentioned halberds.

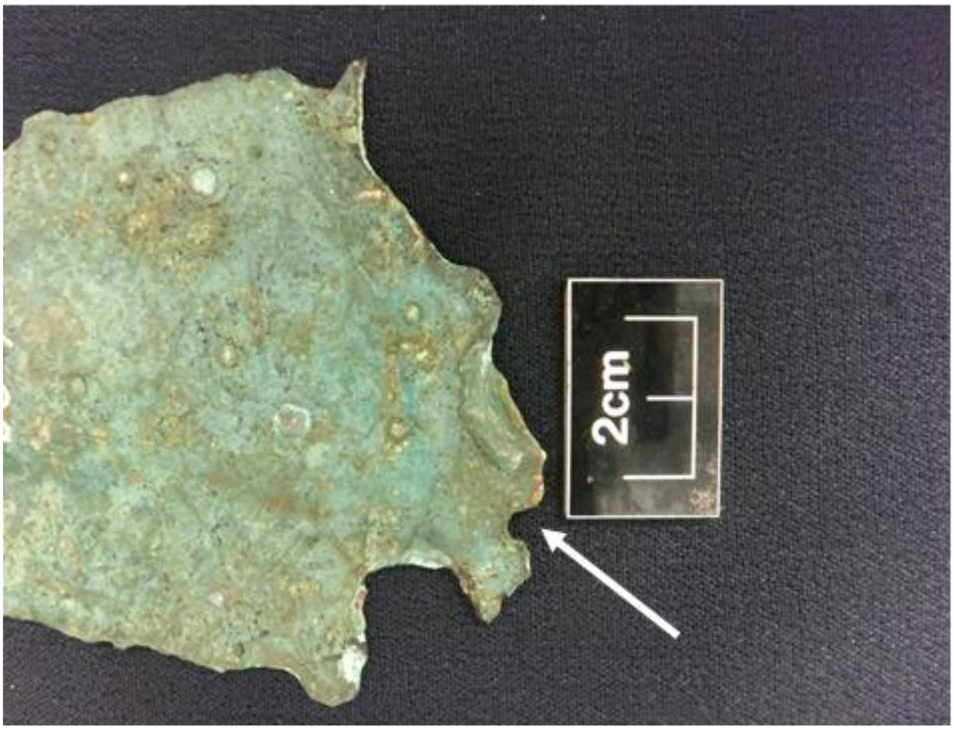

Figure 8.32 *– The hafting plate of halberd NMS X.DJ 7, with the possible small hole implying a second riveting episode indicated by the white arrow. The poor state of preservation is evident. © NMS.*

Outwith Scotland, two further examples of secondary riveting have been identified. The first is from the Castell Coch hoard held by the National Museum of Wales/Amgueddfa Cymru (acc. no. 84.31.H/1). Here, the rivet holes recall the relative sizes and arrangement of the Culloden halberd (Figure 8.13): 'reading' them left to right, the holes measure 9.8mm, 6.8mm, 8.1mm, 7.3mm and 8.9mm – crudely speaking, a pattern of large-small-medium-small-large - which corresponds exactly to the rivet hole arrangement on the Culloden blade. The two outermost rivet holes have – uniquely in the assemblage – been bored into the body of the blade itself, rather than the hafting plate, strongly suggesting that these five rivet holes represent a secondary episode of riveting.

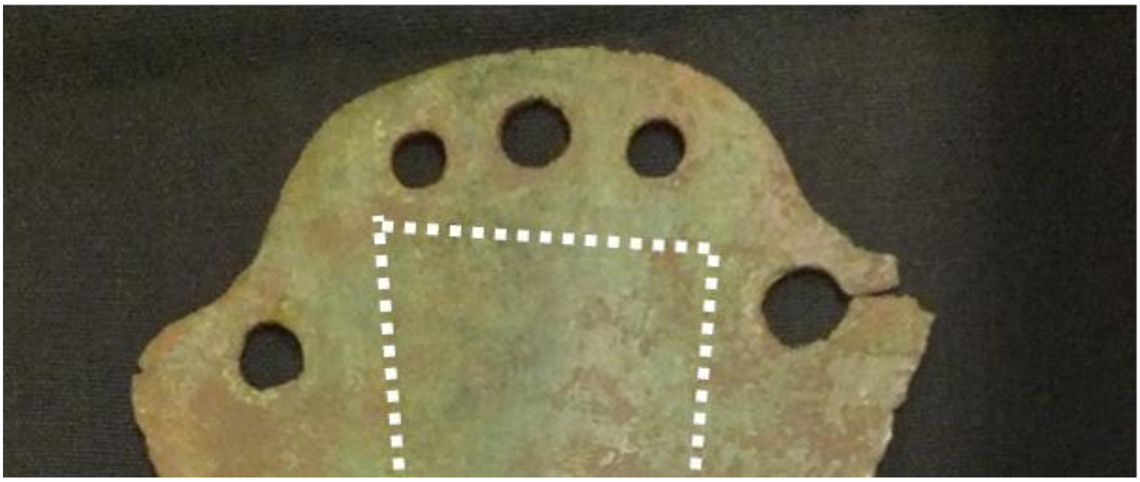

***Figure 8.33** – The hafting plate from one of the halberds from the Castell Coch hoard (84.83.H/1). Both halberds found in this hoard were very well preserved. The midrib (indicated by the white dotted line) extends much further into the hafting plate than any other halberd, suggesting that the surviving hafting plate is the result of multiple events of hafting and riveting occurring over a long period. © NMW/AC.*

The Castell Coch halberd does not fit neatly into the above-mentioned model, however. The hafting plate does not show any indication of the original rivet holes; the interpretation offered here is that the original hafting plate was pared down following damage, involving the intentional removal and reshaping of the damaged plate material to its current shape and size, leaving the midrib at the length appropriate to the original hafting plate. Reshaping the hafting plate would require new rivet holes to be bored. It is therefore possible that the patterning of hole sizes was a later addition, and not part of the original halberd design. A second episode of rivet hole boring, occurring after the removal of much of the original hafting plate, would also explain why the two outermost holes are located on the body of the blade, rather than the hafting plate. Not retaining the damaged hafting plate sets this halberd apart from the Scottish assemblage, but the parallels between the secondary riveting episode and the Culloden blade in particular are worth noting. Culloden to Cardiff is around 900km overland. However, the seafaring capabilities of Bronze Age communities is well documented, as is the significance of river system transportation (see Crumlin-Pederson 2010:53-5); cultural contact and transmission across such distances is a key feature of the Bronze Age, and forms a crucial part of the proposed interpretative model for these halberds (see Sections 9.4 and 9.6).

The final example of clear evidence for multiple riveting episodes is an Irish blade from Ballygawley, Co. Tyrone, currently held by the British Museum (WG 1596). The halberd shows clear evidence for multiple episodes of riveting, wherein the outer row of three rivet holes have worn away and a second row of five has been bored much closer to the midrib (see Figure 8.34). Intensive post-recovery cleaning has removed any traces of patina or surface wear.

Figure 8.34 *– The halberd from Ballygawley, Co. Tyrone, Ireland (WG 1596). Three worn rivet holes are clearly visible on the outer edge of the hafting plate, and an inner arc of five rivet holes – three of which have rivets in situ – have been bored closer to the body of the blade. © British Museum.*

This last blade provides debatable evidence only, and is therefore included for comparison and discussion. The Haverigg halberd (British Museum acc. no. WG 2060, Figure 8.35) shows a very small circular indent in between two of the rivet holes, offered here as an imperfectly or incompletely punched rivet hole from a secondary episode of hafting. The indent is a slightly different colour to the rest of the blade, having less of a thick patina covering it. Its size and location are highly reminiscent of the arrangement of the Culloden halberd's rivet holes, and it being markedly smaller than the extant rivet holes fits well with the pattern observed throughout this section. However, this incomplete hole is without parallel in the assemblage. Furthermore, the Haverigg halberd was part of Rohl and Needham's (1998) study on lead isotopes, and has a small borehole in the midrib on the rear face of the blade. It is possible (though unlikely, as it is not noted in the catalogue or in Rohl and Needham (1998)) that the indent was caused during the sampling process as part of the lead isotope analysis; for this reason, the indent is classed as possible evidence only. Given how well it aligns with the observed patterns throughout this section, however, I am confident that it is reflective of a secondary riveting episode and not of post-depositional taphonomy.

Figure 8.35 *– The hafting plate of the Haverigg halberd (British Museum acc. no. WG 2060). The small circular indent is visible between the two extant holes on the right half of the plate. © British Museum.*

8.5 Evidence for Patching or Fixing the Hafting Plate

One halberd in the assemblage showed unique evidence for mending a damaged area of the hafting plate to retain the rivets. An unprovenanced halberd from the Scottish Borders (National Museum of Scotland acc. no. NMS X.DJ 34) (Figure 8.36), which is in a very poor condition and has undergone significant material loss to the edges, clearly shows a patch on the hafting plate over one of the outermost rivets. The rivet remains in situ, so the patch clearly worked as a fix; the four rivets in situ and the thicker patina towards the end of the blade suggest that the halberd was deposited with the wooden haft intact, protecting the plate from corrosion for a little while before it disintegrated. The patch would therefore not have been visible because the haft would have covered it up – see the discussion in the next chapter (Section 9.6). The rivet holes are placed very close to the main body of the blade – the two outermost are bored on the blade itself, beyond the beginning of the midrib. Given the body of evidence gathered in this chapter so far, it is arguable that this unprovenanced Borders halberd also shows evidence for secondary riveting – that the rivet holes are placed so far into the main blade because the original hafting plate had become damaged. Adopting this interpretation further aids the explanation of the unique patch. Conserving the damaged hafting plate material and the halberd as a whole, rather than melting down and re-casting the blade, suggests that the halberd was revered beyond its combat capabilities (which is discussed at length in Chapter 9). Detailed and targetted XRF testing on the patch and the blade would aid greatly in this case; however, one suggestion would be that the patch is made from the damaged halberd material, conserved and reused to maintain the blade.

