Quantitative Methods in the Humanities and Social Sciences

Andrea Dolfini · Rachel J. Crellin
Christian Horn · Marion Uckelmann
Editors

Prehistoric Warfare and Violence

Quantitative and Qualitative Approaches

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Quantitative Methods in the Humanities and Social Sciences

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Chapter 1
Interdisciplinary Approaches to Prehistoric Warfare and Violence: Past, Present, and Future

Andrea Dolfini, Rachel J. Crellin, Christian Horn, and Marion Uckelmann

A Tale of Two Pasts

For the best part of the last century, studies of prehistoric warfare and violence have been framed by two competing meta-narratives. The first argues that intergroup violence is firmly grounded in human ecology and perhaps in the genetic make-up of our species. Following this argument, lethal aggression is considered to be a defining feature of human societies since the emergence of *Homo sapiens*, if not earlier. The second narrative maintains that the small-scale societies typical of our deep past (and much ethnographic recent past) were largely characterised by low levels of conflict. According to this reading, warfare emerged from a dramatic increase in socio-political complexity in later prehistory or out of contact between 'egalitarian' and 'complex' stratified societies in historical times.

Both narratives claim a noble pedigree rooted in the very foundations of Western political philosophy. One traces its ancestry back to Thomas Hobbes (1588–1679), who famously maintained that the natural condition of humanity was 'the war of every man against every man'. In his view, primitive life – that is, life in the absence

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of an established central authority – was 'solitary, poor, nasty, brutish and short' (Hobbes 1996 [1651]). The other is grounded in the work of Jean-Jacques Rousseau (1712–1778), who argued for the fundamentally peaceful nature of Man as he was unencumbered by the 'unnatural' institutions of monogamy and private property (Rousseau 1984 [1755]). For him, war became generalised only when people turned from 'noble savages' into organised social beings – a process which he saw as a straitjacketing of the human nature by artificially imposed customs and laws (Keeley 1996: 7).

Depending on their views on the subject and broader *Weltanschauungen*, students of intergroup violence in prehistoric and preliterate societies have subscribed to one or the other narrative. This has resulted in a neat split of the research community into two factions, which Otterbein (1997, 2004) colourfully labelled 'hawks' and 'doves'. In the field of American archaeology and anthropology, the first camp is populated by believers in the long chronology of war (Allen 2014: 17–18). Some of the 'hawks' perceive lethal aggression to be grounded in the behavioural development of our species during the past 2–5 million years (Gat 2008; Wrangham and Peterson 1996), while others trace it back to the later Pleistocene or early Holocene; the latter frequently ascribe it to various causes including, primarily, competition for resources amongst hunter-gatherers, foragers, or early agriculturalists. All are united in the belief that violent aggression has characterised human societies at every stage of socio-political evolution and can be more prevalent (and deadly) in small-scale acephalous societies than in stratified and state societies (Bowles 2009, 2012; LeBlanc 1999, 2014; LeBlanc and Register 2003; see also Allen 2014; Otterbein 1999).

In contrast, advocates of the short chronology of war argue that non-complex foragers normally exhibit low levels of intergroup conflict, although this may be countered by high levels of intragroup violence such as feuding and homicide (Allen 2014: 19–21; Fry 2006, 2013; Fry and Söderberg 2013; Haas 2001). Kelly (2000), in particular, maintains that warfare was relatively rare until the development of complex segmented societies, which – in his view – are prone to engendering the 'calculus of social substitutability'. This is the notion that the killing of a group member is perceived as a slight to the entire community and may instigate cycles of revenge killings leading to all-out war. Other researchers embrace an even shorter chronology for the emergence of warfare. They highlight that most of the ethnographically documented conflict in small-scale societies dates back to the last two centuries, a time in which such groups were exposed to an unprecedented degree of change due to European encroachment and dramatic population collapse (Ferguson 2006, 2013; Ferguson and Whitehead 1992).

A similar, if somewhat less clear-cut, split into 'hawks' and 'doves' can be discerned in the realm of European prehistoric archaeology. Here, the belief that our ancient past might have been characterised by widespread aggression and conflict can be traced back to the development of culture history in the early twentieth century (Vandkilde 2006, 2013). In a series of seminal books and articles published in the period 1925–1957, Gordon Childe proposed that much of Old World prehistory could be conceptualised in terms of waves of migration, some of which – he posited – would have entailed bellicose invasion followed by population replacement or admixture (Trigger 2006: 246–7). Childe's broad-brush reconstructions of the social dynamics of early Europe wielded an enormous influence on twentieth-century archaeology. This can be appreciated in the writings of authoritative prehistorians such as Glob and Gimbutas. For them, the spread of the Corded Ware culture in 3rd millennium BC northern/central Europe was to be explained with the invasion of axe-wielding warrior nomads from the Asian steppes, whose novel weapons and horse-riding skills would have enabled them to subjugate the peaceful Neolithic folks of 'Old Europe' (Chapman 1998; Harrison and Heyd 2007; Vandkilde 2013). At the southern end of the continent, similar views were held by Puglisi, who explained the appearance of early metal weapons in Chalcolithic Italy with the arrival of hordes of warrior-shepherds (and metal prospectors) from the eastern Mediterranean (Dolfini 2013; Guidi 1988: 137).

Early diffusionist interpretations of social change intersected with another thriving research strand in European prehistory: the study of Late Neolithic and Bronze Age warrior burials. This centres on the analysis of martial paraphernalia as first seen in Corded Ware and Bell Beaker funerary assemblages, and later in the iconic weapon burials of Bronze Age Europe. Lavishly equipped male graves have frequently been taken as prima facie evidence of the emergence of an individualising warrior ideology in the 3rd millennium BC. This, in turn, would have been instrumental to the development of warrior aristocracies during the Bronze Age (Harrison and Heyd 2007; Kristiansen 1987, 1999, in press; Kristiansen and Larsson 2005; Vandkilde 2014, in press; see also several chapters in Otto et al. 2006). The subject has proved to be exceptionally vital. Not only did it long outlive the demise of culture history; it was able to survive several paradigm shifts throughout the twentieth century and enter the new millennium in a theoretically renewed form, which makes it suitable for the investigation of gender, identity, and other issues lying at the forefront of contemporary social archaeology (Robb and Harris 2013: 64–97; Treherne 1995 and reviews in Frieman et al. 2017).

However, despite studying invasion and the material instruments of aggression, most researchers working within either research tradition eschewed explicitly martial interpretations of early European society. For them, prehistoric battle axes, halberds, and swords would rather have conferred power and prestige to their bearers than be used to kill enemies in pitched battles. Following this premise, generations of scholars conjured up visions of prehistoric elite culture in which weapons, stripped of their potential to cause harm, would largely be employed for self-aggrandisement, or as markers of male identity in funerals and hoarding practices. Their practical uses, if any, would be limited to choreographed duels between champions, which were primarily seen as shows of skill and bravado lacking any conspicuous shedding of blood. It was, as Vandkilde perceptively noted, a tale of warriors without war (Vandkilde 2013: 38–9). This peculiar state of affairs finds its *raison d'être* in the cultural milieu characterising Western society in the latter part of the twentieth century. Exhausted by the unprecedented carnage and destruction wrought by two global conflagrations, influenced by the rise of political pacifism and new, non-violent attitudes to rebellion and social change, people all over the

West made a concerted effort to pacify the past in order to seek relief from a war-torn present (Horn and Kristiansen in press; Keeley 1996; Vandkilde 2013).

Considering the bloodless, ritualised nature of prehistoric violence envisaged by many a post-war researcher, it is perhaps unsurprising that the rift between 'hawks' and 'doves' was far more blurred in European archaeology than in American cultural anthropology. This allowed alternative visions of a combat-free, egalitarian prehistoric Europe not only to be put forward but to harmoniously coexist in archaeological discourse with studies of weaponry and warriorhood. This parallel research strand can be traced back to British archaeologist Graham Clark and his ecological approach to the study of culture change. This emphasised cultural adaptation and gradual, peaceful transition instead of sudden diffusion and destructive migration (Vandkilde 2013: 39–40). In turn, Clark's scholarship influenced the environmental and 'systemic' explanations later favoured by the 'New Archaeologists', who conspicuously shunned population movement and aggression as triggers for social change. Likewise, the post-processualists and social archaeologists operating in the 1980s and 1990s tended to highlight the importance of symbolic behaviour and the representational role of material culture in social interactions – readings that hardly favoured the interpretation of weapons as instruments of war (Hodder and Hudson 2003; Shanks and Tilley 1987; Trigger 2006: 480–3). The cumulative effect of these research approaches was that, for most scholars active between the 1940s and the 1990s, violence was off the menu.

Attitudes began to change from the 1990s. On the one hand, the end of the post-war global order and the breaking out of new theatres of conflict – some of which lay within Europe itself – created a new consciousness as regards the role of warfare as 'a mere continuation of policy by other means' (von Clausewitz 1956 [1832]: 23). On the other hand, mounting dissatisfaction with prevalent narratives of well-balanced, 'love-thy-neighbour' prehistoric and indigenous societies prompted a wave of fresh enquiries into intergroup violence in human evolution and history (Allen 2014: 15; Guilaine and Zammit 2005; Horn and Kristiansen in press; Vandkilde 2013). This fledgling trend coalesced into a mature field of enquiry with the publication of Keeley's *War before Civilization* (1996), a watershed monograph which triggered a new wave of archaeological and anthropological research that continues, unabated, to this day.

Keeley's book can be seen as a disciplinary 'turning-of-the-tide', whose principal merit was to prompt an unprecedented amount of debate about conflict and aggression in prehistoric and preliterate societies. The recent history of research in American archaeology and anthropology has been reviewed above (but see Otterbein 1999 for an alternative narrative). With regard to European prehistoric studies, the rapid pace of development that followed Keeley's monograph has caused research priorities to shift dramatically in the space of just two decades. While early enquiries were mainly concerned with presenting the evidence and making the case for past intergroup violence (e.g. Carman and Harding 2013; Guilaine and Zammit 2005; Jockenhövel 2004–2005; Osgood 1998; Osgood and Monks 2000; Thorpe 2003), later investigations sought to achieve more sophisticated readings of the nature and social significance of sanctioned aggression and conflict (e.g. Armit et al.

2006 and following articles; Harding 2007; Peter-Röcher 2007; Horn and Kristiansen in press; Meller and Schefzik 2015; Molloy 2007a, 2017; Otto et al. 2006; Ralph 2013; Schulting 2013; Schulting and Fibiger 2012; Uckelmann and Mödlinger 2011). Importantly, the last decade has also witnessed the publication of a wide array of specialist studies discussing skeletal injuries and trauma, the manufacture and uses of prehistoric weapons and armour, the imagery of interpersonal and intergroup violence, and the archaeology of fortifications and defended sites. These are too numerous to be cited here. One could appreciate the vigour of the subject upon considering that entirely new research strands have hatched recently in the wake of fresh discoveries and scientific enquiries. This is the case, for example, with battlefield and battlescape archaeology, a thriving field of research in historical archaeology which was extended back into prehistory by the discovery of a likely Bronze Age battlefield in the Tollense Valley, Germany (Jantzen et al. 2011; Lidke et al. 2015; Brinker et al. 2015, Chap. 3, this volume).

While such a proliferation of specialist studies is a welcome sign of disciplinary maturity, it has also had the less welcome consequence of splitting the subject into a number of separate subfields of research. This hinders communication and engagement across disciplinary boundaries. In particular, a gap can often be detected between the approaches grounded in the humanities and social sciences (e.g. the investigation of Bronze Age warrior burials) and those based on the archaeological sciences, which apply an ever-growing assortment of analytical and experimental methods to the study of the material, bodily, and landscape dimensions of prehistoric warfare and violence. As with archaeological science in general, its rapid advancement and the specialist, even esoteric, nature of certain analytical techniques may be perceived by 'traditional' archaeologists as taxing entry barriers to the subject. Despite recent attempts to overcome this problem (e.g. Molloy 2007a; Ralph 2013), inter- and cross-disciplinary explorations of prehistoric warfare and violence are still thin on the ground.

How the Book Is Organised

Such considerations prompted us to organise a session on *Quantitative and Qualitative Approaches to Prehistoric Warfare* at the 21st annual meeting of the European Association of Archaeologists (Glasgow, 3rd September 2015). This book arises from, but is not limited to, the papers presented at the Glasgow Conference. Its aim is to break the mould of entrenched subject boundaries and promote interdisciplinary debate in the study of prehistoric warfare and violence. In particular, the book seeks to promote the investigation of early conflict and aggression through integrated quantitative and qualitative research approaches. The former are grounded in several domains of archaeological science including human osteology, paleopathology, archaeometallurgy, use-wear analysis, artefact morphometry, digital imaging, and experimental archaeology. The latter are rooted in various research traditions which can loosely be grouped under the 'social archaeology' umbrella.

The chapters are organised into four thematic sections inviting cross-disciplinary and cross-period interaction: (1) skeletal markers of violence and weapon training, (2) conflict in prehistoric rock art, (3) the material culture of conflict, and (4) intergroup violence in archaeological discourse. Original essays are presented in each section by a diverse international authorship encompassing early career and senior researchers alike. The case studies being discussed have a broad chronological and geographic scope, spanning, as they do, from the early Neolithic to the Late Iron Age and from Western Europe to Eastern Asia. The volume is concluded by a thoughtful reflection on contemporary approaches to the study of warfare and conflict in prehistoric societies.

Part I discusses osteological evidence relating to raiding, warfare, and weapon training in prehistoric contexts; it comprises three chapters.

In Chap. 2, Meyer and co-workers review the evidence for collective violence at several *Linearbandkeramik* (hereafter LBK) mass-interment sites from central Europe. Their re-examination of the collective burials from Talheim, Asparn/Schletz, Wiederstedt, and Schöneck-Kilianstädten, which have become household names in Neolithic studies, is integrated by the recent discovery of yet another LBK mass grave at Halberstadt, Germany (Meyer et al. 2015, in press). Here, the patterns of deposition typical of deviant burials from the period (e.g. the unceremonious tossing of the dead into a shallow pit without grave goods) are complemented by new aspects, such as the unusual sex and age profile of the deceased, who are all males between 16 and 40 years of age. Their skulls show instances of *perimortem* trauma to the occipital bone, suggesting that these individuals were hit on the head from behind, perhaps in a chillingly controlled manner. Moreover, isotopic fingerprinting indicates that they did not belong to the region. The unusual nature of the evidence prompts the authors to suggest that this is not an ‘ordinary’ massacre site, in which a near-complete village community was wiped out, but the outcome of a failed attack by a raiding party of outsiders, followed by the deliberate execution of the captives. Overall, the chapter provides a prime example of the sophisticated contextual interpretations that can be arrived at by cross-referencing, and critically appraising, the considerable body of osteological and palaeopathological data now available for Neolithic Europe.

In Chap. 3, Brinker and her team examine the osteological and weapon evidence from the Tollense Valley extended site, Germany. The site hardly needs introduction: hailed as the first Bronze Age battlefield ever to be unearthed in Europe, the main locale and surrounding riverine landscape have yielded record numbers of human remains, many of which display *perimortem* injuries (Brinker et al. 2015; Jantzen et al. 2011; Lidke et al. 2015). The unusual scale of the skeletal evidence is compounded by the dominance of young adult males in the sample, while the many weapons from the site, some of which are still embedded in the bone, provide circumstantial indications as to how the deceased would have met their ends. The case for a single-event battle scenario is further strengthened by several radiocarbon dates clustering in a narrow chronological range circa 1300–1250 BC (Jantzen et al. 2011: 427–8; Lidke et al. in press). Whereas the interdisciplinary research strategy deployed by the authors has clarified many aspects of the mighty clash of armies that seemingly took place at Tollense in the late 2nd millennium BC, other questions remain unanswered. These include the characterisation of the injury patterns from the skeletal material as well as the identification of the weapons that caused them.

Discriminating between the penetrating lesions caused by projectile and non-ranged weapons is particularly difficult as both leave similar marks on the bone (O'Driscoll and Thompson 2014). Since penetrating lesions are the commonest type of injury identified at the site, their correct characterisation holds the key to understanding the nature and mechanics of a Bronze Age battle. The team addresses this problem using an integrated research approach which combines weapon tests on animal bone targets, 3D imaging, 3D reconstructions, and digital injury simulation. In several instances, they are able to distinguish between ranged and handheld weapons based on the distinctive shapes and features of the injuries. Furthermore, the method gives them insights into the angle at which the weapons struck the bone, thus adding valuable detail as to how the confrontation might have unfolded. Inferences of this kind significantly advance our ability to reconstruct the realities of prehistoric conflict away from catch-all labels and ethnographically derived interpretations. Perhaps more importantly, they also show the potential of ad hoc investigations which repurpose established analytical methods to address fresh research questions.

Chapter 4, by Gentile and co-workers, tackles a much-debated issue in the archaeology of weapon burials: to what extent do the martial identities laid out in the grave reflect the actual participation of the deceased in martial practices? In other words, are the 'glorious dead' of countless prehistoric weapon burials real or imagined warriors? The authors approach the problem from the vantage point offered by early Samnite burials from central Italy. These fearsome mountain tribes of old are best known for sternly resisting Roman encroachment during the late 1st millennium BC (Bispham 2007; Scopacasa 2015). Yet their warlike reputation has deeper roots, as shown by their custom of depositing panoplies of weapons in male burials throughout the Iron Age period, 800–500 BC.

The analysis presented in the chapter builds upon previous osteological research by part of the team (Sparacello and Coppa 2014; Sparacello et al. 2015). This research showed that high degrees of asymmetry in the mechanical strength of the humeri (upper arm bones) can be used as a proxy for weapon training from a young age. Equipped with this neat biomechanical marker, the team proceeds to investigate the degree of humeral asymmetry and laterality in a large sample of Iron Age Samnite burials. They then cross-reference the osteological data with the typology and layout of weapons in the male burial sample. Intriguingly, the exercise reveals that weapons were often placed in the graves of individuals that had not undertaken intensive military training and, quite possibly, had never taken part in any armed fracas during their lives. This provides strong scientific backing to proposals that weapons may be utilised in prehistoric funerals to mark social identity regardless of the actual participation of the deceased in warfare (Brück and Fontijn 2013; Georganas in press).

Part II is concerned with the representation of violence and conflict in prehistoric rock art. The subject has long attracted specialist interest, mainly in the regions where weaponry and combat iconography are concentrated. Anthropomorphic and non-anthropomorphic stelae and bedrock panels depicting warriors and their panoplies have also provided a strong focus for pan-European research on the subject (e.g. Harrison 2004; Robb 2009). The four chapters contained in this section provide valuable new data and interpretations building on this body of scholarship.

Chapter 5, by Lopez-Montalvo, discusses the chronology and interpretation of the depictions of violence in Spanish Levantine rock art. The article cuts through to the heart of a long-standing debate concerning the origins and early developments of this remarkable pictorial tradition, which has thus far resisted direct scientific dating (López-Montalvo et al. 2014). Three main hypotheses have been put forward to explain its origins: (1) the rock art was produced by indigenous Mesolithic foragers as a response to the 8.2 ka BP (*c*.6200 BC) global cooling event; (2) it resulted from the first encounters between indigenous Mesolithic foragers and incoming Neolithic settlers in the mid-6th millennium BC; or (3) it is rooted in the social dynamics of fully settled Neolithic populations in the subsequent millennia. Drawing on rock art panels representing interpersonal and intergroup violence, the author builds a multipronged argument to refute the first and second hypotheses. She argues instead that considering hitherto overlooked superimpositions of paintings, the developmental sequence of the Levantine stylistic horizon, the complex military tactics portrayed on the panels, and the overall archaeology of the region, this outburst of representational art can only be explained in the context of a full-fledged agrarian society. While the debate over the chronology of Levantine rock art is likely to continue until the paintings can be dated directly, the article does show how the careful interpretation of combat scenes can shed new light on issues of social organisation in prehistoric contexts.

The next three chapters discuss southern Scandinavian rock art; they tackle the subject from differing theoretical and methodological standpoints. In Chap. 6, Horn deploys the concept of pragmamorphism – or the infusion of body parts with the qualities of objects (Derman 2012) – to interpret a group of ambiguous images in which human bodies merge with boats and weapons. He argues that these are not accidental superimpositions or mere upgrades of the original depictions by later carvers. Based on an in-depth re-examination of the engravings, he maintains that these images must be understood as conscious attempts to imbue human beings with the defining characteristics of certain iconic objects, such as the sword's capability to cut through the flesh or the boat's speed. The hyper-masculinity and overt sexualisation of many such images tinge Horn's interpretation with disturbing overtones, which he invites us to incorporate into our readings of the past – unpalatable as they might be to modern sensibilities.

In Chap. 7, Bertilsson re-examines Bronze Age rock carvings of spears, some of which are wielded by unusually large human figures. Using Structure from Motion (SfM), an image-based 3D modelling technique, he is able to discern several phases of carvings of the spear images, some being significantly older than hitherto acknowledged. Crucially, the new 3D documentation shows that the human figures, where present, were carved long after the earliest spear images. This allows him to shift the focus of the analysis from the human beings to the spears themselves, which, it would now appear, are the most salient objects on the panels. To explain their centrality and long biographies, Bertilsson argues that the carved spears might be interpreted as the precursors of Odin's own spear 'Gungnir', dating from a time preceding the emergence of anthropomorphic deities in the Nordic pantheon. The article shows how sophisticated contextual readings can be arrived at when scientific methods of analysis are driven by clear research questions.

Chapter 8, by Ling and co-workers, investigates the relationship between rock art, secret societies, long-distance exchange, and warfare during the Nordic Bronze Age. Southern Scandinavian rock carvings frequently depict weapon-wielding warriors standing in or near watercraft. As argued by the authors, this motif arose at a time when coastal communities participated in long-distance exchange for the procurement of metal. Grounding their interpretation in ethnohistorical and ethnographic data, they argue that the metal trade was made possible by the establishment of secret societies and fraternities of warriors. Not only were members of these societies tasked with protecting the valuable merchandise by force, if necessary; they would make the very existence of the trade possible, for this – the authors submit – was predicated upon access to a body of restricted esoteric knowledge, which would be revealed to the initiated during ceremonies involving the carving of petroglyphs.

Part III explores the material culture of conflict through combined archaeological and scientific methods of analysis.

Drawing on her decade-long research on the subject (Mödlinger 2017), Mödlinger provides a critical overview of European Bronze Age body armour in Chap. 9. Firstly, she clarifies the chronological and technological evolution of bronze helmets, greaves, and cuirasses. Secondly, she investigates aspects of manufacturing technology by means of chemical and metallographic analysis, informed observation, and experimental archaeology. Finally, she puts forward insightful remarks concerning the uses and life histories of these objects based on wear analysis. Such a seamless archaeological-scientific approach to research results in a fresh appraisal of this class of objects. Overall, the importance of Mödlinger's work lies in bringing body armour research on a par with studies of early metal weapons – objects that have enjoyed a much longer history of interdisciplinary research. This will undoubtedly lead to more balanced and holistic appraisals of Bronze Age warriorhood in years to come.

In Chap. 10, Molloy lends his considerable subject knowledge to the exploration of the life histories of Bronze Age weaponry from the Balkans. His approach originally integrates compositional and metallographic analysis, wear analysis, experimental archaeology, and a function-oriented critical review of typology. The outcome is an insightful discussion of the social mechanisms by which ideas about style and function were exchanged and materialised, away from the 'tyranny of ethnography' (Haas and Piscetelli 2013). This is made all the more interesting by his regional focus on the Balkans, a node of communication and exchange lying at the crossroads between central Europe and the eastern Mediterranean.

Whereas Molloy's article is in many respects the outcome of decades of investigations into Bronze Age weaponry, Cao's chapter stands at the opposite pole of the research spectrum for being the first ever exploration of the manufacture, use, deposition, and post-depositional history of copper-alloy weapons from late Shang China (*c*.1200–1050 BC) by means of wear analysis (Chap. 11). Despite the pioneering character of the enquiry and the small sample size, her research succeeds in showing that metalwork wear analysis can profitably be applied to the study of early Chinese bronzes. Significantly, it also shows the ability of this analytical technique to challenge and redefine entrenched research agendas. As Cao argues throughout the chapter, metalwork wear analysis is especially adept at questioning dichotomised readings of 'function' and 'style' and enables nuanced explorations of the complex life histories of ancient bronzes (see also Dolfini and Crellin 2016).

In Chap. 12, Birch explores a single weapon type from the famous Late Iron Age 'war booty' sites of southern Scandinavia: the Havor lance. This is a distinctive iron/steel spear point that has traditionally been considered a standardised product (Ilkjær 1990). Building upon recent research on the subject (Birch and Martinón-Torre in press), Birch investigates whether this is the case. His multidisciplinary approach to the problem involves traditional metric analysis, innovative geometric morphometric analysis (GMM), metallography, and X-radiography. The research reveals that the Havor lances were made using a remarkably uniform construction technique, which the author dubs the 'spiral-form' method. This is in accordance with previous metric and morphometric observations suggesting the lance to be a highly standardised weapon product. However, metallography also reveals that the analysed specimens have non-uniform alloy compositions and microstructures. Such a glaring discrepancy between the appearance and the make-up of the lances presents us with a complex scenario whereby all weapons would be manufactured by one, or very few, workshops, but the iron stocks used in their making would come from disparate sources in modern-day Denmark and southern Norway. As Birch argues, this highlights hidden tensions between the craftspeople's desire to create a highly uniform product and the vagaries of iron procurement in late prehistoric Scandinavia.

Part IV discusses past social understandings of prehistoric armour and weapons, contemporary approaches to their investigation, and the interpretations stemming from both.

In Chap. 13, Crellin and co-workers appraise experimental weapon studies based on their recently concluded 'Bronze Age Combat Project'. Replica weapon testing is proving increasingly popular as a method for investigating ancient fighting practices (e.g. Anderson 2011; Atzeni 2016; Dean 2017; Dyer and Fibiger 2017; Molloy 2007b, 2009; O'Flaherty 2007; O'Flaherty et al. 2011). As the authors maintain, however, the development of this research approach has not been accompanied by a sufficient amount of critical reflection concerning its advantages and shortcomings. They identify current overreliance on historic combat styles as a particularly acute problem, which curbs the ability of researchers to explore prehistoric fighting styles that may be radically different from historic ones, as well as weapons lacking modern counterparts (e.g. Bronze Age halberds; Horn 2014: 174–182). By critically scrutinising their own approaches to weapon testing, the authors try to disentangle the multiple context-specific factors affecting experimental weapon research and chart a new, if tentative, pathway bridging controlled laboratory tests and 'fluid' body-centred field experiments.

In Chap. 14, Lehoërff provides a thoughtful reflection on the concept of value in archaeological discourse. She investigates value from the standpoint of Bronze Age metal cuirasses from French hoards, with which she has a long acquaintance. In the chapter, Lehoërff postulates a formalised three-agent relationship between bronzesmiths, combatants, and commissioners, which would determine armour production choices in Late Bronze Age Europe. Based on archaeological and metallurgical considerations, she posits that the amount of specialist skill and sheer labour involved in their manufacture reveals that prehistoric communities would have invested these objects with social, as well as technological, value. This interpretation would be further supported by the extended life cycles of many a cuirass, encompassing use on the battlefield, curation, and ritualised deposition in hoards. Such observations let her conclude that Bronze Age cuirasses would have materialised deep-seated ideas of value, which informed high-end technological craftwork and the martial ethos surrounding it.

In Chap. 15, Aranda Jiménez provides new ammunition to a long-standing dispute concerning the nature of Early Bronze Age Argaric society, southeast Spain. This pitches historical materialists, who consider Argaric culture as the epitome of prehistoric socio-political complexity in the western Mediterranean (Chapman 2003; Lull et al. 2011, 2014), against researchers of differing theoretical inclinations, who tend to highlight the symbolic rather than political dimensions of material culture (Aranda Jiménez et al. 2015). The author firmly places himself in the latter camp. In the article, he argues that an impartial examination of Argaric fortifications, weaponry, and skeletal trauma hints at a picture which is at variance with prevailing narratives of warlike Early Bronze Age elites. For him, Argaric violence was exercised in a context of ritualised or highly regulated resolution of conflict, characterised by few or no fatalities. While his controversial proposal is unlikely to bring the regional dispute to an end, it does provide a valuable contribution to current debates regarding the nature of prehistoric violence and its role in the development of complex societies (Campbell 2014).

The volume is concluded by Schulting, who discusses the application of scientific methods of analysis to conflict studies (Chap. 16). He places the emphasis on recent advances in the field of biomolecular archaeology applied to human remains, most notably isotopic analyses, ancient DNA, and radiocarbon dating. He argues that, if applied reflexively and integrated with one another, these techniques have the potential to address crucial questions regarding the nature and social context of prehistoric lethal aggression including the identity and origins of the victims. As he points out, however, in and of themselves, methodological advances are not going to improve our understanding of the human past. This can only be achieved by grounding archaeological and osteological investigations within theoretically informed enquiries and broad, interdisciplinary research agendas.

Towards a Multipolar Future for the Study of Warfare and Violence?

In recent years, research into intergroup violence in prehistoric and preliterate societies has moved away from polarised approaches, which pitched against one another believers and non-believers in its antiquity and role in human evolution, towards a generalised consensus as to its presence in nearly all human societies. Although its nature, role, and significance are still hotly debated, lethal aggression is now firmly back on the agenda of social enquiries in both archaeology and anthropology. At the same time, however, the subject has splintered into at least five specialist research strands, namely, the study of trauma and injury on human skeletal remains; representations of conflict and weaponry in various media such as rock art and stelae; armour and weapon studies; the architecture of conflict including hillforts, fortifications, and defended sites; and the analysis of intergroup violence as documented in ethnographic, ethnohistorical, and historical sources (Armit et al. 2006; Thorpe 2013). To these, we can perhaps add the fledgling field of prehistoric battlefield and battlescape archaeology, recently triggered by the discovery of the Tollense Valley extended site (see above).

As we have argued above, such an embarrassment of riches is to be welcomed as a sure sign of disciplinary maturity; yet it has also caused specialist fields of enquiry to grow more entrenched and has hindered communication across disciplinary boundaries. Faced with a bipolar past and a fragmented presence, what can researchers of prehistoric warfare and violence hope for the future? The papers published in this volume help us to discern what lies ahead. They point, in particular, to an emergent multipolar future, in which approaches grounded in specific research areas are to be fertilised by methods, data, and questions developed in related fields. This is especially true of 'traditional' qualitative approaches (grounded in the humanities and social sciences) and 'novel' scientific advances (grounded in quantitative methods of analysis), which seem inescapably set to interact with one another not just more frequently but also more deeply and meaningfully than has hitherto been the case.

Considering the research presented in this book, three interrelated lines of development can be fathomed. The first is the creation of bespoke, surgically targeted approaches to the enquiry. As the questions driving the research become increasingly sophisticated, and the scientific methods of analysis available to us grow ever richer, a tendency is emerging towards carefully calibrated, tailor-made research approaches, which utilise multiple scientific and non-scientific techniques of analysis to address specific problems. Examples of this strategy abound throughout the book. Suffice it to mention here the combination of weapon tests on animal bone targets, 3D imaging, 3D reconstructions, and digital injury simulation pursued by Brinker and her team to discriminate between ranged and handheld penetrating injuries from the Tollense Valley skeletal material (Chap. 3); or the multipronged approach favoured by Birch, which involves the use of traditional metric analysis, innovative geometric morphometric analysis, metallography, and X-radiography.

As discussed in Chap. 12, he deploys these techniques to test unsubstantiated hypotheses concerning the standardised manufacture of a particular type of lance head in later Iron Age Scandinavia. This is no idle question, as it holds the key to addressing broader problems concerning the *chaîne opératoire* of iron production, and who controlled it, in a rapidly evolving society.

The second is the elaboration of fresh fields of analysis and research questions bestowing new enquiring capabilities on the subject. The last 20 years have seen studies of prehistoric warfare and violence, especially in European archaeology, move away from simplistic research agendas towards more sophisticated realms of social and scientific analysis. The cutting-edge research presented throughout the book indicates that the continuing journey has been highly beneficial. Scholars are no longer satisfied with making the case for the presence/absence of violence in a given society, or interpret it based on ethnohistorical categories (Is it raiding? Is it feuding? Or can we label it warfare?). They now want to dig deeper into the evidence in order to understand the nature of lethal aggression, its social significance, and the practices by which it was enacted, as revealed by human and material agents. How many people participated in a Bronze Age battle, and how were they armed? How did they fight with these weapons? And how can we reinterpret weapon burials away from well-trodden readings of warrior aristocracies and elite culture? These are but some of the questions explored in the book, and it seems likely that their number and sophistication will steadily increase in years to come.

The third is the ability of scholars to frame their enquiries using mature social questions and link them meaningfully with other research fields in archaeology. How is violence encultured and socialised? Can we infer the nature of conflict in a given community and, in turn, use our inferences to understand its social organisation? Can we address broader concepts including value, skill, and past ideas of the body by investigating the material culture of violence and its social realities? And can we arrive at a more holistic understanding of prehistoric societies by fertilising data concerning subsistence, mobility, and culture change with the growing amount of evidence of intergroup violence? This doubtless is the most challenging of the three research strands, for its exploration necessitates in-depth engagement with contemporary social theory as well as sustained cross-disciplinary dialogue and interaction. Yet it is also the one bearing the ripest fruits for scholars in both archaeology and anthropology.

We sincerely hope that this book will contribute to the future development of the subject by showing what can be achieved by cross-fertilising state-of-the-art scientific methods of analysis with archaeological and anthropological theory, and use both to address theoretically informed research questions.

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Part I
Skeletal Markers of Violence and Weapon Training

Chapter 2
Patterns of Collective Violence in the Early Neolithic of Central Europe

Christian Meyer, Olaf Kürbis, Veit Dresely, and Kurt W. Alt

Introduction

Violence targeted at the integrity of the human body may affect both individuals and populations and may be intentionally lethal or non-lethal, depending on scale and specific context. Compared to indirect archaeological evidence of violence, like weapons or defensive structures (Christensen 2004), the human skeleton is the sole direct indicator for violent episodes targeted at people that actually occurred in the prehistoric past and which thereby may provide insight into their social meanings (Martin and Harrod 2015). While isolated cases of individual victims of violence are known for several species of fossil hominids (e.g. Zollikofer et al. 2002; Wu et al. 2011; Sala et al. 2015), the archaeological evidence for collective violence, or warfare, defined here as the conscious application of potentially lethal violence by independently acting groups against other such groups, is currently restricted to roughly the last 10,000 years (e.g. Mirazón Lahr et al. 2016). This is likely influenced, in part, by the nature of the archaeological record itself, as the number and density of sites in any given area or time period are not uniformly distributed, and

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sites with preserved human remains become ever sparser with increasing antiquity, thus reducing our chances to uncover solid archaeological evidence for group violence.

In Central Europe, cemeteries or other sites containing high amounts of skeletons only became numerous with the advent of the Early Neolithic and its main cultural group, the *Linearbandkeramik* (hereafter LBK; *c*.5600–4900 BC). This is also the time when victims of violence become much more visible in the osteoarchaeological record. This is especially true of the victims of collective lethal violence, for which the LBK has become almost notorious since the discovery of the first Early Neolithic massacre mass grave at Talheim, Germany (Wahl and König 1987; Wahl and Trautmann 2012). Since then, several other such sites have been found and analysed. In fact, the number of individuals excavated from currently known LBK mass violence sites is such that it now allows quantitative analysis. This may be informative not only about the style of warfare practised at the time, and of the weapons used (Wahl and Strien 2007), but also about the demography of victims as well as warfare-related practices such as torture, dismemberment, and mutilation, in short, about the patterns of collective violence practised by the first farmers of Central Europe.