Figure 8.36 *– Halberd NMS X.DJ 34, possibly from the Borders; a closer view of the mended hafting plate is shown in the lower image. © NMS.*

8.6 Evidence for the Deliberate Removal of the Hafting Plate

The deliberate removal or paring down of the hafting plate was a pattern observed exclusively in the Scottish assemblage, but with fewer examples than the multiple riveting episodes detailed in the previous section. Six of the Scottish halberds showed indications of intentional material abstraction from the hafting plate, whereby the resulting edge was uniform, smooth and/or worked, with no remaining traces of any rivet holes, and a patina consistent with the rest of the blade to indicate that the re-working is not a result of post-depositional taphonomy. Many of the examples in this section are in a poor state of preservation; however, each show re-worked hafting plates (either visible with the naked eye or under a magnifying glass or microscope) and so their poor preservation should not be taken as undermining the evidence. The deliberate labour involved in re-working the hafting plates belies the interpretation of the halberd as a pure weapon, intended only for combat: without rivets, or even flanges to insert into the haft, these modified halberds could not have been hafted securely enough to use offensively. Even if they were used in combat prior to re-working, their final function is not one of a straightforward weapon.

All six halberds in this section are held by the National Museum of Scotland. The first is of unknown provenance (NMS X.DJ 8), and is missing its tip. The hafting plate has been rounded around the narrow midrib; the blade maintains the proportions of a halberd, rather than a dirk or dagger, despite it being without Type due to material loss.

Figure 8.37 *– The unprovenanced Scottish halberd (NMS X.DJ 8). The hafting plate has been rounded into a smooth curve. © NMS.*

The second example is very similar in terms of size and preservation. Also unprovenanced (the catalogue lists it as “from Lanarkshire?”), halberd NMS X.DJ 13 has significant edge material loss and a missing tip. The hafting plate does show evidence of smoothing and rounding following a reduction in width, however, and the patina is consistent with the rest of the blade.

Figure 8.38 *– The Lanarkshire halberd (NMS X.DJ 13), showing significant edge material loss and a re-worked hafting plate. © NMS.*

A third halberd of similar length and similarly unclear provenance completes this first set of small halberds. Reputedly part of a hoard from Islay (questioned by Coles (1968-9:87)), halberd NMS X.DQ 45 is in very poor condition, showing several instances of edge rifling consistent with intentional damage where the blade has been struck with a narrow stone hammer or similar (O'Flaherty et al 2011). This is unusual within the assemblage. The hafting plate has been deliberately removed, but the resulting edge is neither as smooth nor as uniform as the other examples in this section; however, it is included here because the patina is consistent with pre-depositional re-working.

Figure 8.39 *– A halberd from Islay (NMS X.DQ 45). The edge rifling is visible on the lower edge of the halberd, and the hafting plate is not as cleanly-worked as the others in this section. © NMS.*

The three halberds in the second set in this section are much larger, and none could be argued to be daggers or dirks. All three are part of the Auchingoul hoard and are in very good condition. All of their hafting plates are much larger than the three previous examples, indicating that they may not ever have had rivet holes bored in. The edges on each of the three halberds in this section show evidence of post-casting cold hammering, which would be expected on a weapon used in combat; a more robust interpretation would therefore be that the original rivet holes were located close to the edge of the hafting plate, rather than not ever having been bored, because the halberds have been treated to harden the edges ready for impacts and stresses. Their association strongly supports the interpretation offered here that the removal and re-working of the hafting plate was intentional and deliberate, serving a function beyond combat capability.

Figure 8.40 *– Halberd NMS X.DJ 37 from the Auchingoul hoard. Although bronze disease has pitted the surface, the halberd has not undergone much edge damage. The hafting plate is much larger than the earlier examples in this section. © NMS.*

Figure 8.41 *– Halberd NMS X.DJ 39 from the Auchingoul hoard. The tip of this halberd is heavily pitted with bronze disease; the blade is otherwise in excellent condition. Note again the large re-worked hafting plate. © NMS.*

Figure 8.42 *– Halberd NMS X.DJ 40 from the Auchingoul hoard. The best-preserved of the Auchingoul halberds, the incised groove decoration on the midrib and edges is not only beautiful, but their curved extents on the midrib indicates the shape of the haft. © NMS.*

Figure 8.43 *– All four halberds from the Auchingoul hoard held by the NMS (l-r NMS X.DJ 37, 38 (not included in this section due to its typical rivet holes), 39, and 40). © NMS.*

The deliberate removal of the hafting plate is unusual in the wider European assemblage – although no continent-wide comparative study has (yet) been made, based on the national catalogues, there are no other examples of similar removal from Europe (Branderm 2004, 2011; Horn 2014; O'Flaherty 2002; Needham et al 2015). However, it is possible that halberds with deliberately removed hafting plates have been misidentified as dirks or daggers – this is a particular concern for the smaller or more poorly preserved blades, such as the first set of three in this section. Ignoring the size and placement of the rivet holes, halberds can be distinguished from dirks by their increased size and breadth, as well as their narrower midribs and wider, deeper hafting plates. Significant material damage can blur these delineations, and the relative scarcity of halberds and abundance of daggers could lead archaeologists to assign damaged halberds as the more common dirk/dagger. The evidence from the Scottish assemblage should therefore be considered very unusual, but not necessarily unique.

8.7 A Proposed New Group: Tom na Brataich

Table 8.3 and Table 8.4 show the proportional breakdown of the recorded British halberd assemblage according to Type. Issues with typologies are discussed in Section 5.8, though the main point should be reiterated here for clarity: although the Types should ideally be relatively distinct, there are several halberds which display characteristics of multiple Types. The final call as to which category fits best is ultimately up to the researcher, and therefore subjective.

Table 8.3 *– Breakdown of the halberd assemblages by traditional Types (Harbison 1969, O'Flaherty 2002). Note the high proportion of unclassified halberds, all from northern Britain.*

	Whole assemblage	Scotland
Type Breaghwy	25	18
Type Carn	5	1
Type Cotton	3	1
Type Clonard	3	2
Type Tonfannau	2	0
O'Flaherty's theoretical	3	2
Unclear	7	7

Table 8.4 *– Breakdown of the halberd assemblages by traditional Types (Harbison 1969, O'Flaherty 2002) but also including the atypical halberds which do not easily fit into one of Harbison's Types.*

	Whole assemblage	Scotland
Type Breaghwy	14	10
Type Carn	5	1
Type Cotton	3	1
Type Clonard	3	2
Type Tonfannau	2	0
O'Flaherty's theoretical	3	2
Atypical	15	13
Unclear	2	2

Given the volume of the existing typologies – especially considering the small size of the British halberd assemblage when compared to, for example, dirks or socketed axes – and that Coles (1968-9) demonstrated that O'Riordain's (1937) categories stand when applied to the Northern British assemblage, this additional Group is not proposed lightly. This catalogue was constructed using Harbison's (1969) categories, which (broadly speaking) could be applied to the Scottish assemblage. Furthermore, Needham's 2015 paper on the Trecastell halberd, and the accompanying comprehensive catalogue of Welsh types and the corresponding typology (critiqued in Section 5.8) was incredibly detailed – arguably, to a fault. What has not been discussed to a similar degree is the significance and purpose of the types within a typology. Therefore, the Group proposed here will require justification and explanation, as well as demonstrate its relevance to the analytical interpretative discussion in Chapter 9.

As shown in Table 8.3 and Table 8.4, the Scottish halberd assemblage does adhere to Harbison's (1969) established types, with the majority in Type Breaghwy. However, 13 of these Type Breaghwy halberds from Scotland include a caveat or notation (listed on the spreadsheet) – most commonly an unusual hafting plate shape (an important criterion for classification under Harbison's system) which weakens the reliability of the classification. Furthermore, the high proportion of unclassified halberds indicates that Harbison's typology is insufficient to securely account for all of the Scottish halberds, in the same way as it does for the Irish assemblage (on which it is based). Examining the unclassified and the unusual Type Breaghwy halberds for any similarities proved successful: the evidence for unusually thin hafting plates, unusually small rivet holes, and evidence for multiple riveting episodes is listed throughout the previous sections in this chapter, and shows that the atypical Type Breaghwys outnumber the typical examples. It should be clear from the two tables above that the introduction of a theoretical class based on the unusual features observed in Sections 8.2 to 8.6 inclusive reduces the number of unclassified halberds in the assemblage, and also provides a useful analytical tool for over a third, if not more, of the Scottish halberd assemblage. It also means that the halberds which were classified as Type Breaghwy despite their unusual features which rendered their classification suspect could be more confidently grouped with similar artefacts displaying common traits. The extensive examples of sympathetic re-riveting given in the previous section are based on objective catalogue data: this was not an expected or intended outcome of the research, and examples were not sought or favoured above others. Halberds in this Type are noted as such in the catalogue (Appendix 1). All but one come from Scotland; the outlier being the Haverigg halberd, which was included in the

Scottish assemblage counts (see the short explanation in Section 8.3). Clearly, therefore, 'typical' in this case has been inappropriately delineated and requires revision.

One of the better examples of this proposed Type comes from Tom na Brataich, Auchingoul, a few kilometres north of Fort William in Invernesshire, and is considered the eponymous type-find because it was this halberd which first made clear the significance of the damage to the author (Figure 8.21). It is held by the West Highland Museum (acc. no WHM 1520), though in storage at the time of writing (summer 2019). The Tom na Brataich halberd was used as the template on which to make the replica halberds used in the experiments in Chapters 6 and 7, though taking the outer edge of the hafting plate as the limit from which to bore the rivet holes, rather than reproducing the unusual original hole layout. Based on the evidence from the catalogue, the proposed Group Tom na Brataich is defined as follows:

> *A broad, asymmetrical blade with a straight midrib occupying <30% of the total blade width, made from copper or bronze. Most critical is the hafting plate: the plate must show evidence of damage and re-working, such as re-bored rivet holes, holes bored close to or even on the main body of the blade itself; ideally, there should be conservation of the damaged material of the hafting plate. If a Group Tom na Brataich halberd were to be hafted, the blade would not be completely secure and would not be able to inflict a powerful blow without suffering severe structural damage.*

It is my suggestion that this new Group be used alongside Harbison's (1969) categories, which when used in conjunction account for 94% of the Scottish assemblage (and 96% of the entire catalogue in this study) – it is in no way intended to replace or overrule the existing typology. Its addition clarifies the position of most of the unclear or insecurely typed halberds from northern Britain, based on common traits relating to reuse or reworking of the hafting plate for reasons which I propose in the following chapter. As Group Tom na Brataich is based on secondary features – re-working, conservation of damage, re-riveting – it is of course entirely possible that halberds of this Group were originally cast as one of Harbison's original Types, and then modified into Group Tom na Brataich; this would account for many of the halberds displaying features common to typical Type Breaghwy halberds in particular. However, it would be possible to cast a Group Tom na Brataich halberd, rather than modifying an existing blade. The Culloden halberd (British Museum WG 2061, Figure 8.16 and 8.17) shows no evidence for any post-casting treatments, or even hafting, and it is therefore entirely possible – probable, even – that this halberd was cast with no thought to the security of the haft in terms of offensive use. Regardless of its original casting potential, this proposed new category is therefore a Group and not a Type so that it can work alongside the existing Types.

The adoption of this proposed new Group opens the halberd assemblage up to a novel interpretation. If a significant proportion – almost a third – of the assemblage has been cast or modified for purposes other than combat, then the halberd is not *just* a functional weapon. The experiments detailed in Chapters 6 and 7 demonstrated that when wielded confidently against single inert opponent, a hafted halberd was capable of inflicting massive, potentially mortal, damage, but that it was not suited to melee combat or multiple opponents. The evidence from the catalogue further suggests that combat capabilities were not a priority when re-working damaged halberds; it is likely, however, that the damage was incurred through combat usage (see Section 8.2). A more nuanced interpretation should therefore be the aim, which incorporates all of the experimental and artefact evidence and accounts for the long period of use, and changing priorities, suggested by the damage and re-working of the hafting plates. This will be the primary focus of the next chapter.

Chapter 9 – A New Model for Considering the Halberd in EBA Scotland and Ireland

9.1 Introduction

This chapter will synthesise all of the work presented in the thesis thus far into an interpretive model, in which the writer will propose one way to view the unusual distribution, short period of usage, and 'atypical' features of halberds discussed in Chapter 8. The approach taken will also complement current research on metallurgy and the movement of metal objects across Europe by considering some ideas on the creation, purpose and dissemination of the halberds, and provide a novel interpretative paradigm for the discussion of weaponry in the Bronze Age. This is not intended to be a definitive model for understanding the EBA halberds in Scotland, but rather offer one interpretation which includes all of the available empirical data from this project and contemporary metallurgical research, in the hope of encouraging further discussion and reflect the recent trend towards a more holistic approach in Bronze Age research (cf. Frei et al 2015, Bergerbrant et al 2017, Hoole et al 2018).

9.2 Overview of the Relevant Findings

This section will briefly summarise the key features found in the Scottish halberd assemblage which are relevant to the model proposed below (Section 9.6). As they have already been discussed at length in their relevant chapters, only minimal detail is given here.

The distribution patterns of the halberd across Europe, with particular concentrations in Britain and Ireland, Iberia, Italy, Germany, and southern Scandinavia have been discussed in recent literature; there is neither space nor relevance to critically evaluate current provenance studies in this thesis, but work is ongoing across Europe throughout the Bronze Age (Schuhmacher 2002, particularly figs 9 and 10, 281-3; Horn 2014; Needham et al 2015; Needham forthcoming). The most recent distribution map covering all of central and western Europe (Figure 9.1) shows these clusters of halberd deposition, as well as the large swathes of Europe where halberds were not distributed – most notably central France and Spain, much of central Europe, and England. The areas devoid of halberd finds were nonetheless occupied at the relevant period within the Bronze Age (Brück 2000, Amesbury et al 2008, Sheridan 2008)), when a thriving trade network crisscrossed the continent (Earle et al 2015): the lack of halberd deposition is thus not correlated to an absence of prehistoric activity.

Figure 9.1 *– A distribution map of European halberds by type as of 2002. The Irish, German, Scandinavian, and Iberian clusters are noticeable, as are the areas with few or no depositions. After Schuhmacher (2002:283)*

The chronology of the halberd is debatable (Schuhmacher 2002), but there is a consensus that the Type Breaghwy halberds found in Ireland and Scotland predate the Iberian and French Type Rowans, and that all the types of halberds were produced only during the Early Bronze Age (Schuhmacher 2002, Needham et al 2015). The halberds in Scotland tend to be deposited as single finds or in hoards with other Migdale-horizon metalwork; halberds as grave goods are rare in northern Britain, but there are some examples – the Trecastell halberd (Needham et al 2015), and (arguably) the Dalgety Bay blade

(Proudfoot 1997). The later EBA Iberian and Italian halberds are deposited in tombs and graves, alongside pottery (Schuhmacher 2002:264-70, 271-73; Schubart 2001).

These earlier halberds in Scotland, dating to the first half of the EBA, show a high incidence of atypical features when Harbison's typology is applied (Harbison 1969), unlike when it was successfully applied to the contemporary Irish assemblage (O'Flaherty 2002); this supports the treatment of the Scottish halberds separately from the Irish record (contra Kristiansen and Larsson 2005). These variant features were mostly centred on the hafting plate, primarily in evidence for multiple episodes of riveting or non-functional small rivet holes (Section 8.4), but also including evidence for patching or mending (Section 8.5), and evidence for the deliberate removal of the plate (Section 8.6). The two other categories of unusual damage, profile deformation and ripping across the midrib (Section 8.2), correlate to the experimental damage observed in Chapter 7 and are not related to any conscious casting decisions. There was also evidence across the Scottish, Irish and Scandinavian collections for the conservation of the halberd throughout its lifetime (Bray and Pollard 2012, Radivojević et al 2019), where any damage sustained was incorporated into the repaired blade (Sections 8.4 and 8.5), rather than melting down and recasting the halberd into a new blade to maintain its efficacy as a combat-ready weapon. This concept of conservation instead of recycling is discussed further in Section 9.3 below.

In terms of the offensive use of halberds in combat, the experiments described in Chapters 6 and 7 show that a skilled wielder could inflict mortal damage on a single, preferably prone and almost definitely immobilised, opponent. However, the depth attained by a fatal blow into the body, as well as the angle at which the blow enters the body, means that it takes several seconds to extricate the halberd depending on how deep the blade has sunk into the body, and if it has snagged on any bone or thick connective tissue, during which time the wielder is highly vulnerable to attack. That the halberds were used in combat is evidenced by the profile deformation, and arguably by the rips and tears across the midrib; however, the experiments showed that the weapons were not suited to melee-type combat, and an unhurried, potentially ritualised, scenario is much more likely. This is discussed in more detail in Section 9.4.

9.3 Chemical Evidence for the Conservation of Halberd Blades

The patching evidence detailed in Section 8.5 and the placement of secondary rivet holes sympathetic to the primary, damaged holes (Section 8.4) indicate that the copper or bronze used to cast the halberd blades was revered, and that the people making and using the halberds were reluctant to recast a blade at the expense of the original if a serviceable implement could be formed without destroying and recasting the original blade. This argument is upheld by recent chemical studies of British BA copper and bronze axes, daggers and halberds (Bray and Pollard 2012). XRF can be used to give a trace element analysis, or compositional analysis, of the x-rayed sample.[29] By cross-referencing the chemical composition of an artefact with a range of known compositional signatures from known ore sites and mines, a provenance can be suggested; provenance studies were the earliest focus of antiquarian chemical analyses in archaeology during the nineteenth century (Pollard, Bray and Gosden 2014:625). This does, however, rely on ore sites being identified and a compositional signature acquired; exhausted sites, or those which are too small for modern researchers to identify reliably as having been used during the Bronze Age, are not included. Furthermore, the time dimension between casting and deposition has long been overlooked: ore A does not necessarily become object B and then be deposited at site C immediately. Implying that it does minimises human agency and the contemporary social and technological contexts, and "fails to engage with the rich life of the material beyond its first and last points" (Pollard et al 2014:627). Indeed, considering the missing time dimension can aid the interpretation of the chemical analyses. Considering the time dimension also includes the impact of recycling on the metal artefact's chemical composition, which is particularly important when studying the Scottish halberds.

Bray and Pollard (2012:858-60) demonstrated that the Scottish halberd assemblage had an arsenic content of around 1.93%, much higher than the contemporary axes produced from the same Ross Island copper (1.19%, a difference which is statistically significant at a 99% confidence), as shown in Figure 9.2 below. This has led to some confusion over the halberds' origins, because their chemical composition does not neatly correlate with any of the known British or Irish sources. However, by accounting for factors in play *during* the life of the halberd, the composition becomes an interpretative tool rather than

[29] See www.oxford-instruments.com/businesses/industrial-products/industrial-analysis/xrf

a problem. The more reactive trace elements in copper ore, primarily arsenic (As) and antimony (Sb), are thus the first to be lost during oxidation, while silver (Ag) and (to a lesser extent) zinc (Zn), being less reactive, are retained (Kearns et al 2010). Annealing (heating the metal to its melting point) triggers the oxidation process: the more times a copper object is melted and re-cast, the more As and Sb will be lost to oxidation (Bray and Pollard 2012:859). Rather than indicating the extensive exploitation of an unknown ore source specifically used for halberd production, the difference in arsenic levels between the EBA halberds and axes can instead be attributed to the axes being recycled or recast during their lives, and the halberds retaining their original shape, regardless of damage (Bray and Pollard 2012:859). The closed-mould casting process used to produce the halberds would prevent some of the oxidative loss, unlike the open-cast axes, but not to the degree which would result in a 0.77% arsenic discrepancy (Bray and Pollard 2012:859). By accounting for the lack of processing during the halberds' lives, the chemical analyses stop clouding the issue of provenance and instead become an interpretative tool: the Scottish halberds show a composition indicative of Ross Island copper, but with the higher As and Sb levels reflecting their unrecycled state. The conservation of damaged hafting plate material, the sympathetic placement of secondary rivet holes, and patching/fixing evidence (Section 8.5) thus correspond to the interpretation offered by the chemical analyses, whereby the halberds were not being recast, re-melted or recycled, unlike contemporary axes, and consequently retain higher levels of more reactive elements. Recycling has been claimed to make objects "more accessible as [they were] passed from hand-to-hand, by infusing local ownership and values into the metal" (Pollard, Bray and Gosden 2014:630); that the halberds were unique in the EBA metal assemblage in not being recycled is highly significant in this respect, and suggests that the values imbued in the metal at casting were immutable and fixed. Interpretations of the social significance of the halberd as an artefact type should therefore include the importance of the material used in underpinning the status of the blade. The metal was being traded or exchanged between Scotland and the rest of mainland UK: applying the lost elements calibration to existing isotope studies (Northover 1980; Rohl and Needham 1998) showed that Scotland was the biggest supplier of Ross Island copper to south-east England (Bray and Pollard 2012), but that the metal was heavily re-worked and recycled during the journey. The exchange networks and recycling technologies were well-established and well understood in halberd-producing communities in Iberia and Italy by the EBA (Delfino 2014); that the halberds were *not* recycled is therefore a deliberate choice made by EBA society. This perspective leads to the interpretation offered in the next section.