As shown by numerous ethnographic and archaeological studies of ancient warfare, the conscious decision to attack and violently kill others often has its ultimate roots in real or imagined competition over geographically situated and limited resources. This is especially common at times of climatic instability, when the survival of the group is perceived to be threatened by fluctuating and thereby unpredictable, agricultural productivity (e.g. Maschner and Reedy-Maschner 1998; Otterbein 2004). However, unravelling the context of each act of collective violence becomes all the more challenging with increased antiquity due to the paucity of corroborating information. When considering chronologically remote prehistoric societies, whose environments, worldviews, and perceptions of themselves and others are largely unknown to us, interpretation is difficult and will always remain speculative, at least partly. Nevertheless, robust insights into past societies and the violent events that impacted on them (both as individuals and as members of victimised groups) may be gained by grounding our analyses and interpretations in observable and objectively describable patterns. This chapter attempts such an analysis based on the human skeletal record for collective lethal violence in the Early Neolithic of Central Europe.

Burial and Violence in the Linearbandkeramik

Generally, the identification of patterns of violence is grounded in the reliable recognition of past violence itself. In bioarchaeological terms, this may be evident from either skeletal injuries or the context in which the human skeletal remains of suspected violence victims are found – and occasionally from both (Martin and Harrod 2015). Especially if skeletal remains and burial features are adversely affected by taphonomic damage, opinions are sometimes divided as to what constitutes reliable evidence for lethal violence and what is simply the result of naturally occurring diagenetic processes (e.g. Mirazón Lahr et al. 2016; Stojanowski et al. 2016). Without going into too much methodological detail here, which would be beyond the scope of the present paper, perimortem skeletal trauma and deviant deposition have to be evaluated as objectively as possible and always within their specific context.

For the LBK, there is a near-perfect overlap between the two, as individuals with lethal perimortem injuries are mostly found as part of larger groups in disorganised mass graves or as scattered remains at conflict sites (Wahl and König 1987; Teschler-Nicola et al. 1999; Meyer et al. 2015a). These depositional contexts differ greatly from the usual single inhumation burials of the LBK, which are mainly characterised by the careful arrangement and patterned orientation of the bodies within dedicated cemetery areas. Furthermore, these graves often contain distinctive grave goods such as pottery, stone tools and weapons, and bone and shell artefacts (e.g. Nieszery 1995). Cremation burials are also known in the LBK, which show significant amounts of care and energy expended in their making (Trautmann 2006). In contrast, all mass graves and massacre sites lack any recognisable evidence for a similarly elaborate treatment of the dead, as bodies were deposited in a disorganised and commingled manner without any recognisable care, if indeed they were gathered in one spot at all. At times, the dead were not deposited in cemeteries but within settlement sites (Meyer et al. 2014). However, the mass graves discussed in this chapter do not fall into this category either due to the higher number of bodies relative to the settlement burials and their seemingly careless disposal. The practice of burying the dead within villages is now understood to be just another type of normative burial in the LBK mortuary "portfolio", which likely aimed at providing the deceased with a respectful funerary treatment (Meyer et al. 2014). Although cemetery and settlement burials seem to differ slightly regarding demography and the number and frequency of durable grave goods (Hofmann 2009), they are overall very similar, and sometimes the distinction between them is blurred, for example, when burials are arranged in a cemetery-like pattern within a settlement site (e.g. Krause 1998; Fritsch et al. 2008).

If compared with the normative cemetery or settlement burials, be they cremation or inhumation, the mass graves, as a group, may therefore be regarded as deviant burials, which apparently followed devastating and traumatic events (Meyer et al. 2014; Hofmann 2015) including massacres (i.e. the violent killing of one group of people by another within a very short time and during more or less chaotic circumstances; cf. Dwyer and Ryan 2012) and mass execution (i.e. the systematic killing of restrained victims for reasons deemed more pragmatic than ritual; cf. Otterbein 2000; Meyer et al. in press).

Although individuals showing healed skeletal injuries were sometimes interred in traditional cemetery burials, the victims of lethal violence were only rarely included in such burial sites by LBK communities (Petrasch 2006; Bickle and Whittle 2013). A possible reason for such a differential treatment might be that their social units had been destroyed during collective violence events, leaving the disposal of the corpses to others, perhaps even the perpetrators of the violent acts. These "others" would not be expected to invest the same amount of care and effort into the post-mortem treatment of the deceased, especially if there were larger numbers of them to be disposed of. However, the one LBK mass grave without recognisable perimortem skeletal trauma, namely, Wiederstedt, suggests that disorganised mass graves were possibly also used to quickly dispose of large numbers of deceased from one's own community under special circumstances (see below). This may be the case with victims of epidemic disease, starvation, accidental poisoning, or a variety of other accidents and natural catastrophes, which possibly overtaxed the capacity of the surviving community for arranging a proper burial (Meyer et al. 2014).

It is currently unclear whether violently killed people that were not part of mass fatality events received a special treatment in LBK society, as their overall numbers are still too low for meaningful interpretation (Bickle and Whittle 2013; Fibiger 2014). In isolated cases of cranial trauma, it is also difficult, and sometimes impossible, to differentiate between injuries suffered by accident and injuries resulting from interpersonal violence with a lethal intent.

This short summary of the relationship between violence and burial within the LBK shows that – as far as we currently know – the victims of collective lethal violence were usually deposited simultaneously, as a group, and in a deviant manner vis-à-vis the regular and mostly individual burials found in coeval cemeteries and settlements. Additionally, the precisely contemporaneous nature of the mass fatality population samples allows detailed insights into their demographic structure. This kind of information is especially important as it is not normally preserved in traditional burial sites, which lack the unique "snapshot" element of the mass burials (Bentley et al. 2008; Meyer et al. 2014).

Sites of Collective Violence and/or Deviant Mass Burial

The LBK mass burial sites, which, for the most part, have provided evidence for prehistoric massacres (apparently the most frequent form of lethal perimortem collective violence within LBK communities), are well described in the archaeological literature. For this reason, this chapter solely provides a brief presentation of these sites (Fig. 2.1), focussing in particular on the human skeletal remains and their cranial injuries, which are the sole lesions to be numerous enough to allow for comparative analyses. Further details are available from the literature cited, which include the original site reports as well as key comparative and analytical works. Only the mass grave site of Halberstadt, Germany, will be presented here in more detail, as it is the most recently discovered and analysed LBK mass fatality site and also displays a unique pattern of demography and skeletal injury (Meyer et al. in press). This mass grave will then be compared to the other sites (all listed below in the chronological order of their discovery), and the results of this comparison will be discussed, paying special attention to key similarities and differences in the osteoarchaeological quantitative data.

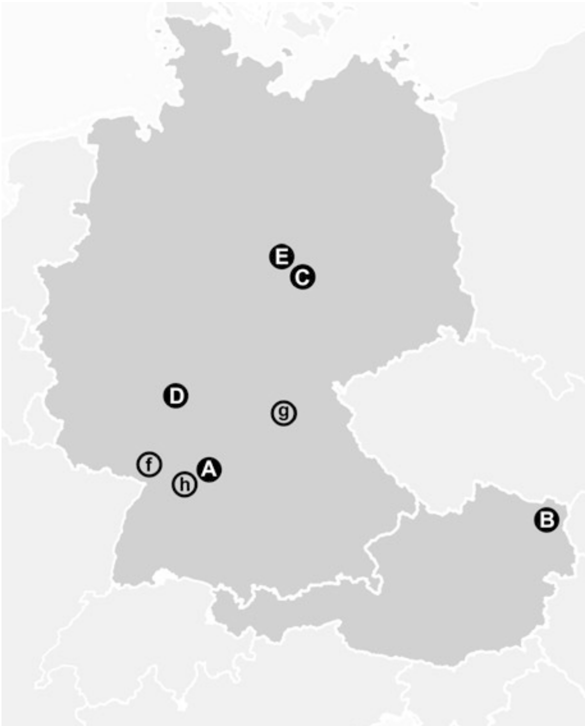

Fig. 2.1 Map of Germany and Austria showing the LBK sites mentioned in the chapter. The mass fatality sites are depicted by solid circles and capital letters, while the other sites discussed in the chapter are marked by open circles and lower case letters. **A** Talheim, **B** Asparn/Schletz, **C** Wiederstedt, **D** Schöneck-Kilianstädten, **E** Halberstadt, **f** Herxheim, **g** Tiefenellern, **h** Vaihingen/Enz (Image: Christian Meyer)

Talheim, Germany (Fig. 2.1, Site A) (Wahl and König 1987; Wahl and Strien 2007; Wahl and Trautmann 2012)

The first evidence of lethal mass violence from the LBK came with the discovery and analysis of the disorganised mass grave at Talheim in southwestern Germany. At this site, about 34 individuals, including similar numbers of subadults and adults of both sexes, were deposited in a pit near a probable LBK settlement. Slightly over half the skeletons showed perimortem injuries consistent with the typical ground stone weapon tools of the LBK. Most traumatic lesions were found on the parietal bones of the skulls, while the frontal and occipital bones were affected to a much lesser degree and almost equally. Overall, the right side of the skull showed slightly more injuries than the left, which might suggest that the victims were, in part, struck down from behind by right-handed attackers while fleeing. As the left half of the frontal bone is the least affected of the major skull bones, a classic face-to-face confrontation seems to have been unlikely for most individuals. Otherwise, the left frontoparietal region would likely be the one with the most injuries, as indicated by various studies of the distribution of cranial trauma (e.g. Fibiger et al. 2013). In any case, the pattern of cranial injuries encountered at Talheim, with all major cranial vault bones affected repeatedly, suggests that the blows were received during a largely uncontrolled situation, in which both victims and attackers were likely able to move about without significant restraint.

Asparn/Schletz, Austria (Fig. 2.1, Site B) (Teschler-Nicola et al. 1996, 1999, 2006; Teschler-Nicola 2012)

The LBK mass fatality site of Asparn/Schletz consists of large ring ditches which contained the partly disarticulated and scattered remains of more than 60 individuals, both subadults and adults. As the site has not been completely excavated, the total number of individuals is currently unknown. Many of the recovered bones show traces of carnivore gnawing, which indicate that the dead had been lying unburied for some time after their violent demise. Apparently, the final layout of the bodies and body parts within the ditches was the result of natural sedimentation following the scattering by carnivores. All of the 33 recovered and analysed skulls from the site show signs of perimortem violence which clearly focussed on the parietal bones, similarly to Talheim. The frontal bones are affected less frequently, followed by the occipital bones, which show the least amount of trauma. The right sides of the skulls show slightly more injuries than the left sides, but the difference is negligible. As slightly more injuries are found on the frontal than the occipital bones, the cranial trauma pattern at Asparn is slightly more indicative of a face-to-face confrontation than that described for Talheim, but overall they appear rather similar, once again suggesting an uncontrolled lethal conflict situation where both attackers and victims were able to move more or less unrestrained.

Wiederstedt, Germany (Fig. 2.1, Site C) (Meyer et al. 2004, 2013, 2014)

The disorganised mass grave found at Wiederstedt in Saxony-Anhalt, Germany, contained the articulated skeletal remains of ten individuals, eight of them biological subadults. The osteological analysis revealed no traces of blunt force cranial injuries similar to those found at Talheim or Asparn. This very much suggests that the cause of death was likely non-violent for these individuals; in any case massive cranial trauma can be excluded. Although the absence of violent injuries in skeletal remains does not equate to evidence of the absence of violence, which might have affected soft tissues only, the previously described examples of Talheim and Asparn, along with many other sites, show that Neolithic lethal violence – if present – is usually quite evident in cranial remains. Therefore, epidemic disease, starvation, poisoning, or other catastrophic events, intentional or accidental, might have been responsible for the deaths of these individuals. Despite the lack of recognisable skeletal trauma, the bodies were collected and deposited in a deviant burial feature like the violence victims from Talheim and likewise did not receive any careful funerary treatment.

Schöneck-Kilianstädten, Germany (Fig. 2.1, Site D) (Lohr 2013; Meyer et al. 2013, 2014, 2015a; Lohr et al. 2017)

A disorganised mass grave containing the skeletal remains of at least 26 individuals was discovered at the site of Schöneck-Kilianstädten in Hesse, Germany. Preservation of the bones was partly poor; therefore it could not be determined if all remains were still articulated (but most apparently were). Additionally, some evidence of trauma will undoubtedly have been destroyed over time, probably more so than at other mass fatality sites, where bones seem better preserved. Nevertheless, a multitude of cranial injuries were recorded, which not only affected the major bones of the cranial vault but also frequently the mandible and temporal bones. Overall, the left side of the skull shows more injuries than the right side, which is in contrast to the other massacre sites of Talheim and Asparn. With the left parietal and the left half of the frontal bone sustaining most injuries, this pattern is more similar to that expected for a face-to-face confrontation. But apart from the parietal bones, the left-right difference is rather small, resulting, as it does, from a rather uniform distribution of injuries all over the skull. Once again, this indicates that the cranial injuries seem to have occurred within an uncontrolled situation, like at Talheim and Asparn, which is in contrast to the pattern of the numerous perimortem postcranial fractures that have been observed in this population sample, but not in others. Although some upper limb bones do show perimortem trauma, there is a clear and statistically significant dominance of fractured lower leg bones. As tibia and fibula seem to have been specifically targeted, this strongly suggests a controlled situation for these particular injuries, in which victims were unable to protect their legs, probably because they had already been killed or incapacitated by the cranial blows likely received earlier. Methodologically, ante-mortem torture and post-mortem mutilation cannot be differentiated from skeletal remains; thus this problem cannot currently be resolved with any confidence.

Further Sites

A few other LBK sites may also be mentioned in the wider context of collective violence, as these were interpreted by certain authors as being connected to Early Neolithic warfare, mainly based on preliminary, outdated, and sometimes misrepresented data (e.g. Golitko and Keeley 2007). The enclosure site at Herxheim in Rhineland-Palatinate, southwestern Germany (Fig. 2.1, Site f), is the most intriguing of these. Here, several hundred individuals have been systematically processed and dismembered, in what is now commonly interpreted as evidence for ritual cannibalism and human sacrifice (Zeeb-Lanz et al. 2016). In addition, some perimortem cranial injuries, which survive underneath the slightly more recent traces of extensive post-mortem dismemberment, might also suggest violent deaths for at least some of the individuals from this site (Boulestin and Coupey 2015). In any case, the repeated and periodic deposition of the skeletal remains within the pits and ditches of the enclosure, mixed with pottery and selected animal bones, strongly indicates some form of ritual practice focussing on the bodies, which is unlike that encountered at the massacre sites discussed above, all of which lack complex post-mortem treatment. At Herxheim, the bodies and body parts were not just dumped into the nearest conveniently placed pit or left lying where they fell. Instead, a lot of effort and energy were invested into their processing and transformation (Zeeb-Lanz et al. 2016), but such practices are difficult to fathom without any reliable knowledge of the multifactorial and highly complex contextual background surrounding their performance.

The cave site of "Jungfernhöhle" near Tiefenellern, southeastern Germany (Fig. 2.1, Site g), has also been interpreted as a location connected to violence, sacrifice, and possible cannibalism in the earlier literature (Asmus 1955; Buhmann 1979). However, a recent re-examination of the site and of the spoil heaps of the original excavation, along with a re-evaluation of the quality of the old excavation practices, has revealed that many small skeletal elements had been missed or disregarded during the 1950s excavations, so that any modern reinterpretation of the site has to wait until the new finds are analysed (Seregély 2012).

The enclosed LBK settlement and cemetery site of Vaihingen/Enz, southwestern Germany (Fig. 2.1, Site h), has also sometimes been interpreted as violence related (Golitko and Keeley 2007), as most of the human remains were found in close association with the ditch surrounding the settlement. However, in contrast to the other enclosure sites mentioned above, the skeletons from Vaihingen were mostly found in regular burials, with only a few of them seemingly being deviant (Bentley et al. 2003). As the results of the osteoarchaeological analysis have not yet been fully published, a final assessment of the site and its burials is still pending (Welge 1997; Krause 1998). In contrast to earlier claims, however, Vaihingen appears to have been, for the most part, a regular burial place, which offers further evidence of the blurred boundaries separating cemeteries and settlements in LBK society.

The Mass Grave of Halberstadt

In 2013, another Neolithic mass grave was discovered at the site of Halberstadt, Saxony-Anhalt, Germany (Fig. 2.1, Site E; Meyer et al. 2015b, in press). The whole feature was block lifted and later meticulously excavated under controlled conditions. The mass grave contained articulated skeletal remains of nine individuals, which were deposited haphazardly in a sub-circular pit (Fig. 2.2). Certain skeletal elements were already missing upon discovery due to post-depositional disturbances of the burial feature. A similar fate had befallen some individuals from the LBK mass grave at Wiederstedt, located *c.*40 km to the southeast, where the removal of one cranium could be attributed to eighteenth-century grave-digging activity (Meyer et al. 2012). In the case of Halberstadt, however, the observed

Fig. 2.2 The mass grave of Halberstadt, Saxony-Anhalt, Germany, where nine individuals were deposited in a pit feature. Some skeletal elements are missing due to animal activity and later anthropogenic disturbance (Image: State Office for Heritage Management and Archaeology Saxony-Anhalt)

anthropogenic disturbances could not be traced to a specific event or cause, but it is very likely that they were mainly the result of later (pre)historic farming or settlement activities, as the area was coveted for both throughout the centuries (Meyer et al. 2015b). Durable grave goods were absent from the pit. The small fragments of pottery found scattered throughout the feature are typical of Neolithic settlement debris accidentally included in the infill or later introduced by burrowing animals. Similar observations were made at the other LBK mass grave sites, all located near settlements. The same holds true for the Halberstadt mass grave, which was found only a short distance from a roughly contemporary LBK settlement, which encompassed a rather high number of settlement burials (Fritsch et al. 2008).

Except for one individual, a probable female, all other skeletal remains from the mass grave could be determined as male. The age range excludes subadults below the age of 16 years and does not exceed *c*.40 years of age at death. Carnivore-gnawing damage was noted on several limb bones, mostly those from the edge of the feature, and the distal parts of the affected limbs were usually missing. Scavenging carnivores seem to be responsible for at least some of the missing elements of the appendicular skeleton. Smaller bones were likely dislocated and scattered by burrowing animals, whose tunnels and skeletal remains were observed throughout the feature during the excavation. The carnivore-gnawing marks found

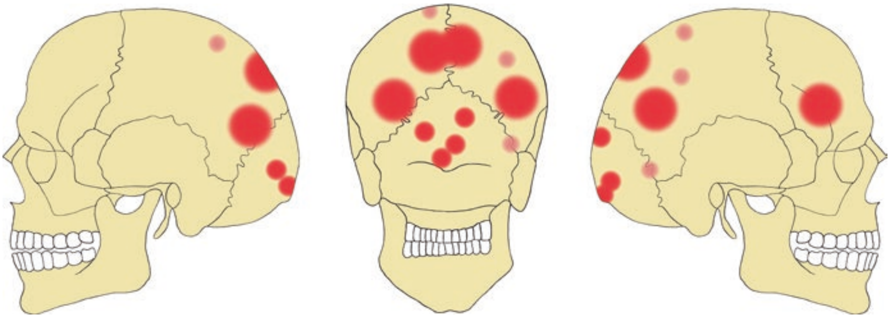

Fig. 2.3 Compilation of perimortem cranial injury locations of the individuals from the mass grave of Halberstadt. Larger dots signify larger injuries, while smaller dots signify smaller injuries. Likewise, darker spots signify securely identified trauma, while lighter spots stand for likely trauma. With the exception of one instance of trauma on a frontal bone, all cranial injuries identified from the site are clustered at the back of the head (Image: Christian Meyer)

on the human skeletal remains at Halberstadt are reminiscent of those observed on the Asparn skeletons (Teschler-Nicola et al. 1996, 1999), which might indicate that the bodies were not completely covered with soil upon deposition.

A few long bones of the upper and lower extremities showed perimortem fractures which probably occurred before deposition, as suggested by their anomalous layout. Overall, pathological lesions are rare and rather insignificant with the exception of cranial trauma, which could be diagnosed in all seven individuals who still retained complete skulls or skull fragments. Again, as in all other LBK violence-related mass fatality sites (see above), the parietal bones show the highest frequency of injuries. In this, they are closely followed by the occipital bone, while a single instance of perimortem trauma was observed on a frontal bone. The right side of the skull was hit almost twice as often as the left side, which, in accordance with the massacre sites of Talheim and Asparn and assuming largely right-handed attackers, indicates that the trauma was inflicted from behind. This is further supported by the evidence that almost all injuries are located at the back of the head in a tightly circumscribed area (Fig. 2.3), with some of them even being very similar in shape. If we contrast this evidence with the massacre sites of Talheim, Asparn, and Kilianstädten, the cranial trauma pattern from Halberstadt strongly suggests that these younger men were apparently killed in a much more controlled manner, likely to be an execution (Meller 2015; Meyer et al. in press). As isotope analysis has shown, the individuals buried in the mass grave had a different diet and geographical origins from the village population buried within the settlement, thus indicating that they were outsiders (Meyer et al. in press).

If we cross-examine this evidence, it appears that the mass grave at Halberstadt did not include massacre victims like those found at Talheim, Asparn, and Kilianstädten and therefore is not representative of a local residential community, but instead possibly contained the remains of a failed raiding party of outsiders. As already noted, the demography of those killed at Halberstadt is strongly skewed towards young adult males, which is currently unique for the LBK evidence. To explore this further, the demographic patterns established for each mass fatality site will be examined below in more detail and also contrasted with one another.

Demographic Patterns of Collective Violence Victims in the Early Neolithic

Upon comparing the demographic composition of the population samples found at the different LBK mass fatality sites, several patterns do emerge, which can be utilised to support the overall interpretation of the interrelation of collective violence and deviant mass burial in LBK society (Table 2.1). Importantly, the "snapshot" nature of these samples allows a tightly focussed look at people who truly lived and died contemporaneously at each site – something that is impossible to achieve from more traditional burials (Meyer et al. 2014).

Firstly, individuals of the *senilis* age category (older than 60 years) are almost absent from the mass fatality sites – an occurrence that fits well with the average life expectancy known for the Early Neolithic, which was below 30 years (Trautmann 2006). Individuals of the *maturus* age class (between the ages of 40 and 60 years) are much more common at LBK mass fatality sites but are still less numerous than younger adults or children at most sites. Among the skeletal samples examined here, mature individuals are found at Talheim, Schöneck-Kilianstädten, and Asparn. At the latter location, there is a balanced ratio of males (53%) and females (47%) for this age class, while females slightly dominate at the former two sites. However, as absolute numbers for this age group are very low at both Talheim and Kilianstädten, this datum is not particularly informative. This clearly changes in the *adultus* age class (between 20 and 40 years); here, the situation is reversed, as there are fewer females than males at all four mass fatality sites. The sex imbalance is least pronounced at Talheim (1.75:1; males 64%, females 36%), is more evident at Asparn

Table 2.1 Demography of the mass fatality sites discussed in the chapter. Age and sex data have been compiled from the literature cited herein (the few individuals lacking reliable age and sex determinations are not included in the table)

Site	Inf. I	Inf. II	Juv.	Ad. Male	Ad. Female	Mat. Male	Mat. Female	Sen. Male	Sen. Female
TH	7	6	3	7	4	2	3	1	–
AS	12.5	8.5	5.5	16.5	5	9.5	8.5	–	–
KS	10	2	1	9	–	–	2	–	–
WS	1	5	2	1	1	–	–	–	–
HS	–	–	1	7	1	–	–	–	–

TH Talheim, *AS* Asparn/Schletz, *KS* Schöneck-Kilianstädten, *WS* Wiederstedt, *HS* Halberstadt. Age classes are those commonly utilised in continental Europe (e.g. Herrmann et al. 1990). *Inf.* infans, *Juv.* juvenis, *Ad.* adultus, *Mat.* maturus, *Sen.* senilis

(3.3:1; males 77%, females 23%) and Halberstadt (7:1; males 88%, females 13%), and is most obvious at Schöneck-Kilianstädten, where no females of this age group were identified, which is in stark contrast to the nine male individuals of the same age. This discrepancy is commonly interpreted as a result of the differential treatment of younger women during collective violence events. Rather than being killed outright during the massacres, as ostensibly happened with the younger, older, and male population segments, women of reproductive age may have been preferentially captured alive – a practice that is well known from ethnographic studies (Otterbein 2000). This was probably followed by forced inclusion into the attacker's own communities, although the further fate and status of these women remains unknown. The selective capture of women is currently the most likely explanation for the imbalanced adult sex ratios encountered at Talheim, Asparn, and Schöneck-Kilianstädten, which also contain numerous subadult individuals who were violently killed just like the adults.

Normally, the sex of subadults cannot be reliably determined by osteological analyses alone, hence the difficulty of knowing if male and female children are equally represented in mass fatality samples. Although some older children might have occasionally been captured (something that is perhaps indicated by an age gap within the Kilianstädten sample; Meyer et al. 2015a), they are among the victims of lethal violence identified at all three massacre sites. However, this was not the case at Halberstadt, where, in contrast to Talheim, Asparn, and Schöneck-Kilianstädten, children were completely missing from the mass burial feature. The youngest individual deposited at Halberstadt has been determined as a 16–20-year-old male. Although this age range is covered by the age class *juvenis* (13–20 years), which technically characterises the individual as a biological subadult, it is highly likely that a person of this age would already be considered a social adult within their LBK community, especially considering the rather low average life expectancy documented for this period (Bickle and Fibiger 2014). Paired with the overall 89% male sex estimation, the demography of the Halberstadt mass grave sample is clearly unusual, highly selective, and thereby different from all the other sites discussed in this chapter (Fig. 2.4). Indeed, the demographic pattern is an important factor in the contextual interpretation of this mass grave as an execution rather than a massacre site, which is independently supported both by cranial trauma patterns (see above) and isotope analysis (Meyer et al. in press).

Focussing specifically on the age classes *infans I* (0–6 years) and *infans II* (7–12 years), subadult individuals belonging to either group are numerous at Asparn (32%), Talheim (38%), and Kilianstädten (46%). While they are clearly outnumbered by older individuals at Talheim and Asparn, their ratio is evenly balanced at Schöneck-Kilianstädten (Fig. 2.5). Despite such slight differences between the sites, the respective demographic patterns of subadults vs. adults are very suggestive of complete (or near-complete) settled communities that were violently destroyed (Duering and Wahl 2014). The only mass fatality site where subadults actually outnumber the older individuals, regardless of whether the age class *juvenis* is counted as biological subadult (80%) or social adult (60%), is the mass grave of Wiederstedt. As mentioned above, no signs of lethal perimortem violence could be detected in

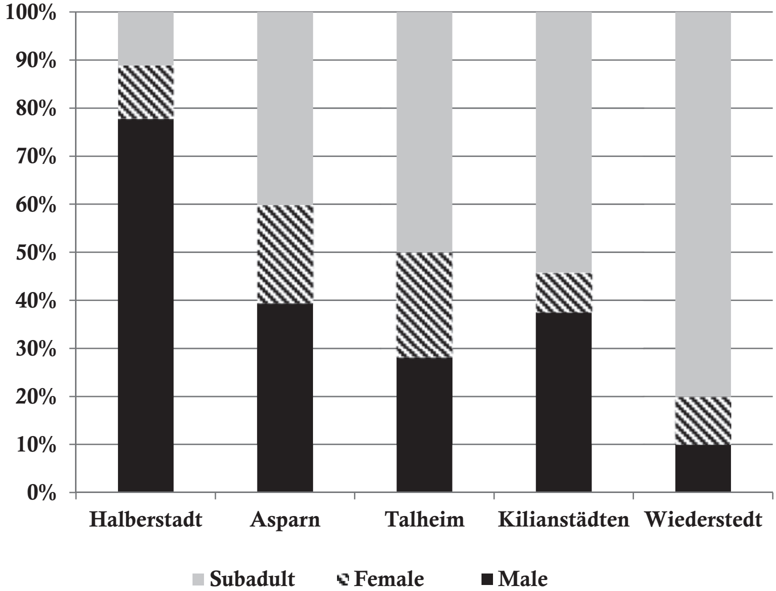

Fig. 2.4 Relative demographic structure of the mass fatality sites discussed in the text; only precisely age- and sex-determined individuals have been included in the graph. The category "subadult" is used in the biological sense and includes all individuals below the age of *c*.20 years. This is not necessarily consistent with social understandings of this age group in LBK society (Image: Christian Meyer)

the skeletal remains from this site, which indicates a likely non-violent cause of death for these individuals. In this regard, Wiederstedt evidently differs from the massacre sites – a fact that is also reflected in the demographic structure of the skeletal sample. It is quite likely that the Wiederstedt mass burial contains some of the physically weakest members of the community, who were most prone to fall victim to infectious disease, poisoning, or other types of natural catastrophes.

As mentioned above, Halberstadt is the other mass grave whose demographic pattern clearly deviates from the three massacre sites. In contrast to Wiederstedt, however, such skewing towards younger adult males cannot be interpreted as reflecting physical weakness. It is much more likely that the non-local male individuals from this site were originally chosen by their community because of their prowess in warfare (Meller 2015; Meyer et al. in press). If this was indeed the case, these individuals represent a counterpoint to the massacre victims of Talheim, Asparn, and Kilianstädten, by being possible outside aggressors who might have failed in their attack. By comparing and contrasting the patterns of demography, perimortem injury, and deviant burial available for the site, this currently appears to be the most likely explanation, which of course does not mean that alternative interpretations have to be categorically rejected. Further research, re-evaluation of older sites, and new discoveries will in the future doubtlessly refine the picture of LBK collective violence and deviant burial painted in these pages.

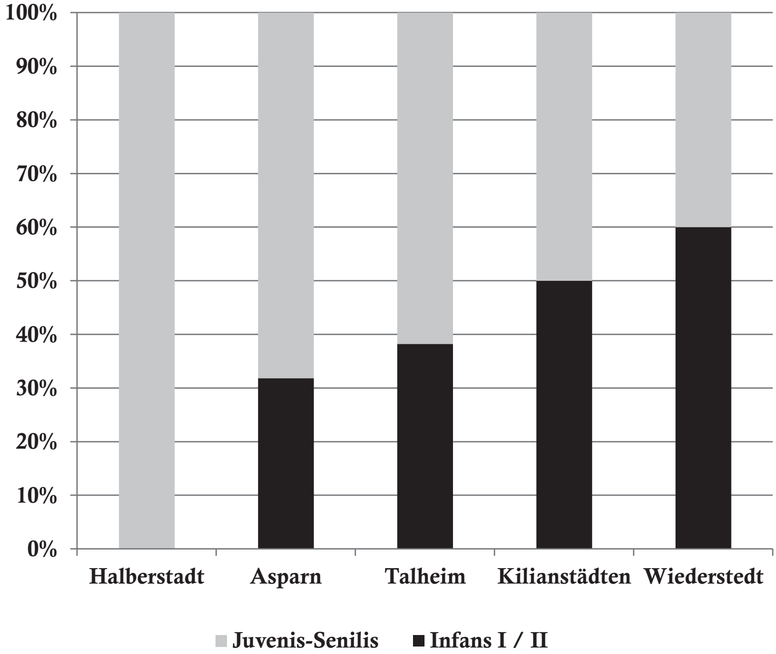

Fig. 2.5 Percentages of younger children (age classes *infans* I and II) in relation to older individuals from the mass fatality sites discussed in the chapter. Only precisely age-determined individuals have been included in the graph (Image: Christian Meyer)

Conclusion

Based on the sites discussed above, it is now clear that the victims of mass fatality events display demographic patterns that can be interpreted meaningfully by reference to one another. The mass grave at Halberstadt, in particular, stands out in this cluster of sites in terms of demographic structure as females are very much underrepresented and children are completely absent from the sample, while conversely both females and children are numerous at all other mass fatality sites. This demographic peculiarity clearly suggests a different context for the violent deaths met by the Halberstadt individuals compared to Talheim, Asparn, and Schöneck-Kilianstädten. Overall, the latter sites appear rather similar to one other in probably representing the remains of near-complete village communities that were destroyed by unknown attackers during short-term massacres. Unlike any of these, Wiederstedt can instead be interpreted as a mass fatality episode, in which a lethal infectious disease or some other non-violent event must have brought death to the weakest members of the community, first and foremost the children.

Generally, the mass fatality sites discussed above show that subadults were frequent targets of lethal collective violence, as indeed were men of all age groups and older women. It would appear that only young women and possibly (female?) adolescents were routinely spared during the attacks, probably to be captured alive.

Judging from the cranial trauma patterns, lethal attacks were mostly conducted in largely uncontrolled, chaotic melee clashes, and injuries commonly affected all major skull areas. Once again the mass grave at Halberstadt stands out from this trend. Here, cranial injuries are overwhelmingly clustered at the back of the head as to likely indicate the execution of the victims in a deliberate and controlled manner. Regardless of whether the cause of death was violent or non-violent, however, the post-mortem deposition of mass fatality victims seems to have been a common element at all these sites. This is the lack of careful treatment of the deceased, which clearly differentiates deviant mass burials from the normative cemetery and settlement interments found throughout the LBK world.

In LBK communities, group deaths seem to have effectively caused the identity and individuality of the victims to be erased. This stands in stark contrast to more traditional burial treatments, in which selected information pertaining to the role and standing of the deceased was routinely preserved through an individualised funeral rite. However, by being denied this treatment, the dead dumped in the mass graves discussed in this chapter have preserved other kinds of information, which can shed new light on the episodes in which lethal collective violence broke out and on the social choices made during these short-lived and dramatic events.

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Chapter 3
Perimortem Lesions on Human Bones from the Bronze Age Battlefield in the Tollense Valley: An Interdisciplinary Approach

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Introduction

The recent discovery of the remains of an armed conflict dating to about 1300–1250 BC in the Tollense Valley in the federal state of Mecklenburg-Western Pomerania, Northeast Germany, has led to ongoing intensive investigations of this remarkable site. An interdisciplinary research project, financially supported by the Deutsche Forschungsgemeinschaft (German Research Foundation) since 2010, has engaged in the excavation and analysis of the human remains, focusing in particular on the main site being researched, Weltzin 20 (e.g. Jantzen et al. 2011, 2014a; Jantzen and Terberger 2011; Krüger et al. 2012; Terberger and Heinemeier 2014; Terberger et al. 2014; Lidke 2014a; Lidke et al. 2014b, in press; Brinker et al. 2014a, b). Until the end of 2014, a total of about 11,000 human skeletal remains were recovered from the valley, nearly 8500 of them being from Weltzin 20 alone. The minimum number of individuals (MNI) recognized for the whole valley has steadily increased over the

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years to at least 133 units (2014 record), 83 of which are from Weltzin 20 (MNI based on the number of left femora). Osteoarchaeological studies suggest a strong dominance of young adult male individuals within the bone assemblage (Brinker et al. 2015). Additional weapon finds, as well as numerous bones with lesions, hint at the occurrence of a violent event of unusual scale. Among the almost 100 perimortem injuries observed on the human remains, stabbing and projectile point traumas clearly dominate, while a few sharp blow injuries have also been identified. Whereas injuries caused by stabs and blows mainly affect the front side of the upper body, most of the arrowhead lesions were identified on the back of the trunk; blunt force trauma focusing on the skull is also attested.

This spectrum of injuries corresponds to a range of late Bronze Age weapons found in the valley including numerous flint and bronze socketed arrowheads, different types of spearheads, axes, wooden clubs, and a sword, the latter assigned to Period III of the Nordic Bronze Age (Dombrowsky 2014, in press; Lidke 2014b; Lidke et al. 2014b; Terberger 2014; Klooß and Lidke 2014). In general, the individuals showing perimortem injuries are spread over the entire excavated area. Injuries caused by close combat as well as by ranged weapons are found side by side. This suggests a conflict scenario in which both ranged and close-combat weapons were employed. It is currently presumed that a group of people would have been attacked by archers while trying to cross the river. The group would then have scattered around the valley, and the fighting would have shifted northwards, with combatants from both parties being killed by arrows as well as by blunt force and bladed weapons at several locations throughout the valley (Jantzen et al. 2014b; Lidke et al. 2015).

Current research on the Tollense Valley site is opening a new window into the complexity of Bronze Age warfare, which may have involved thousands of combatants wielding a variety of nonstandardized weapons. More extensive discussion about this subject, the battlefield site, and the reconstructed conflict scenario, as well as the previously conducted anthropological investigations of the skeletal remains, can be found in the literature (Jantzen et al. 2014b; Lidke et al. 2015, Accepted; Brinker et al. 2015, 2016).

With regard to perimortem injuries, recent research has focused on characterization and differentiation of the injury patterns including the identification of the possible weapons that caused them. An overview of the previous results is given in Brinker et al. (2015). In this study, certain specific injuries will be presented in more detail, focusing in particular on the penetrating injuries, which have yielded some of the most important information for reconstructing the Tollense Valley conflict scenario. This paper aims to demonstrate how specific questions regarding the characteristic features of the injuries, the possible type of weapon, and the direction of the attack can be answered by using non-destructive high-resolution imaging and 3D reconstruction combined with experimental weapon testing.

Materials and Methods

One skull and a left femur, both with embedded objects, and a left hipbone (os coxa) with a piercing wound from site Weltzin 20 were examined as part of this research. The skull (ALM 2008/0460-0254) was fragmented postmortem. The fragmented skull calotte consists of the nearly complete right parietal bone, the fragmented left parietal bone with remains of the fontal bone and the fragmented occipital bone. The hipbone (ALM 2008/0460-0036) and the femur (ALM 2013/0463-1959) are completely preserved. A range of established methods have been used to determine the sex and skeletal age of the human remains (e.g. Buikstra and Ubelaker 1994). A trauma was considered perimortem based on distinctive criteria for fresh bone fracture and absence of healing (e.g. Villa and Mahieu 1991; Sauer 1998; McKinley 2004; Boylston 2004; Buikstra and Ubelaker 1994: 160; Wedel and Galloway 2014). To identify projectile lesions, published experiments (e.g. Smith et al. 2007; Letourneux and Pétillon 2008) and forensic studies of high-velocity projectile trauma were taken into consideration (Wedel and Galloway 2014; Kneubuehl et al. 2008; Dodd and Byrne 2006; Coe 1982; Denton et al. 2006; Marchetti et al. 2003). These were integrated by the experiments with replicas of Bronze Age weaponry conducted by our project team (see below). We used a modified version of the Istanbul protocol (Appleby et al. 2015) to reach standard levels of precision in our observations.

In order to obtain information about the shape and size of the weapons and the direction of attack, a transdisciplinary suite of methods, including experiments on animal bones, 3D imaging, 3D reconstructions, and digital injury simulation, were deployed for the analysis of the lesions. The experiments were conducted on pig carcasses with replicas of Bronze Age arrowheads and stabbing weapons (cf. Lidke et al. 2014a). The various injuries created in our experiments were compared with the aforementioned hipbone lesion using macroscopic examination as well as microscopic analysis. In addition, cross-sections of different projectiles and stabbing weapons were created in floral foam and compared with the cross-section of the injury.

The injury patterns of the experimental bones as well as those of the Bronze Age bones were analysed using a Keyence Digital Microscope VHX-5000. The digital microscope offers high-depth field measurements and creates a deep composite image. 2D measurements such as radius, distance, angle, and area and 3D measurements such as volume, angle, distance, and profile were also obtained. The Stitch Image function can be used in both 2D and 3D and allows the capture of wide area images by using a pattern-matching algorithm.

As in many other bones from the Tollense Valley, clinical CT scanning was performed on the skull, femur, and hipbone discussed here by the Department of Diagnostic and Interventional Radiology, University Hospital Rostock, Germany, in order to obtain further information concerning the injuries. To better visualize the embedded objects and wound canals (i.e. the marks left by the perforating injuries), and also possible signs of healing, additional micro-CT imaging was carried out. This technique provides a much higher resolution than clinical CT imaging, which can be crucial for a correct diagnosis of the changes seen in archaeological bone (see also Flohr et al. 2015). The human remains and different types of socketed bronze arrowheads found in the valley were scanned at the BAM Federal Institute for Materials Research and Testing, Berlin, Germany, using the BAM-225 kV device for microcomputed tomography (micro-CT). This consists of a micro-focus X-ray tube (X-RAY WorX XWT 225-SE) with 225 kV maximum acceleration voltage and a flat-panel detector (Perkin Elmer PE 1640) with 2048 × 2048 pixels at a pixel pitch of 0.2 mm. For the measurement, the acceleration voltage was set to 190 kV; the target current was 100 μA. A pre-filter of 1 mm copper was used; 2400 projection images with 10 s exposure time each were taken for the full rotation. The volume data with voxel sizes from 26 to 55 μm were obtained by a standard Feldkamp filtered back-projection algorithm.

3D CT imaging allows the exact measurement of the lesions, the visualization of the internal and external bone structures, and the quantification of very fine injury patterns. Volume rendering techniques (VRT) provide a 3D model that can be viewed from every perspective and also trimmed and sectioned virtually. By means of a segmentation process using volume segmentation and processing software (Seg3D by NIH Center for Integrative Biomedical Computing/VGStudio Max 2.2 by Volume Graphics GmbH), 3D volume and surface models of the injured bones and weapon finds were generated by threshold-based segmentation from clinical and micro-CTs. Based on these models, fragmented bones and fracture distributions could be digitally reconstructed. Furthermore, virtual cross-sections of the lesions were performed on the volume model in order to analyse and measure the perforation and to identify embedded objects. These objects were isolated for further analyses using segmentation techniques. In addition to the microscopic imaging, the 3D analyses allowed us to determine detailed characteristics of the specific injury patterns in relation to the weapons that caused them as well as possible trajectories and entry angles. The exported surface models of the injured bones and weapons were processed and cleaned (MeshLab by Visual Computing Lab – ISTI – CNR) and deployed for the digital simulation of the injury process and weapon matching, which was carried out using CAD and 3D modelling and animation software (AutoCAD by Autodesk, Cinema4D by MAXON).

Results

Hipbone Lesion

The left hipbone (os coxae) belongs to a juvenile individual. The age was determined from the auricular surface of the ilium (Lovejoy et al. 1985; Meindl and Lovejoy 1989), the os pubis (Brooks and Suchey 1990), and the fusion of the iliac crest (Buikstra and Ubelaker 1994), suggesting that the individual was probably

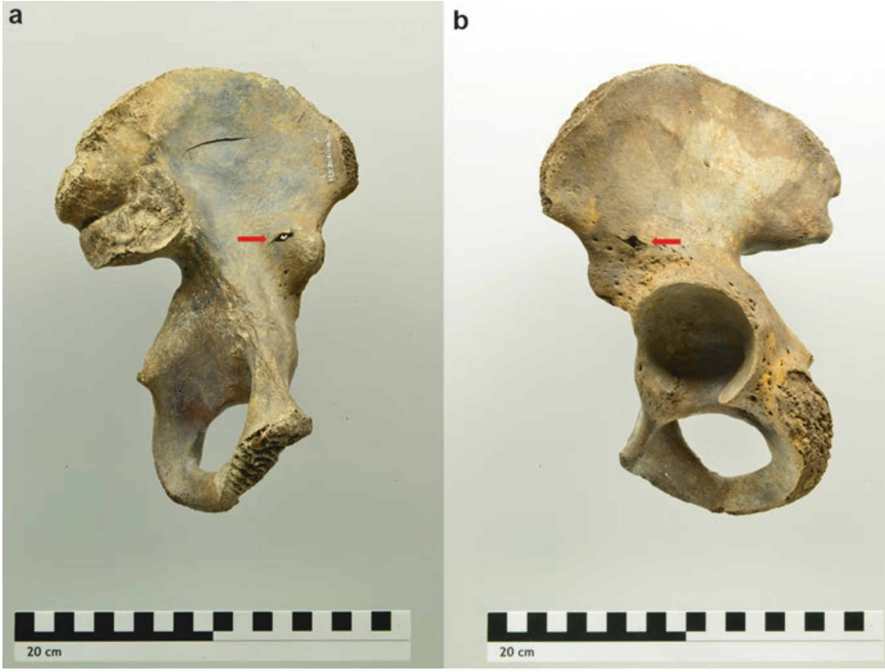

Fig. 3.1 (**a**) Outer and (**b**) inner face of a hipbone with a rhombic penetration injury caused by a pointed object (Images: S. Suhr © LAKD M-V)

18–20 years of age. Sex estimation is based on the morphological pubis features (e.g. subpubic region, greater sciatic notch, and absence of preauricular sulcus), which clearly indicate male characteristics.

The hipbone shows a rhombic full-thickness puncture at the ilium next to the inferior iliac spine (Fig. 3.1). The lesion measures about 15 mm anterior-posterior and 6 mm superior-inferior on the lateral side and about 11 mm anterior-posterior and 4 mm superior-inferior on the medial side of the hipbone. The penetration depth is about 19 mm. To identify the weapon that would have inflicted this wound, injury patterns created by experimental weapon testing with socketed bronze arrowheads (cf. Lidke et al. 2014a; Brinker et al. 2016) and spearheads on modern pig bones were compared with the hipbone lesion; the cross-sections of the weapons were also considered. Although useful, such macroscopic analyses were unable to determine which weapon might have caused the wound, as the lesions created by arrow and spearheads on modern pig bones were very similar to each other, both showing funnel-shaped penetrations with rhombic or triangular cross-sections (Fig. 3.2). Therefore, the analysis only led to determining that the lesion was caused by the ingress and perforation of a sharp metal point belonging to either weapon.

In order to resolve this issue, the hipbone injury was further analysed by micro-CTs and microscopic imaging, trying to narrow down weapon size and proportions. Furthermore, this aimed to investigate the point's trajectory and angle of entry and

Fig. 3.2 (**a**, **b**) Rhombic penetration injury caused by a bronze spearhead on a modern pig tibia. (**c**, **d**) Triangular penetration injury caused by a bronze spearhead on a modern pig fibula. (**e**, **f**) Rhombic penetration injury caused by socketed bronze arrowhead on a modern pig scapula, showing hinge fractures on the anterior side (**e**: exit side of the projectile) and on the posterior side (**f**: entry side of the projectile). (**g**, **h**) Rhombic penetration injury caused by a socketed bronze arrowhead on a modern pig vertebra (Images: S. Suhr © LAKD M-V)

therefore the direction of the attack. Several indicators of a sharp weapon point, which entered the bone at a downward-inclined angle, can be observed on both sides. The fracture is wider on the lateral side (about 13–15 mm) than on the medial side (about 7–8 mm) (Fig. 3.1). A further feature observed was an impression on the cortical bone on the superior-anterior margin of the wound (Fig. 3.3a), indicating that the point entered the bone on the lateral side (Langley 2007, 533). Hinged-out bone fragments (flakes still connected to the margin of the lesion), bevelling and external chipping on the lateral and medial side (Fig. 3.3a–f), lying opposite but asymmetric from each other, indicate an angle of entry other than 90° (Dodd and Byrne 2006, 104; Langley 2007, 536). In addition, there are longer and deeper fissures on the lateral side, extending from the anterior corner (about 7 mm) and posterior corner (about 15 mm) of the perforation (Fig. 3.3a). On the medial side of the bone, a much smaller fissure extends (about 2–3 mm) from the posterior corner of the perforation (Fig. 3.3b). The lengths of these fissures indicate that the initial energy of the shot or stab decreased as the weapon penetrated the bone, thus causing a smaller fissure on the exit side. Taking all fissures into account, the weapon probably struck with high kinetic energy, which perhaps indicates an arrowhead rather than a handheld weapon. Wastage and bevelling can be observed on both sides of the bone. The bevelling on the lateral side (Fig. 3.3e) indicates an acute angle and oblique penetration on entry (Kneubuehl et al. 2008, 290–291). The external bevelling on the medial side (Fig. 3.3f) indicates the exit of the point. Ballistic and forensic studies (Dodd and Byrne 2006; Denton et al. 2006; Scott and Buckley 2010) have documented that fractures of flat bones, like pelvis and cranium, may show external bevelling at the exit with a conical shape facing outwards (Fig. 3.3e).

After identifying the likely entry and exit point of the weapon, a vector-based 3D reconstruction was carried out to reconstruct the possible proportions of the weapon and its entry trajectory (see Ryan and Milner 2006 for a similar procedure). First, we measured the distance of the horizontal middle line between the margins of both sides of the fracture and the length of the perforation. The tolerance of the measurements lies at 0.5–1 mm. Three vectors were then plotted according to the surface model of the lesion (Fig. 3.4a). One vector was placed at the rims of the entry and another at the exit. The distance of the vectors correlates to the length of the penetrating injury. A third vector was plotted running between the midpoints of the first and second vectors. This vector represents the central axis of the weapon point and therefore the direction of its entry trajectory. Six surface models of bronze arrowheads (Fig. 3.5) and a bronze spearhead from the Tollense Valley finds were positioned on the vectors. The keyframe function in Cinema4D was used to move them along the central axis, simulating the path followed by the point as it penetrated the bone. Only one arrowhead (ALM 2007/655) did not extend or fall below the maximal width at the entry vector while following the path down to the minimal width of the exit vector (Fig. 3.4a). Subsequently, the vectors and arrowhead were positioned on the surface model of the lesion (Fig. 3.4b), and the arrowhead was again moved along the path (central axis) (Fig. 3.4c–e). It became clear that an arrowhead, or some other point with similar proportions, was very likely to have caused the wastage and hinging fractures on the entry side as well as the rhombic margins at the

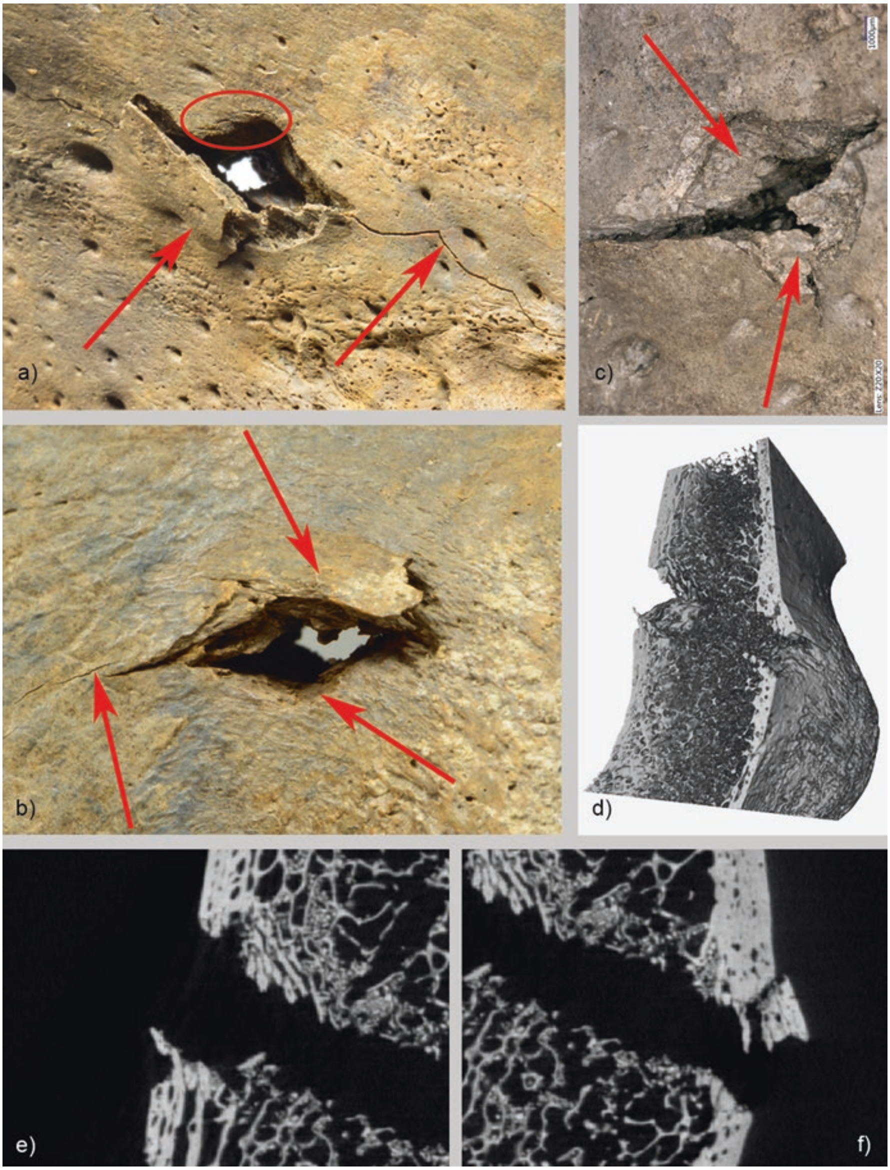

Fig. 3.3 Characteristic features of the hipbone injury: (**a**) the circle shows an impression, while the arrows point to hinge fractures, external chipping, and long fissure on the lateral side; (**b**) the arrows show hinge fractures, external chipping, and a small fissure on the medial side; (**c**) bevelling on the lateral side; (**d**) micro-CT volume clipping – section through the injury canal; micro-CT cross-sections sagittal, entry side (**e**) and exit side (**f**) (Microscopic and micro-CT analyses **a**–**f** H. Harten-Buga © Univ. Hamburg; Images **a**–**d** S. Suhr © LAKD M-V; micro-CT data acquisition **d**–**f** A. Staude © BAM)

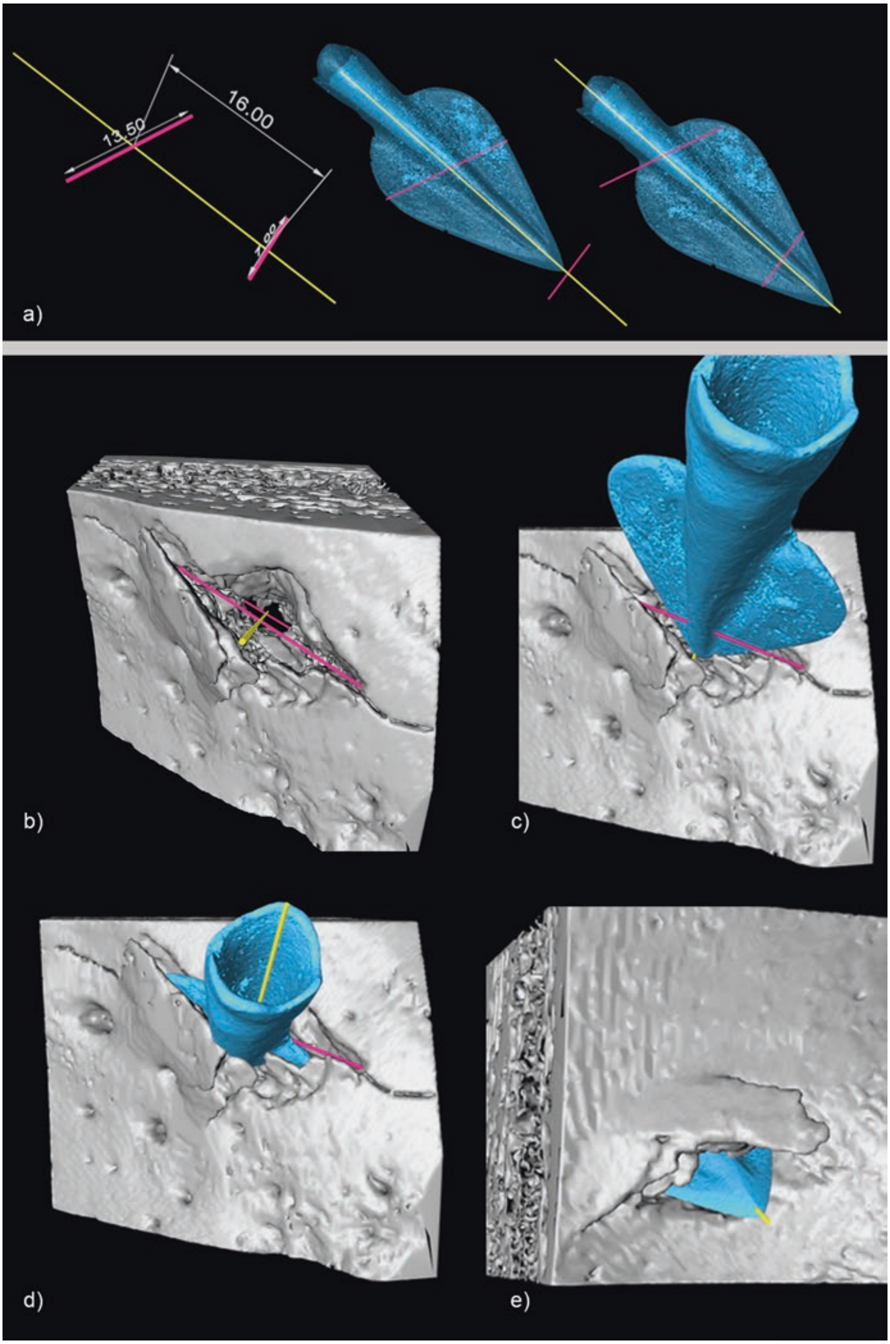

Fig. 3.4 Vector-based 3D reconstruction and simulation of weapon matching: (**a**) 3D models of bronze arrowheads positioned at the vectors; (**b**) vectors positioned at the micro-CT volume model of the lesion; (**c–e**) simulation of the path followed by the point through the bone (Images: H. Harten-Buga © Univ. Hamburg)

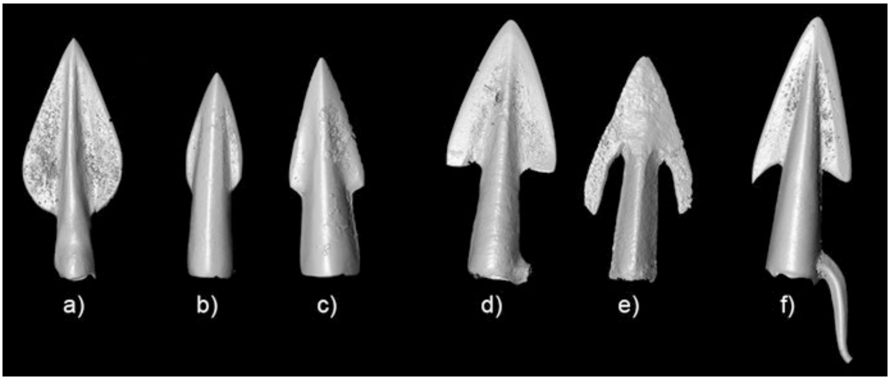

Fig. 3.5 3D models of six bronze arrowheads from the Tollense Valley finds: (**a**) ALM 2007/655, type 5 variant A, leaf-shaped. (**b**) ALM 2012/954, 15, type 5 variant B, slim shape. (**c**) ALM 2010/1860, 7, type 4 variant B2, slightly rhombic. (**d**) ALM 2008/458, 89, type 4 variant B1, triangular head with straight base. (**e**) ALM 2012/988, 1, type 4 variant A1, triangular blade with long wingtips. (**f**) ALM 2010/1860, 16: type 4 variant C, extra barb (Typology by Eckhardt (1996), integrated with Dombrowsky (2014). Rendering: H. Harten-Buga © Univ. Hamburg; micro-CT-based 3D models: A. Staude © BAM)

entry and exit. The tip of the point would have protruded approximately 8–10 mm from the surface of the bone on the exit side (Fig. 3.4e).

Furthermore, the 3D models of the bone and arrow enabled us to reconstruct the presumed angle of the projectile's trajectory. Although this ran at approximately a 90° angle based on the longitudinal axis (vertical middle axis) of the human body (Fig. 3.6a, c), it is most likely that the arrowhead would have penetrated the bone at a sharper angle of approximate 60° due to the morphology and anatomical position of the hipbone in the human body (Fig. 3.6a). If a shooting or stabbing perforation occurs at an angle other than 90°, the shape of the external margins of the fracture alone is no accurate indicator of the shape and size of the weapon's point. An acute or obtuse angle and/or oblique orientation of the projectile's cutting edges most likely produce a unique entry shape while following the path through the bone before the point comes to a halt. The entry angle and orientation of the weapon were identified based on wastage, hinging of bone, fissures, bevelling, and the examination of the injury canal. Taking into account the geometric relations of the lengths of the canal and the width of the entry and exit margins, it was possible to reconstruct the profile and size of the point and therefore to narrow down the type of weapon that must have caused the injury. Based on our analysis, we are now confident that the punctured fracture of the hipbone must have been caused by a small projectile point similar in shape and size to one of the bronze arrowheads recovered from the Tollense Valley, or to some other point of very similar proportions and shape.

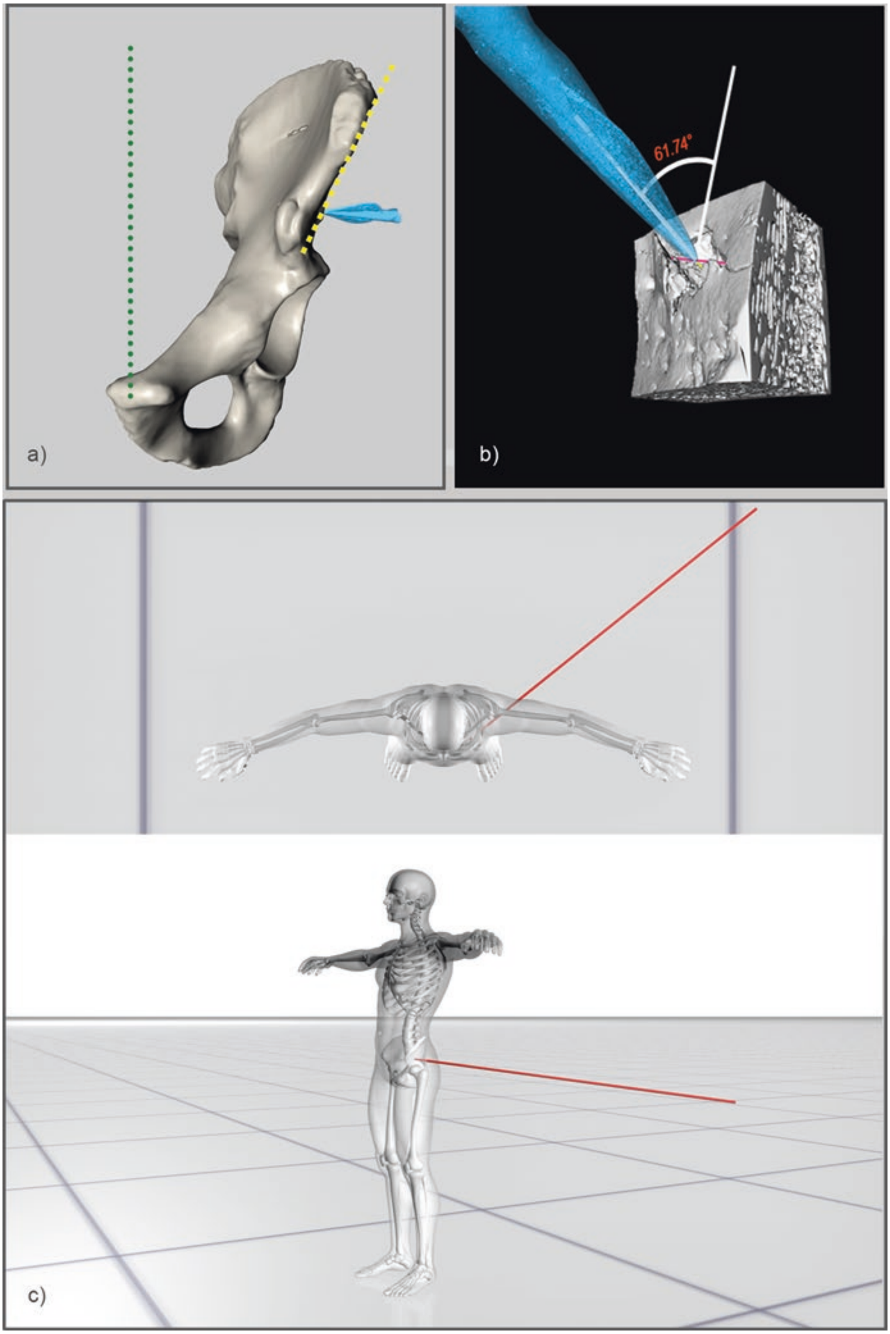

Fig. 3.6 Reconstruction of the weapon's trajectory and entry angle: **a** Concept anatomical position – longitudinal axis of the human body (*green dotted line*) and vertical axis of the bone in the penetration area (*yellow dotted line*); **b** 3D representation of the entry angle; **c** 3D visualization of the direction of attack (Images: H. Harten-Buga © Univ. Hamburg; micro-CT data acquisition: A. Staude © BAM)

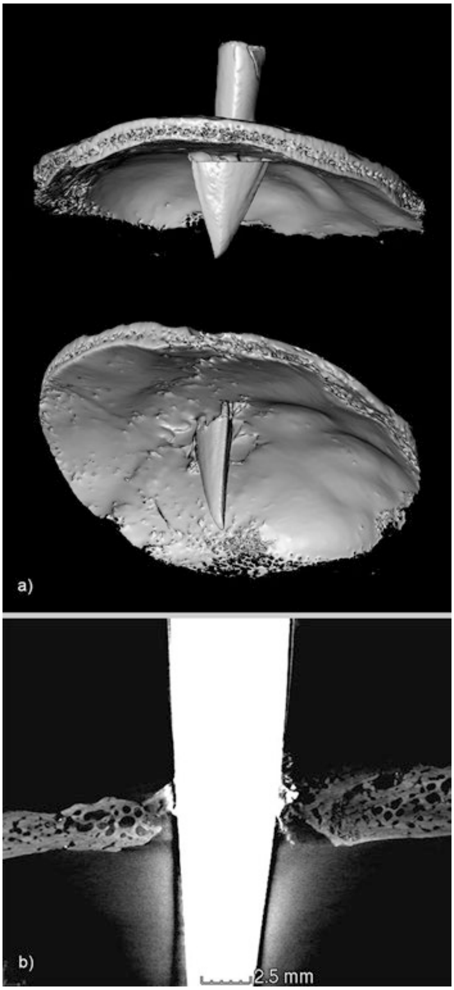

Fig. 3.7 (**a**) 3D models of the cranial bone with embedded arrowhead showing the injury features on the entry (above) and exit side (below); (**b**) micro-CT frontal section image of the bone with embedded bronze arrowhead (Micro-CT-based 3D models **a** H. Harten-Buga © Univ. Hamburg; micro-CT images **b** A. Staude © BAM)

Cranial Calotte with Embedded Arrowhead

Most remarkable among the skeletal remains showing violent lesions is a cranial calotte with a socketed arrowhead embedded in the occipital bone (Jantzen et al. 2014b, 239; Terberger et al. 2014, 98). According to the available diagnostic features, namely, the analysis of cranial suture closures (Szilvássy 1988), the skull fragment belongs to an adult individual of undetermined sex. The arrowhead is embedded in the upper left area of the occipital planum (Fig. 3.7a). The projectile penetrated the bone adjacent to the lambdoidal suture between the left parietal and the occipital for approximately half its length (Brinker et al. 2015, 348: Fig. 3.1). The fracture shows a rhomboid shape corresponding to that of the arrowhead on the entry site at the ectocranial surface as well as typical features of a high-velocity projectile trauma. External bevelling is visible at the endocranial surface (exit site) (e.g. Galloway et al. 2014, 55f). Micro-CT imaging revealed that the bone surface around the projectile shows no signs of bone remodelling. However, the arrowhead is partially surrounded by small particles of the same density as the bronze, which presumably result from the corrosion of the arrowhead (Fig. 3.7b).

The arrowhead has a maximum length of 22.9 mm and maximum blade width of 12 mm. It is a willow leaf-shaped arrowhead type 5 variant A according to Eckhardt (1996; see also Dombrowsky 2014, 139ff.), a type commonly found in central Europe in the late Bronze Age (A. Dombrowsky, pers. Comm.). The arrowhead solely displays minor damage to the top of the socket and the wing ends. However, the tip of the point was also slightly bent following impact on the bone, as visible in the 3D image of the arrowhead (Fig. 3.8). This is probably due to the fact that the projectile had penetrated the bone at high velocity (Galloway et al. 2014, 55).

The skull was penetrated at an angle of approximately 88° relative to the central axis of the arrowhead and the tangential axis of the ectocranial surface (Fig. 3.9a). This explains the typical injury pattern associated with a perpendicular shot: sharp margins (no hinge fractures) on the entry side and external bevelling on the exit side (endocranial surface) (Langley 2007, 533–535; Kneubuehl et al. 2008, 290–291). The angle was taken from a surface model based on micro-CTs, which only covered a small region around the lesion in order to limit the size of the files. A volume model based on clinical CTs of the complete preserved fragment and the micro-CT model were superimposed onto a surface model of an intact, modified example skull for better visualization of the lesion's position (Fig. 3.9b).

Femur with Embedded Object

The femur belongs to a young adult. The epiphyseal closure of the femoral head suggests that this individual of undetermined sex was probably in their early 20s; the sex could not be determined. An embedded object, hardly visible from the outside, was observed in the distal femur. Based on clinical CTs, the clipping of the volume model (Fig. 3.10e, f) revealed a small pointed object of about 1 cm in length, which shows no apparent consistency with an arrow or spearhead from the Tollense Valley finds. In order to clarify the precise shape of the fragment and to obtain detailed information about the surrounding bone structure, a volume model based on micro-CTs was generated. This showed that the pointed object has a pyramidal shape with a slightly rhombic cross-section (Fig. 3.10a–d). The section images also indicate that the object is solid and its surface is heavily corroded. The penetrating wound canal shows a rhomboid shape and tapers toward its end following the shape of the object. The canal is surrounded by a formation of compacted trabecular debris. This is probably due to the fact that trabecular bone tissue was crushed as the object penetrated the bone, and the debris was displaced laterally; this clearly indicates a perimortem injury. Corrosion particles are also visible along the wound canal (Fig. 3.11). The object seems to be a broken tip of a sharp bronze weapon yet to be identified. Further typological and metallurgical studies are planned to try to identify the weapon type and to provenance the metal.