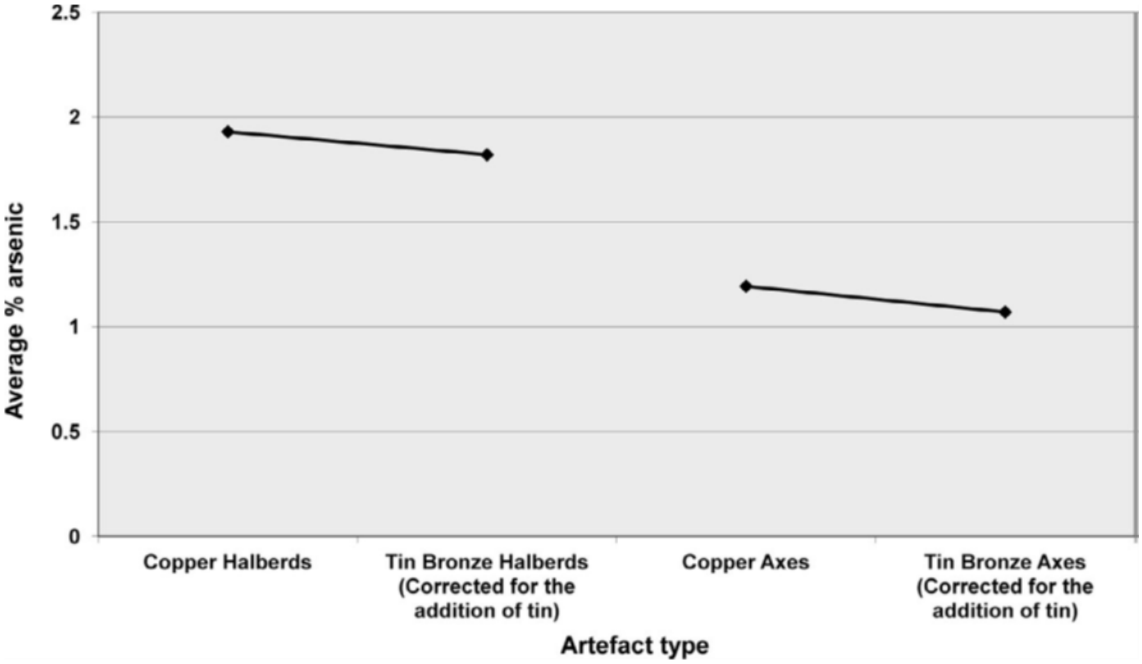

Figure 9.2 *– The higher arsenic levels retained by the halberds, compared to the contemporary axes, including the corrected values for copper-tin alloys; copper in tin bronze is kept molten for longer to accommodate the alloying process, resulting in increased oxidative loss. Bray and Pollard (2012:859)*

9.4 Prehistoric Weaponry as Proxies for Violence

The experiments detailed in Chapters 6 and 7 demonstrated that a halberd, wielded effectively, is a lethal weapon capable of delivering skull-splitting blows. However, the analyses in Chapters 8 and 9 showed that the halberd blades were conserved, even re-hafted, following combat-related damage, but in such a way as to render them unusable as weapons. Offensive functionality was therefore not the single most important feature of halberds, at least in the later stages of their pre-deposition life cycle. One interpretation posits that throughout prehistory, weapons were proxies for conflict, used by political elites in status hierarchies to communicate with leaders of rival or aggressive societies in order to establish peace or understanding without having to resort to larger-scale conflict, which is economically, socially, and politically costly (Robbs 1997:137). This function as small-scale representatives of a potential wider-scale conflict can be seen as an extension of the symbolic roles enacted by Hektor and Aias (Ajax) in Homer's Iliad – a Bronze Age epic, albeit one which was only written down many centuries later. There is neither space nor focus in this thesis to address the myriad issues in interpreting Classical literature through an archaeological lens; see Section 2.8.2 for a brief overview, and

Snodgrass 2002 or Mallory 2016 for detailed discussions of Bronze Age literature as sources in Greek and Irish archaeology. In terms of an interesting addendum for the halberd use model proposed above, however, the Iliad offers a notable analogy. In Book 7, after assembling a huge fleet of ships and massing their armies at the gates of Troy, Hektor and Aias meet. Their vast assembled armies then proceed to sit down, and watch the two champions fight in single combat in full view of both sides for most of the day. Realising that they are equally matched, the two men congratulate each other on their prowess in combat, exchange symbolic tokens of their warrior status (Hektor gives Aias his sword, receiving Aias' belt in return), and leave – taking their armies with them, thus establishing a stalemate without a single casualty (Hammond 1987). The two warriors functioned as proxies for their armies, fighting a representative battle to avoid the time, effort, and bloodshed of a massed battle. Robbs (1997) develops this theory further. His study on prehistoric Italy indicates that the assumption that inter-personal violence only occurs with any regularity with the onset of status hierarchies and metallurgy is wrong (Robbs 1997). Italian Eneolithic skeletons show no evidence for trauma at all, making the Bronze Age skeletons displaying trauma look like the product of a sudden and unprecedented surge in violence; however, Neolithic Italy has the highest incidence of skeletal trauma of any period in prehistory, far outstripping the Bronze and Iron Ages (Robbs 1997:133), thus showing a non-correlative relationship between the production of bronze weaponry and skeletal evidence of violence. Robbs' dataset is as comprehensive as possible at the point of his writing, reducing the likelihood that survival or recovery bias have sufficiently affected his conclusions so as to undermine them. The relationship between cultural expressions of violence (weapon production, social glorification of combat) and actual violence itself is furthermore not causatively correlated, as theorised by some earlier researchers (e.g. Trump 1962:14). Robbs suggests that the relationship between violence and cultural expressions thereof is in fact an indirect correlation: the production of cultural indicators of conflict reduces the conflict itself because personal violent tendencies and interpersonal grievances are channelled safely into the creation, ostentatious display, and exchange of weaponry, rather than as outbreaks of actual violence (Robbs 1997:136). The warrior elite, the evidence and theories for which were summarised in Section 2.4, can advertise their violent capabilities and consequent power through the acquisition and display of metal weapons, without having to literally fight and conquer every single one of their inferiors. Martin and Frayer (1997:71) further argue the comparative point that in terms of endemic spousal abuse, the fear of violence, rather than violence itself, is used as a means of social control. In terms of Bronze Age society, a less aggressive interpretation can be constructed, wherein the reminder of past or potential combat prowess is sufficient to maintain political power, without the immediate threat of actual physical violence.

That the halberds were capable of inflicting injury during interpersonal combat has been shown through experimental testing using replicas (Chapters 6 and 7; O'Flaherty 2007, O'Flaherty et al 2011); their shape and usage precludes their use in hunting, as the opponent must be fairly stationary for an effective blow to be delivered (O'Flaherty 2007; Chapter 6). This is a completely novel concept: inter-personal violence in Neolithic communities is attested (Schulting and Fibiger 2012, Dyer and Fibiger 2017), but this is the first instance where a form of object is designed which is specifically suited to interpersonal combat *alone*, rather than objects which could be used as weapons but also to hunt (e.g. arrows and slingshot) or to create things (e.g. woodworking axes, and using knives to shape textiles and prepare food). To paraphrase Thomas' (2006) *Archaeology of Ideas*, the present writer argues that rather than thinking in terms of the more traditional cognitive archaeology (cf. Segal 1994), a degree of complex symbolic thinking intrinsic to Bronze Age society can be extrapolated from the halberds (Thomas 2006:181). O'Flaherty's (2007) experimental trials, and the trials in this study (Chapters 6 and 7), indicated that the halberd was best wielded overarm. This delivers a blow along a fixed trajectory, one which an upright and mobile opponent would be able to avoid or dodge. O'Flaherty (2007:432) concluded that the halberd would be most effective against a prone opponent, hypothesising that the shaft of the halberd would be used as a club to inflict blunt force trauma, knocking the opponent down to the ground; the killing blow with the blade could then be delivered. The lethal blows inflicted on the Synbone™ sphere (Section 6.4.2) also led the present writer to this conclusion; however, the blunt force trauma experiments in Section 6.5 were inconclusive, most likely due to a poor choice of human tissue proxy. An alternative interpretation would be one of conducting judicial violence against a restrained or unresponsive opponent, also potentially involving an audience to legitimise the killing and assert the moral and physical superiority of the wielder – as with the dramatic public hangings in 19th century Britain, the last of which occurred in 1868 (McGowen 1994:257). Both of these models place the halberd wielder in a position of dominance and power: the hafted halberd would have added at least another metre to the wielder's height, creating a visually impressive display for onlookers, and displaying an intimidating figure to the prone or restrained opponent. One interpretation of the halberd carved into the Ri Cruin (Argyll) stone is that it was adorned with lengths of ribbon tied around the handle, which would have fluttered and danced in the air as the weapon moved (Needham and Cowie 2012:100-101). The performative element of combat has received little attention in halberd studies to date, but consideration of it becomes unavoidable when replicas are used and the scale and size of the wielded halberd become apparent. It is notable that the continental petroglyphic depictions of halberds rarely show the weapon by itself; in contrast to contemporary daggers, short swords, and axes, the halberds are instead shown being used in a grandiose display of aggression, superiority, and performance: the intention is debatable, but the stance rarely is (Figure 6.16). The power and prowess of the wielder is emphasised by the halberd itself – not necessarily the ownership thereof, but the impact from effectively wielding it. It follows, then, that the halberd would become a specific cultural reference point, indicating the power and superiority of its bearer based on the physical assertion of dominance in ritualised, potentially judicial, combat.