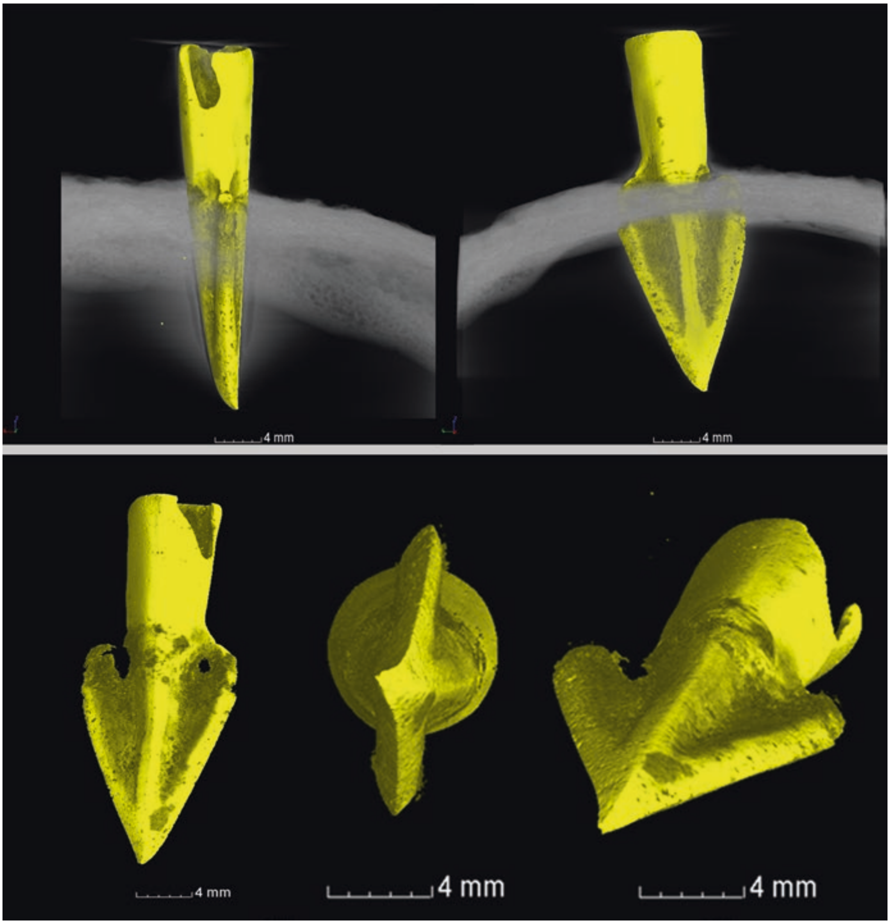

Fig. 3.8 Above: 3D reconstruction of the diploe and arrowhead, lateral (left) and anterior (right) view. Below: 3D micro-CT reconstructions of the socketed bronze arrowhead, general view (left), view from the tip (middle), obliquely from above (right). Scale bar: 4 mm (Micro-CT images: A. Staude © BAM)

Discussion and Concluding Remarks

A number of osteological studies and weapon tests have documented features, which are characteristic of traumas caused by lithic and osseous projectile points (e.g. Smith et al. 2007; Letourneux and Petillon 2008; Petillon et al. 2011; O'Driscoll and Thompson 2014; Yeshurun and Yaroshevich 2014, Duches et al. 2016). Patterns consistent with penetrating injuries were also observed in the weapon experiments carried out by our team using replicas of the bronze weapons from the Tollense Valley site (cf. Lidke et al. 2014a; Brinker et al. 2016). Our tests have further confirmed previous observations that the injury patterns created by bronze arrow and spearheads can be very similar to one another (e.g. Letourneux and Petillon 2008,

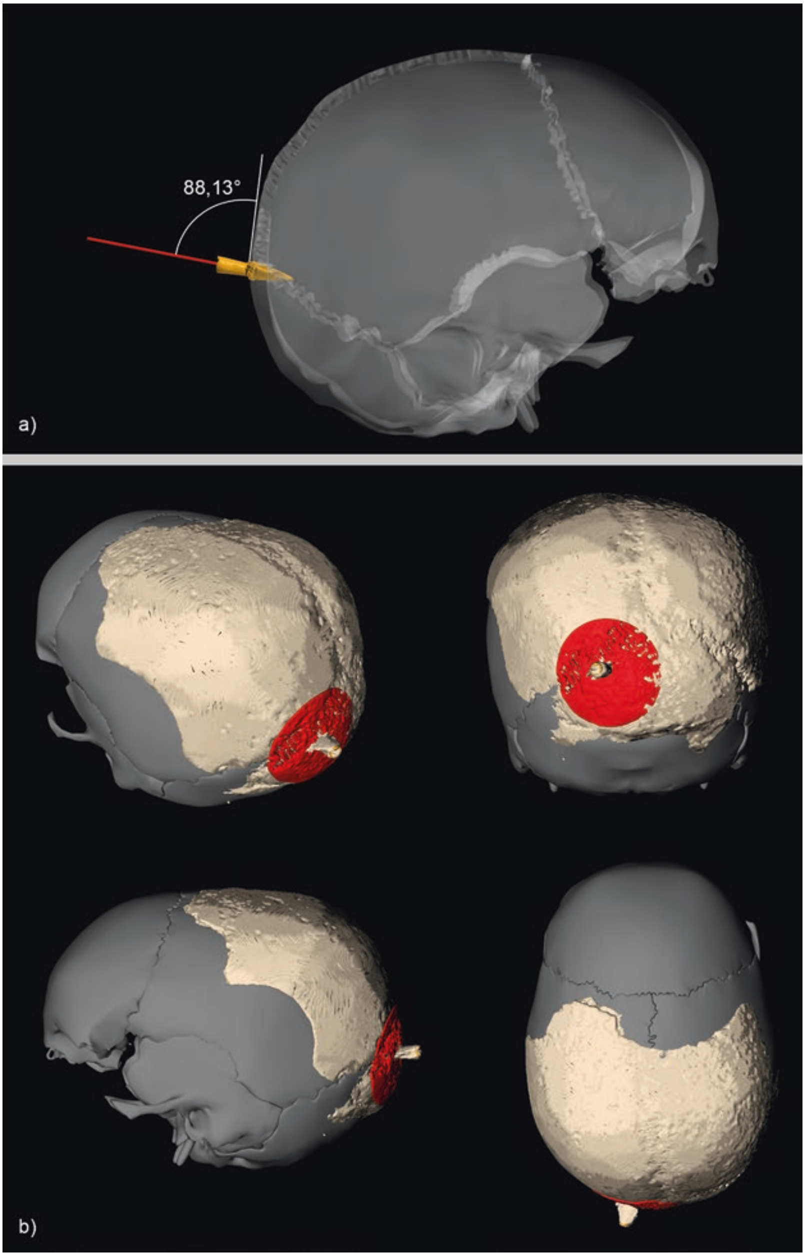

Fig. 3.9 Reconstructed skull and entry angle of the projectile point: (**a**) The point penetrated the bone at an angle of approximately 88° relative to the central axis of the arrowhead and the tangential axis of the ectocranial surface. (**b**) Views of the 3D reconstruction of the skull with the injury – micro-CT volume (red), clinical CT volume of the calotte (grey), skull reconstruction (opaque) (Analysis and reconstruction: H. Harten-Buga © Univ. Hamburg; micro-CT data acquisition: A. Staude © BAM; clinical CT data acquisition: K. Hauenstein, Department of Diagnostic and Interventional Radiology © Univ. Hospital Rostock)

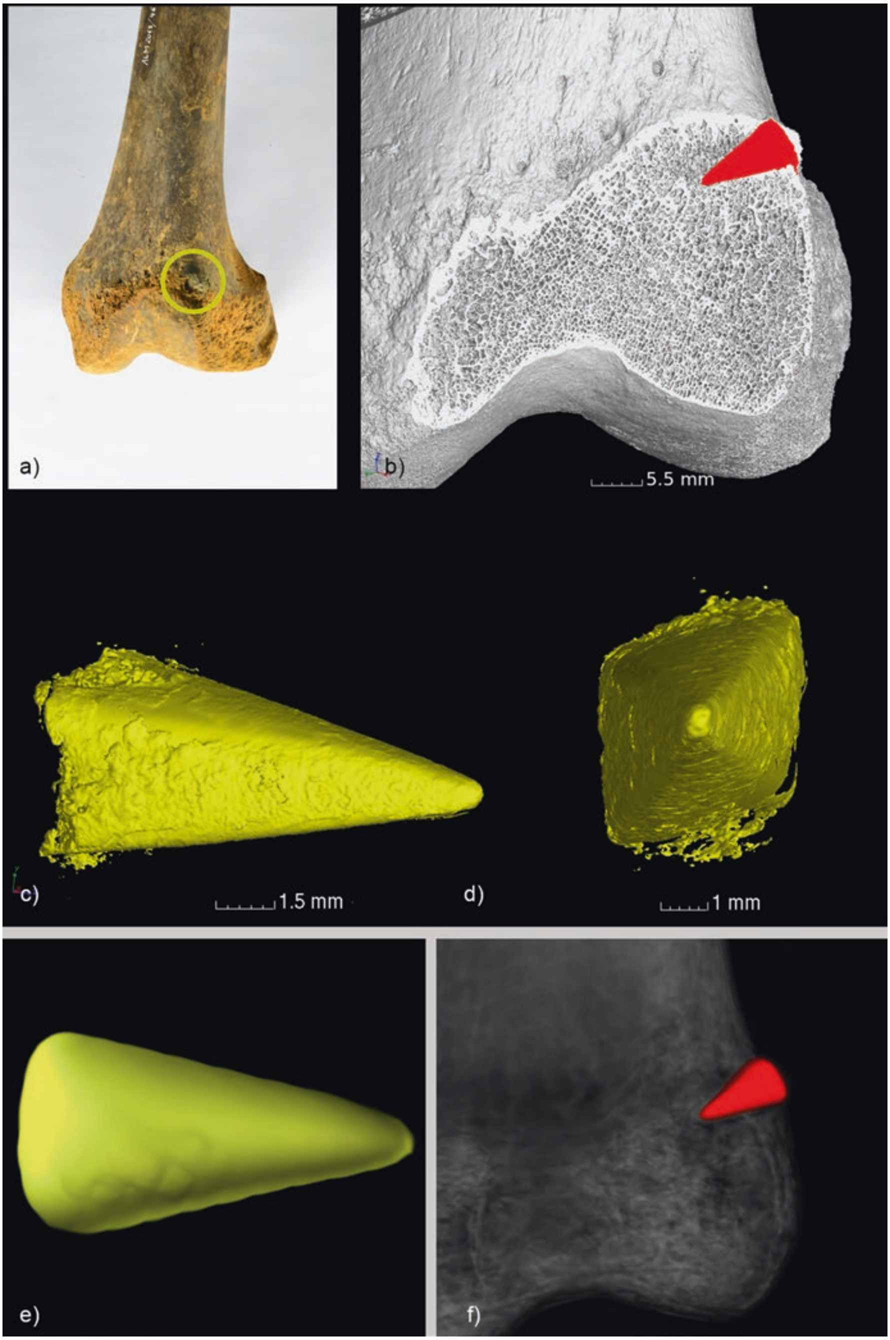

Fig. 3.10 (**a**) Distal femur with embedded object, anterior view. (**b**) 3D reconstruction of the distal femur with the object (red), scale bar 5.5 mm. (**c**, **d**) 3D reconstructions of the pointed object: view from above (**c**), scale bar 1.5 mm; view from the tip (**d**), scale bar 1 mm. (**e**, **f**) 3D reconstructions of the object and distal femur based on clinical CTs (Image **a** S. Suhr © LAKD M-V; micro-CT images **b**–**d** A. Staude © BAM; clinical CT analyses **e**–**f** H. Harten-Buga © Univ. Hamburg; clinical CT images, K. Hauenstein, Department of Diagnostic and Interventional Radiology © University Hospital Rostock)

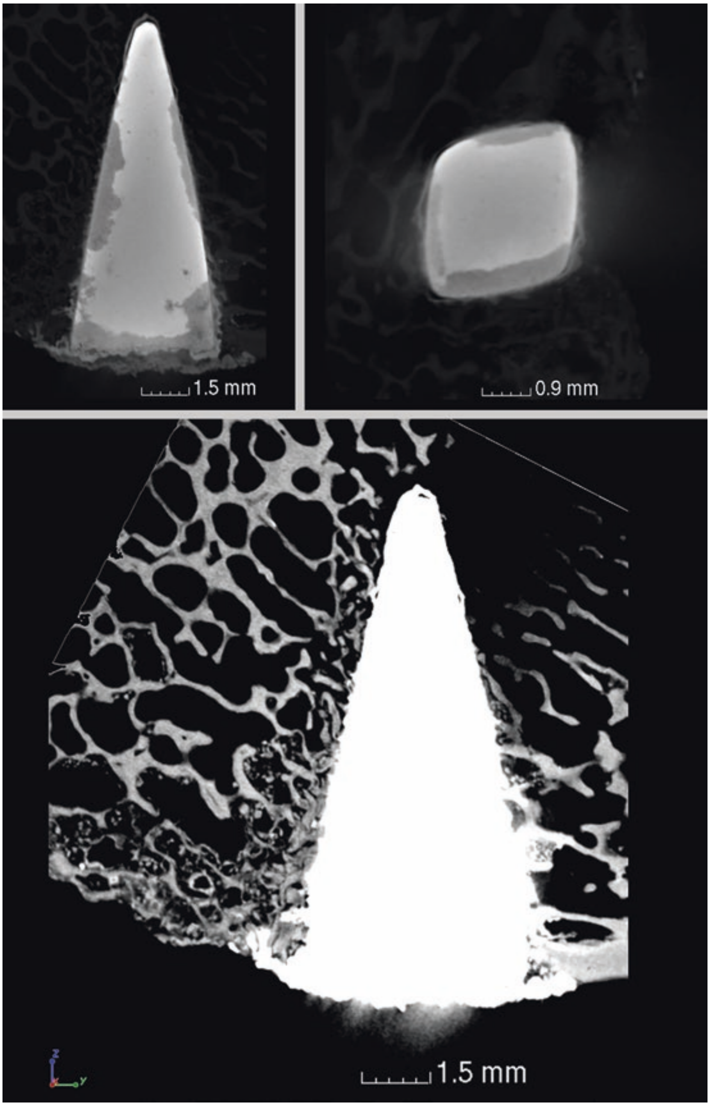

Fig. 3.11 Micro-CT cross-sections of the distal femur showing the longitudinal section (above, left) and cross-section (above, right) of the object as well as the wound canal (below) (Micro-CT images: A. Staude © BAM)

O'Driscoll and Thompson 2014). Therefore, while experimental weapon testing is crucial for providing information concerning the injury patterns and weapon types, it may not offer any clues as to whether the injury originates from a stab or a shot. This is the case with the hipbone lesion presented here, for which macroscopic and microscopic analyses alone do not allow us to discriminate between a handheld weapon and a projectile point (section "Hipbone lesion").

In order to address this problem, we have presented in this chapter a method that enables the secure identification of the weapon used in such ambiguous cases, based on the hipbone lesion discussed above. 3D imaging and 3D reconstruction methods have shown that, in this particular case, distinctive injury patterns including the rhombic shape of the penetration wound are consistent with a specific type of socketed bronze arrowhead. Being able to discriminate between arrow and spearheads, and thus between ranged and handheld weapons, is especially important for the interpretation of the Tollense Valley conflict scenario, for which our study confirms that nonstandardized weapons were utilized on the battlefield. In the case of the injured hipbone discussed above, it was also possible to define the features created by an arrowhead striking a flat bone at an acute angle. Furthermore, the effect of a bronze arrowhead perforating a flat bone at an angle close to 90° and the deformation of the point associated with high-velocity impact were discussed with regard to a skull example (section "Cranial calotte with embedded arrowhead"). Since embedded points are very rare in the archaeological record (Smith et al. 2007, 541–542), the results of our study are extremely valuable for understanding the numerous penetrating injuries documented in the Tollense Valley skeletal material.

The potential of non-destructive, high-resolution 3D imaging is also evident in the case of the femur discussed above (section "Femur with embedded object"). Here, macroscopic examination was insufficient to determine the size, shape, and position of the embedded object. Our micro-CT-based sections and segmentations not only allowed us to address these problems but also revealed information about the deformation sustained by the trabecular structure upon impact. In the future, the results presented here will be integrated with ongoing palaeomechanical analyses. Palaeomechanics is a new transdisciplinary research method which investigates the relationship between the external mechanical forces affecting the bone vis-à-vis specific injury patterns. This will allow us to verify or falsify our current hypotheses concerning injury processes and weapon efficiency.

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Chapter 4
Martial Practices and Warrior Burials: Humeral Asymmetry and Grave Goods in Iron Age Male Inhumations from Central Italy

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Introduction

This chapter discusses archaeological and skeletal evidence from several Iron Age cemeteries dating to the Orientalizing and Archaic periods (*c*.800–500 BC), from the Central Apennines mountain range in Italy (Fig. 4.1). The study explores the relationship between the deposition of martial paraphernalia in graves and the participation in martial practices of the individual buried therein, as inferred from the biomechanical properties of their upper limbs. The aim of the research is to investigate military practices (including weapon training) and their significance among Iron Age communities of the Central Apennines.

Roman historians collectively refer to the numerous Oscan-speaking tribes (e.g. Pentri, Irpini, Vestini, and several others), which dwelled in the mountainous areas of central Italy in the late 1st millennium BC, as the 'Samnites' (La Regina 1989, 301–4). Tagliamonte (1997) further defined 'proto-Samnites' the pre-fourth-century BC communities of the area, so as to identify a number of social groups with shared cultural traits but which had not yet reached the stage of political development typical of the later periods. Bestowing later Roman ethnic labels upon pre- and

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This chapter is dedicated to the memory of Domenico Mancinelli.

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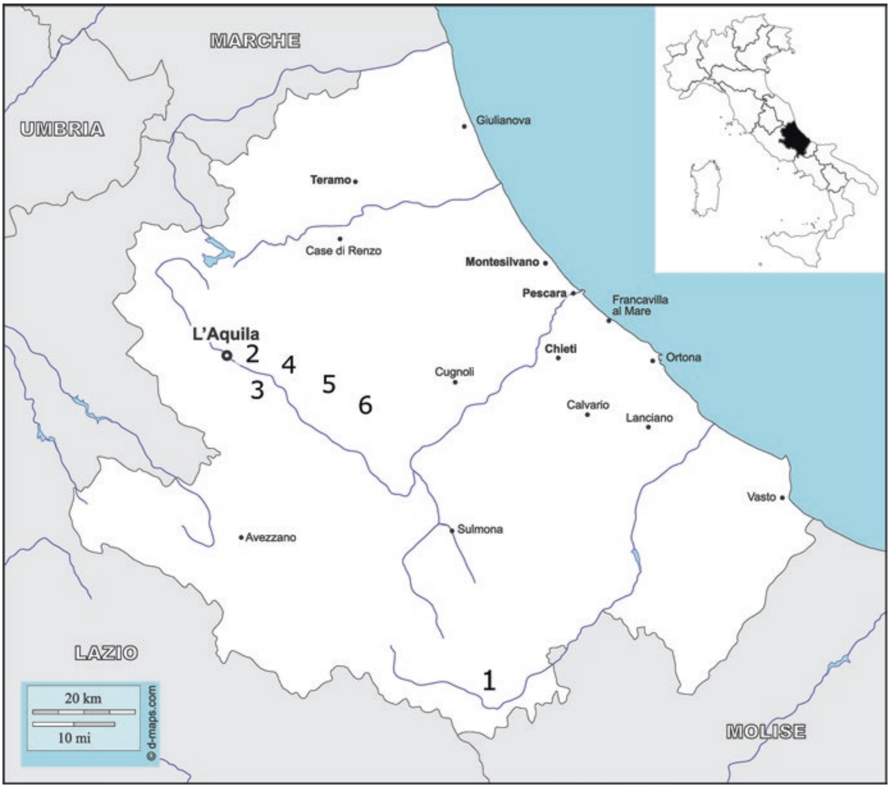

Fig. 4.1 Map of modern-day Abruzzo region with the burial sites mentioned in this study: *1* Alfedena and other cemeteries in the Aterno Valley; *2* Bazzano; *3* Fossa; *4* Barisciano and Poggio Picenze; *5* San Pio-Colli Bianchi and San Pio-Campo Rosso; *6* Cinturelli (Map base from http://www.d-maps.com)

proto-historic communities is of course problematic, since the exercise does not take into account population movement, regroupings, and changes in the perception of ethnic identity over time (Dench 1995). Nevertheless, while bearing these problems in mind, in this chapter we refer to the Iron Age communities of the Central Apennines as 'Samnites' for the sake of simplicity (see also Bispham 2007, 179).

Based on historical, iconographic, and archaeological evidence, the Iron Age Samnites have long been considered a warlike society, in which martial practices held considerable social significance (Bispham 2007; D'Ercole 1999; Salmon 1967; Scopacasa 2015, 89; Tagliamonte 1999). By the Orientalizing and Archaic periods, the Samnite communities were probably organized around tribal chiefs and their retinues (Bietti-Sestieri et al. 2000; Boatwright et al. 2004). During this phase, cemeteries were organized in circles of burials containing kin-related males (as inferred from anthropological data) featuring varying degrees of wealth in terms of grave goods, including weaponry (Bietti-Sestieri et al. 2000: 232; Bispham 2007; Bondioli et al. 1986; Rubini 1996; Tagliamonte 1997: 85). This may suggest the presence of competing elite groups based on kinship.

Osteological research supports the martial attitude hypothesized for these populations by reporting the presence of a high prevalence (12.9%) of healed and perimortem sharp and blunt force trauma among adult males (Macchiarelli et al. 1981; Paine et al. 2007; see also Bennike 1985; Jurmain 2001; Fibiger et al. 2013; Robb 1997a, b). Furthermore, recent research (Sparacello et al. 2015) has presented biomechanical evidence of functional adaptations to weapon use among 'high-status' males of the Orientalizing-Archaic period, corroborating the thesis of the existence of elite Samnite militias (D'Ercole 1999; Tagliamonte 1999).

Despite the wealth of research on the subject, the relationship between the military component of the funerary assemblage (represented by weapons and defensive gear) and the actual involvement of the deceased in martial activities has largely been left unexplored. The chapter examines the vast bioarchaeological database available for the region with the aim of narrowing the gap between the representation that Samnite communities gave of themselves in death and their lifetime habitual activities (including weapon training), as seen through indicators of upper limb biomechanical adaptations.

Archaeological Proxies of Martial Practices Among Iron Age Samnites from the Central Apennines

Early historical accounts depict Samnite 'tribes' as divided into small communities intent on regularly raiding neighbouring villages (Salmon 1967; Tagliamonte 1994, 1997, 1999). The warlike attitude of these populations is further suggested by the presence of swords, spears, and armour, found in male burials of the Orientalizing and Archaic periods alongside feasting and banqueting equipment (Bispham 2007; Scopacasa 2015, 84–118; Tagliamonte 1997, 1999). Furthermore, one of the very few examples of Iron Age Samnite figurative art, the so-called Warrior of Capestrano (a sixth-century BC life-sized statue; Fig. 4.2), portrays a political leader exhibiting martial paraphernalia including two spears, an axe, a sword, and a disc breastplate (Barker et al. 1995, 177; Bispham 2007, 190; Calderini et al. 2007; D'Ercole 1999; D'Ercole and Cella 2007; Scopacasa 2015, 73–74).

During the Orientalizing period (*c*.800–600 BC), the military equipment included in Central Apennines Samnite graves consisted of a limited combination of weapons. Spears were most common; their point size varied considerably, from 10 to over 50 cm in length (D'Ercole 2011: 161). They were often deposited as pairs and were frequently (but not always) accompanied by butt spikes. The two spears depicted on either side of the 'Warrior of Capestrano' show an *amentum*[1] on their shafts, supporting the idea that at least some of these weapons could have been used

[1] A strap (usually made of leather) attached to a javelin, which can be looped around the first two fingers of the warrior's hand to increase the speed and range of the throw.

Fig. 4.2 Close-up of the statue of the 'Warrior of Capestrano' (total height: 210 cm) with sword, axe, and breastplate visible on the chest (Courtesy of Museo Archeologico Nazionale d'Abruzzo - Villa Frigerj, Chieti, Italy)

in ranged combat (D'Ercole 2011: 161; D'Ercole and Cella 2007). Daggers (*c*.30–35 cm in length) were also common, often with antennas (*stami*) on their hilts (Weidig 2008). These were replaced by longer, cross-hilted swords (c.75 cm in length) in the Archaic period (*c*.600–500 BC), while spearheads were still used in large numbers (D'Ercole 1999, 2011). Protective armour, such as bronze disc breastplates, have also been found, albeit rarely, in burials dating to the Orientalizing and Archaic periods (D'Ercole 1999, 2011). Shields were likely used, although no surviving specimen has ever been found as they were presumably made of perishable materials such as wood, wicker, or hides (D'Ercole 2011: 152).

Mace heads were considerably rarer than other weapons in early Samnite burials. Furthermore, while daggers, swords, and spears may have constituted the only piece of weaponry in the grave, maces were only found alongside other weapons. Most mace heads consist of heavy undecorated spheres of iron, with a hole or a socket to host the handle; such items appear to be fully functional fighting tools (D'Ercole 2011: 160). However, several burials from the wider Central Apennine region have yielded decorated maces, which are best interpreted as insignias of power (Weidig 2015: 247–249). Maces are also represented in Iron Age iconography from ancient Samnium, with the 'Fibula of Pizzoli', a bronze brooch from an eighth-century BC male inhumation, being one such example (Fig. 4.3). The brooch is decorated with a series of figurines (possibly enacting a ritual or ceremony; Tuteri 2011), one of which is holding a mace in its right hand and a small round shield – somewhat similar to a medieval buckler – in its left hand. Incidentally, the brooch provides first-hand evidence of the use of this kind of defensive equipment in Iron Age Samnium. Perhaps more importantly, this masterpiece of prehistoric metallurgy exemplifies the in-depth connections that must have existed between finely crafted items, weaponry, and belief systems in early Samnite society.

Fig. 4.3 The 'Fibula of Pizzoli' (length: 9 cm) (Courtesy of Museo Archeologico Nazionale d'Abruzzo - Villa Frigerj, Chieti, Italy)

Axes are the rarest type of weapons found in Samnite burials and can sometimes be the only piece of military equipment in the grave assemblage (D'Ercole 2011). For this reason, and since the 'Warrior of Capestrano' holds an axe in his right hand (Fig. 4.2), it has been suggested that axes may have been symbols of prestige and power rather than actual weapons to be used on the battlefield (D'Ercole 2011: 161). By the fifth-century BC, weapons, as well as other grave goods, ceased to be placed in Samnite burials of the region, probably due to the introduction of sumptuary laws preventing the display of wealth (D'Ercole 1999, 2011).

The lack of heavy protective armour in burial contexts argues against the adoption of tight 'phalanx-like' formations among these peoples (D'Ercole 2011: 150–1; cf. Schwarz 2013). Although specific imagery and archaeological evidence are currently absent, it can be speculated that Samnite warriors might have used light body armour made from perishable materials, in addition to the aforementioned bronze disc breastplates. The 'Fibula of Pizzoli' indicates that shields lacking reinforcing metal bosses were probably used by early Samnite warriors. Although the addition of such bosses would have increased the effectiveness and durability of shields, these have never been recognized in early Samnite burials.

Drawing upon the panoplies found in graves (assuming that burial assemblages and imagery provide accurate pictures of the warfare equipment used by early Samnites), it seems likely that early Samnite combat tactics would have involved loose formations of lightly armed warriors, who would have first attacked the enemy at distance throwing their spears/javelins and subsequently engaged in close-range combat using hand-held spears and swords (or daggers). They would have relied on skill and mobility, rather than heavy armour, for protection. This kind of approach to fighting is typical of the lightly armed troops of non-state societies (cf. Keeley 1996; Otterbein 1985).

Aim of the Study and Expected Outcomes

The purpose of this research is to gain insights into the martial practices of Iron Age Samnite communities through the joint analysis of funerary treatment and biological traits related to the use of weapons. Previous biomechanical studies of Samnite male burials have given insights into the degree of asymmetry in mechanical strength in the upper limbs, through the analysis of paired humeri (Sparacello et al. 2011, 2015; Sparacello and Coppa 2014). When the asymmetry value is particularly high, this is assumed to be informative about the training in one-handed activities, which in this context can be inferred to be weapon use.

Studying the same skeletal series of Orientalizing-Archaic males examined in this research, Sparacello et al. (2015) found a correlation between the degree of humeral asymmetry and the Status Index – an assessment of the 'richness' of a burial based on the quantity and rarity of grave goods (Bernabei et al. 1995; Cuozzo 2003; D'Andrea 2006; Melandri 2010). They interpreted such a correlation as indicative of the military organization typical of early Samnites, which would have been based on elite militias composed of individuals from the highest social strata. Here, we expand upon their analysis by examining in more detail the layout of the grave goods and the typology of the weapons. In addition, we consider whether humeral asymmetry in the deceased was due to them having a more robust right or left arm, which is informative about the preferential use of one arm over the other, and therefore on handedness in vivo (Shaw 2011).

This research aims to analyse whether the evidence provided by biomechanical stress in relation to one-handed weapon training and handedness is coherent with early Samnite mortuary rituals. In particular, we aim to:

1. Assess whether weapons were consistently deposited with highly asymmetric individuals, which are expected to be those who most likely took part in martial activity
2. Assess whether handedness was reflected in the location of the sword or the dagger in the burial, i.e. whether it is consistently contralateral to the dominant arm and thus functional to unsheathing the weapon

The null hypothesis is that there is no correlation between the presence and position of weapons in the grave and the level and directionality of humeral asymmetry. A significant correlation would suggest the existence of a funerary ritual that (1) acknowledged the martial practice of the deceased through the deposition of weapons and/or (2) acknowledged the specific way the individual fought or buried the individual wearing weapons in the same way they were worn in life.

In addition, we will determine whether the prevalence of left-handed individuals in our sample of early Samnite males is compatible with what is normally found in modern human populations. Assuming that early Samnite warriors fought in relatively loose ranks, we predict that left-handed individuals in the sample should be roughly as numerous as those normally found in human populations (c. 10%; Raymond and Pontier 2004), if not above the average, due to the advantage that left-handedness may provide in one-to-one combat (Raymond et al. 1996).

Materials and Method

Materials

The study analysed skeletal and archaeological data from male inhumations of the Orientalizing-Archaic period (*c*.800–500 BC), all unearthed from eight neighbouring cemeteries within modern-day Abruzzo in the east-central Apennines (Fig. 4.1). Grave goods data (used for calculating the Status Index) are available for all the 238 burials in the sample (Sparacello 2013). Upper limb mechanical rigidity via cross-sectional geometry data (CSG, see below) was calculated for 216 individuals which were deemed complete enough for the calculation of CSG properties; 153 of these were buried with weapons. Anthropological parameters of the individuals including determination of sex and estimation of age are detailed in Sparacello (2013). All cemeteries lie in what is believed to be the territory of early Samnite 'tribes': seven are clustered in the Aterno River Valley and are traditionally ascribed to the 'Vestini' tribe (D'Ercole 1990), while the necropolis of Alfedena, some 50 km further south, is commonly attributed to the 'Pentri' community (Parise Badoni and Ruggeri Giove 1980). Of the 171 burials containing weapons, only 82 have yielded reliable information concerning the layout of these objects in the grave as well as skeletons complete enough to gather CSG data. Although most of the cemeteries examined for this research have been excavated in the last few decades, only Bazzano (Weidig 2014), Fossa (D'Ercole and Benelli 2004), and Alfedena (Parise Badoni and Ruggeri Giove 1980) are fully published. This explains the lack of contextual data for several burials in the sample.

Status Index Analysis

Grave goods have long been used in archaeology to make inferences about the social role of the deceased and the organization of ancient communities (e.g. Bietti Sestieri 1992; Binford 1971; Saxe 1970). Nevertheless, as the dead do not bury themselves, the nature of burial assemblages is determined by the living according to their own cultural values, beliefs, and several other contingent factors including ideas about individual and group identity (Morris 1992; Brown 1995; Parker Pearson 1999: 8–9). In addition to assuming that grave goods belonged to the dead, another problem is that objects may have changed their meanings upon entering the mortuary domain (Ekengren 2013: 182). These issues are particularly important in later prehistoric studies. The widespread practice of depositing weapons in burials has sometimes been interpreted as evidence of the rise of an elite warrior class in later European prehistory (Kristiansen and Larsson 2005). On the other hand, the prevalence of weapons in wealthy burials may indicate that weaponry was used to signal status rather than the actual participation of the deceased in martial practices (Sørensen 2013: 221). Furthermore, one could postulate that in occurrences of 'bad deaths' (Humphreys 1980; Langdon 2005), high-status individuals may have been buried with poor or otherwise anomalous grave good assemblages. This suggests that the relationship between weapon-rich graves and the graves of actual warriors may not be straightforward (Härke 1990; Whitley 2002). As burial rites do not provide an unambiguous portrayal of the social identity, role, and lifetime activities of the deceased, we should ask ourselves if, and to what extent, funerary contexts allow insights into past martial practices and the societal values attached to them (see also Lehoerff, Chap. 14, this volume). This research attempts to address this question by considering both skeletal and archaeological data. It has been noted that, in Samnite burial practices, 'richness' is most often expressed in quantitative rather than qualitative terms, since the same categories of objects tend to recur in both 'rich' and 'poor' burials, albeit in different quantities (Tagliamonte 1997). For this reason, our investigation of status has been grounded in the quantitative, rather than qualitative, appraisal of the grave goods.

The Status Index (SI) used in this study as a proxy for lifetime status was calculated for 238 Orientalizing-Archaic burials following the formulae discussed in Bernabei et al. (1995; see also Cuozzo 2003; D'Andrea 2006; Melandri 2010). Grave goods were divided into several categories (including weapons, meat-grilling equipment, banqueting equipment, and food containers; details in Sparacello 2013), and a 'coefficient of status' was calculated for each category. The coefficient measures two properties of each category: how frequently the object (or set of objects) is found in the assemblage and, when found, how many other items are present in the burial. The SI of a burial is the sum of the number of items in each category multiplied for its coefficient of status (see Sparacello 2013 for raw data and further details on the calculation of the SI). For the statistical analysis, the SI was categorized based on the analysis of histograms showing the frequency of burials for the whole range of SI in the sample (details in Sparacello 2013). Individuals were considered of low status when the SI was between 0 and 15, medium status when the SI was between 15 and 45, and high status when the SI was above 45 (Sparacello et al. 2015).

It should be noted that the method utilized in Sparacello (2013) does not consider the intrinsic value of the goods, for example, whether a certain item is finely crafted or imported. Potentially important information concerning past ideas of status is, therefore, overlooked, and a typological analysis of each grave good would certainly give a more accurate depiction of the level of prestige associated with each burial. By distinguishing between 'common' and 'rare/prestigious' weapons, this study attempts a first step towards a more in-depth analysis.

Assessing Humeral Biomechanical Asymmetry (HUMBA) and its Directionality

Cross-sectional geometry (CSG) of the humerus is the method used here to evaluate the mechanical competence of the upper limb, which provides insights about the levels and types of past physical activity. This method is based on the widely accepted notion that bone tissue responds dynamically to mechanical load.

According to what is loosely referred to as 'Wolff's Law', bone tissue is deposited in the shaft's cross-section where mechanical loads require it to prevent strains in excess of the elastic limit; below a certain strain threshold, the bone tissue is reabsorbed (for review see Pearson and Lieberman 2004; Ruff et al. 2006). The shape and dimension of the bone cross-section are therefore informative about the mechanical loads applied in vivo. Through CSG analysis, the polar moments of area (J) can be calculated; this is a quantitative measure of the mechanical competence of long bones correlating with torsional rigidity (Ruff et al. 2006). After standardization to take body size into account, this value is informative about the activity-induced mechanical loads, which in turn provide insights on subsistence activities performed using the upper and lower limbs, mobility levels, and the preferential use of one arm, or humeral biomechanical asymmetry (HUMBA).

In this research, the so-called 'Solid CSG' method was used to determine the mechanical competence of long bones (Sparacello and Pearson 2010). The protocols used for data collection (i.e. reconstruction of the mid-distal cross-section) and extraction of CSG properties from the humeri are standard in the field of CSG (see Ruff 2003) and are described in detail elsewhere (see Sparacello 2013; Sparacello et al. 2015).

The variable HUMBA [(maximum J – minimum J)/minimum J] is particularly important because it is associated with the repetitive and intensive use of the dominant arm in single-handed activities. In a modern Western sample, people would show asymmetry values around 10% due to physiological handedness caused by lack of high muscular stress to either the right or the left hand. High lateralization in modern samples is due to sports practices involving asymmetric use of the upper limb (e.g. tennis and various throwing-based sports: Churchill et al. 1996, 2000; Haapsalo et al. 2000; Ireland et al. 2013; Shaw and Stock 2009; Trinkaus et al. 1994). In bioarchaeological research, high asymmetry has been associated with spear throwing (Churchill et al. 1996, 2000) and the use of small hatchets (Marchi et al. 2006, 2011; Sparacello and Marchi 2008) and weapons (Rhodes and Knüsel 2005; Sparacello et al. 2011). Moreover, it has been noted that in the absence of specific and, above all, repetitive activities causing one arm to be preferentially loaded, the degree of asymmetry of agricultural human groups is still around 10%, although their level of mechanical strength (or 'robusticity') is much higher than in samples from industrial societies (Sparacello and Marchi 2008; Sparacello et al. 2011).

The high-status Orientalizing-Archaic individuals from our sample display levels of humeral asymmetry (*c*.30%) similar to those found today in cricket bowlers who had trained since adolescence (cf. Shaw and Stock 2009). This has been attributed to weapon training and use, in particular swords and spears (Sparacello et al. 2015). Although other activities such as metallurgy and woodworking may increase asymmetry, they were probably not the cause of high asymmetry in high-status Orientalizing-Archaic males. In fact, a significant decrease in asymmetry is present in males from later periods, when weapons disappear from burials, but no evidence is available to suggest a decrease in metallurgical production or woodworking (Sparacello et al. 2015).

Following Shaw (2011), in this study individuals with a HUMBA value above 5% were considered to be lateralized; below this threshold, asymmetry was categorized as 'low' and therefore ambiguous to interpret. Humeral asymmetry was further categorized as 'normal' between 5% and 15%, 'medium' between 15% and 25%, and 'high' above 25%.

Layout of Weapons in Early Samnite Burials

The layout of weapons in relation to the body of the deceased is used here to gain insights into funeral behaviour. Spear points are normally found to the side of the dead, near the head, or feet. Swords and daggers, on the other hand, are normally found in closer connection with the skeleton, suggesting that they may have been worn as part of a 'costume' (sensu Sørensen 1997). Archaeological and iconographic data indicate that swords and daggers were carried on the side, or on the torso, by means of a sort of a baldric made of metal chains (D'Ercole 2011, 157; Weidig 2008). If the location of swords and daggers within the grave mirrored the way in which they were carried during life, we would expect them to be positioned on the opposite side of the dominant arm, where one would be most comfortable unsheathing them upon use. Conversely, a significant deposition pattern on a specific side, with no regard for the dominant arm of the individual, would argue in favour of culturally sanctioned ways to carry the weapons, at least in death. For example, the Warrior of Capestrano carries the sword on the right side of the torso (Fig. 4.2). Assuming that he was right-handed, such an orientation would not be considered functional (see below) and may indicate that there were socially recognized preferences in the way weapons should be carried.

The location of one-handed weapons such as daggers and swords has been reconstructed based on excavation recording sheets and field pictures. These weapons were most commonly located on either side of the ribcage, next to either femur, and next to either arm of the deceased. However, considering that the layout of the grave goods could have been altered by post-depositional processes, we excluded from the study the burials in which the weapons lay too close to the central axis of the body and took into account only the side of the body on which the weapon was found (as opposed to the exact find spot). This rests on the assumption that it is unlikely that post-depositional processes may have been significant enough to cause such heavy objects as swords and daggers to move from one side of the body to the other.

Research Results

Table 4.1 plots weapons against humeral asymmetry category considering the presence of 'a weapon' as well as the weapon type (i.e. sword, dagger, or spear), if known. Considering that 'low' and 'normal' asymmetry categories yielded similar values, and so did 'medium' and 'high' asymmetry categories, these two groups

Table 4.1 Contingency table for categorized humeral asymmetry and presence/absence of weapons

All individuals	Weapon	No weapon	Chi-square test
High-medium asymmetry (>15%)	101	38	
Normal-low asymmetry (0–15%)	53	25	NS
	Sword	**No weapon**	
High-medium asymmetry (>15%)	30	38	
Normal-low asymmetry (0–15%)	23	25	NS
	Dagger	**No weapon**	
High-medium asymmetry (>15%)	37	38	
Normal-low asymmetry (0–15%)	18	25	NS
	Spear	**No weapon**	
High-medium asymmetry (>15%)	80	38	
Normal-low asymmetry (0–15%)	43	25	NS
	Spear	**No spear**	
High-medium asymmetry (>15%)	80	59	
Normal-low asymmetry (0–15%)	43	34	NS
Only armed individuals	**Spear**	**No spear**	
High-medium asymmetry (>15%)	80	21	
Normal-low asymmetry (0–15%)	43	9	NS

NS statistically non-significant at $\alpha = 0.05$

were pooled together. The table consistently shows that the frequency of individuals with medium/high asymmetry is not significantly different in armed versus unarmed individuals. The same is true when considering the presence/absence of the spear, which being also a throwing weapon is expected to highly influence humeral asymmetry. These data suggest that the presence or absence of weapons is independent from the level of biomechanical asymmetry of the individual buried in the grave.

Table 4.2 shows that rare and prestigious weapons such as maces and axes are consistently associated with highly lateralized individuals; the result is significant only at the $\alpha = 0.1$ level, probably due to the small size of the sample. Likewise, the even smaller subsample of individuals with 'prestige weapons' has, on average, higher humeral asymmetry than other armed (Mann-Whitney U test $P < 0.05$) and non-armed individuals (if marginally; Mann-Whitney U test $p = 0.053$). When considering the Status Index of the burials, 'prestige weapons' appear consistently in otherwise 'rich' burials (Table 4.3 and Fig. 4.4). No statistically significant relationship was observed between the dominant arm of the dead and the location of weapons on either side of the body (Table 4.4). Furthermore, the layout of one-handed weapons in relation to the deceased is highly variable – a fact that seems to argue against any strict rule for the placement of these objects in burial.

The incidence of left-handed individuals in the sample (12 out of 198; 6.1%, considering only individuals with asymmetry above 5%) is well within the range of modern populations and is not significantly different for those buried with weapons (9 out of 140; 6.4%) vis-à-vis those buried without weapons (3 out of 58; 5.2%).

Table 4.2 Contingency table for categorized humeral asymmetry and presence/absence of prestige weapons

Presence of prestige weapon (axe and mace)	Yes	All individuals	Chi-square test
High-medium asymmetry (>15%)	9	130	
Normal-low asymmetry (0–15%)	1	76	$P < 0.1$
	Yes	**Armed individuals**	
High-medium asymmetry (>15%)	9	92	
Normal-low asymmetry (0–15%)	1	51	$P < 0.1$
	Yes	**No weapon**	
High-medium asymmetry (>15%)	9	38	
Normal-low asymmetry (0–15%)	1	25	$P < 0.1$

Table 4.3 Contingency table for categorized Status Index (calculated without considering weapons) and presence/absence of prestige weapons

Presence of prestige weapon (axe and mace)	Yes	All individuals		Chi-square test
Status index >45	7	28		
Status index 15–45	3	129		
Status index 0–15	1	70		$P < 0.001$
	Yes	**Armed individuals**	**No weapon**	
Status index >45	7	22	6	
Status index 15–45	3	90	39	
Status index 0–15	1	48	22	$P < 0.001$

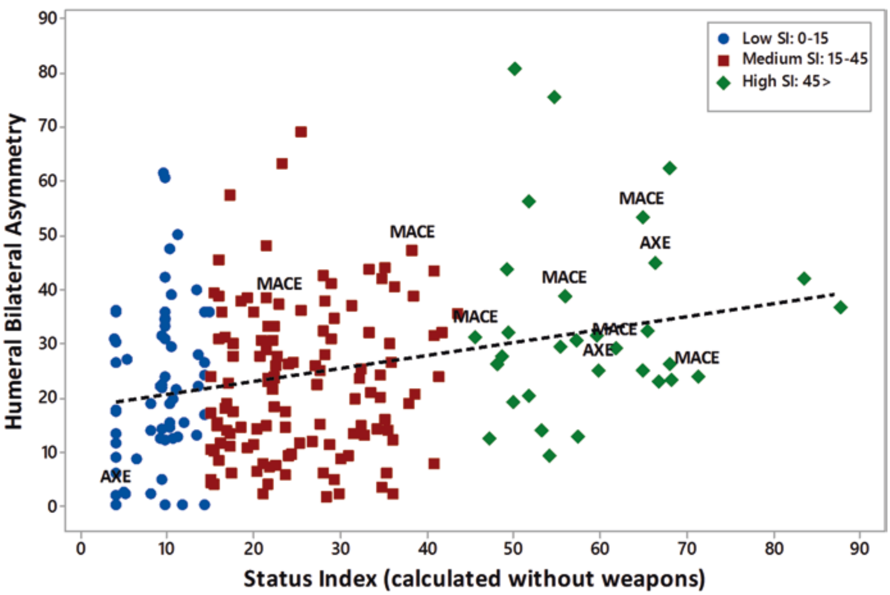

Fig. 4.4 Scatterplot showing humeral bilateral asymmetry against Status Index (calculated without considering weapons) in a sample of 216 Iron Age Samnite male burials, c.800–500 BC. The graves with 'prestige weapons' (i.e. axes and maces) are marked on the plot

Table 4.4 Contingency table for the side of deposition of weapons and 'handedness' inferred from the directionality of humeral asymmetry (HUMBA)

All individuals except for low HUMBA	Chi-square test		Chi-square right vs left	
Individuals with swords	*Right*	*Left*		
Right handed	23	16		
Left handed	2	0	NS	NS
Individuals with daggers	*Right*	*Left*		
Right handed	20	19		
Left handed	2	0	NS	NS
Swords and daggers cumulative	*Right*	*Left*		
Right handed	43	35		
Left handed	4	0	NS	$P < 0.1$
Individuals with swords and medium-high HUMBA	*Right*	*Left*		
Right handed	15	11		
Left handed	1	0	NS	NS
Individuals with daggers and medium-high HUMBA	*Right*	*Left*		
Right handed	16	14		
Left handed	1	0	NS	NS
Swords and daggers cumulative (medium-high HUMBA)	*Right*	*Left*		
Right handed	31	25		
Left handed	2	0	NS	NS

Individuals with low HUMBA (below 5%) were excluded due to lack of asymmetry. The chi-square test has been calculated taking into account two categories of side of deposition (right and left) and two categories of directionality in asymmetry (right and left handed). NS statistically non-significant at $\alpha = 0.05$

However, when considering the degree of humeral asymmetry in the sample, the number of left-handed individuals decreases with increased humeral asymmetry (Table 4.5 and Fig. 4.5). Even after excluding the individuals with very low asymmetry (<5%), for which laterality may be ambiguous, chi-square tests show that the pattern is still statistically significant.

Discussion

In this study, we employed a bioarchaeological approach for reconstructing the interplay between funerary rites and combat/training activities among the Samnite communities of the Orientalizing-Archaic period (*c*.800–500 BC). Based on previous research on the subject (Sparacello 2013; Sparacello et al. 2015), we identified individuals with skeletal evidence suggesting weapon training (and perhaps participation in combat) from a young age, as shown by high humeral asymmetry in mechanical rigidity, and verified their handedness for this variable. Previous studies have demonstrated a significant correlation between the level of humeral

Table 4.5 Contingency table for the categorized humeral asymmetry and 'handedness' inferred from the directionality of humeral asymmetry (HUMBA)

All individuals	**Right handed (*n*)**	**Left handed (*n*)**	**Right handed (%)**	**Left handed (%)**	**Chi-square test**
High asymmetry (>25%)	98	1	99.0	1.0	$P < 0.01$
Medium asymmetry (15–25%)	37	3	92.5	7.5	
Normal asymmetry (5–15%)	50	7	86.4	13.6	
Low asymmetry (<5%)	13	6	72.2	27.8	
All individuals	**Right handed (*n*)**	**Left handed (*n*)**	**Right handed (%)**	**Left handed (%)**	**Chi-square test**
High-medium asymmetry (>15%)	135	4	97.1	2.9	
Normal asymmetry (5–15%)	50	7	86	14	$P < 0.01$
Only armed individuals	**Right handed (*n*)**	**Left handed (*n*)**	**Right handed (%)**	**Left handed (%)**	**Chi-square test**
High asymmetry (>25%)	70	1	98.6	1.4	
Medium asymmetry (15–25%)	28	2	93.3	6.7	
Normal asymmetry (5–15%)	33	6	84.6	15.4	
Low asymmetry (<5%)	9	4	69.2	30.8	$P < 0.05$

Individuals with low HUMBA (below 5%) are reported in the table but excluded from the chi-square test

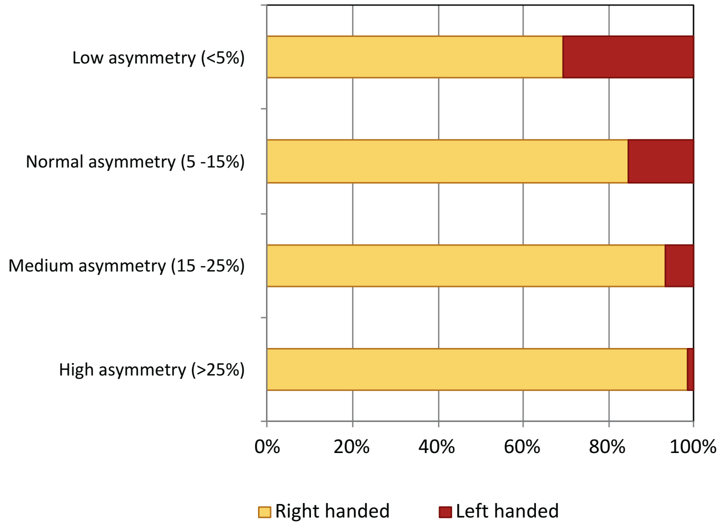

Fig. 4.5 Bar chart showing the percentage of left-handed and right-handed individuals across the different categories of humeral bilateral asymmetry identified in this research

asymmetry and the Status Index calculated from funerary treatment, suggesting the presence of militias consisting of elite individuals (Sparacello 2013; Sparacello and Coppa 2014; Sparacello et al. 2015). By studying the burial rite in more detail, in order to verify possible correspondences between biomechanical data, the presence/absence of weapons, and their location in the grave with respect to the body, this study has expanded upon these results.

Teasing Apart Warrior Burials and Burials of Warriors

Over two-thirds of the male graves in the sample (171 out of 238) included at least one weapon. Even considering possible biases caused by selective or anomalous burial rites, this figure highlights the importance of weapons as grave goods among early Samnite communities; it also emphasizes that not all the males were portrayed as warriors in death. Importantly, the analysis of biomechanical humeral asymmetry also shows that the most common weapons – such as daggers, swords, and spears – were often placed in the burials of non-lateralized people. Assuming that lack of lateralization means that these individuals did not train extensively in the use of weapons (Sparacello et al. 2015), this trend suggests a discrepancy between the representation of the dead as a warrior and his actual involvement in military training and martial practices.

It could perhaps be speculated that only individuals who died in battle were buried with weapons, while people who suffered from a 'bad death', perhaps away from the battlefield, might have been buried without martial paraphernalia (cf. Humphreys 1980; Langdon 2005). Among the males buried with weapons, however, there are also preadolescent individuals whose age seems incompatible with combat training, let alone taking part in battle (Cianfarani et al. 1978; Parise Badoni and Ruggeri Giove, 1980).

Another discrepancy between burial treatment and lifetime activities of the deceased emerges from the analysis of weapon placement within the grave. If swords and daggers were placed on the body so as to reflect the way they were worn in life (cf. Scopacasa 2015, 81), we would expect them to be located on the opposite side to the dominant arm as inferred from humeral asymmetry. This is not the case in the sample analysed here, in which weapons were deposited on either side of the body regardless of the dominant arm; the same is true of the highly lateralized individuals, for which no clear relationship between weapon placement and dominant arm is visible either. It can thus be inferred that the weapons were deposited in the grave without paying special attention to whether and how they were worn in life. This further disproves the hypothesis that burial behaviour would mirror actual use of the weapons in life.

While the placement of swords, spears, and daggers in burial vis-à-vis humeral asymmetry appears to challenge straightforward interpretations concerning early Samnite warrior roles, rarer weapons such as maces and axes were consistently deposited with individuals showing significantly higher degrees of asymmetry than the rest of the sample. Furthermore, maces and axes are present in burials showing a high Status Index, even upon excluding the weapons (including axes and maces) from the SI calculation.

These weapons were likely imbued with meaningful cultural values; for example, the 'Warrior of Capestrano', ostensibly a Samnite political leader of the Archaic period (Barker et al. 1995, 177; Bispham 2007, 190; Calderini et al. 2007; D'Ercole and Cella 2007; D'Ercole 1999; Scopacasa 2015, 73–74), holds an axe in his right hand (Fig. 4.2), while one of the figurines depicted on the 'Fibula of Pizzoli' holds a mace (Fig. 4.3). The special meaningfulness of the latter weapon emerges upon considering that the brooch illustrates what seems to be a ritual rather than an explicitly martial practice. Axes and maces are also far rarer than swords and spears in early Samnite burial sites, thus further suggesting their special significance for these communities.

It therefore appears that, while ordinary weapons cannot be taken to directly mirror the martial practices carried out by the deceased in life, a significant correlation is found in the sample between high humeral asymmetry, Status Index, and special weapons such as maces and axes. Consequently, the existence among early Samnite communities of a warlike ideology in which social prestige was not only tied to the display of warrior prowess but also to actual martial practices is, at least partly, supported by the research results.

Asymmetry, Handedness, and the Role of Weapon Training in Early Samnite Burials

Another significant result of this research lies in the discovery that left-handedness in males with high humeral asymmetry (as arising from sustained weapon training from a young age; Sparacello et al. 2015) is significantly underrepresented in the sample. In fact, the subsample of highly asymmetrical individuals shows an almost complete absence of left-handed people among their ranks. Cross-cultural studies show that left-handed individuals make up about 10% of human populations (Faurie and Raymond 2004; Papadatou-Pastou et al. 2008; Shawn 2011). An oft-cited hypothesis explaining this pattern suggests that left-handedness survival in human evolution is due to it being a significant factor for frequency-dependent selection. In formulating the so-called fighting hypothesis, Raymond et al. (1996) observed relatively high rates of left-handed athletes in close-combat disciplines. To account for this pattern, they argue that being left-handed may be advantageous for those engaging in fighting, which in turn can perhaps explain the survival of left-handedness as a minority trait in human evolution.

The fighting advantage of left-handed individuals is not merely to be ascribed to the use of a different arm than the opponent but rather to the combat stances influenced by the leading hand (cf. the southpaw and orthodox stances in contemporary boxing). For instance, in a sword-and-shield combat, contenders hold their sword with the dominant hand: when two fighters with the same leading hand face each other, their swords face the opponent's shield. Conversely, when a left-handed fighter faces a right-handed fighter, the positions of the weapons are not inverted but mirrored, with shields and swords being on the same side. Since left-handed people have always been a minority, combat training for both left-handed and right-handed fighters is mainly focused on dealing with a right-handed opponent; at parity of skill, this favours the left-handed fighter. Gursoy (2009) observed that left-handed boxers have a considerably higher success rate than right-handed ones, and similar results have been recorded with regard to wrestlers (Ziyagil et al. 2010).

Based on these considerations, left-handedness was expected to be substantially represented in the sample of individuals we identified as highly combat-trained based on their humeral asymmetry. The opposite pattern emerged instead. Importantly, it was also noted that left-handedness is present in a normal ratio within the total sample but is unevenly distributed among the different humeral asymmetry groups, indicating that left-handedness was not discouraged within the society as a whole. Results therefore suggest a relationship between right-handedness and high asymmetry, which we argue to be due to intensive combat training (Sparacello et al. 2015).

The weapons known from these communities do not seem to have a particular design feature that may restrict their use to the right hand only. Therefore, it seems reasonable to ascribe the prevalence of right-handed individuals among the most military trained members of society to particular combat tactics and styles rather than to the combat tools themselves. One might see in this pattern a proxy for combat in tight-rank formations, perhaps a type of less complex precursor of the 'phalanx' known from Greek and Roman armies. When fighting in a formation of this kind, warriors hold shields in their left hand and a one-handed weapon, normally a spear, in the right: every member is expected to protect the right side of the man next to him with his shield, thus forming a solid frontline (Keegan 1993, 248). It follows that a warrior holding his weapons the other way round would have breached the tightness of the rank. Consequently, in a society in which such combat tactics were adopted, martial training would have focused on achieving the skill necessary to operate with others as a single fighting unit, encouraging the use of the right arm to strike and of the left arm to defend.

There is little additional evidence suggesting that tight ranks might have been in use in the Italian peninsula during the Orientalizing-Archaic period. The decoration of the sixth-century BC Certosa *situla* (a bucked-shaped bronze vessel) from Bologna in northern Italy portrays a military parade consisting of warriors equipped with long spears, large shields, and helmets: a warfare equipment that is compatible with this kind of tactic (Cherici 2003). On the other hand, the existence of tight ranks in such an early period is not fully supported by the archaeological record, mainly due to the lack of heavy protective gear (Cherici 2003: 529; D'Ercole 2011: 150; see also above). The only piece of evidence that is not at odds with the use of tight combat formations in the Orientalizing period in the area of study is the adoption of the dagger, which appears suitable for fighting in close ranks, where one may have extremely limited room for manoeuvring (D'Ercole 1999: 116–7). During the Archaic period, however, the dagger is replaced by the sword, a weapon with a longer reach and likely different use mechanics (D'Ercole 2011: 156–7). Unfortunately, by dividing the sample into dagger and sword bearers, results are not significant as the subsamples become too small (Table 4.5). At this stage of the research, it is therefore not possible to evaluate diachronic changes in the degree of asymmetry and handedness from the Orientalizing to the Archaic period.

Another possible reason for favouring right-handed weapon training may be found in the dearth of heavy defensive gear, as inferred from early Samnite iconography and grave goods. Holding the spear or sword in the right hand would have resulted in exposing mainly the right side of the body, while keeping the left side (where the heart is located) better protected by the shield. Attacking with the right arm would thus improve the odds of receiving non-lethal wounds instead of fatal strikes (Harris 2010: 37–8).

Finally, it should be said that alternative interpretations of the archaeological and skeletal data are possible. Combat techniques are learned and internalized in a given cultural and social milieu and do not necessarily follow parameters of functionality and efficiency alone (Horn 2014; Mauss 1973). Widespread reluctance to use of the left arm for wielding a weapon might be explained by cultural values and beliefs typical of this warrior community (cf. Mandal 1999; Medland et al. 2004). In the absence of a much-needed comparative framework, our inferences of military tactics based on handedness can only be regarded as preliminary.

Conclusion

The multidisciplinary approach employed in this research has provided new insights into several aspects of proto-historic Samnite communities from the Central Apennines. Departing from merely decoding how a society represents itself in burial, the combined archaeological and osteological approach adopted here has allowed a better understanding of significant social practices carried out by the community of the living and how they were represented in the mortuary realm.

The study of the depositional patterns of daggers, swords, and spears suggests that these weapons were deposited in burials of varying degrees of wealth, which were often characterized by non-asymmetric individuals who presumably had not received any sustained weapon training during their lives. This suggests that the weapons may have been deposited to signal affiliation to certain social categories, which may or may not result from actual involvement in martial practices. On the other hand, the presence of rare weapons such as maces and axes in the burials of highly lateralized individuals (who were also endowed with lavish grave goods) hints at a society in which status and wealth may have been intertwined with the display and practice of martial prowess and combat skills.

Biomechanical analysis of humeral asymmetry and arm dominance has challenged what was expected to be found in a population allegedly bent on raiding and loose-rank combat. As a matter of fact, highly asymmetric left-handed individuals are exceedingly rare in the sample, which would be expected if the military organization was based on tight ranks. However, left-handedness in weapon training may have also been discouraged for hitherto unexplored reasons, and one must leave the door open to alternative interpretations.

The data and interpretations presented in this chapter intend to stimulate new debates and avenues of research. The multidisciplinary approach applied here, which is grounded in the combined analysis of skeletal, iconographic, and archaeological evidence, has advanced our knowledge and understanding of early Samnite society. Similar approaches can fruitfully be applied to other periods and regions in order to carry out cross comparisons with societies with different attitudes to warfare. Likewise, future advances in the investigation of use-wear on iron weaponry (going beyond current applications to copper alloys; Dolfini and Crellin 2016), as well as applications of the methodology proposed in this chapter to Bronze Age contexts, would certainly allow new, and indeed more in-depth, reconstructions of past combat practices and of their social significance.

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Part II
Conflict in Prehistoric Rock Art

Chapter 5
War and Peace in Iberian Prehistory: The Chronology and Interpretation of the Depictions of Violence in Levantine Rock Art

Esther López-Montalvo

Introduction

The Mediterranean regions of the Iberian Peninsula provide exceptionally rich evidence for the study of the first phases of the Neolithisation process in the sixth millennium BC (Juan-Cabanilles and Martí-Oliver 2002; García Puchol et al. 2004; Bernabeu Aubán 2006; Bernabeu Aubán and Martí Oliver 2012). The great amount of archaeological and pictorial evidence brought to light in this area is of paramount importance for understanding the spread and establishment of the Neolithic way of life in the Western Mediterranean. As of today, however, important questions remain unanswered with regard to this process.

One of these questions centres upon the chrono-cultural relationship between the three stylistic horizons documented in the rock art of Mediterranean Iberia: the Macroschematic, the Schematic, and Levantine rock art. While the first two horizons can be understood in relation to other developments in symbolic behaviour occurring in the broader Western Mediterranean during the spread and early consolidation of the Neolithic, Levantine rock art is a unique artistic phenomenon that solely manifests itself in Mediterranean Iberia (Fig. 5.1). This rock art tradition, which is characterised by naturalistic depictions of human and animal motifs set in wide narrative scenes, lends itself to two important questions: when did it emerge, and why? The first question is still being debated as it is not yet possible to obtain radiocarbon dates from pigments, either because they are mainly mineral-based or because the amount of charcoal required for their dating would seriously compromise the preservation of the paintings (López-Montalvo et al. 2014, 2017). To make things worse, the chronological debate surrounding Levantine rock art tends to

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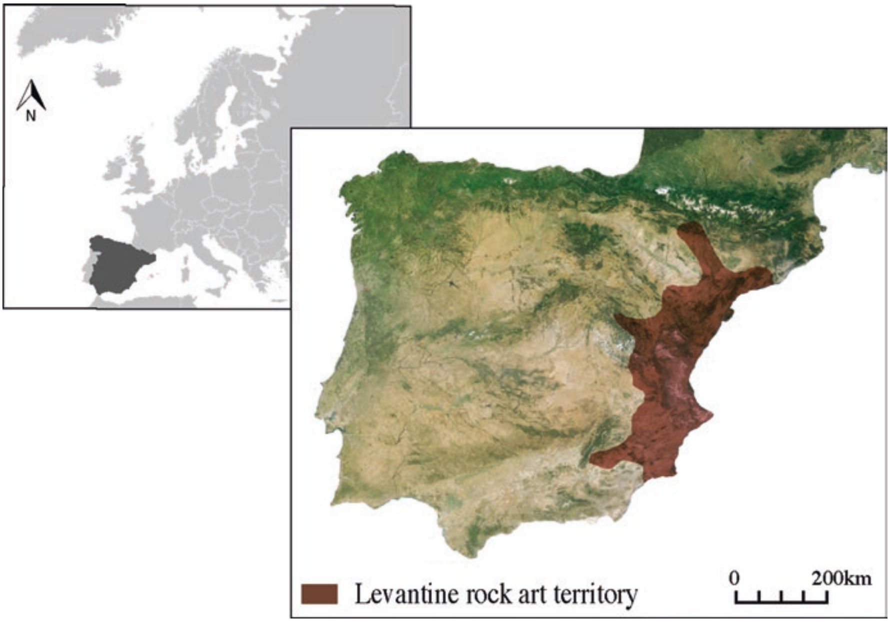

Fig. 5.1 Map of the Levantine rock art area

eschew the archaeological and social context of its development. It is regrettably common for scholars to examine this pictorial tradition in isolation, as if it was a separate entity disconnected from other contemporary strands of material and cultural production. This has led to the formulation of disparate chronological hypotheses, which, in most cases, are widely at variance with the archaeological record. Moreover, the figurative naturalism of most Levantine rock art depictions, in which specific economic and social activities are portrayed, has often led to narrowly literal interpretations leaving no room for broader social and symbolic readings (Martí Oliver 2003). For example, big game hunting, one of the most common themes in Levantine rock art, is normally thought to provide insights into the subsistence economy of the artists. It therefore seemed natural to many a scholar that these paintings would be rooted in a hunter-gatherer lifestyle and should therefore be dated to either the Palaeolithic (Breuil et al. 1912) or the Mesolithic (Alonso and Grimal 1999a, b; Mateo Saura 2005).

The second question presents us with a different, and perhaps more formidable, challenge, which is to explain the emergence of a pictorial tradition that seems fundamentally different from earlier rock art both stylistically and in the narratives portrayed in the panels. Seen from this perspective, it seems indisputable that the origin of Levantine rock art must be related to profound social and behavioural changes, whose material traces one would expect to see in the archaeological and environmental record. Several hypotheses have been put forward to explain the emergence of Levantine rock art. These tend to cluster around two overarching explanations: climatic deterioration and social change. On one hand, climatic and environmental changes associated with the 8.2 ka BP (*c*.6200 BC) cooling event have recently been seen as the primary stimulus for the rise of this pictorial tradition, since the new climatic regime could have seriously impacted on the lifestyle of Mesolithic groups, sparking novel cultural responses (Utrilla and Bea 2015). On the other hand, sociocultural reasons have been evoked, which would put the origin of Levantine rock art in the context of the first encounters between foragers and farmers in the mid-sixth millennium BC Mediterranean Iberia. According to this reading, the rock art would be an indigenous cultural reaction to the Neolithic settlers – a sort of visual vindication of the forager way of life, which was slowly but inexorably collapsing in the face of the expansion of farming (Fortea and Aura 1987; Llavori de Micheo 1988–1989). Although different, both hypotheses revolve around the idea of conflict and competition. The first suggests that the conflict is to be explained with territorial reorganisation of Mesolithic groups concerned with the exploitation of increasingly scarcer resources; the second conjures up ideas of landscape, social, and economic tension between two radically opposed subsistence strategies and ways of life: foraging versus farming (Llavori de Micheo 1988–1989).

This chapter aims to assess these hypotheses by means of a comparative analysis of the scenes of interpersonal and group violence depicted in Levantine rock art (López Montalvo 2011, 2015, 2018), vis-à-vis the regional archaeological evidence for the latest Mesolithic groups (*c*.6700–5300 BC) and the spread and consolidation of the Neolithic, from about 5650 BC (Bernabeu Aubán et al. 2018). The aim of the research is to evaluate whether the episodes of violence portrayed in Levantine rock art can support either hypothesis or chronological framework: that is, intergroup Mesolithic conflict motivated by either territorial reorganisation (Utrilla and Bea 2015) or competition over natural resources (Mateo Saura 2000), from 8200 to 7700 BP (*c*.6200–5700 BC), or conflict between late Mesolithic and early Neolithic communities in the mid-sixth millennium BC. As the two hypotheses are rooted in alternative chrono-cultural frameworks, their assessment will significantly contribute to the long-standing debate concerning the chronology of Levantine rock art.

Levantine Rock Art: Graphic Evidence of a Violent Past

Levantine rock art shows a complex internal evolution as well as distinctive regional traits in several of its features including painting techniques, style, and the thematic contents of the scenes. However, our comprehension of this remarkable artistic phenomenon is still limited. While the stylistic phases and their hypothetical chronological sequences are only barely characterised in the northern (Villaverde et al. 2002; Domingo 2006; López Montalvo 2007; and central regions (Martínez i Rubio 2011) of the Levantine rock art territory (Fig. 5.2), many questions still arise about the characterisation of the formal variation within these stylistic phases and their territory of influence. Moreover, further archaeometric analyses of pigments would

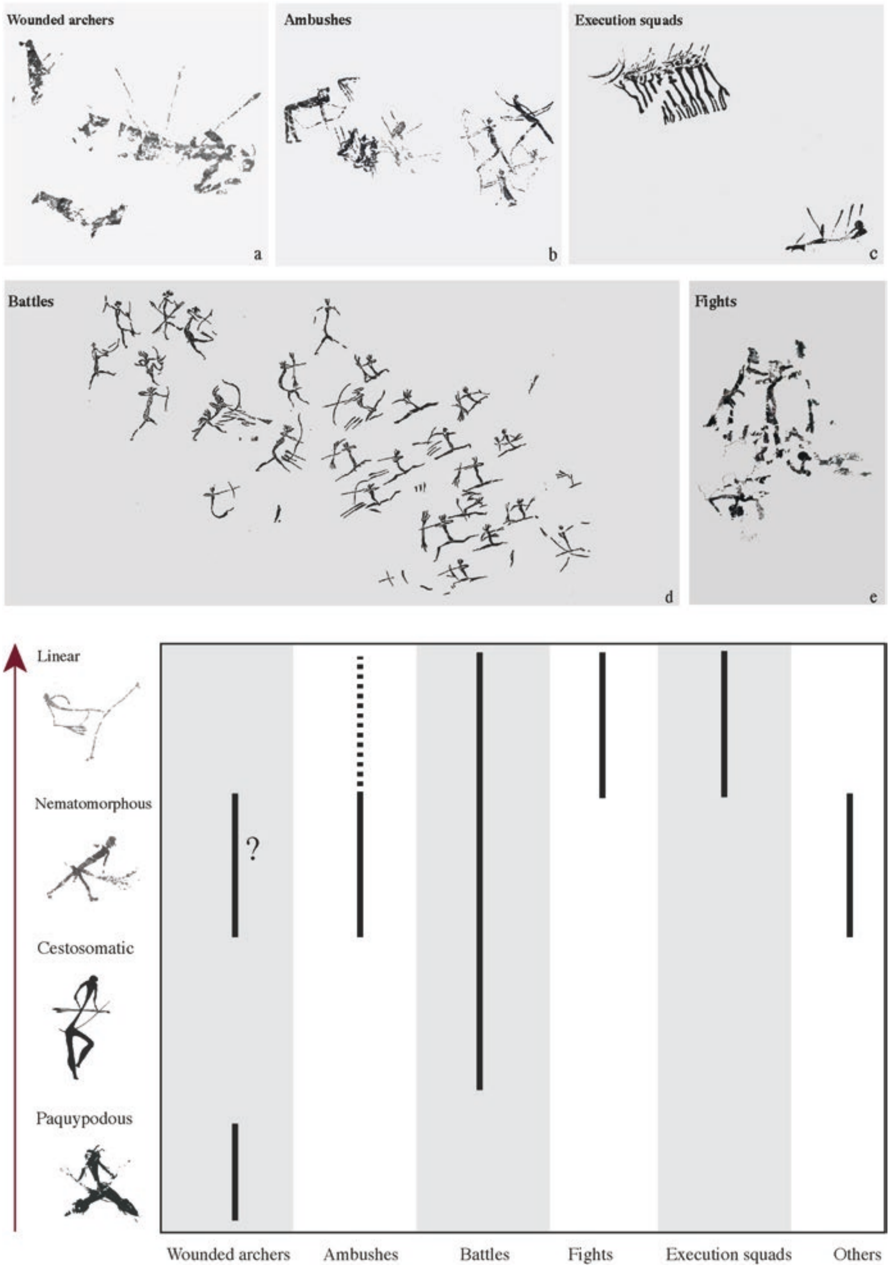

Fig. 5.2 Above: scenes of violence in Levantine rock art panels. (**a**) and (**c**) Wounded archers and execution squads from Cova Remigia (Ares del Maestre, Gassulla, Castellón) (digital tracing by E. López-Montalvo). (**b**) Ambushes from Cueva de la Vieja (Alpera, Albacete). (**d**) Battle scene from Les Dogues (Ares del Maestre, Gassulla, Castellón). (**e**) Fight scene from Cañada de la Cruz (River Segura, Jaén). Below: variation in portrayed violence throughout the Levantine stylistic sequence (Alonso and Grimal 1999; Porcar 1953; Soria et al. 2012)

be necessary to assess the evolution of pictorial techniques (López-Montalvo et al. 2017; Ruiz López 2012). Despite these problems, important aspects of Levantine rock art have been clarified recently. In particular, notable variations in the design of figures (especially human beings), but also in panel layout and contents, strongly suggest that this pictorial tradition developed over a relative long span of time, although it is difficult to say exactly how long. Crucially, however, we can presume that the social changes hinted at by the paintings should also be visible in the archaeological record. This correlation may provide useful indications as to the dating of Levantine rock art, including its main stylistic phases.