It is at this point that most halberd interpretations end, with the blades becoming significant because of their status as weaponry (Wilde 1856-7:439, 451; O'Flaherty 1998:75 and even (to some extent) O'Flaherty 2007:432, O'Flaherty et al 2011). However, by applying selected aspects of recent theoretical approaches, most notably queer and feminist theories (as discussed in Section 2.10 in the literature review), which encourage interpretative plurality through the vocalisation of marginalised viewpoints (cf. Dowson 2000:163), a more holistic, nuanced interpretation of the halberd in northern Britain can be offered.

9.5 Gender, Society and the Halberd Assemblage

Constructions of prehistoric masculinity and gender identity are often based on the binary model of physically dominant male-ness, firmly rooted in prowess in combat, in opposition to the passive, physically subservient femininity which prevents weapon usage (Traherne 1995, Hafsaas-Tsakos 2013:86, Horn 2013:238). Studies in Bronze Age Italy suggest that during that period violence decreases as status hierarchies develop (Robbs 1997:136-7). This is in direct contrast to the 'warrior elite' or 'chiefdom' model so often proposed in Bronze Age studies (most notably by Kristiansen – see Earle and Kristiansen 2010), where political power and combat prowess are directly equated. The chiefdom model itself has recently been the subject of re-evaluation, as it underpins so many Bronze Age system models (Kristiansen 1998, 1999, Kristiansen and Larsson 2005; Earle 1987, Earle and Kolbe 2010, Earle and Kristiansen 2010, Harding 2005). The chiefdom model was derived using examples from 18th and 19th century Africa and Oceania, based on the social structures encountered by European colonialists. However, these structures were not pristine pre-capitalist societies; contact with mercantile colonialism had altered their economic and social dynamics, and the European contacts sought to formalise indigenous hierarchies so that they could be better understood by the western incomers, and to make trade easier by only dealing with community leaders (Brück and Fontijn 2013:202). This imposition of modern post-Marxist capitalism onto prehistory has continued: discussions of Bronze Age society and trade systems revolve around concepts of competition, productivity, exploitation, and value (cf. Earle 2002), disguising rationalist-economic language as objectivity (Brück and Fontijn 2013:2002). This latent and uncritical bias is also very limiting in terms of gender relations and the wider conceptualisation of Bronze Age society, as "the androcentric preoccupation with 'male' qualities and values [power, agency, the primacy of the warrior chief] means that warfare and other forms of competitive individualism are considered the primary factors in social change" (Brück and Fontijn 2013:203). The replica experiments have shown that the halberd, though capable of inflicting damage, was not a well-designed weapon for interpersonal combat, and that the form of combat in which it would have excelled (i.e. a prone or restrained opponent, and a stylised performative blow) is not easily incorporated into the aforementioned model of 'warfare and competitive individualism'. Furthermore, the skills involved in making an incapacitating, if not fatal blow with the halberd are primarily in aim, hand-eye co-ordination, and steadiness of hand. The weight of the hafted weapon, particularly when a dense wood such as white oak has been used for the handle, inflicts a powerful punch from the momentum of an overarm blow: the wielder does not need a great deal of upper body strength to use the halberd effectively. Therefore, unlike the models for using swords, dirks, and axes (Kristiansen 2002), [able-bodied] women are at no great physical disadvantage compared to [able-bodied] men when wielding the halberd. Both men and women wielded the replica weapons during the experiments, and no difference in results was observed. The only striking difference noted was in the relative heights of wielder and opponent during the soft tissue experiments, which could be interpreted as favouring male wielders over female; however, an immobilised opponent would at least be made to stoop, if not kneel or lie prone on the floor, automatically making the standing wielder taller. I can envisage no physical reason why an able-bodied older child or teenager could not effectively have wielded a hafted halberd (cf. Fahlander 2011); the experiments in Section 6.8 demonstrated that a small girl child was more than capable of inflicting damage on a prone opponent, further supported the idea that relative height is a more important factor in determining damage than the wielder's expertise or training. Following on from this, there would therefore be no logical reason why a seated wielder could not inflict damage – further experiments with wielders who use wheelchairs, or who have reduced upper body strength due to age and/or a physical disability, would be a fascinating avenue of research.

In terms of the halberd being a brand new weapon form – and arguably the very first weapon form designed exclusively for combat – the symbolic significance of the halberd Type gains greater consequence. Being imbued with social significance and indicating physical and spatial dominance, halberds were a wholly novel weapon form that stems from huge contact networks – comprising Irish or/and Welsh copper, Cornish tin, to say nothing of trade links between continental Europe and Scandinavia, as well as within the Scottish mainland, the Hebrides, and Orkney and the Shetland Isles. The halberd originated in Ireland (Schuhmacher 2002:281), and the handful of Types Carn/Cotton/Clonard (one, one and three examples respectively) found in Scotland indicate that smiths were aware of the Irish Types, either through seeing and handling traded halberds, or personal travel to Ireland. Trading contacts and agreements occurred between political communities over vast distances, particularly using water routes, during the European Bronze Age (Brück 2006, Crumlin-Pederson 2010, Earle 2002, Frei et al 2015, Harding 2000, Kristiansen and Larsson 2005). Stratified societies – regardless of the degree of stratification – create tokens or symbols of their power to display to non-members, or "outsiders" (Brück and Fontijn 2013), and it is in this light that the halberds are considered in the next section.

9.6 The halberd as a political representation

Based on the evidence presented in this chapter, and the thesis as a whole, I propose an interpretation to fill in the missing time dimension in the *chaîne opératoire* of halberd production, dissemination and deposition (Pollard et al 2014:626-7). It is by no means definitive, but does encompass all of the results from this study and those contained in the recent literature. This interpretation is of the halberd as a *pars pro toto* or representative part of a whole: a tool used to represent a political entity, for use in symbolising an agreement or alliance, or to formalise an exchange with another political entity, and by extension to maintain political, economic, or social links across wide distances and over long periods of time.

It has been established that as initially manufactured halberds were functional offensive weapons deployed in stylised and highly ritualised contexts; the relatively small assemblage (when compared to contemporary flat axes, for instance (Coles 1968-9, Schmidt and Burgess 1981)) suggests that they were not widespread. If it were accepted that only people with significant socio-political power in EBA society owned and used halberds, then their use in combat becomes imbued with significance due to its infrequency – such as in judicial violence, or in ritualised duels between high-status elite members (cf. the ostentatious displays of wealth and power of the French and English monarchies at the Field of the Cloth of Gold (1520), as well as the two kings and all of their courtiers jousting and wrestling to establish political and social dominance (Watts 2017)). It then follows that the halberds could have been developed over time from symbolic weapons which were also used in ritualised combat (leaving nicks and notches in the blade edges, and stressing and wearing the hafting plate) to symbolic weapons which become imbued with combat-related significance *without ever being used in combat* (similar to modern heads of state wearing swords or similar military regalia that have never been used to fight an opponent). The Culloden halberd, with its unworked edges, is an unambiguous example of this interpretation: heavy, delicately crafted, in use for a very long time (as attested by the multiple riveting events), but crucially, *unsuitable for combat* due to its unworked edges. Halberds could thus have been used as representations of dominance without the need for actual combat, which is socially, politically, and economically expensive; political agents can use symbolic expressions of conflict to settle disputes without literally killing each other (Robbs 1997:137). As such, the halberds (hafted or unhafted) could have been used as *pars pro toto* for political, social and spatial dominance, and be given or exchanged along trade networks between political entities as a representation of mutual recognition of political power, cementing alliances or trade agreements, mutually supporting against aggression, or as part of resource sharing and management agreements.

Figure 9.3 *– Detail from The Field of the Cloth of Gold (unknown artist, c.1545) in the Royal Collection at Hampton Court Palace (Public Domain, Wikimedia Commons), showing King Henry VII of England and King Francis I of France wrestling in front of their courtiers during the summit in 1520. The summit was intended to shore up the faltering Treaty of London, a non-aggression pact signed by all of the major Renaissance European powers; the stylised combat between two socio-political elites was symbolic of the diplomatic struggle between England and France throughout the sixteenth century.*

Figure 9.4 *– The Crown Jewels of the British Royal family; the ceremonial sword in the foreground is Curtana, the Sword of Mercy, and has been used to coronate monarchs since Queen Eleanor in 1236, although the practice was known at the coronation of Richard the Lionheart in 1189. The current sword was made for the coronation of Charles I in 1626. ©Royal Collection, Jewel House, Tower of London (acc. no. RCIN 31730)–*

This reading has not previously been proposed as an interpretation for the creation, use, and deposition of halberds in northern and central Europe, but it could help explain many of the previously inexplicable aspects of halberd research. The unusually high level of regionality in halberd production – particularly when compared to the relatively uniform production of flat axes (Schmidt and Burgess 1981) – could be the result of many regional political entities crafting their own halberds as specific emblems or references to their own dominance over space, resources, or people. Finding 'typical' Types outside of their usual find area – Irish-type blades in Scotland and Wales, for instance – would then be the result of the movement of halberds between regional polities as part of far-reaching diplomatic networks. The abundance of regional subtypes (see Needham forthcoming, Needham et al 2015) thus reflects the existence of many regional polities producing halberds for use in inter-polity diplomacy and trade, each blade variant recognisable as representing a specific polity. This model would then also account for the much larger Irish halberd assemblage (O'Flaherty 2002); the lost element calibration is first applied, wherein the low or absent levels of arsenic and antimony in one group of artefacts (the so-called 'silver-only' copper items (Howarth 2018)) is recognised as the result of repeated recycling and recasting, causing extensive oxidative loss of the more ignoble elements, rather than as indicative of a unique copper ore source signature. Once this calibration is applied, the Ross Island mine complex in Co. Kerry is chemically recognisable as the primary source of copper for all of the halberds of northern Europe during the EBA (Ixer and Budd (1998:34) once the calibration is applied; see also Bray and Pollard (2012)), the exchange network becomes particularly complex in the area immediately surrounding the mines, and one would expect a great deal of communication and trade markers to be produced. It must be remembered that despite being pre-literate, EBA European societies must have had some method of inter-polity communication, and of recording significant events or developments, not least to maintain the vast exchange networks which kept copper and tin flowing: in this interpretation, the halberds served this function (see Kristiansen 2016). Accordingly, the concentration of halberds along the Atlantic seaboard would make sense in this model, wherein groups in contact with each other created and exchanged the blades. These groups would not use the halberds as political signifiers among entities which did not share the syntax of representative halberds, such as south-east England. The relatively small number of halberds when compared to flat axes and later copper and bronze object types would thus not reflect their reduced functionality in combat, but rather their use as political representations. A single halberd could thus have represented an entire community within a trade/communication network, and such items would therefore only occur infrequently in the archaeological record.

This interpretation also accounts for the very restricted period during which halberds were manufactured and circulated. The complete disappearance of halberds in the Middle Bronze Age has never been satisfactorily addressed, but the apparently abrupt decline and disappearance of a widespread, well-established artefact type without an associated social collapse is a rare phenomenon; for an artefact type to vanish from production is unusual. Halberds do not survive as a deviant or divergent artefact type; they are not subsumed into another mode of production. Unlike axes, for instance (Schmidt and Burgess 1981), the halberd does not develop into further elaborate or technologically advanced forms. Halberds re-surface in medieval Europe, as long pole-axes slotted onto wooden hafts without riveting, and bear little resemblance to their Bronze Age predecessors. It is highly implausible to suggest that medieval halberds developed from the prehistoric form, stemming rather from pole-arm technology (Waldman 2005). However, if the proposed model as halberds as political signifiers is adopted, the comparatively short period in which halberds are produced and circulated becomes less enigmatic. Poor climatic conditions and developments in other artefact types such as dirks and flanged axes at the onset of the MBA would have required a change in how communities related to each other, as increased communication and trade shored up societies struggling with diminishing harvests or which relocated to better agricultural lands (Toolis 2005, Tipping et al 2007, Amesbury et al 2008, Stevens and Fuller 2012,). Consequently, the methods of expressing long-distance agreements or relationships would have changed to reflect the nature of these altered relationships, and the halberd *pars pro toto* system would have fallen out of use over time, leading to the deposition of halberds in sacred spaces, and potentially creating aggregate hoards. The development of dirks/rapiers, early spear forms, and flanged axes rendered the halberds outmoded as a weapon for ritual combat, and production ceased. Halberds remaining in circulation were gradually destroyed or deposited as trade and political agreements ended – though not recycled, as the metal they contained was still imbued with social and political value – and the form is never resurrected.

As to the artefact evidence, the myriad examples in Section 8.4 of hafting plates showing multiple episodes of riveting and re-hafting to the detriment of the blade’s combat capability slot neatly into this model of halberds as political representations. As a *pars pro toto*, the survival of the halberd in its original and – crucially – recognisable morphology is of prime importance in maintaining the represented relationship between regional political entities. Mending and re-hafting the blade would have been integral to maintaining the represented trade or political agreement, as modification of the part would alter the whole. If "Recycling… made [the object] more acceptable as it was passed from hand-to-hand by infusing local ownership and values into the metal" (Pollard, Bray and Gosden 2014:630), then the immutable values represented by the unchanged metal in halberds, and their deployment as symbols of long-distance alliances and agreements superseded local ownership and values, protecting halberds from recycling as they were passed on from region to region. Halberds with deliberately-removed hafting plates also fit into this interpretation, whereby the metal blade itself was politically significant, rather than the whole item including its organic handle; and so in this manner a heavily damaged hafting plate could have been carefully pared down to retain the shape (and thus the symbolism) of the weapon, but either not hafted or only hafted very loosely, using twine or a glue, to preserve the signifier role of the weapon, rather than its combat functionality.

As noted by Vankilde (1996:73), the hafting plate itself would have been hidden by the shaft, leaving only the capped rivet heads visible. The multiple episodes of riveting would therefore not be immediately obvious when the blade was hafted, and the knowledge of the blade's long life would not necessarily be known to people outside of the institutional syntax. Hidden knowledge and exclusionary discourse as agents of socio-political power are well attested in archaeological and anthropological literature (Foucault 1969:215-7; Thomas and Tilley 1993:317; Barth 2002:4, to highlight just a few). The handle itself could also have been an indicator of the long life history of the halberd – the wood may have darkened with use, or become smoother where it has been handled, or even have been inscribed with signifiers of previous and current ownership. The lack of surviving complete hafts renders these interpretations as speculative only; there are, however, ethnographic parallels for the reverence of organic age markers. Pollard et al (2014) note that whale teeth (tabua) gained status and value in Fiji as their colour deepens through handling, and kula rings in Papua New Guinea are engraved with the names of previous owners: in both cases, the social prestige and exchange value of such items was derived from the number and status of previous exchange partners to whom they had belonged (Pollard et al 2014:628). A similar scenario could be hypothesised for the halberds and their handles, whereby the prestige and respect accorded to the agreement or values imbued in the hafted weapon increased over time and were represented in the careful conservation of the aging object.

Similarly, at the cessation or altering of an agreement, the halberd representing the now-defunct arrangement would be symbolically destroyed, much as the old arrangement was symbolically destroyed by a newer agreement or treaty, or through the onset of hostile relations. Horn (2013:99) argued that the removal of the shaft from the blade constituted an act of intentional destruction; V-shaped notches in the blade edge also indicate intentional damage (see O'Flaherty et al 2011:47, especially Figure 4). It is also possible that the death (natural or otherwise), or the removal from power, of one of the key political agents in an agreement represented by a halberd would have had an effect on the blade, possibly as the halberd was then deposited in the ground. The deposition of halberds in single-artefact-type hoards, or as single depositions, is noteworthy and suggests that the halberds were deposited according to rules or rituals that did not extend to axes or other tool types because they were not similarly treated; correspondingly, weapons would not be deposited with bodies as grave goods because they continued to serve a political purpose, long after the original owner had died. The deposition of the New Machar hoard is particularly interesting in this respect. The two blades discussed in Section 8.3 (ABDUA 19677 and 19678) are typologically similar and show similar patterns of pre- and post-depositional wear. It is very likely that these constituted a single episode of deposition. However, there is a third halberd (ABDUA 19679) found in proximity to this hoard that is in significantly worse condition than the other two blades; it is also much smaller (even allowing for taphonomic material loss) and displays a much darker patina than the others (see Appendix 1). It is very unlikely that halberd ABDUA 19679 is an associated find; however, the three halberds were recovered very close together - within 10^2m, though the circumstances of the discovery in 1908 were poorly recorded at the time. Despite as much detail as possible being recorded in the museum archives, there is a serious lack of written or photographic evidence for the excavation, associated finds, and how and to where the artefacts were dispersed. A plausible interpretation of the site would be that the halberds constitute two separate episodes of deposition, and that the location was identified by a Bronze Age community as being specifically appropriate for the deposition of halberds. This would correspond well to the model of politically representative halberds and their eventual deposition at the termination of the represented agreement. The Langalbuinoch hoard (see Figure 8.24) and the Auchingoul hoard (see Figure 8.43) could also be interpreted in this way; a succession of depositions in a single spot over many decades would also help explain the different degrees of patination on the associated artefacts, as the earlier deposits were exposed to the slightly acidic, possibly waterlogged soil for longer than the later deposits.

The proposed new Group Tom na Brataich (Section 8.7) should therefore be seen as a complementary Type, rather than as a replacement or reassignment. In this interpretation, Group Tom na Brataich halberds have served as *pars pro toto*, with a long period of conservation and care while they represented an ongoing political alliance, agreement, or trade arrangement, and were deliberately deposited (sometimes with an episode of ritual decommissioning or destruction) at the cessation of the represented diplomacy. This does not prevent their offensive use beforehand, however: a Type Breaghwy halberd could have been used for many years in periodic ritualised combat, before transitioning to a more symbolic role and eventually as a political tool. The label ‘Group Tom na Brataich’ should in these cases be assigned *alongside* the original Type, rather than as a replacement.

9.7 Conclusions

The model presented in this chapter, wherein halberds served as indicators and representatives of political, social, economic, and spatial dominance based on their capacity and capability for combat, is one way of interpreting the halberds beyond the single-function models previously favoured (cf. Brandherm 2011, Skak-Nielsen 2009, Lenerz-DeWilde 1991). It is based on detailed artefact analysis and critical re-assessment of existing research, but is by no means designed to exclude other interpretations. However, it does account for several so-called ‘irregularities’ in the halberd assemblage, such as their restricted period of production, high degree of regionality, and the presence of frequent outliers within the accepted typology. Furthermore, the development of a socio-political model based on a holistic approach to the available evidence offers an example of applying queer and feminist theoretical approaches to a field which has not been subjected to a great deal of theoretical examination. The development of multi-functional interpretative models based on secure data and objective and reflexive analysis that encourages ‘left-field’ thinking has guided the present writer has been useful, not least because such models can account for many features deemed ‘deviant’ or incomprehensible in more traditional single-function models. The direct equation of combat prowess and political power, and the frequently associated gender bias, should be treated with caution; such simplistic and reductionist interpretations easily gloss over many of the regional nuances within the artefact evidence, and the resulting models are difficult to apply to individual artefacts, sites, and localities. An overview of the edge-wear analyses of halberds is a good example of this: most are in agreement that a significant proportion (around a third) of the European halberds show clear evidence for combat usage when specific assemblages are examined (for Germany, see Brandherm 2011, Horn 2013a and 2014; for Britain and Ireland, see O'Flaherty 2002, O'Flaherty et al 2008). However, other assemblages show less edge-wear evidence from combat usage (Dolfini 2011), which results in a less definite, more nuanced interpretation of their use (Horn 2017). Not only does this emphasise the importance of a comprehensive assemblage to a study, it also highlights the importance of recognising regionality in the Early Bronze Age, and the significance of local and regional practices in the material record. The *pars pro toto* model proposed in this chapter incorporates these regional differences – arguably, the variation is a key aspect of the halberd as political signifier – but also provides a wider geographical framework in which the halberds can be contextualised and considered. Accordingly, it is hoped that some of the methods and the theoretical paradigm used in the development of this model are critically adopted by other researchers, and multi-functionality becomes a more accepted research approach.