The portrayal of violence provides especially valuable information regarding the social dynamics and organisation of prehistoric communities, for violent practices including raiding and warfare are socially constituted. For example, diachronic changes in the design and frequency of acts of interpersonal and group violence might help us discern isolated tensions or deeply rooted conflictive dynamics between communities. Similarly, special concentrations of this kind of scenes in certain areas may allow us to identify hotspots of conflict and political instability. Finally, the naturalistic design characterising certain stylistic phases provides us with tantalising opportunities to carry out a fully fledged archeo-anthropological analysis of prehistoric social organisation including the degree of social complexity of the communities depicted.

Previous analysis of Levantine rock art has shown an increase in the number of scenes of violence over time (López Montalvo 2011, 2015). This goes hand in hand with the development of ever more complex raiding and ambushing tactics, in which increasing numbers of players seem to participate. Diachronic changes of this kind provide valuable information concerning the social dynamics of the groups involved in the clashes. Firstly, the near-complete absence of women from the scenes of conflict points towards not only deep-seated gendered divisions of labour but, perhaps more importantly, differential access to critical sources of power and prestige such as warfare and big game hunting, both represented as exclusive male domains. This inference is made possible by the frequent display of sex- and gender-specific elements in female figures including breasts and skirts, which are never associated with weapons. Secondly, the presence of possible 'battlefield leaders', characterised by features such as tall headgears, a bigger size than the other combatants, a better-modelled body, or a prominent location on the panel, points to differences in rank or status that might arise from the prestige gained in battle (Fig. 5.3). Finally, the identification of attack and defence tactics as visible in the spatial arrangement of warriors on the battlefield reveals a level of coordination that can only be achieved through training. All these features suggest a certain degree of complexity in the social organisation of the groups involved in the fighting (López Montalvo 2018). It is perhaps possible to take this interpretation further and say that what is displayed in the rock art panels is not a warrior society but a society with warriors, in which individuals with outstanding fighting skills and bravery would have gained social standing by taking part in warfare (Sarauw 2007).

Overall, the picture offered by Levantine rock art shows that violence, and more specifically the resolution of conflict by violent means, was a subject of great concern for the local communities. The warlike activities displayed on the panels

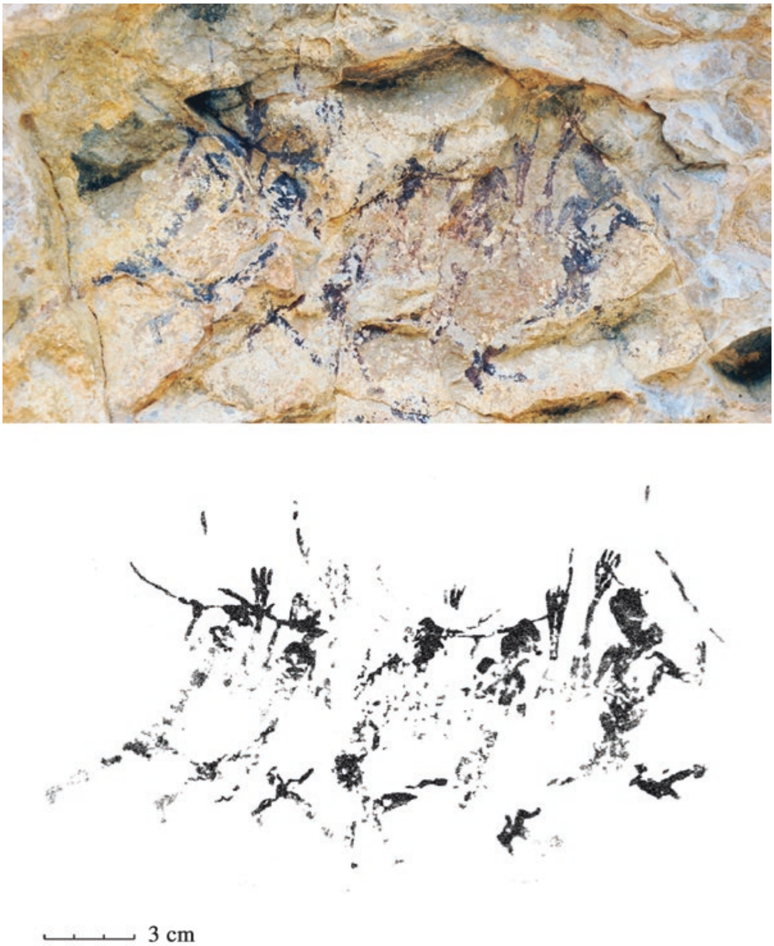

Fig. 5.3 Ranked formation from Cingle de la Mola Remigia IX (Ares del Maestre, Gassulla, Castellón). The tall headgear of the formation leader hints at the existence of established leadership roles. (Digital tracing by E. López-Montalvo)

must be considered as one of the social strategies used by self-aggrandising individuals to gain prestige and manipulate communal resources in order to accrue a higher status for themselves (Hayden 1995).

Foragers Versus Foragers?

This section discusses various scholarly proposals considering Levantine rock art to be wholly, or partly, Mesolithic in date. Two main proposals can be distinguished within this broad hypothesis. The first argues that the entire sequence of Levantine rock art developed during the Mesolithic period, *c*.8100–5300 BC (Mateo Saura 2005; Nash 2005). The second, on the other hand, maintains that only the early Pachypodous phase can be assigned to the Mesolithic, while this artistic tradition would have continued during the transition to farming and into the Neolithic (Utrilla and Bea 2015; Guillem and Martínez Valle 2004).

The first proposal does not take account of the data provided by the archaeological record. In particular, it ignores the complex relationship between the regional distribution of Levantine rock art shelters and the Mesolithic and Neolithic archaeological evidence from Mediterranean Iberia. In recent years, the analysis of the regional archaeological sequence vis-à-vis the location of rock art sites has revealed major discrepancies between the two, especially in those areas where Neolithic pioneering communities first established themselves (Juan-Cabanilles and Martí-Oliver 2002; Molina et al. 2003). In particular, in those areas where Levantine rock art is best represented, no evidence of late Mesolithic Geometric archaeology (*c*.6100–5600 BC) has been recorded thus far (Bernabeu Aubán et al. 2008). Therefore, the proposal to date the entire sequence of Levantine rock art to the Mesolithic is mainly grounded in the contents of the paintings, especially those showing the hunting of wild forest animals such as deer, wild goat, wild boar, and auroch. This proposal disregards the fact that Levantine rock art does not show a linear evolution over time, but is instead characterised by idiosyncratic regional traits and notable diachronic changes in style, painting techniques, and the layout and thematic contents of the scenes (López Montalvo 2007). This consideration points to the existence of a complex cultural mosaic. I argue that both stylistic changes and regional traits in the rock art must be understood in social terms, since both must respond to processes of change or reorganisation of the societies portrayed in the paintings, and both must be taken into consideration when trying to reconstruct the chrono-cultural framework of Levantine rock art.

When trying to utilise the portrayal of violence for dating Levantine paintings, the goal is not to demonstrate, using ethnographic parallels, that hunter-gatherer groups expressed violent behaviour (Mateo Saura 2000), as this is something all scholars agree upon. On the contrary, the goal is to infer the social organisation and degree of complexity of the communities involved in the fighting and assess if this fits the evidence currently available for Mesolithic Mediterranean societies (Binford 2001; Marchand 2014). In this respect, one of the key lines of evidence rests on the large number of warriors involved in the clashes, as is the case, for example, at Cingle de la Mola Remigia (Ares del Maestre, Gassulla, Castellón), Cova del Civil (Tírig, Valltorta, Castellón), and Les Dogues (Ares del Maestre, Gassulla, Castellón). At these sites, the number of individuals shown in the battle scenes largely exceeds those estimated for a band of hunter-gatherers (Kelly 2007; Binford 2001; Marchand 2014). To temper this statement, one should consider that these scenes could have had further figures added over time and would not therefore offer an accurate portrayal of the prehistoric groups involved in the fighting (Mateo Saura 2005). However, as far as the scene from Les Dogues is concerned, recent archaeometric analyses of pigments and painting techniques suggest that all the warriors involved in the battle were depicted at the same time (López-Montalvo et al. 2017).

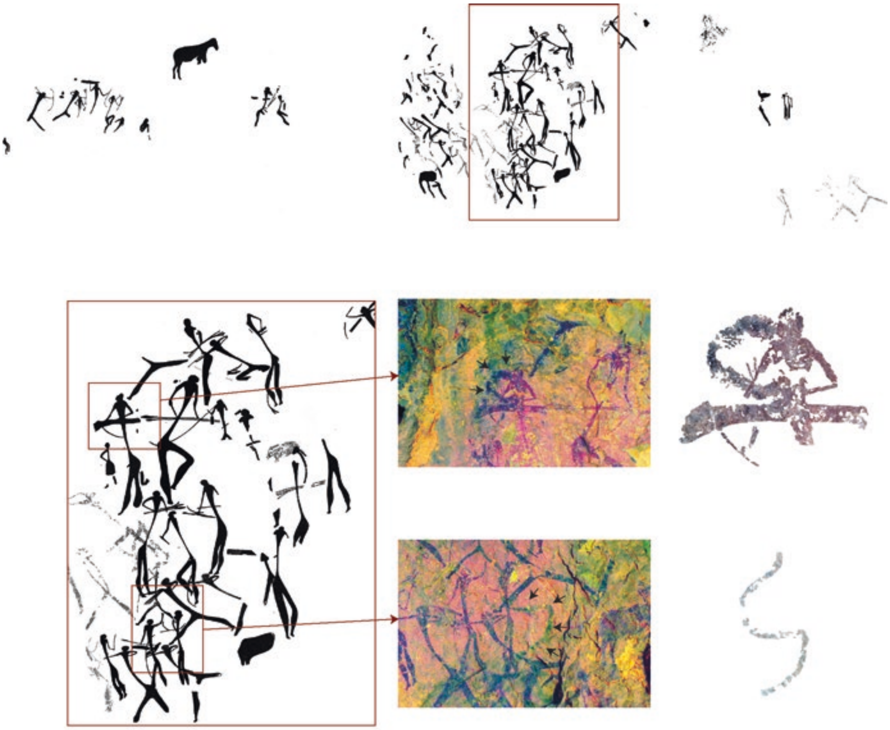

Fig. 5.4 Superposition of Levantine warriors (Cestosomatic style) over Schematic motifs at the Coves del Civil rock art shelter (Tírig, Valltorta, Castellón). (Tracing modified from Obermaier and Wernert 1919; image detail of the superposition using enhancement tool DStretch for Image J; digital tracing of superposition between Levantine and Schematic motifs by E. López-Montalvo)

At a broader level, there are other factors casting doubts on the Mesolithic dating of the paintings. One of these is the chronological and territorial relationship between Levantine rock art and the Schematic horizon, whose Neolithic chronology is undisputable (Hernández Pérez 2006). This can be best seen in one of the most famous scenes of conflict, the one from Cova del Civil (stylistically assigned to the Cestosomatic phase), which overlies several Schematic motifs (Fig. 5.4). As the Cestosomatic phase is normally assigned to the second stage of the Levantine rock art sequence, at least in the Valltorta-Gassulla region, this superimposition can be taken as a *post quem* for the first Neolithic groups in the area, whose presence is dated to circa 5450 BC. This indicates that a substantial portion of the Levantine sequence should be contemporary to, or later than, Neolithic Schematic art. This seriously questions the Mesolithic chronology hypothesis, since the latest Mesolithic evidence in the Maestrat region dates to about 5550 BC (Bernabeu Aubán et al. 2018).

The second proposal is more complex in its formulation, for chronological considerations are intertwined with stylistic, archaeological, and palaeoenvironmental data in one elaborate argument. Here, the challenge lies, firstly, in identifying the stylistic phases that can be assigned to the contact period between foragers and farmers and, secondly, in characterising the stylistic elements supporting the Neolithic acculturation model. In other words, can we identify which stylistic phase(s) could be considered as a ‘cultural reaction’ of the indigenous Mesolithic foragers to the incoming Neolithic farmers? And which phase(s) could be read as evidence of cultural assimilation and integration of the former economy and way of life into the latter and also of the development of the Neolithic?

If we accept that the acculturation process should be accompanied by profound social and economic changes, we must also assume that these changes must be detectable in the pictorial record and most notably in the themes and contents of the paintings. In the northern regions of the Levantine rock art territory – Catalonia, Lower Aragon, and the northern counties of Castellón – the emergence of this pictorial tradition is marked by the Pachypodous style (Villaverde et al. 2002; Domingo 2006; López Montalvo 2007). The human figures typical of this style are characterised by remarkable naturalism, which is expressed through a well-proportioned bodily anatomy, rather massive legs, and the realistic display of various personal ornaments and items of clothing. Significant formal variations can be noticed within this phase, which, however, are not yet well defined at the regional and macro-regional scales. One of the most common themes of Pachypodous paintings consists of groups of men marching, as documented, for instance, at Cova dels Cavalls (Tírig, Castellón). Occasionally, they are joined by women and children, as seen at Centelles (Albocàsser, Castellón) and Val del Charco del Agua Amarga (Alcañiz, Teruel). Contrasting interpretations have been proposed for these scenes, including seasonal foraging and hunting expeditions, which may also have reinforced control over tribal territories (Villaverde and Martínez Valle 2002); Mesolithic population displacement resulting from the spread of Neolithic farmers (Utrilla et al. 2012); and mass migration of Mesolithic groups from Lower Aragon due to the 8.2 k BP (*c*.6200 BC) climatic recrudescence event, a period allegedly marked by a major settlement gap in the area (Utrilla and Domingo 2014; Utrilla and Bea 2015). According to the latter proposal, these communities would have taken refuge in the neighbouring region of Valltorta-Gassulla (Castellón), but not before leaving evidence of their departure on the rock shelters of their homeland in the form of paintings of large human groups on the move (Utrilla and Bea 2015). This proposal, which integrates data provided by pictorial, archaeological, and palaeoclimatic records, argues that territorial reorganisation in the wake of the 8.2 ka BP cooling event would also have seen increasing competition over resources. The portrayal of wounded archers, as well as alleged depictions of abducted women in Valltorta-Gassulla area, could thus be read as graphic evidence of growing conflict (Utrilla and Bea 2015).

In order to assess the strength of this proposal, each line of the argument must be analysed separately. With regard to the pictorial record, three main elements characterise the portrayal of violence during the Pachypodous phase. First is the fact that the scenes with violent contents are uncommon. Despite the large area covered by this style, including Castellón, Teruel, Tarragona, and Lérida, and the presumably long time span of its development, only five scenes of interpersonal violence have hitherto been documented (López-Montalvo 2015). Secondly, most of these scenes are found in a circumscribed area of the Maestrat region (Castellón), comprising the Saltadora shelters, in the upper Valltorta ravine, and the Cova Remigia shelter, in the neighbouring Gassulla ravine. Finally, the portrayal of violence is limited to the depiction of archers shot down by projectiles, either in isolation or in pairs, as is the case of the Saltadora VII and the Remigia I shelters (Fig. 5.5). Outside this area, only a single wounded archer is documented from Serra de Llaberia, Tarragona (López-Montalvo 2015).

This way of depicting violence marks out the Pachypodous phase as different from all subsequent stylistic phases in that the narrative focuses on the outcome of the action, i.e. the killing of the archers. As no information is provided about the killers, who are solely alluded to by the projectiles, it is difficult to assess whether these scenes intend to show one-to-one fights or group clashes. Their intrinsic ambiguity has given rise to contrasting interpretations ranging from intertribal scraps motivated by territorial disputes (Mateo Saura 2000) to intra-community executions of perceived dangerous or threatening individuals (Guillem and Martínez Valle 2004). Be that as it may, the narrative changes dramatically in the following phases, as the focus of the paintings shifts from the outcome to the unfolding of conflict (see below).

It has been recently proposed that certain Pachypodous scenes would depict abducted women. This was suggested, in particular, for images from the Centelles, Covetes del Puntal, and Saltadora IX shelters, where female figures, crouching next to men, are ostensibly painted with their arms tied together (Centelles and Saltadora shelters). At Covetes del Puntal, moreover, blood would allegedly run from the body of one of the 'captive' women (Utrilla and Bea 2015) (Fig. 5.6). However, recent in situ re-examination and digital recording of the images has cast doubts on this interpretation. The layout of the women's arms seems to be due to a Pachypodous stylistic convention that has nothing to do with the tying up of captives. Similarly depicted female arms are shown at other rock art panels from the Maestrat region (Fig. 5.6), in which women are not associated with violent acts or weapons (e.g. at Cingle de Palanques and Rossegadors rock art shelters), nor are they depicted next to men (e.g. at the Racó Gasparo rock art shelter). Furthermore, in the case of the so-called Venus of Valltorta (Covetes del Puntal), a re-examination of the painting suggests that the red pigment previously interpreted as blood may be something else altogether. Although now seriously degraded, the pigment seems to portray a figure of some kind, probably an animal. Additionally, the presence of differently coloured pigments between the female figure and the alleged blood suggests that the two motifs may not be coeval. Finally, and most importantly, it is utterly uncommon in this pictorial tradition to show (human) blood, even in the most gruesome and explicit battle scenes. As for the Saltadora IX rock art shelter (Domingo Sanz et al. 2007), the reading of the three figures involved in the alleged scene of abduction is complex due to the extreme degradation of the pigments. A recent reassessment of

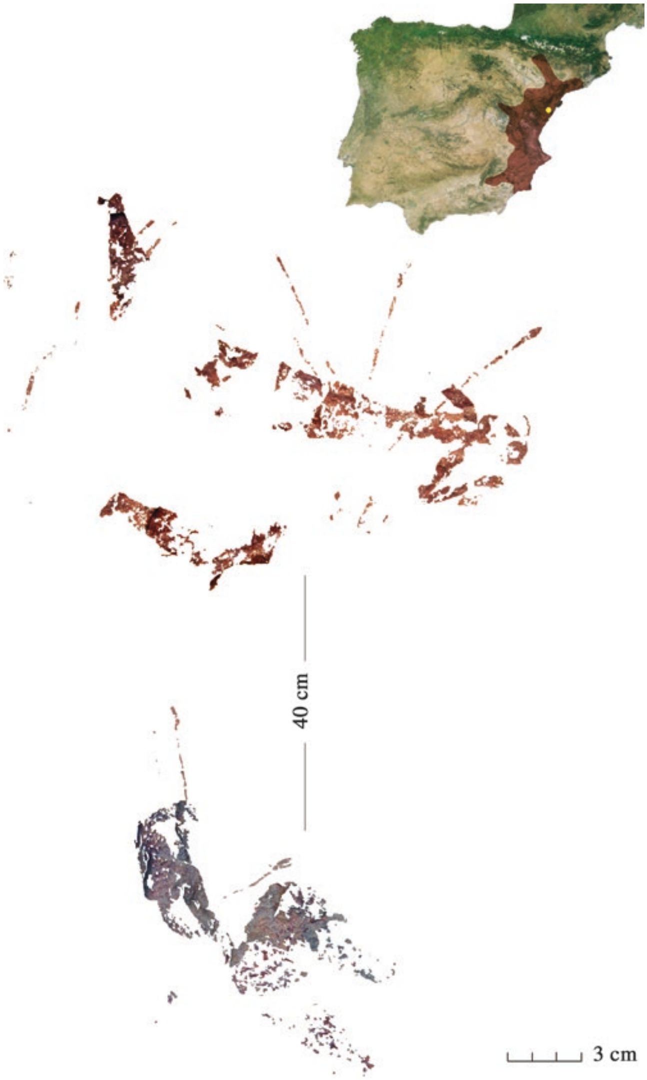

Fig. 5.5 Wounded archers from Cova Remigia I (Ares del Maestre, Gassulla, Castellón) (Digital tracing by E. López-Montalvo)

the site (Domingo Sanz et al. 2007) has not identified any of the figures as women and has cast doubt on the overall interpretation of the scene. Finally, the Centelles shelter (Fig. 5.7) is a complex panel that lends itself to competing interpretations (Villaverde et al. 2006). The concentration of figures, the different styles utilised in their depiction, the complex overlaps and superimpositions between motifs, and the notable preservation issues all contribute to make this panel extremely difficult to

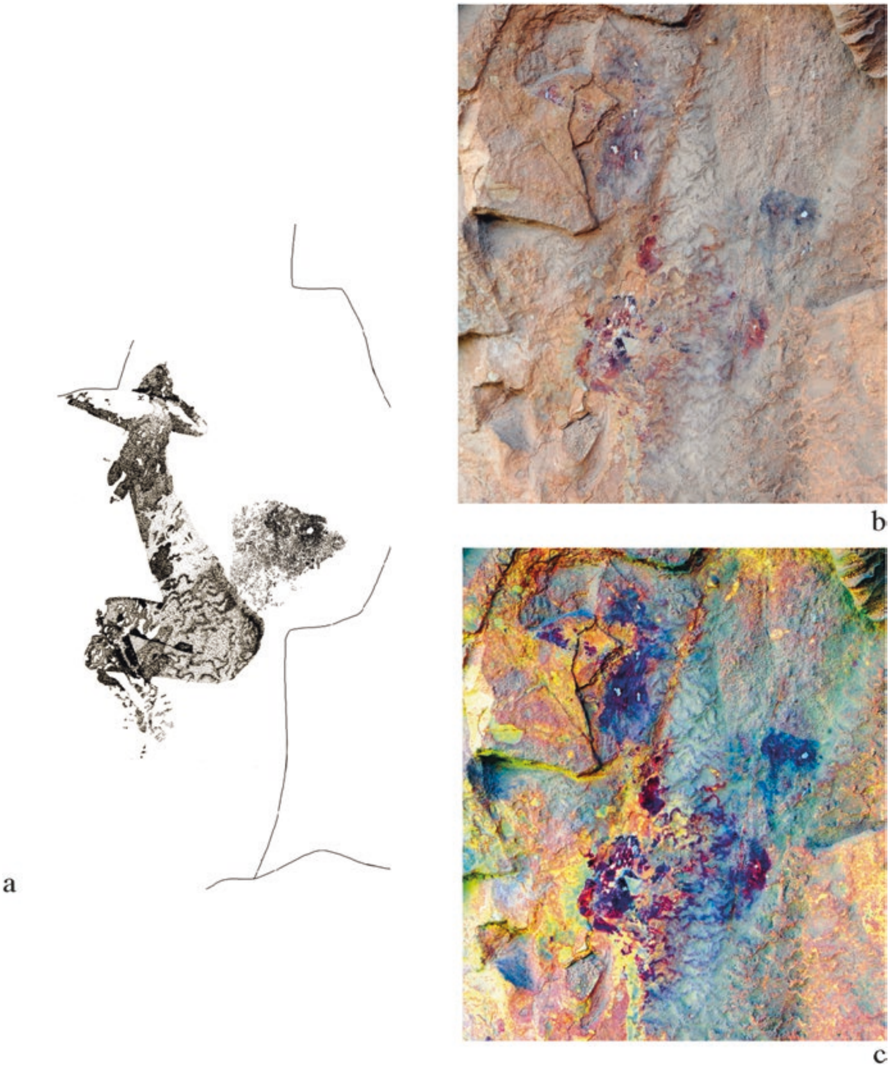

Fig. 5.6 (**a**) The so-called Venus of Valltorta (Covetes del Puntal). (**b**, **c**) Female figures from Covetes del Puntal (Valltorta, Castellón) (Viñas 1982). Remnants of pigment are still visible on the left-hand side of the panel. (Image (**c**) has been colour-enhanced by the author using DStretch)

read. These considerations suggest that current interpretations of abducted women in Pachypodous style rock art are to be treated with extreme caution.

As far as the archaeological and palaeoenvironmental evidence is concerned, the argument whereby the Pachypodous phase should be dated to the Mesolithic period, and in particular to the Geometric phase B in Lower Aragon (coinciding with the 8.2 ka BP climatic event), is problematic. On one hand, the alleged relationship (established by Utrilla and Bea 2015) between the Pachypodous stylistic phase and

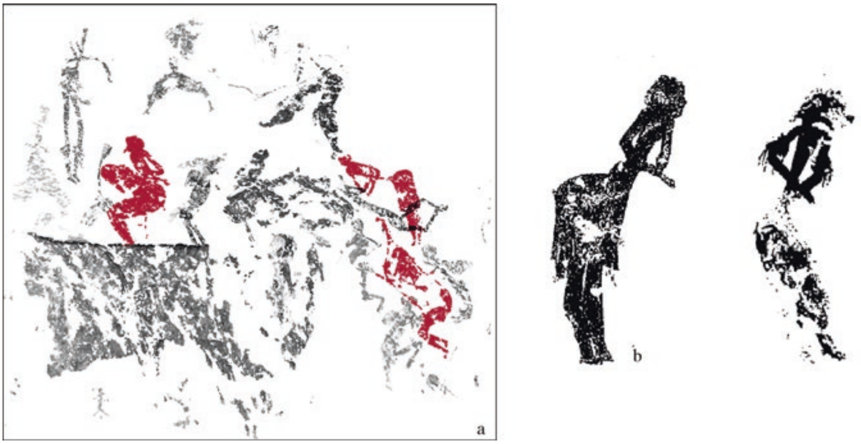

Fig. 5.7 (**a**) Scene from the Centelles shelter (Albocàsser, Valltorta, Castellón) showing female figures in red. (**b**) Women from the Racó Gasparo shelter (Gassulla, Castellón). (**c**) Women from the Cingle de Palanques shelter (Els Ports, Castelló). (Modified from Viñas et al. 2015; Porcar 1965; Mesado Oliver 1995)

Mesolithic Geometric settlements in Lower Aragon is far from proven, considering that several sites, such as El Pontet (Maella, Saragosse), El Angel (Ladruñán, Teruel), and Botiquería (Mazaleón, Teruel), show long sequences of occupation including both Mesolithic and Neolithic layers (Utrilla and Domingo 2014). Given the absence of radiocarbon dates for the Levantine paintings, the combined analysis of stylistic and archaeological evidence remains a complex but indeed necessary approach and one that requires more elaborate landscape-based approaches than the ones attempted thus far (Cruz Berrocal 2005; Fairén 2006; Villaverde et al. 2016). On the other hand, one ought to carefully assess whether the settlement gap observed in Lower Aragon between 6200 and 5700 BC is genuinely motivated by the 6200 BC (8.2 ka BP) cooling event or is simply due to radiocarbon dating problems ranging from the use of heterogenous materials including long-lived wood samples to the lack of unified calibration criteria and methods.

Moreover, the breaking out of fights over forager group rights to control resources, which is supposedly captured in the depictions of Pachypodous wounded archers, is at variance with the archaeological record known for this period. Demographic estimates available for the Maestrat region suggest that population density was not as high in the Mesolithic as to explain such an increase in conflict over resources (Fernández López de Pablo 2006; Villaverde et al. 2016). If scuffles or all-out warfare did actually take place in this area, there might be different reasons for that.

Finally, this hypothesis is grounded in a controversial proposal: that is, the identification of Lower Aragon as the area where the Levantine pictorial tradition would have first emerged. This problem, however, cannot be assessed from a regional perspective, but rather by means of a holistic stylistic and archaeological analysis in the entire Levantine rock art area, paying special attention to the identification of exchange networks and their evolution over time. Unfortunately, the data needed to carry out such an evaluation are presently scant.

As is clear from this review, violence was represented infrequently in the Pachypodous stylistic phase and normally focused on just one or two individuals at a time. In all instances, violence is depicted as a masculine sphere of action. In fact, women are very rarely shown within scenes of violence in Levantine rock art as a whole, and they are never directly involved in offensive action (López-Montalvo 2015). As they are solely found in specific areas, Pachypodous depictions of violence can best be explained with small-scale intertribal conflict or isolated scraps. As for the chrono-cultural framework of Pachypodous scenes of violence, the combined analysis of the location of rock art shelters and Mesolithic sites, as well as the superimposition of certain Pachypodous figures over Schematic motifs, does not allow us to accept a wholly Mesolithic chronology for Levantine rock art nor to presume the existence of Mesolithic conflict caused by growing pressure over scarce resources. Similar conclusions can also be reached with regard to the proposed dating of the Pachypodous style to the Mesolithic Geometric phase B, as well as the alleged portrayal of abducted women.

Foragers Versus Farmers?

In a similar way, the hypothesis arguing for Levantine rock art to be a form of cultural reaction to the arrival of the first Neolithic settlers stresses the emergence of conflict as a result of territorial, social, and economic competition (Llavori de Micheo 1988–1989). To assess this hypothesis, one should consider multiple factors including the Levantine stylistic sequence, the archaeological data available for early forager-farmer interaction, and the information provided by the scenes of interpersonal violence including their diachronic evolution and their uneven distribution in the rock art area.

Regarding the first and second aspects, the remarkable stylistic variation observed in Levantine rock art and frequent reuses of the same panels over time suggest that this pictorial tradition developed over a long period of time and also grew into distinctive regional styles. This does not fit well with the archaeological evidence available for the Neolithisation period in Mediterranean Iberia, which is currently thought to be short-lived. According to the latest scholarship, this lasted for 200–300 years from about 5650 BC, after which period Mesolithic evidence all but disappears from the area (Juan-Cabanilles and Martí Oliver 2007–2008; Bernabeu Aubán and Martí Oliver 2012).

The third aspect underpinning this proposal, i.e. the alleged conflict between indigenous foragers and incoming farmers, must be assessed carefully. This is best done in the areas showing the highest concentrations of scenes of interpersonal violence, as these can be envisaged to reflect actual hotspots of prehistoric conflict. These areas are Valltorta-Gassulla (Castellón) and the Upper Segura River, with

Taibilla-Nerpio (Albacete-Murcia) being a site of special interest in the latter area (López-Montalvo 2015). Valltorta-Gassulla is taken here as a case study, for in recent years it has seen a surge in the research of both Levantine rock art and the regional archaeology. Moreover, this area is of special interest as it boasts the greatest concentration of scenes of violence and warfare (21 scenes hitherto documented); the longest time span in terms of stylistic phases involved, ranging from the Pachypodous to the linear phase; and the most varied evidence of violent acts, including wounded archers, battles, execution squads, and various other images of death and conflict (López Montalvo 2011, 2015).

The archaeological evidence from this area indicates low population density during the late Mesolithic and early Neolithic. It is only during the middle Neolithic (*c*.5000–4000 BC) that settlement evidence increases, thereby showing higher population density and more intensive exploitation of resources (Casabó 2013). All Neolithic sites from the area appear to have newly been founded in this period. With regard to the interaction between late Mesolithic and early Neolithic communities, which is central to the forager-farmer conflict argument, all archaeological contexts known from Mediterranean Iberia present notable taphonomic alterations (Bernabeu Aubán 2006; García Puchol et al. 2004; García Atiénzar 2011). The Valltorta-Gassulla region is no exception to the general trend, for several archaeological sites (e.g. Cingle del Mas Cremat and Portell de Morella in Castellón) show sterile levels between the latest Mesolithic and the earliest Neolithic occupation (Vicente Gabarda et al. 2009). Similarly, other sites (e.g. Mas de Martí and Albocàsser in Castellón) display complex taphonomic alterations making the identification of the Mesolithic-Neolithic transition levels difficult (Fernández López de Pablo et al. 2005). Such problems stand in the way of any thorough and unbiased assessment of forager-farmer interaction in the area.

If one discards the explanation arguing for an autochthonous process of Neolithisation of the indigenous Mesolithic communities, which is widely questioned, it remains to evaluate the hypotheses of the acculturation or assimilation of the local Mesolithic groups into the novel Neolithic way of life, with conflict likely arising during the process. Unfortunately, both settlement and burial data are inconclusive in this respect. The taphonomic problems concerning the former have been discussed above; as for the latter, no evidence of violent trauma has been recorded during the early Neolithic neither in Valltorta-Gassulla nor in the entirety of Mediterranean Iberia. Broader difficulties with characterising prehistoric violence must also be stressed (Vencl 1984; Jackes 2004; Kim and Keely 2008). These are partly due to the scant funerary data concerning both the Mesolithic-Neolithic transition period and the early Neolithic (Bernabeu et al. 2001; Rojo et al. 2016) and partly to widespread problems with the objective identification of violent acts, their interpretation as interpersonal or collective violence, and the discrimination between violent and accidental trauma on human remains (Thorpe 2003). With regard to early Neolithic Iberia, the only burial interpreted as a likely execution comes from El Llano del Montico (Navarra), an inland site that is located outside the Levantine rock art territory (Rojo et al. 2016). Alleged episodes of cannibalism are also documented at certain Andalusian Neolithic sites (Botella et al. 2002). These too seem to point to violent practices, which however would have had strong symbolic or ritual dimensions (Knüsel and Outram 2006).

In the absence of conclusive archaeological evidence regarding forager-farmer interaction and conflict, we must focus our analysis on the information provided by the rock art, paying special attention to overlaps between Levantine depictions of violence and Schematic motifs. The best such evidence is provided by the Coves del Civil panel discussed above, in which the Levantine paintings partially cover Schematic motifs (Fig. 5.4). The Levantine figures belong to the Cestosomatic stylistic phase, which is thought to be the second in the regional sequence, while the Pachypodous figures from the same panel lie at the margins of the figurative space. This contradicts the habitual spatial patterning of Pachypodous images, which tend to occupy the central and upper areas of the panels (López Montalvo 2009). The overlying of Cestosomatic and Schematic motifs and the spatial patterning of the Pachypodous images allow us to conclude that at Coves del Civil, both Pachypodous and Cestosomatic depictions are later than the Schematic motifs. This unambiguously places the first phases of the Levantine pictorial tradition at the time of the early Neolithic communities in the region.

Considering this evidence, we must refuse the proposition that the violence depicted on Levantine rock art panels can be explained with conflict between foragers and early farmers. In particular, the period of time between the arrival of the first Neolithic farmers and the disappearance of all Mesolithic evidence from Mediterranean Iberia – thought to be in the range of 200–300 years – is not long enough to account for the rich evidence of panel reuse, the stylistic changes, and the complex superimpositions of motifs documented at rock art shelters such as Coves del Civil.

Conclusion

The analysis of Levantine rock art must be framed in the social and economic dynamics of the Neolithisation process (and full development of the Neolithic), taking three elements into account: firstly, the territorial and temporal relationship between Levantine rock art and the Macroschematic and Schematic horizons, which are both securely dated to the Neolithic; secondly, the internal Levantine stylistic sequence and the location of the various stylistic phases in the landscape; and finally, the archaeological evidence at both regional and macro-regional scales. The latter aspect is of special importance if we are to make any progress in understanding the chronological and social context in which Levantine rock art developed.

Previous research by this author has focused on the combined analysis of both depictions of violence and the archaeological markers of violence in Mediterranean Iberia from the sixth to third millennia BC. This has led to a better understanding of the social dynamics of prehistoric societies from the region (López-Montalvo 2015, 2018). The research has also shown that the representation of violence on Levantine rock art likely increased over time. Interpersonal and group violence is thought to have grown alongside other phenomena including social complexity and the emergence of high-ranking individuals, whose social standing may have arisen from their skills and bravery in combat.

Building on this work, the analysis carried out in this chapter has led to a re-evaluation of the chronology of Levantine rock art. Two contrasting chrono-cultural frameworks were discussed: one that suggested a wholly Mesolithic trajectory for this pictorial tradition and one that saw it emerge from the encounter between indigenous foraging communities and incoming Neolithic settlers.