Chapter 10 – Conclusions

10.1 Conclusions and Completed Research Objectives

The model proposed in the preceding chapter, drawing as it did on the majority of the data gathered throughout the thesis, provides an opportunity to extend and explicitly address of initial research aims, as outlined in Chapter 1, as well as to reflect on the project as a whole. Although the final thesis differs slightly to the project proposed in 2013, the main thrust has remained the same: to investigate the Scottish halberd assemblage, and to establish how much it can contribute to wider British and European discussions of halberd manufacture, function and eventual deposition over the period from the Chalcolithic/Late Neolithic through to the Late Bronze Age. It is worth briefly revisiting the research aims from the first chapter, in order to demonstrate how they have been met.

- **To evaluate and demonstrate the viability and accuracy of replica weapons testing, including an assessment of the most suitable human tissue proxies.** As put forward in Chapters 3, 6 and 7, replica weapons testing provides invaluable data – when a number of possible variables are considered, if not actively controlled. Using O'Flaherty (2007) as a starting point for the halberd experiments provided a solid framework on which to build: a replica halberd could be wielded successfully. Where this project goes further is in applying O'Flaherty's conclusions to a broader research base: improving the tissue analogue, using a wider array of movements, a wider range of wielders, more body-part analogues rather than just crania, and a wider range of opponent positions. In terms of application to current research into weapons testing, this study provides conclusive evidence as to the benefits of (as far as feasible) designing all aspects of an experiment to the study's specific research aims, rather than relying on extant work; it also demonstrates the benefits of including non-academic specialists and opening up the experiments to non-traditional participants. Working closely with relevant specialists in metallurgy, pyro-technology and carpentry proved very successful, and allowed every stage of the replica halberd creation to be closely monitored and controlled. As the replica dirk had already been made prior to beginning this project, fewer variables could be controlled in terms of the manufacture and design of both the metal blade and wooden haft, resulting in the shattering of the soft wood handle. When similar experiments take place in the future, a protocol for rigorous overview has been set and its importance and viability demonstrated in practice. The Synbone^{TM} spheres proved an excellent proxy for a human cranium, but the long tubes of the same material were a poor choice as a limb proxy, and should not be considered for similar testing in the future. In their place, consideration should be given to animal limb proxies (perhaps red deer; see Humphrey 2016), alternatively, different set-ups could be devised to better utilise the long bones.

- **To establish how the data gathered from replica weapon experiments can best be applied to the prehistoric assemblage[s], using the dirk as a pilot project**. The satisfactory deployment of experimental data was amply demonstrated in Chapters 4 and 8 and discussed in the concluding sections of those chapters. Using the dirk as a pilot project allowed many problematic issues to be side-stepped or controlled for during the larger-scale halberd trials, such as the choice of human tissue proxy, the importance of choosing an appropriate wood for the haft and handle, the importance of an audience, the primacy of an accurate catalogue for comparative study, and the importance of recording every step of the trials to track the development of any damage incurred during the weapons' use. Developing a specific experimental methodology for these trials, critically evaluating extant studies and using the lessons from the dirk experiments to inform the later halberd experiments, ensured that the experimental data was appropriately comparable to the catalogue data, with as few issues of accuracy and reliability as possible. The application of experimentally-derived data to the investigation of comparative catalogue data proved fruitful – particularly with regards to modifying the experimental methodology (see Section 7.4), and in a manner which led to the unexpected development of the new complementary Group Tom na Brataich proposed in Section 8.7, where the damaged, modified and conserved hafting plates observed on the Scottish halberds could be linked to the damage observed on the replica halberd following the soft an skeletal tissue experiments. The comparative experimental and catalogue data methodology developed throughout this thesis proved apt and yielded workable results, and should be considered during any related future projects as a viable and applicable methodology.

- **To establish whether recent developments in queer and feminist theory can successfully be applied to experimental and combat studies in archaeology,**

primarily reflexive approaches, multi-linear interpretations, minority voice vocalisations, and scrupulous accountability. Feminist and queer approaches have been incorporated throughout this thesis and have been discussed by the writer (Faulkner-Jones 2016, 2017, Appendix 2), and were discussed in a presentation at Graduate Archaeology Oxford (GAO) 2015. The emphasis on reflexivity was of particular support early in the project, when the replica Friarton dirk was incorporated into the project following discussion with M. Hall at Perth Museum and Art Gallery, restructuring the thesis plan accordingly, and then again when the dirk suffered severe damage during the trials. I intend that the level of detail in the rationale and methodology of the experiments, and the analysis of the results, given throughout this thesis is sufficient for the experiments either to be replicated and validated, or adapted to accommodate a related research speciality; for instance, in helping to inform experimental methodologies for other researchers working with different replicas or using different tissue proxies. The multi-linear narrative approach was valuable in developing the theoretical model proposed in Chapter 9, because it allowed the halberds to have multiple functions simultaneously, as lethal weapons, symbols of socially-sanctioned elite power, and as symbols of that power used in diplomatic communications across large distances. As an analytical tool, it can be used alongside existing models of use, rather than instead of, or in disagreement with, them. Among models in recent literature, Brandherm (2014) focussed on microscopic analysis to demonstrate how a halberd's biography can be constructed based on evidence for mending, and use in combat. This can be usefully juxtaposed with Horn (2011 and 2017) who uses edge wear analysis data to interpret meaning as to the combat capabilities of the blade, and how the halberds were eventually ritually decommissioned and deposited. Recent collaborations (Radivojević et al 2018) have used compositional analyses to determine the geographic origins of copper and tin in BA objects across Europe to better understand the supply chains and distribution patterns from core mining areas; this echoes Bray and Pollard (2012), who use compositional analysis to establish the origin of the metals used and whether recycling or recasting can be detected in the artefacts.

- Minority voice vocalisation was not as significant an issue as is commonly seen in queer archaeology (see Rizvi 2008), because the primary data and experiments were contained to Scotland in the E/MBA so there were no issues of historical oppression or colonialism, institutional sexism and racism etc (see Mallory and McNiell 1991). However, where possible, audiences were sought and their suggestions and responses incorporated where appropriate. Opening the experiments to the general public (Section 3.4) and to University staff and students (Section 6.4.1) meant that perspectives other than the author's were incorporated. Including a child in the final set of skeletal tissue experiment (Section 6.8) was enormously successful and demonstrates that wider audience participation and a truly reflexive approach to designing an experiment can yield robust and illuminating results. Future work should work on improving accessibility for the audience to ensure that minority voices which were not included here – such as people who have not continued to tertiary education, for instance – could also be included. There is much scope for further developments in this area, however, as discussed below in Section 10.2. Finally, as the product of an LGBT+ person with a small child, this doctoral project could be considered an application of the theoretical tenets outlined above, as I encountered issues and obstacles relating to my specific circumstances and identity which are not often discussed in the broader archaeological literature; for instance, the latent bias amongst researchers in weapons and combat studies, who were occasionally nonplussed (and in one unfortunate instance, actively unhelpful) because of my gender presentation. Networking events are often scheduled for evenings, which are difficult to attend without childcare, which can also prevent researchers attending conferences that involve nights away from the home. These and similar issues are discussed in the next paragraph.

- The issues with childcare, geographical and temporal academic job instability, and the poor retention of women in senior research positions are better documented, but little has yet been done to proactively address said issues (although the explosion of social media has helped in documenting and raising awareness of marginalised academic voices, especially of parents and women, as a brief Google search demonstrates). The impact of the Covid-19 pandemic on women in academia has already been noted, and I am sure will continue to be an issue long after restrictions are lifted (Gabster et al 2020, Kibbe 2020: there are hundreds more articles and studies at the time of writing (May 2021), and will be thousands more as research continues and the secondary impacts of the pandemic becomes more widely visible). Athena SWAN and similar initiatives are making progress in terms of identifying these problems and encouraging women's careers in STEM subjects, but was only expanded to include the arts and humanities in 2015 (ECU 2019, Athena Swan Charter, https://www.ecu.ac.uk/equality-charters/athena-swan/); structural inequalities persist (Pell 1996; Bonawitz and Andel 2009). A more rigorous theoretical examination of small-scale works may lead to a more rigorous examination of wider structures and biases; a kind of trickle-up effect, as it were, and the application of queer and feminist theory to this thesis is therefore considered to have been successful, in terms of ensuring good science by identifying latent biases and minimising their impact on the data (Tomaskova 2007:271).

- **To determine, if possible, the relationship (if any) between the Scottish halberds and the assemblages from Ireland, Wales, and mainland Europe, and to offer an interpretation for the distinct distribution patterns and morphological differences observed.** The model proposed in Chapter 9, wherein the halberd – particularly the Type Breaghwy halberds, which have been noted for their atypical features when compared to the wider Irish assemblage, and a possible secondary symbolic role suggested (O'Flaherty 2002:404-5) – functions as a political *pars pro toto*, addressed this research objective. Less clear, however, is how applicable this model could be to the assemblages from Aunjetitz Germany, Iberia, and Italy. These halberds show different morphologies, different deposition patterns, and different use-wear indications to the Irish and British halberds (O'Flaherty 2002 throughout, though see 403-5 in particular). The halberds' role as effective, specifically-designed weapons is transferable across assemblages, as is their potential for symbolic significance outside of their role in combat. This contributes to existing models of European-wide communication and influence networks by offering one interpretation for the physical manifestation of political power etc. through the use of conserved halberds as a pars pro toto; this idea of ritual conservation for meaningful objects is gaining traction in recent UK-wide studies (Knight 2019). However, to extrapolate further would require detailed, comparative study of all of the European halberds, which is beyond the scope of this project; Christian Horn is undertaking major research in this field, however (Horn 2014). Given the extant immense scope of the Prahistoriche Bronzefunde, however, this research would easily contribute to wider European society through a straightforward application of the comparative experimental-catalogue data process. The model suggested in Chapter 9, whereby the high number of Scottish halberds which show secondary modifications after their initial casting and/or are difficult to classify using Harbison's 1969 typology is interpreted as intentional and representative various socio-political groupings, does however account for the variation within the assemblage and could also be applied to the Irish Type Breaghwy halberds. At the absolute minimum, contact between Ireland and Scotland during the Late Neolithic and Early Bronze Age is attested in the flow of Ross Island copper (Bray and Pollard 2012; Pollard, Bray and Gosden 2014). Maintaining a trade network over such a distance and time period would necessitate extensive pre-literate record keeping and communication, using either human or material vectors. Extracting and processing the ore, and then transporting it to communities in Ireland and across the Irish Sea to Scotland, does not happen by chance or on a whim; communication across large distances would have been required, and the supply chain maintained over centuries through keeping records which have not left clear archaeological traces; having the halberds serve as representations for distinct communities, as indicators for agreements or relationships, would be one interpretation to how the communication systems were manifested in the EBA.