As argued throughout the chapter, there is currently no archaeological or pictorial evidence supporting the first hypothesis. As for the second proposal, despite the scant archaeological evidence concerning the Mesolithic-Neolithic transition in Mediterranean Iberia, the pictorial record is unambiguous in showing that even the earliest Levantine stylistic phases – Pachypodous and Cestosomatic – are later than the Neolithic Schematic motifs they overlie. This suggests that the emergence of Levantine rock art may be explained with the expansion and consolidation of prehistoric farming communities. The evidence of social complexity inferred from the rock art agrees with this hypothesis, as generally does our knowledge about developed Neolithic societies in the region. Even though it is at times difficult to piece together the archaeological and pictorial evidence, the marked increase in the depiction of violence over the time and the likely emergence of specialist warriors (hinted at by battle and execution scenes in the latest Levantine stylistic phases) are fully in line with the material evidence of social complexity, inequality, and collective violence seen in the Iberian Peninsula during the late Neolithic (Gibaja 2005).

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Chapter 6
Fast Like a War Canoe: Pragmamorphism in Scandinavian Rock Art

Christian Horn

Introduction

Scandinavian rock art is a rich source of information regarding societies and people's lives during the Bronze Age. Rock art was made for the purpose of expressing thoughts in an idealized form, including believes, perceptions, ideologies and myths. Warriors, rivalries, violent encounters and travels are depicted on the rocks, all based on real-life experiences as far as the archaeological record can tell us (Ling 2012; Fyllingen 2003; Kjær 1912; Frei et al. 2015; Kristiansen and Larsson 2005; Ling et al. 2013). However, several social and mental filters, i.e. ideology, perception, expectation, tradition and intention, must have shaped and influenced the images before they were carved (Bertilsson 1989: 315; Ling and Cornell 2010; Toreld 2012; Bevan 2015). Previous work on the subject has shown that rock art was not necessarily stable over time and that images were not conceived as complete compositions from the outset. Several researchers have pointed out that panels were built up over time, with new motifs being added as late as the Late Iron Age. Particular lines were often re-engraved ostensibly to reactivate certain parts of an image; this is evident in those cases in which the newly carved lines show in a lighter colour than the rest of the carving (Bengtsson 2004; Ling 2008; Goldhahn and Ling 2013; Nilsson 2012; Hauptman Wahlgren 2004). However, no researcher has hitherto entertained the notion that later re-engravings could have *transformed*, subtly or openly, the carved motifs, thus fundamentally altering their original meanings. As a matter of fact, research has used superimpositions as means to build relative chronologies for Scandinavian rock art (e.g. Burenhult 1980), while the few studies that go beyond this seem to imply that later additions are nothing but

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upgrades of the original motifs (e.g. Fredell 2003: 229). The chapter aims to explore the social implications of the transformation of rock art. However, since a wholesale interpretation of such a rich and diverse corpus of rock art would be problematic, the chapter will concentrate on a particular group of figures, i.e. those in which body parts are replaced by objects.

At the heart of the following considerations lies a group of images that merges human bodies and objects, i.e. boats and weaponry. These carvings represent a small but significant group in rock art data comprising over 3800 individual anthropomorphic figures which were compiled in a database by the author for a spatial network analysis of human figures in Scandinavian rock art. These figures interact with different objects that have been identified partly by reference to the archaeological record but also by interpreting objects and assigning a specific function to them based on their form. The database was analysed using MS Excel and the social network analysis software UCINet 6 and Gephi. Naturally, anthropomorphic images are mainly found in regions rich in rock art, namely, Tanum, Uppsala (both Sweden) and Østfold, Norway (Fig. 6.1). Overall, the human figures under discussion date to the Nordic Bronze Age, possibly excluding the first and the last periods (Table 6.1).[1]

In the following pages, after a description of the images in question, the theoretical concept of pragmamorphism will be deployed to interpret the carvings. Pragmamorphism is the infusion of body parts with qualities of objects (Derman 2012). This paper seeks to explore this group of images and what they might tell us about warriors, body images and material objects. The questions to be investigated include:

- What kind of relationship is depicted between objects and bodies?
- How was the body of a warrior perceived?
- Which bodily characteristics were important in a warrior?

Rock Art and Warriors in Southern Scandinavia

Not considering the tens of thousands of cup marks occurring in the region, figurative rock art exists in southern Scandinavia with a plethora of motives including ships, humans, horses, oxen, birds, wagons and ploughs. With over 19,000 depictions, canoes dwarf the number of human figures documented in the area (Ling 2008); still, the latter make up a substantial amount of engravings with over 3500 in Bohuslän alone (Bertilsson 1987). Undoubtedly, land-focussed images also exist,

[1] As a brief technical note, it should be mentioned here that the abbreviation RAÄ refers to the cataloguing system of the Swedish National Heritage Board (Riksantikvarieämbetet). The rock art images represented in the illustrations have been redrawn from rubbings, tracings and photographs available on the website of the Swedish Rock Art Research Archive (www.shfa.se). In Figs. 6.3, 6.4 and 6.5, the image under discussion has been coloured black, while the surrounding images are grey. This will enable the reader to focus on the particular position of human body and attached objects.

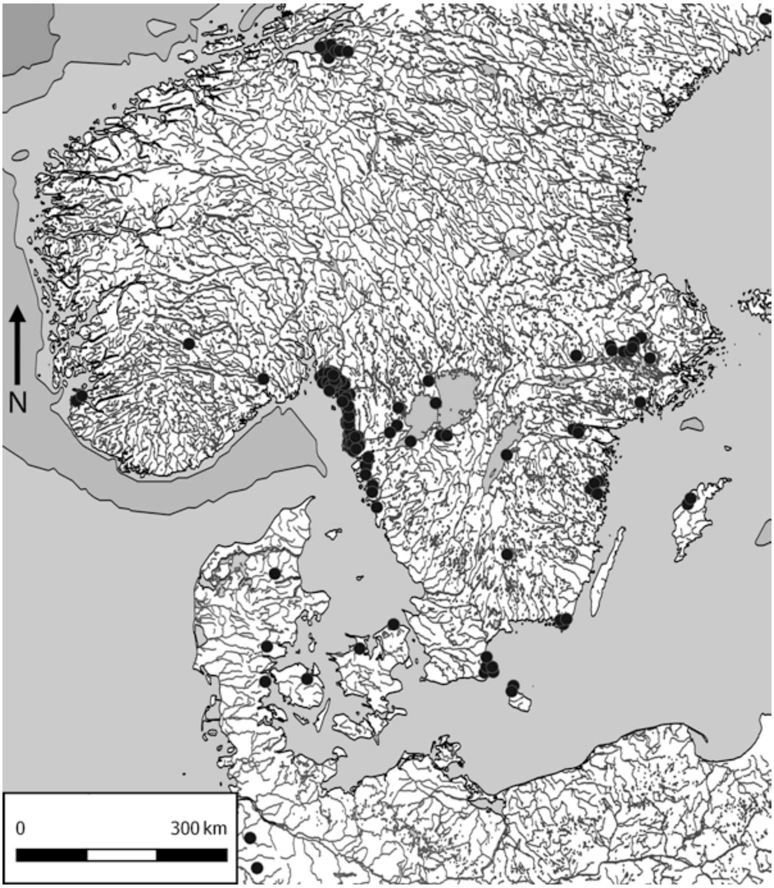

Fig. 6.1 Map of anthropomorphic rock carvings in southern Scandinavia (major sites only)

Table 6.1 Periodization of the Nordic Bronze Age (Montelius 1917; Olsen et al. 2011)

Period I	1750/1700–1500 BC
Period II	1500–1300 BC
Period III	1300–1100 BC
Period IV	1100–920 BC
Period V	920–720 BC
Period VI	720–550 BC

which depict agricultural practices including ploughing (RAÄ Tanum 193:1) and animal herding (RAÄ Bottna 56:1) (Almgren 1927). However, in maritime locations a clear focus on canoes has been noted (Coles 2008; Ballard et al. 2004; c.f. Ling 2008). By projecting ship engravings on a map with the Bronze Age shoreline modelled on the land uplift, Ling was able to show that some might even have been applied from the sea while being in a canoe. This observation has led him to hypothesize that seafaring practices and institutions such as maritime warriorhood may have been very important during the Nordic Bronze Age (Ling 2008, 2012). This can be seen on panels showing natural water flow marks crossing their surfaces, as the marks were often incorporated into the carved scenes. For example, canoes may have been placed at the centre of the water mark, or this may have been used to separate engravings (Bradley 2000; Bengtsson 2004). This seems to support the notion that rock art canoes and warriors were closely connected to waterways. Carvings often depict seemingly idealized warriors: muscular, phallic, sometimes horned and usually armed. Such stylistic conventions find a material expression in the rich contemporary graves and hoards that have yielded swords and spears, which, on occasion, are highly ornamented (Earle and Kristiansen 2010). This suggests that waterborne mobility would have played a central role in the construction of warrior identities in Bronze Age southern Scandinavia.

Following Alfred Gell's concept of secondary agency, Johan Ling and Per Cornell have argued that rock art was made with the intention of influencing outcomes in the real world (Ling and Cornell 2010; c.f. Gell 1998). Their view that rock carvings influenced human action by reinforcing social ideals (e.g. by encouraging travellers, frightening intruders, etc.) is based on the observation that canoe engravings are mostly close to the ancient shoreline. Since other rocks would have been available to Bronze Age artists, it was not necessary, from a practical standpoint, to engrave rock art using repeated percussive actions from a potentially unstable canoe. This choice may thus be interpreted as an entanglement of important social practices, namely, seafaring and the performance of rituals.

In the Nordic Bronze Age, direct evidence of warfare exists, among other things, in the form of combat marks on weaponry (Horn 2013b; Kristiansen 1984, 2002); sites of violent conflict such as the Tollense Valley battlefield, Germany (Brinker et al. 2014; Chap. 3, this volume); a mass grave of massacre victims from Sund, Norway (Fyllingen 2003, 2006); and a male burial with a spear tip embedded in his pelvis from Over Vindinge, Denmark (Kjær 1912). In rock art, killing scenes displaying the use of swords and spears provide further evidence of the existence of warriors (Toreld 2012, 2015). This, and the presence of weapons in male burials, indicates that actual fighting lay at the heart of Bronze Age warrior identities. Whether those who claimed this identity were actually those who fought is, for the purpose of this paper, relatively unimportant, although the combat wear visible on the weapons from contemporary graves does suggest that those imbued with warrior identities were also involved in real combat practices (Horn 2013b; Kristiansen 1984, 2002).

Based on the observation that important features and passages in maritime travel, such as narrow straits, acted as hotspots for the ritual deposition of weaponry used in combat as well as the carving of figurative rock art, it has been argued that waterborne raiding was an important aspect of violent conflict during the Nordic Bronze Age (Horn 2016b; Melheim and Horn 2014). This is substantiated by the observation that the same maritime features and passages were also important for Viking Age raiding activities, because they are placed in strategic locations that facilitate fast transport and enable control over exchange routes (Horn 2016b). If we analyse

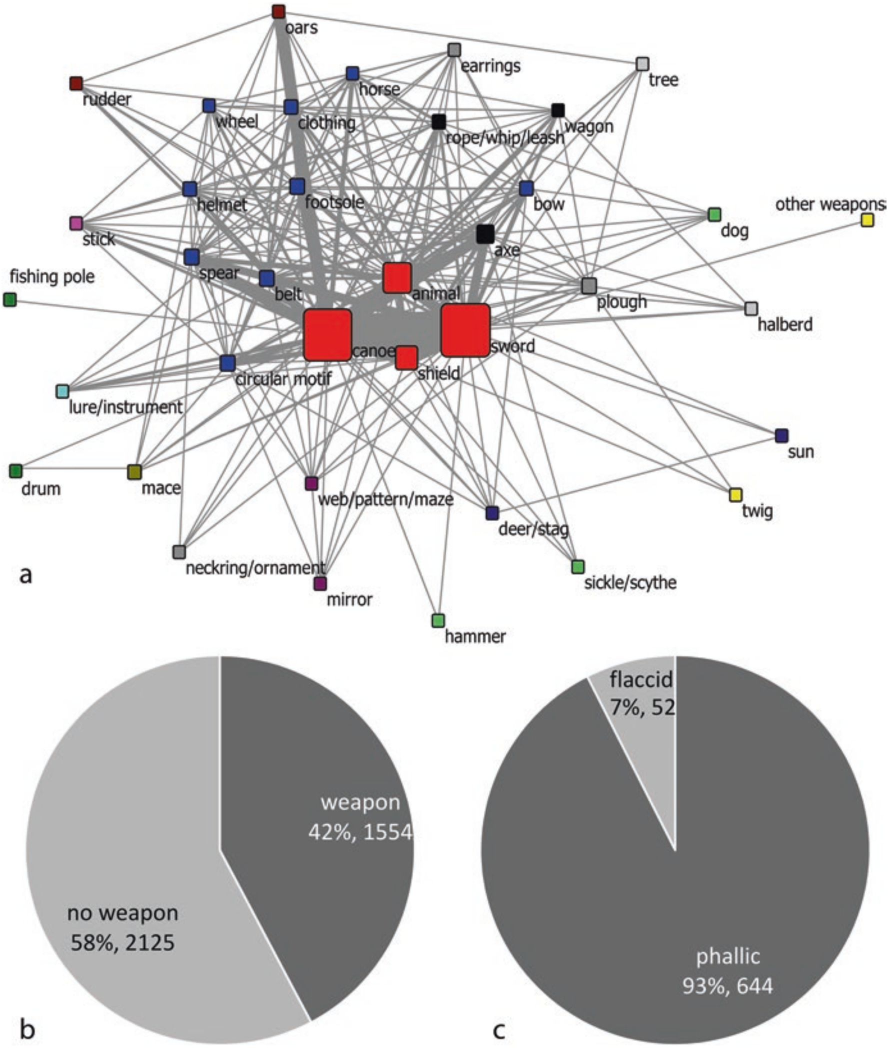

Fig. 6.2 (**a**) Network pattern of objects associated with anthropomorphic figures; (**b**) anthropomorphic figures with weapons vs. those without weaponry; (**c**) phallic figures vs. figures with flaccid genitals

our database by means of pie charts and network analysis, we can make three general observations supporting the notion that warriors, violent conflict and maritime practices were highly important in Nordic Bronze Age societies:

- Boats are linked to human figures in general and warrior figures in particular (Fig. 6.2a; Ling 2008).
- About a third of all humans possess weapons (Fig. 6.2b; see also Nordbladh 1989).

- When sex is depicted, most of the warriors are phallic (Fig. 6.2c; see also Kristiansen 2014b; Skogstrand 2014; Yates 1993).

This further indicates that such images were based on, and in turn reaffirmed, maritime practices – above all seafaring. They were also connected to certain social institutions, in particular maritime warriorhood (Ling 2008: 203, Ling 2012; Kristiansen 2014b). We can also assume that the high prestige, which must have been connected to the warrior ideal, was grounded in the actual involvement in violent action, which possibly aimed to maintain the flow of metal into southern Scandinavia and reinforce tribal alliances (Kristiansen and Suchowska-Ducke 2015). This involvement could have played out at two levels: organizing raids and warfare facilitated by waterborne mobility and actively participating in the raids as a boat crewmember and fighter.

It must be said, however, that human figures in Scandinavian rock art have been interpreted in a variety of ways, including gods (Kaul 2003; Kristiansen 2014a; cf. Goldhahn and Ling 2013). Although the images possess recurring normative features that could possibly represent godly attributes, it is argued here that they are too varied to be deities. Rather, these figures may refer to the realm of the ancestors and heroes engaged in ritual and other social practices (Ling and Cornell 2010; Coles 2003; Goldhahn and Ling 2013; Fari 2003; Kristiansen 2014a). There is also a wider argument to be made against the interpretation of anthropomorphic figures as gods, at least in most cases. Generally, social organization in the Nordic Bronze Age is thought to be based on decentralized polities – the so-called chiefdoms (Kristiansen 2007). In this context, in order to stabilize power relations, chiefs would have needed to control the flow of raw materials as well as the playing out of conflict and spiritual matters (Kristiansen and Larsson 2005; Earle et al. 2015). However, as most rock art sites are accessible and widely visible, it can be presumed that rock art was inherently hard to control (Earle 2013). In this context, carving practices may be seen as political arenas used by chiefs to strengthen their support and attract followers. This could have been achieved through the depiction of popular myths taken from a shared oral heritage, for example, iconic episodes from tales or poems narrating the deeds of heroes and ancestors. Whether the images were carved and re-carved by the chiefs themselves, or by commoners, cannot be determined at present. Whichever the case, the rock art sites are best interpreted as arenas for the playing out of local politics rather than locales used for the expression of a normative, strictly regulated religion.

Furthermore, it is clear that images were added to and transformed over time in a wide variety of ways, for example, by constantly adding new images to existing panels (Bengtsson 2004), by re-carving lines to emphasize particular features (Hauptman Wahlgren 2002, 2004) and by reusing cup marks as heads in human figures (Horn 2016a). This indicates forms of active engagement with the rock art, which seem to be more in line with ancestral or hero worship than the worship of some deity, for which we would expect to see the panels being treated as sacrosanct and perhaps immutable. We may therefore conclude that stories, maritime practices or social archetypes such as ancestors and heroes were depicted on the rocks, rather than gods (Earle 2013; Ling and Cornell 2010; Melheim 2013).

Morphing Things into Body Parts

Certain rock art panels display a particular transformation of human figures: body parts and objects morphing into each other. For example, sometimes the line that indicates the sword sheath seems to be prolonged in front of the body (Fig. 6.3a and b). It would be reasonable to maintain that this is the hilt extending at crotch level, because it would naturally extend here if the sword was carried on a belt around the hips. However, there are good reasons to argue that this depicts at once the sword's hilt and the person's phallus. This kind of representational ambiguity can be seen in

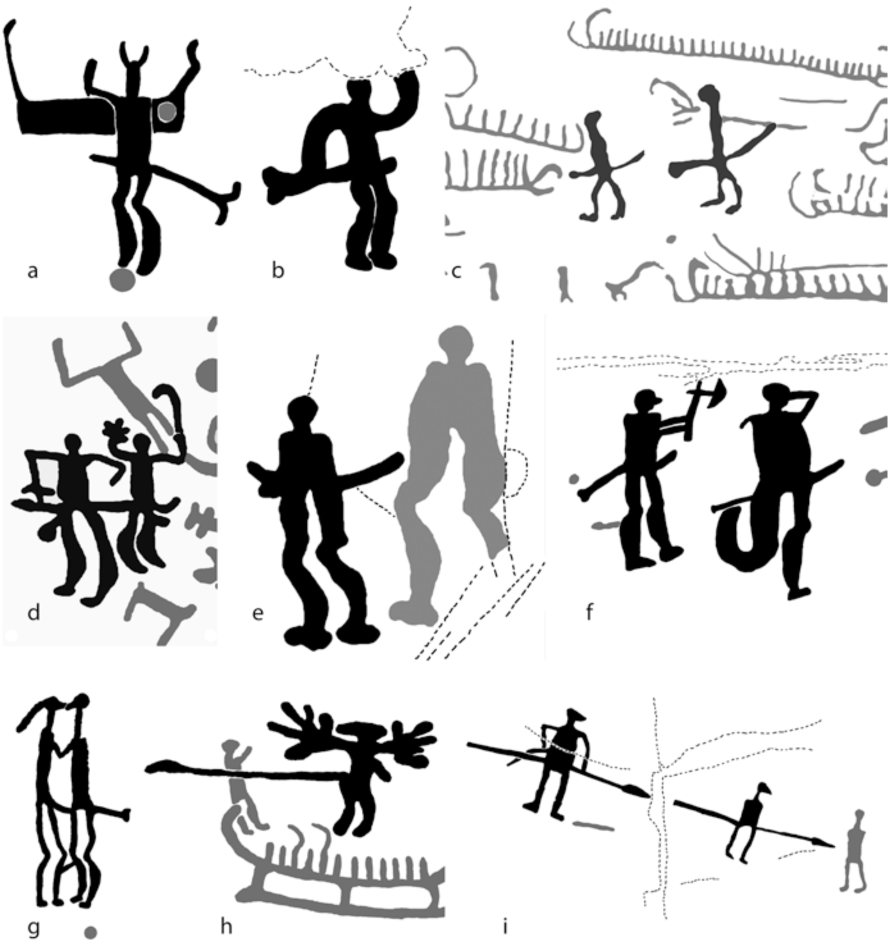

Fig. 6.3 (**a**) Färlev, Bro RAÄ 607:3; (**b**) Balken, Tanum RAÄ 262:1; (**c**) Bjørngård I, Stjørdal Askeladden ID: 7204–3; (**d**) Säm, Tossene RAÄ 97:1; (**e**) Södra Torp, Kville RAÄ 204:1; (**f**) Fossum, Tanum RAÄ 255:1; (**g**) Vitlycke, Tanum RAÄ 1:1; (**h**) Aspeberget, Tanum RAÄ 12:1; (**i**) Fjäll, Bro RAÄ 33:1

particular in certain figures, which were engraved with greater anatomical details than most. Here, the 'hilt' sometimes includes testicles and/or the glans (Fig. 6.3c, d and e). In other cases, the line curves upwards – a feature unknown on Bronze Age sword hilts which, however, is compatible with a phallus in a state of arousal (Fig. 6.3e and f). Occasionally, the two lines do not quite match up, thus further reinforcing the ambiguity between objects and body parts (Fig. 6.3f). In all these cases, it may be suggested that the hilt and phallus were deliberately equated with one another. This is further supported by sexual intercourse scenes (Fig. 6.3g) which also depict the phallus as a continuation of the sword sheath (Fari 2003). Sporadically, other weapons are depicted in a similar position, for example, spears (Fig. 6.3h and i).

Less frequent and more complex are depictions of canoes morphing into human body parts. These can take various forms. Most frequently, on canoes a longer line, for example, the keel line, extends in front and behind human beings at the hips. This is the typical placement for the combination penis/hilt and sheath mentioned above. In this case, too, it can reasonably be argued that the keel metaphorically stands for the sheath and the prow for the phallus (Fig. 6.4a, b and c). At least 157 cases have been identified in which canoes and human bodies form such hybrid figures. Despite occasional interpretative difficulties, this occurs too frequently, and the placement of objects and anatomical parts is too precise to be a mere coincidence. It is my contention that these depictions would bring boats and phalli into an intentionally ambiguous relationship and, in a sense, one that allowed equivocating one with the other. Moreover, where lines of canoes extend through the body, the carvers' intention was arguably to morph canoe, sword and phallus into one another.

Canoes also replace other body parts. Anthropomorphic figures may use ships for arms and prows for legs (Figs. 6.1a and 6.4d, e). Conversely, certain rock carvings allow for an inverse perception of these figures in that arms can imitate typical, if simplified, canoe shapes and legs may stand for prows (Fig. 6.4f, g). At times, human figures are constructed from multiple boats, while in other cases, humans appear to be hidden within compositions of multiple boats (Fig. 6.5a). Lastly, canoes may be carved as having legs or hands instead of prows (Fig. 6.5b, c). Taking all these depictions into account, there appears to be a considerable degree of variability in the morphing of canoes into body parts. The range of possibilities to build human bodies with object seems to represent a continuum of abstraction from the replacement of smaller parts of the body to a quasi-complete construction of the body from objects. This blurs the distinction between humans and things, perhaps suggesting that people in the past may not have considered the two as distinct and separated entities (Olsen 2010; Fowler 2004: Table 2.1).

Some of these superimpositions may be accidental, because older eroded engravings might have been hard to discern for new carvers. However, most of the features discussed above are arranged very neatly and show consistent matchings of objects and body parts. For example, rarely do boats intersect human bodies at an oblique angle – a fact that indicates an awareness of extant carvings. Moreover, on most panels, there would have been enough space to carve new pictures without tampering with the old ones. This can be appreciated in the many cases in which Bronze

Fig. 6.4 (**a**) Gisslegärde, Bottna RAÄ 74:1; (**b**) Övre Tun, Svenneby RAÄ 17:1; (**c**) Aspeberget, Tanum 25:1; (**d**) Tuvene, Tanum RAÄ 302:2; (**e**) Torsbo, Kville RAÄ 157:1; (**f**) Hopestad I, Telemark Askeladden ID: 101851; (**g**) Askum, Askum RAÄ 57:1; (**h**) Vitlycke, Tanum RAÄ 1:1; **i** Askum, RAÄ 68:1

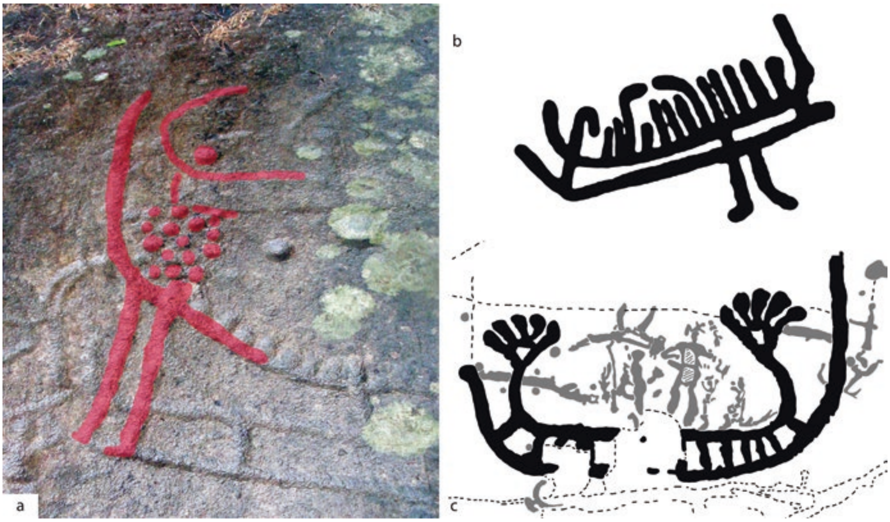

Fig. 6.5 (**a**) Kalleby, Tanum 406:1; (**b**) Askum RAÄ 6:1; (**c**) Backa, Brastad RAÄ 1:1

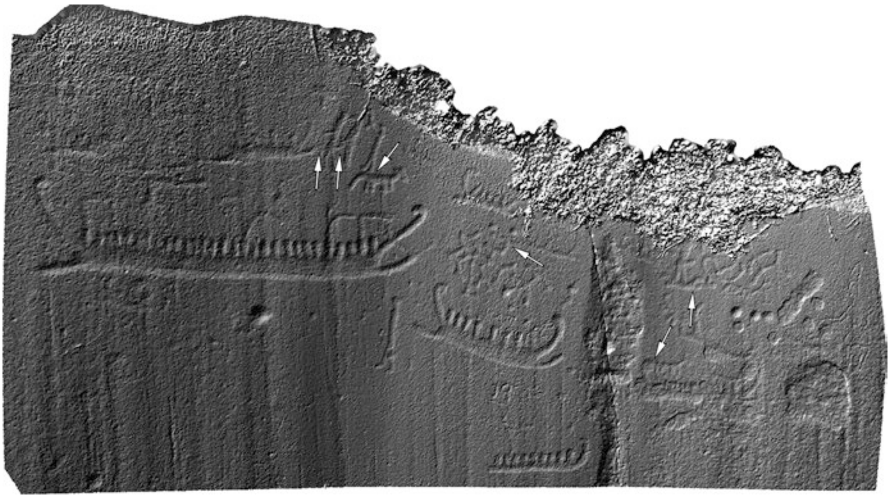

Fig. 6.6 Examples of figures placed close to each on a rock art panel, showing no or very limited crosscuttings; Hoghem, RAÄ Tanum 160 (by Rich Potter using SfM)

Age carvers decided to add new, separate images to previously engraved panels, as they normally avoided intersecting older carvings. For example, a panel from Hoghem (RAÄ Tanum 160:1) displaying two humans in a sexual intercourse scenes. They are very close to each other, but show no intersection. Another telling example is provided by an animal whose back is enclosed within a ships prow, with again neither figure crosscutting the other (Fig. 6.6). Therefore, none of the superimpositions and fusing of carvings discussed above appears to be coincidental. It must be concluded that these human-object hybrids are deliberate and meaningful compositions. It might not always be possible to determine which feature, if the body or the object, was carved first and which came second, but at some point in time, the decision was made to morph ships, other objects and body parts into each other and equate them with one another.

Pragmamorphism: Body Parts and Material Qualities

In the Scandinavian Bronze Age, objects like canoes and weapons were functionally linked to social practices such as travel, warfare and exchange. All these practices have a bodily dimension in that they require activities to be carried out in the real world. By referring to Mauss' techniques of the body (Mauss 1992), it is possible to understand how things could affect bodily motions in various social circumstances (Horn 2014; see also Warnier 2011; Malafouris 2008). In activities such as raiding, fighting and seafaring, particular body parts (e.g. the arms) may have been perceived as especially important. During these activities, certain distinctive qualities linked to them – for example, the attribute of possessing *strong* arms – might have come to the fore. The phallus, in contrast, may have had a more stable meaning and was perhaps used to assert masculinity and virility in most circumstances (Bevan 2015; Horn 2013a). Furthermore, in addition to representing meaningful social links between objects, action, bodily techniques, body parts and body qualities, the equation of objects and body parts on rock carvings may indicate how people perceived and experienced their own bodies. This consideration calls for the introduction of a new concept, that of *pragmamorphism*, which further aids explorations of the meaning of hybrid human-object engravings.

The concept of pragmamorphism as defined by physicist and economist Emanuel Derman (2011a, b, 2012) is particularly helpful for analysing the morphing of objects into body parts. The term itself is derived from the Greek word *pragma*, meaning 'material object', and *morphē*, meaning 'shape'. Taken at face value, boats with legs and hands may seem to represent anthropomorphized canoes, because human body features are added to boats. However, as I have argued above, most such carvings are not merely boats with added body parts (but see Fig. 6.5b, c for possible exceptions). Similarly, I have argued that swords and other weapons morph into particular body parts but are not in themselves equipped with parts of the human body. In reality, what we see in these carvings are humans with parts of their bodies replaced by objects – a practice that makes both the objects and the human anatomy inherently ambiguous. I maintain that this is a different semantic category to anthropomorphism and one which expresses a different set of ideas.

The concept of pragmamorphism does not posit that objects like ships and swords are imbued with human qualities such as personhood or agency, although of course this cannot be excluded. More simply, it claims that body parts and entire human beings are partly constructed from material objects, as the etymological definition of the term suggests (see above). Importantly, however, the term has a deeper meaning, just like anthropomorphism signifies more than just objects to which human features have been added. Reflecting its Greek etymology, the term signifies a form that embodies an essential inner substance.

Derman maintains that pragmamorphism 'refer[s] to attributing to humans the properties of inanimate things' (Derman 2011a); it is an infusion of human minds with material qualities (Derman 2011a, b, 2012). A key problem faced by archaeologists, however, is that a process like this does not necessarily leave material traces. As we cannot address prehistoric minds directly, we have to rely on inferences from their material remains. This, of course, is an archaeological platitude. Nonetheless, rock art presents us with uniquely qualified evidence for gaining insights into past perceptions of bodies and their relation to material culture, because both are depicted in direct connection to each other. We may assume that, when depicting human bodies, prehistoric rock carvers modelled the images based on their own bodies. Arguably, this means that people put thoughts into rock art, because before the images emerged on the rocks, they had to picture them in their minds (Lewis-Williams 2002; Sacco 2004). As Ling and Cornell (2010) argued, rock art may have been carved with the intention of influencing outcomes in the real world by infusing the pictures with secondary agency.

Pragmamorphizing limbs, phalli and entire humans carved on rocks might suggest that specific body parts, or even the body as a whole, were imbued with certain characteristics of the objects with which they were equated. We still do this today. Equating body parts with material characteristics is a metaphorical process frequently invoked when we highlight a person's qualities. For example, if we say that someone has a 'heart of gold', we do not mean that the person literally has a golden heart. Similarly, if we point out that someone's brain works like a computer, we do not mean that that person literally performs his thinking in binary code. Material qualities are used metaphorically because they are thought to surpass normal human capabilities. In the metaphors mentioned above, gold is used as it is thought of as purer than any human heart could ever be, while a computer is thought of as faster, more logical and precise than any human brain could possibly be. By doing this, we imply that a particular person, or a part of their body, surpasses the ability of average humans.

For the modern mind, things and bodies are perceived to be more separate than it may have been the case for past societies, in which, in particular, there seems to be an especially close relationship between fighters and their weapons. This relationship has been discussed by a number of researchers using concepts including body maps, body perception, techniques of the body and habitus in the Maussian sense of the word (Horn 2014; Malafouris 2008; Molloy 2008; Warnier 2011). In these readings, the fighters and their weapons become mechanical pairs of elements (Mauss 1992), i.e. they form a functional unit through training and frequent practice in combat. Weapons thus merge into the body map of fighters; they become artificial limbs and could then be perceived as body parts (Malafouris 2008).[2] In this way, the

[2] However, contrary to Malafouris' (2008) argument, it is assumed here that this was a temporary

sword becomes an integral part of the warrior, and by morphing the sword-phallus into a canoe, the whole warrior is imbued with those characteristics of the canoe that are perceived to surpass a normal fighter's abilities.

Strong Like a Bronze Sword, Fast Like a War Canoe: Interpreting Bronze Age Rock Art

Much of southern Scandinavian rock art revolves around speedy and forceful mobility and movement in general. This is evident in the omnipresent ships found at coastline locations and in the foot soles, horses and wagons found on higher ground (Coles 2003, 2008; Skoglund 2013a, b; Bertilsson 1987; Bradley 2009; Ling 2008). Moreover, exaggerated calf muscles of many human figures emphasize their capability to stride with determination, while procession scenes are also linked to movement (Coles 2003; Taylor 2005).

The speed and conduct of movement was important in Bronze Age warfare tactics such as raiding. Momentum is imperative to surprise defenders, overrun enemies or chase down fleeing victims. Examples can be found throughout history, from Caesar's forced marches leading, for example, to the capture of Vesontio (Ezov 1996), to Macedonian King Alexander moving his phalanxes at high speed (Arrian 1976) and up to the German 'Blitzkrieg' of World War II (Jersak 2000). Paul Virilio has explored the link between velocity and warfare and has incorporated it into his dromology, i.e. 'the science of speed' (Virilio 1986: 47), arguing that environments that enable high speed see a higher frequency and intensity of violence. He specifically mentions maritime and waterborne mobility as a case in point (Virilio 1986: 73–80). In the Nordic Bronze Age, violent encounters are typified by numerous pieces of evidence including the mass grave with massacre victims from Sund, Norway (Fyllingen 2003); the male burial from Over Vindinge, Denmark, who had a spear tip stuck in his back (Kjær 1912); and the Tollense Valley battlefield with over 200 victims identified thus far (Jantzen et al. 2011). Moreover, pictorial evidence suggests that Bronze Age boats were potentially able to travel at high speed. They were arguably designed in a similar way to the Iron Age ship from Hjortspring (Kaul 2003), which has been proven to be seaworthy and capable of fast travel (Vinner 2003: 117–118).

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perception, because people in the past may have been aware that they could remove objects from their bodies. This means, for example, that a sword could be put aside and a canoe left ashore. One archaeological indication of the awareness that objects and humans were ultimately perceived as separated entities may be seen in hoarding and single-object depositions. Here, humans gave up weapons and separated themselves from them (Horn 2011). This is also the case in barrows in which the deceased are usually separated from their swords, as they were put into the sheaths and laid at the side of the dead, and not placed as extensions of limbs, e.g. in the hands of the dead (see Randsborg and Christensen 2006).

Pragmamorphism comes into play here as a way to imbue a person with desirable qualities. Warriors, or their legs, may have been infused with the ability of canoe-like speed by using older ship carvings as legs or carving the warriors' legs in a ship-like style. As pointed out above, momentum is related to speed and is especially important for forceful attacks. Therefore, older canoe carvings or canoe-like depictions may have been important ways to liken arms, swords and perhaps whole bodies to canoe-like momentum and power.