The relationship between the Scottish halberds with the Welsh assemblage is less clear (a closer comparison based on Needham's forthcoming work should help by establishing whether there are pronounced similarities or differences in halberd manufacture, type, usage and eventual deposition; see also Section 10.2), but a similar situation can be envisaged. The copper mines at Great Orme supplied copper to the UK throughout the Middle Bronze Age onwards, and a preceding network of contact and communication between the Great Orme area before the mines were established and the wider UK is not beyond imagination (Pollard et al 2014). As an interpretative tool, then, the *pars pro toto* model offers one way in which to conceptualise the Early Bronze Age in Britain and Ireland, encompassing all of the data available through modern and traditional analyses in order to achieve an interpretative model based on the data collected from Scotland, but its relevance to mainland Europe is less clear-cut based on its geographically restricted dataset.

- **To investigate how this object-centred study can inform broader understanding of BA Scotland.** The model proposed in Chapter 9 demonstrates how this study can contribute to broader social models for BA Scotland; maintaining long-term, long-distance networks of influence, communication, community and contact using the halberds as physical representations offers one way to interpret the extant archaeological record in a way that moves beyond a monolithic economic explanation of trade and exchange. The settlement pattern known from EBA Scotland of dispersed villages, combined with the wide range of physical geographic features in the Highlands and Lowlands, makes the European models of chieftains in large settlements difficult to implement (per Kristiansen 2005); this study offers an alternative interpretation of how localised powers could wield their influence over long stretches of time and space without having a large settlement to signify their status.

10.2 Recommendations for Further Work

The methodology, data and conclusions presented in this thesis offer a number of potential avenues for future work.

10.2.1 Methodology

The application of queer and feminist theory to the development of the experiment methodologies ensures scientific rigour was maintained throughout by ensuring accuracy and accountability (Chapters 3, 6 and 7), and ensured the most reliable results are feasible by identifying, accounting and controlling as many variables – latent or otherwise – as possible. The methods used can easily be replicated across disciplines, and were discussed at a conference (GAO 2015) and in the subsequent publication (Faulkner-Jones 2017).

The in-depth recording and accounting for as many variables as possible, most notably in the work reported here in the creation of the replica halberd (Section 6.3), offered a substantial number of future work possibilities. The effects of each material and casting decision on the resulting experimentally-derived data, such as the choice of wood for hafting, the post-casting treatments, and the casting methods, could all be explored further through the creation of replicas experimenting with these variables: for instance, the replica halberd was a direct copy of the Tom na Brataich halberd (West Highland Museum acc. no. 1520, the justification for which is given in Section 6.3.1). One obvious recommendation for future work would be to create a series of replica halberds, ideally

15 at least so that all four of Harbison's Types and the new one proposed here (Carn, Cotton, Clonard, Breaghwy and Tom na Brataich) are represented, all copies of specific prehistoric halberds covering a range of Types, modifications, atypical features and in copper and bronze, to establish whether the morphological differences are likely to have affected the combat capabilities of each specific halberd, and so to refine and adapt the existing interpretative models accordingly. The only other replica halberd experiment undertaken to date, by O'Flaherty (2007), used a representative Type Carn replica based on the average measurements of the entire Irish Type Carn assemblage; it would be interesting to compare results from specific and representative replicas, to see if the outcomes are in any way divergent.

The construction of the comparative catalogue was very time- and resource-intensive, involving visits to museums across the country. Access to collections may be problematic for future researchers in terms of time and distance, but the importance of accurate and reliable catalogue data has been demonstrated throughout this thesis; cross-disciplinary research, and increased collaboration with the museum staff themselves, would greatly aid data collection and presentation, and ensure that (for instance) typologies remain applicable to assemblages. If, as was found in Chapter 8, the typology used (Harbison 1969) leaves a significant number of halberds as outliers or poor fits, then the typology should be examined and potentially refined, as demonstrated in Section 8.7. Furthermore, these collaborations between university and museum researchers greatly improve the outreach potential of the research, which – as with many doctoral projects – is in danger of not reaching an audience outside of academia. The performative element of replica weapon testing was noted throughout Chapters 3, 6 and 7, and offers a wonderful opportunity for researchers and museums to work together to engage their local community through demonstrations for schools, local heritage interest groups, and the general public. This was the case for the replica dirk, where Perth Museum and Art Gallery engaged with a local primary school for a morning to examine the weapon displays; there was also a significant amount of interest on their social media platforms. Similarly, in agreement with the senior curator Fiona Marwick, one of the replica Tom na Brataich halberds created for this doctoral project will be donated to the West Highland Museum, which holds the original halberd, for display and for use in demonstrations and outreach programmes in Fort William and the surrounding area. Encouraging non-traditional audiences to engage with research is a key tenet of the queer and feminist theoretical approach applied throughout this project, and will be encouraged wherever possible in any related future work.

10.2.2 Data

The raw data for the replica dirk experiment, the halberd catalogue, and both halberd experiments are available on the USB included with this thesis, and have also been lodged with the ADS; the relevant chapters should, however, provide sufficient detail for replication and adaptation where required. As noted in Section 6.3.6, further work into the range of replica weaponry used would expand our knowledge of their potential range of uses in the BA; different woods used to haft the blades, for instance, could affect their use as blunt or crushing weapons. One major omission, and one which could support or undermine the model proposed in Chapter 9, is the lack of XRF data for the halberds. Where testing has been done, the results have been noted, but knowing the composition of the majority of the halberds would advance our knowledge of their use, remodelling, and circulation beyond any of the studies undertaken so far, and should therefore be considered a priority for future work – one which would be particularly suited for a PhD project application.

10.3 Conclusions

The *pars pro toto* model proposed in Chapter 9, based on all of the data gathered throughout the thesis, can be considered a conclusion to the work. It could therefore be tested against the continental European assemblages to establish whether it should be considered region-specific only, or whether a similar system of diplomatic exchange and tokens could have been in place across Europe, rather than just in Scotland (and potentially across Britain as well). This would require a pan-European project to record and examine every single halberd; as noted by many researchers already, this may be too big a project to be feasible without a huge amount of cross-institutional support and funding, as well as a team of researchers (O'Flaherty 2002, Schuhmacher 2002). However, the Scandinavian assemblage would be a much more manageable comparative data set to assemble; the known contact route between Scotland and Scandinavia during the third millennium BCE would also be upheld and the existing body of evidence expanded (Crumlin-Pederson 2010, Frei et al 2015).

In terms of the interim conclusions presented at the ends of Chapters 3, 6 and 7, the applicability of replica weapon testing to archaeology has been established by the work reported above and validated: replica testing is an ongoing research speciality for many, such as Dolfini's research group at Newcastle University (Dolfini and Collins 2018). As the number of publications increases, the methodologies will become increasingly refined, and a degree of uniformity or minimum standard develop – which would greatly aid in comparative study of various prehistoric weapon types.

The comparison of catalogue and experimental data proved a useful way of generating and comparing data, and future work on related weapon types would benefit from adopting a similar approach – Middle Bronze Age spears would be an obvious candidate, which appear in Britain as the halberd declines, particularly as the Prähistoriche Bronzefunde series has recently published a catalogue of the complete British spearhead assemblage (Davies 2013). This proposed spearhead study would therefore be an update of the experimental work undertaken by Anderson (2011) and could incorporate the XRF and provenance study methods applied in Chapter 9.

The multi-linear interpretation developed in Chapter 9 offers a very different view on the halberds from the purely functional weapon interpretations common in earlier BA artefact studies (see Harding 1999). The interpretation offered in Chapter 9 expands the existing model of the halberds as the first 'pure' weapon type developed in Britain by placing them in a role supporting contact, co-operation and communication, as well as combat. The title of this thesis is taken in part from Alexander Pope's translation of the Iliad (first published in 1715), the relevant section of which is quoted below. As Hector and Ajax end their duel, Hector notes that they have not fought for bloodlust, vengeance, or revenge, but for glory. Their long, skilled fight – watched by both of their massed armies, as well as a divine audience – was not just meant to establish who was the comparatively better warrior, but also the greater man, the better leader, the most beloved of the gods. This multiplicity of meaning runs throughout the interpretation of the significance of halberds in the work presented here, and underlines how theoretical and practical paradigms shift and develop over time, because human nature will always find many ways of conceptualising our shared experiences.

"But let us, on this memorable day,
Exchange some gift; that Greece and Troy may say,
"Not hate, but glory, made these Chiefs contend;
And each brave foe was in his soul a friend."'

With that, a sword with stars of silver graced,
The baldrick studded, and the sheath enchased,
He gave the Greek. The gen'rous Greek bestow'd
A radiant belt that rich with purple glow'd.
Then with majestic grace they quit the plain;
This seeks the Grecian, that the Phrygian train."
The Iliad, tr. Alexander Pope, Book VII

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<u>No listed author[s]</u>

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Personal communications contact details

Neil Burridge, smith. www.bronze-age-craft.com, neil.bronzeagecraft@gmail.com

P. M. Driver, bespoke carpentry. www.pmdjoinery.net, pmdriver85@hotmail.com

Fergus Milton, metalworking at Butser Ancient Farm, Chalton Lane, Chalton, Waterlooville, PO8 0BG. fergus@fingerbuster.com

Simon Timberlake, metalworking and pyrotechnology at Cambridge Archaeological Unit, Downing Street, Cambridge, CB2 3ER. simon.timberlake@gmail.com

Mark Young, Deputy Head of Technical Services, Edinburgh College of Art, 74 Lauriston Place, Edinburgh, EH3 9DF. m.young@ed.ac.uk