Certain objects may have had broader and more contextual meanings. Swords, for example, were not only used in warfare but were also deposited in high-status graves and hoards (Aner and Kersten 1973–2014; Oldeberg 1974, 1976; Maraszek 2006; Kristiansen 1974; Melheim and Horn 2014). Therefore, we may observe on the rock carvings male genitals pragmamorphized into swords as ways to express links to violence but also to social power and the capacity to rule over others and to retain a fellowship; it may perhaps also signify that the phallus could be turned into an implement of sexualized violence. We have long known that, in several ancient societies, the sexuality of hero-warriors was described in aggressive terms, e.g. in the Gilgamesh epos. Here, Enkidu is described on tablet I, column IV, as '*attack[ing], fucking* (sic) *the priestess*' (Gardner and Maier 1985: 77). In another passage, Gilgamesh reserves for himself the right of the first night with freshly married wives as indicated in tablet II, column II (Gardner and Maier 1985). Sexualized violence is a means to exert power. Sigmund Freud pointed out that weapons symbolize male genitals through many ages and cultures and defined two material characteristics that provide semantic substance for this symbolic equation (Freud 1999: 156–158 170):

- Resemblance of physical characteristic: long, hard and pointed
- The capability to penetrate

In this respect, the pragmamorphism of genitals as swords, spears and canoes opens up the possibility of a disturbing new reading of rock art as depicting, at least in part, sexualized violence. Timothy Taylor pointed out that themes like slavery, rape and the like are understudied in archaeology because they disquiet modern researchers (Taylor 2005). However, it is evident that abduction, rape and other forms of sexualized violence have been employed as a tactic in many a violent encounter through history, from modern wars to Native American conflict (Burch 2007: 22; Seifert 1996; Gottschall 2004: 129–130). Since the evidence at our disposal is ambiguous, it is uncertain whether such acts were committed during the Nordic Bronze Age. However, this is something that we ought to consider, as the portrayal of 'hyper-masculinity' and the existence of warfare do provide a fertile ground for the emergence of sexualized violence (Bevan 2015, 2006; Yates 1993; Horn 2013b; Kristiansen 2013; Vandkilde 2014).

Conclusion

The carving of rock art may have been triggered by many different events such as a crew embarking on a raid, the initiation of young warriors or even fertility rites wishing for a large breed of powerful new warriors. As rock art scenes are complex and extremely varied, there is no need to settle on just one interpretation, since rock art likely marked several socially sanctioned events and practices. In this chapter, I have argued that the transformation of body parts into material objects in southern Scandinavian rock art was a deliberate act. I have then introduced the concept of pragmamorphism to explore the thoughts and beliefs underpinning such acts. I have contended that pragmamorphism was more than just a stylistic process of equation or replacement. It infused body parts with certain desirable characteristics expressed by the objects. This may have been done in order to infuse the body of a warrior with the rapid mobility and the momentum of canoes, thus making this individual a more capable raider. The engraving of these images may have been driven by the desire to influence the outcome of raids and other violent encounters. I have also argued that rock art was used to reinforce social ideals. Fighters may have moulded themselves according to ideals of what a warrior ought to be. Similarly, young males may have found or assumed an identity to which they aspired and which we can also see archaeologically in graves and hoards; this is the warrior ideal. Changes in weapon technology throughout the Bronze Age, their widespread adoption and their connection to a high social status indicate that swords, in particular, were highly valued and that some of their qualities were perceived as superior. The combat marks visible on them show that this perception was being based on actual experience. This may have been the case for canoes as well, but this can only be inferred from rock art as we lack the physical remains of Bronze Age Scandinavian boats. Their superior material characteristics may have included speed, just as deadliness must have been associated to swords. Such cultural equations may have instilled into fighters the desire to be deadly like a sword and into raiders to be fast like a war canoe.

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Chapter 7
“In the Beginning There Was the Spear”: Digital Documentation Sheds New Light on Early Bronze Age Spear Carvings from Sweden

Ulf Bertilsson

Introduction

Depictions of metal weapons such as spears, swords, and axes are frequent in the Swedish Bronze Age rock carvings of Bohuslän, Uppland, Östergötland, and Skåne. Most images are non-representational and mostly portray the object type rather generically. Occasionally, the carvings exhibit details of the objects including the shape of the hilt, ferrule (or butt-spike), and scabbard, so as to suggest that they are images of real objects that existed during the Bronze Age. It is at times possible to determine precisely the type and chronology of the object depicted. This is the case, for example, with the swords shown on the Ekenberg rock carving in Norrköping (Östergötland), which compare to actual Bronze Age swords from the archaeological collections of the Stockholm Historical Museum (Bertilsson 2015b; Hildebrand 1869). It has often been argued that most of the weapons depicted in Swedish rock art are to be dated to the Late Bronze Age, in particular to Period V (*c*. 920–720 BC; Vogt 2011). However, detailed analysis of the carvings, including the digital technology analysis presented here, indicates that this may not be the case, as a number of carvings appear to depict spear types from the Early Bronze Age. In some cases, it appears that carved spearheads were re-engraved to represent new types over a period of several hundred years, as is the case with well-known carvings from Bohuslän. This demonstrates the importance of the spear as the warrior’s principal weapon in the Scandinavian Early Bronze Age. This chapter presents previously unknown examples of the practice of re-carving spearheads, which provide unprecedented insights into the close link that must have existed in Bronze Age Sweden between real and represented weapons.

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Odin's Spear *Gungnir*

Fighting and weapons are frequent themes in the Nordic sagas; their prominence is due to the notion that the ultimate and most glorious way for a warrior to die was as a result of single combat or in battle. In this way, the fallen would achieve hero status and be admitted to the company of other warriors in Valhall, the hall of Odin described in the Grimnesmal poem cited below. There, the glorious dead were resurrected the morning after a ritual banquet:

Easy is it to know | for him who to Othin
Comes and beholds the hall;
Its rafters are spears, | with shields is it roofed,
On its benches are breastplates strewn.
Easy is it to know | for him who to Othin
Comes and beholds the hall;
There hangs a wolf | by the western door,
And o'er it an eagle hovers.
(The Poetic Edda, Grimnesmal, verse 9–10; translated by Bellows 1923)

The weaponry used by the warriors and gods mentioned in the Nordic sagas encompassed swords, axes, and more rarely spears. The spear was the weapon of Odin, the highest Norse god; he prevailed over the living and the dead, and his spear was called Gungnir – meaning "the swaying one" in Old Norse. The significance of the spear is highlighted in multiple sources including the book of *Gylfaginning* (*The Prose Edda*, Chapter 51), which describes Odin, on the way to the battlefield at Ragnarök, riding his horse Sleipnir above Einherjar (i.e. those warriors who have died in battle and are brought to Valhalla by the Valkyries) wearing a coat of mail and a golden helmet, armed with his spear Gungnir, which he will use to attack Fenrir the Wolf. Gungnir was said to be so well-balanced that it could hit any target.

The Norse sagas, first written during the Late Iron Age, from 500 AD, bear witness to the importance of the spear as a weapon of the highest status. A common view among scholars of Old Norse religion is that the gods appearing in the classic Iron Age mythology would have replaced an earlier belief system based on the sun cult, which had dominated the region since the Bronze Age (Almgren 1927–28; Nordberg 2013). Several strands of archaeological research have convincingly argued that the cult of the sun, and probably also that of a personified sun god, was a widespread religious belief in southern Scandinavia during the Bronze Age (Nordberg 2013; Bertilsson et al. 2014). Until recently, this discourse dominated research into Nordic Bronze Age religion, which is vividly embodied by the story of the sun's journey across the sky during day and night (see, e.g. Flemming Kaul's 1998 book on the subject). Although there is a consensus among researchers that the basic tenets of this model are correct, over-reliance on it has driven alternative hypotheses about cult and religion in the Scandinavian Bronze Age into the background (Kristiansen 2012; cf. also Nordberg 2013).

In an attempt to offer an alternative approach to research in this field, this chapter will shift the focus of the analysis to the rock carvings of Bronze Age weapons,

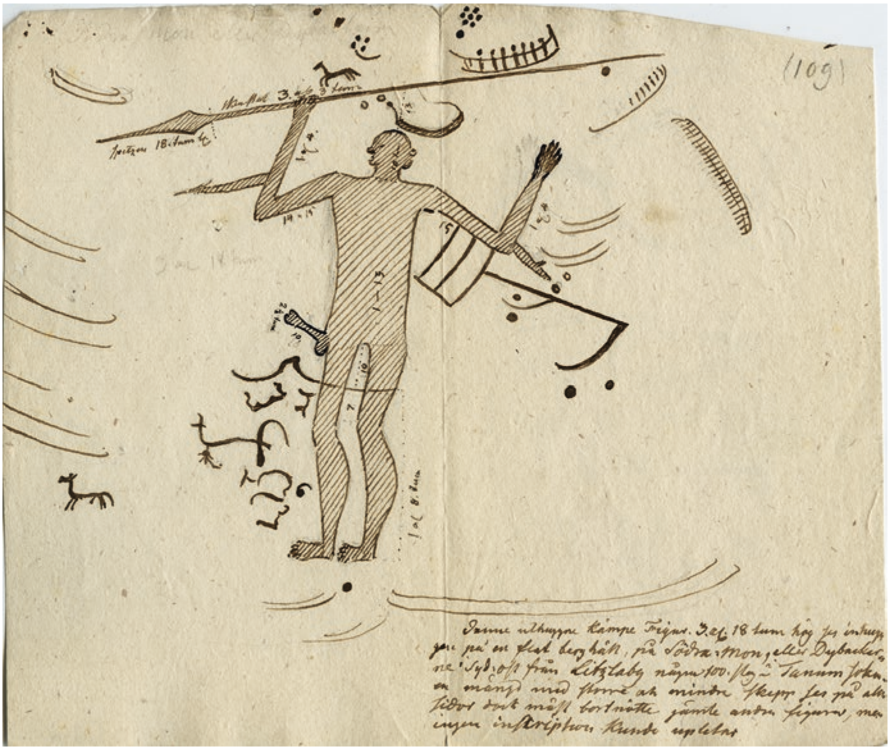

Fig. 7.1 Carl G.G. Hilfelings' 1792 ink drawing of the rock carving from Litsleby, later named the "Spear God" and now frequently referred to as Odin. (Source: SHFA. Original: Antikvariskt Topografiskt Arkiv, National Heritage Board, Stockholm)

paying particular attention to images depicting spears. One of the ideas underlying this approach is that the weapons and fighting scenes displayed on rock carvings may express cultic or religious beliefs. This chapter will also discuss whether the "warriors and weapons discourse" characterising the Nordic sagas can be traced back to the Bronze Age and its petroglyphs. To explore these problems, I shall analyse a number of images depicted on Swedish rock carvings, namely, the spears engraved on panels from Bohuslän and Uppland. I will not apply quantitative methods of analysis to their study but will instead focus on the qualitative reading and interpretation of selected carvings displaying extraordinarily clear images of spears. These are the panels from Litsleby, Kalleby, and Finntorp (Tanum, Bohuslän), and also from Tuna (Bälinge, Uppland), all of which exhibit spear carvings of unusual type and quality.

Some of these images are of notable historic importance; for example, the Litsleby carving was the first ever documented rock carving from Tanum, as shown by an ink drawing produced by Carl G.G. Hilfelings in 1792 (Fig. 7.1) (Bertilsson 2015b). However, Hilfelings' drawing does not report all the carvings visible on this rock, whose number is now known to exceed 200 images. Instead, he focused on the most impressing image, namely, the 238 cm tall, phallic, spear-armed male figure, which he depicted in a detailed "portrait-like" manner. In contrast to the overall quality of his drawing, however, his rendering of the spearhead is not completely accurate, though the length is. The modern three-dimensional images analysed below discuss the differences between Hilfelings' ink drawing and the actual carving (Figs. 7.1 and 7.3).

Three-Dimensional Documentation with Structure for Motion (SFM)

In recent years, a 3D analytical technique known as Structure for Motion (SFM) has seen marked improvements in its accessibility and cost-effectiveness. Such improvements have broadened its uses, which now include the digital documentation of rock art. SFM uses photographs of the rock surface to calculate a high-resolution, three-dimensional model of the engravings. Contrary to traditional two-dimensional methods such as rubbing and tracing, SFM accurately records structure, topography, and texture of the rock panel surface (Bertilsson 2015a and Bertilsson et al. 2017).

One problematic aspect of SFM is that it generates extensive amounts of data, especially when documenting large rock art panels; for example, the Aspeberget carving (Tanum) required 1500 images for a full 3D documentation (Bertilsson et al. 2014). Depending on the computer system utilised, computing this amount of data can take several hours. Despite the time and effort involved, SFM does produce highly accurate 3D models of the carvings, showing more details than rubbing and tracing. A pilot study conducted in Tanum in 2014 compared SFM with other techniques of rock art recording (Bertilsson et al. 2014). The results show that SFM provides a significant advantage over traditional methods including better opportunities for morphological identification and typological dating; it also improves the recognition of superimpositions and is ultimately less time-consuming than rubbing and tracing (cf. Sevara and Goldhahn 2011; De Reu et al. 2012). In the following pages, I shall present examples to illustrate this point.

A challenging factor in the study of rock art is the recent practice of painting carvings red in an effort to make them more visible for the convenience of tourists. The red paint tends to smooth over the engraved lines, blurring important details including superimpositions. For example, the Litsleby carving depicts a wheel directly adjacent to the so-called Spear God discussed below. The wheel is painted in as complete and shows up so in the textured version of the 3D file. However, close examination of the un-textured 3D model shows that the wheel does not have a continuous rim but one that is made from several noncontiguous sections (Fig. 7.2). This demonstrates that regardless of how experienced the modern painter of the carving is, his/her intervention adds another layer of interpretation to the recording process. Nevertheless, as SFM highlights very fine details, this drawback is mitigated to some degree, in a way that enables us to “see through” the paint (Domingo et al. 2013). Therefore, SFM creates better opportunities to record, describe, and analyse previously unrecognised details that may be of the greatest importance for our understanding and interpretation of the rock carvings.

The Mighty Spearman from Litsleby

Our first case study concerns the extremely large spear carrier depicted on a rock panel from Litsleby, Tanum. The SFM recording has revealed hitherto unrecognised details in the carving, and a careful analysis of the 3D model of the spear has shown previously unnoticed information of great importance. In particular, it was observed that the spear was engraved before the human figure because the arm and hand overlie the spear shaft (Figs. 7.2 and 7.3). The spearhead itself is notable because it may have been re-carved twice after the original engraving, considering that the 3D model highlights three different spearheads on the rock surface (Fig. 7.3). Another noteworthy observation stemming from the SFM documentation is that the wheel is not only interrupted on its upper and left sections but is also overlain by the phallus of the spearman. This means that the phallus was carved after the wheel had been drawn. The absolute chronology of the two engraving episodes is not easy to establish, but their relative sequence is interesting nonetheless.

Fig. 7.2 3D model of the Litsleby carving, textured (left) and untextured (right). (Source: SHFA. Photograph: Ellen Meijer)

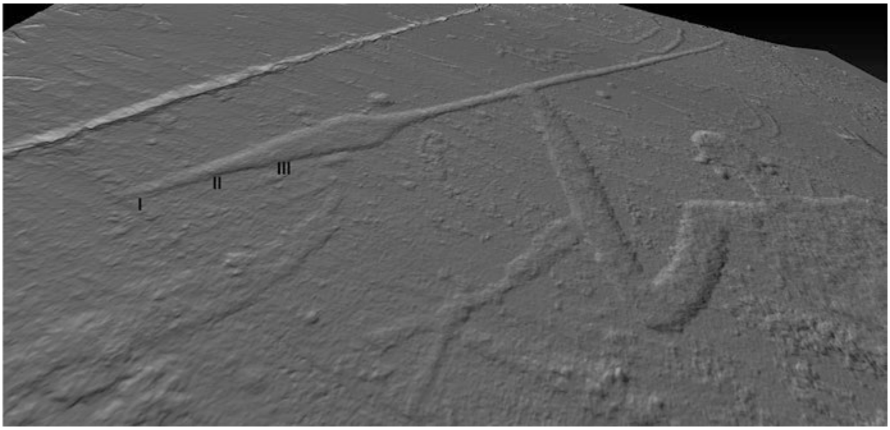

Fig. 7.3 Structure for Motion (SFM) 3D model of the "Litsleby Spear God" marking the three different spearheads discussed in the text (I, II, and III). The SFM picture also shows that the arm and hand holding the spear overlie the shaft, and are thus younger than the shaft itself. (Image editing: Catarina Bertilsson. Source: SHFA. Photograph: Ellen Meijer)

The Chronology of the Litsleby Panel

Before a detailed chronology is proposed for the carving events documented on the Litsleby panel, a discussion of the overall chronology of the panel itself, and of the spearman in particular, is necessary. The spear carrier has long been considered to date to Period V of the Nordic Bronze Age (*c*. 920–720 BC in absolute terms; Maraszek 2015). This proposal is grounded in comparison with other large human carvings such as "Skomakaren" (or "The Shoemaker") at Backa, Brastad. This chronology, however, is solely based on the style of the carving.

For a better appraisal of the chronology of this figure, attention has to be paid to the boats engraved on the panel, since their typology and relative height convey important information concerning the carving sequence and absolute dating of the images (Ling 2008; Kaul 1998, 2003). The earliest boat associated with the spear carrier is a small vessel overlain by the spear shaft. The vessel belongs to the so-called Nag-type, which dates to the Late Neolithic, from 2100 to 1700 BC (Bengtsson 2013). A similar chronology can be suggested for the three-line boat overlain by the left upper arm. The spearman's thighs superimpose on a third boat. This boat is of a type dating to Period II of the Nordic Bronze Age, from 1500 to 1300 BC (Ling 2008:105; cf. Kaul 1998). Based on these considerations, one could say that the large spearman was carved after Period II, when the latest boat was drawn; however, nothing indicates that it has to be assigned to Period V.

On the panel, but not in direct connection to the spearman, are other boat carvings showing significantly lower chronologies. In particular, two large and heavily stylized boats found in the northern section of the panel are overall similar to Hjortspring-type vessels, which are dated to the early fourth century BC by a Danish bog find of a wooden boat of the same design (Kaul 2003). If we accept this chronology for the three boats carved on the Litsleby panel, this would suggest that multiple carving events took place on the panel over a time possibly extending from the Late Neolithic to the Pre-Roman Iron Age (from about 2100 to 300 BC) – a remarkable 1800 years period. The 3D model also indicates that three different spearheads were carved on the panel, the shorter two spears appearing to overlie the longer. This raises the question as to whether it is actually possible to determine which of the three spearheads was carved first. Analysing the carving in detail will help clarify the complex chronology of the panel and of the spear carrier.

The Litsleby Spearheads: Typology and Chronology

The longest spearhead on the Litsleby panel has rounded shoulders and a long, slender tip (Fig. 7.3, I). The image is deeply carved, and its design is so detailed as to resemble real metal spearheads from the Bronze Age, examples of which can be found in museum collections. Some years ago, the author noticed that the shape of the carved spearhead deviated from the shape of the spearhead that was painted in modern times. This is especially apparent in the bulge at the bottom of the blade, which is clearly rounded compared with the angular blade butt shown in red paint. This interpretation was confirmed by cross-checking existing documentation obtained via *frottage* (rubbing). This spearhead shape is consistent with actual objects belonging to the Valsømagle type, dating to Period IB of the Nordic Bronze Age, about 1600 BC (Horn 2013; Jacob-Friesen 1967; Vandkilde 2011).

A bronze spearhead matching the Litsleby carving almost perfectly was discovered in Falköping, Västergötland. This is 37 cm long overall and has a 9 cm long socket. Both blade and socket are beautifully decorated with spirals forming a running dog motif framed and a continuous band of double arches. Drawings of this object have been published by Montelius (1917: 61, no 917), Jacob-Friesen (1967, Tafel 28:1), and Oldeberg (1974: 303, no. 2373; Fig. 7.5a). A direct comparison of the archaeological and carved spearheads was made using Photoshop (Fig. 7.4, right). Bearing in mind that the drawing of the spearhead had to be scaled down for the comparison to be made, it is noteworthy that the Falköping specimen fits almost perfectly into the carved spearhead. This strongly suggests that the Litsleby carving intended to show a Valsømagle-type spearhead. This interpretation is further supported by a similar comparison, which the author has made using a photograph of the Falköping spearhead obtained from the National Historical Museum (despite the spearhead photograph being slightly turned to the side: Figs. 7.4, centre, 7.5, and 7.6).

A cursory examination of the second carved spearhead based on the SFM 3D model (Fig. 7.3, II) indicates that this may depict a Hulterstad-type spearhead. Spearheads of this kind are shorter and more compact than those of the Valsømagle type and of Period II spearheads in general (Jacob-Friesen 1967). The eponymous Hulterstad spearhead was found in a burial mound excavated in the 1920s on the

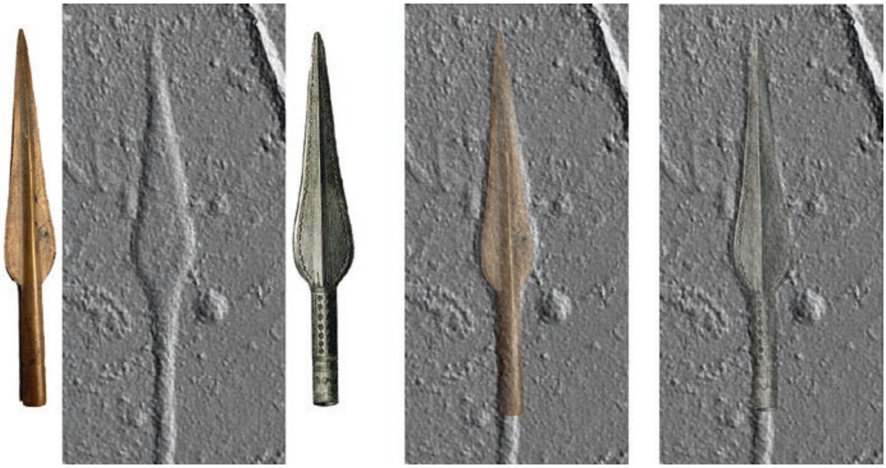

Fig. 7.4 Left: Photograph of the bronze spearhead from Falköping next to an SFM 3D model of the Litsleby spearhead carving. Centre and right: drawing of the Falköping spearhead from Montelius (1917: 61, no 917) and superimposition of the photograph and drawing on the 3D model (Comparative analysis by Christian Horn, Gothenburg University)

Fig. 7.5 Photograph of the bronze spearhead from Falköping; the object belongs to the Valsømagle type, which is dated to Period IB of the Nordic Bronze Age. (Photograph: The Swedish History Museum – SHM)

island of Öland. The burial assemblage can be dated to Period III of the Nordic Bronze Age, 1300–1100 BC. Further comparisons were carried out to validate the initial hypothesis, using the method discussed above. These comparisons have confirmed that the second spearhead belongs to the Hulterstad type, while also firming up the idea that the longer spearhead was carved first and the shorter two second (Fig. 7.3, I–III and Figs. 7.7, 7.8, and 7.9).

The near-perfect matches between carved and archaeological Bronze Age spearheads discussed above demonstrate that the Litsleby rock carvers must have had access to actual bronze spearheads from their time and intended to depict them as realistically as possible. Moreover, the exceptional craftsmanship of the spearheads from Falköping and the Valsømagle hoard, as well as their unusually rich and artful decorations, suggest that these were not ordinary weapons but objects that presumably belonged to great warriors and quite possibly prominent members of their communities. This consideration sheds new light on the Litsleby carvings, which, I argue, depict spearheads of special value and importance. This proposal is hampered to some extent by the fact that the Litsleby spearheads were seemingly

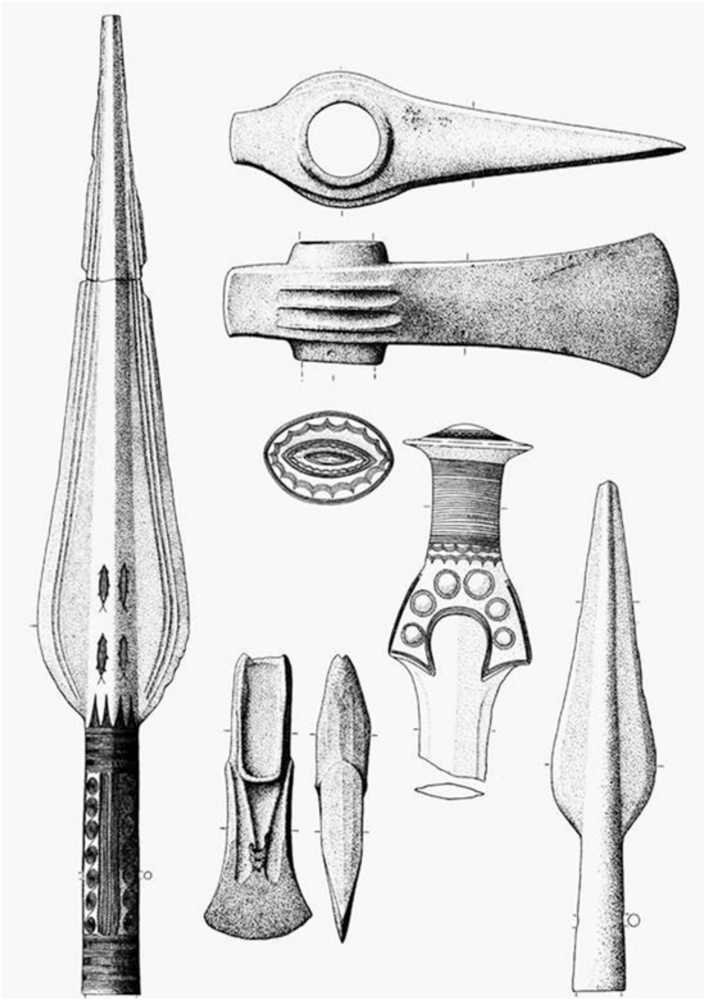

Fig. 7.6 The Valsømagle hoard from Denmark; note the spearhead on the left and the cast-hilt sword in the centre. (After Aner and Kersten 1976, plate 79–80 no. 1098)

redrawn over a period of several hundred years. A possible explanation for this is that the carvers belonged to a leading warrior dynasty that dominated the area during a period of nearly a millennium; they would have used the carving and re-carving of the Litsleby panel as a social strategy to manifest and consolidate their power (Kristiansen and Larsson 2005; Ling and Cornell 2015).

There are, however, several factors making this hypothesis problematic. At Litsleby, there are no images depicting opposing warriors armed with swords, axes, or spears, which are commonly found in many other carvings from Tanum including Bro Utmark, Aspeberget, Vitlycke, and Fossum (Ling and Bertilsson 2016). The Litsleby carving is instead dominated by a single, supernaturally large human fig-

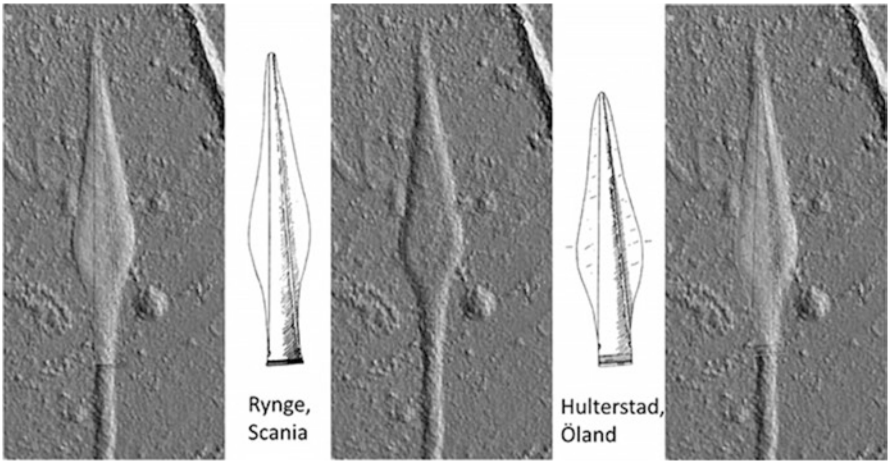

Fig. 7.7 Bronze spearhead of type Hulterstad from Rynge, Scania (left), and Hulterstad, Öland (right), scaled down proportionally to fit the carved spearhead from Litsleby. Both objects match the carving reasonably well but the Hulterstad-type spearhead provides a better fit, suggesting that this was the template used for the re-carving of the Litsleby spearhead. (Comparative analysis by Christian Horn, Gothenburg University)

Fig. 7.8 Period III spearhead found in a Bronze Age burial mound at Hulterstad, Öland. (Photograph: Swedish History Museum – SHM)

Fig. 7.9 Period V spearhead from Nynäsvägen, Kalmar. This provides a possible template for the third spearhead from the Litsleby carving (Photograph: Swedish Historical Museum – SHM)

ure – the "Spear God", which is unparalleled in Scandinavian rock carvings. As pointed out above, the figure is likely to date to Period V of the Nordic Bronze Age (920–720 BC) by analogy with the so-called Shoemaker from Backa, Brastad, as well as other large figures of the same type. I have argued above that since the figure's hand overlies the spear shaft, which dates to Period I (1750–1500 BC), the entire human figure must necessarily be later. This indicates that the Period V chronology proposed for it may actually be correct; in fact, the "Spear God" figure might have been carved in Period V together with the third spearhead (Fig. 7.3, III). This suggests that the first spearhead and shaft (i.e. the Valsømagle-type spear) were carved much earlier, presumably in late Period I, and that this spear was the most important and prominent image on the panel as it was originally engraved on the rock individually, without a human figure holding it. But how can we explain the apparent paradox of a weapon without its bearer? It could be suggested that this spear was conceptualised as a unique weapon of great power and symbolic importance, which would justify its depiction in "splendid isolation". We could perhaps push this reading a little further to suggest that the carving intended to represent the most important spear of all: Odin's "Gungnir" or its Bronze Age precursor.

This reading chimes with current interpretations of the human figure as Odin, the supreme Norse god. However, the spear carving may also be interpreted as an illustration of a non-anthropomorphic religious belief dating to the Late Neolithic and Early Bronze Age, which focused on weapons made of new shiny materials: copper and bronze. These new materials may have been thought to radiate so much power that the objects were perceived as divine or as gifts from the gods. During the Late Bronze Age, new mythological ideas may have been established, which would have called for the depiction of a god-like bearer of metal weapons, along with other, less exalted figures (e.g. heroes and warriors) armed with simpler, more schematically depicted spears as well as other weapons. Seen from this perspective, the spear engravings may suggest that a "weapon cult" would have emerged in the Late Neolithic and Early Bronze Age; this would have evolved into a fully articulated warrior ideology in the Late Bronze Age and Iron Age. This ideology seemingly informs the myths and tales of the Nordic sagas, which narrate heroic deeds and supernatural feats that may have emerged from a body of mythological beliefs ultimately dating to the Late Bronze Age, *c*. 1100–550 BC (Bertilsson 1987).

The Spear and Warrior from Finntorp (Tanum, Bohuslän)

A question arising at this point is whether the redesign of the spearhead on the Litsleby panel is unique. Interestingly, an examination of southern Scandinavian rock art shows that this is not the case, for other examples of spear carvings and recarvings can be identified, although none are identical to the remarkable Litsleby panel. In particular, a rock carving from Finntorp, Tanum, shows a spear with a head not unlike the one from Litsleby. Recent research carried out using reflectance

Fig. 7.10 Photograph of the central section of the rock carving from Finntorp (Tanum, Bohuslän) showing the great spearman and the so-called Wismar warrior. The human figure overlies a spear with slightly curved shaft and an angular arrow-like head. (Source: SHFA. Photograph: Bertil Almgren)

transformation imaging (RTI) shows that the spearhead from Finntorp was redesigned on three occasions and was also carved before the human figure which is now its bearer (Horn and Potter 2017). Both the carving process and the engraved motifs display striking similarities with the Litsleby panel. However, both weapon and human figure differ stylistically from the Litsleby ones as the spear has a curved shaft and its heads most likely represent flint points (Figs. 7.10, 7.11, and 7.12). In his discussion of the "pagan" antiquities from Tanum, Montelius (1874–1879: 354–8) describes flint spearheads from Early Bronze Age cairns at Arendal, a village in northern Tanum. These objects may date to the end of the Late Neolithic or the beginning of the Early Bronze Age (*c*. 2100–1700 BC) and are thus several hundred years older than the spearheads carved on the Litsleby panel. Moreover, the body of the Finntorp spearman consists of concentric circles representing a shield akin to that depicted on the Wismar horn, which, according to Kristiansen and Larsson (2005), dates to Period I of the Nordic Bronze Age (Fig. 7.10). This means that the Finntorp spearman could be significantly older than the Litsleby "Spear God". Based on a recently performed recording using RTI (Fig. 7.11), however, Horn and Potter (2017) suggest that the Finntorp shield resembles Watenstedt-type shields, for which several *comparanda* exist in Spain and the British Isles. These are overall dated to Periods II–III of the Nordic Bronze Age (1500–1100 BC), which would be consistent with the chronology of the Wismar Horn as proposed by Kristiansen (2012). The Wismar Horn shows ships with stem bows turned inwards as well as ships with stylized horse-headed bows. Based on the palaeodating of the North Sea

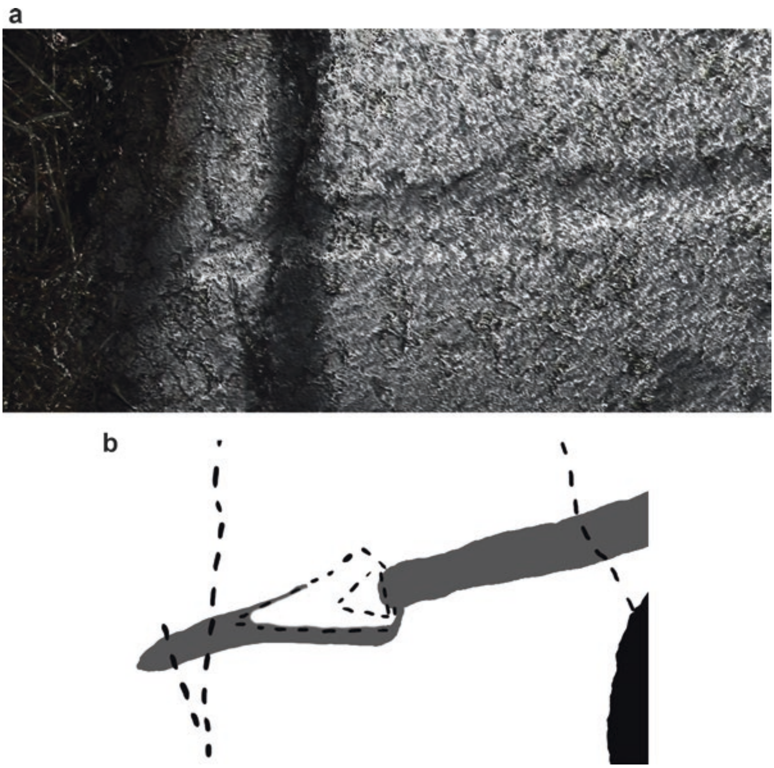

Fig. 7.11 RTI-image (**a**) and drawing (**b**) of the Finntorp spearhead showing three spearheads of different length and design (Photograph and drawing courtesy of Richard Potter and Christian Horn)

and Baltic Sea shorelines, ships with horse heads were first carved in Bohuslän and Uppland around 1400 BC, in the advanced Period II (Ling 2008, 2013). This type of ship is also displayed on the Finntorp panel, thus suggesting that the carving may date to this period, although the ships could have been engraved later than the human figure with the shield-shaped body. Moreover, the spear with its original point appears to have been carved earlier because the human figure overlies it (Fig. 7.10).

Regardless of the chronology of the Finntorp spearman, the early chronology of the spear seems supported by the nearby depiction of an anthropomorphic figure driving a plough drawn by a pair of oxen. Similar engravings are found at other European rock art locales including Monte Bego, France, and Valcamonica, Italy (de Lumley et al. 2003: 350, 381; Anati 1976: 74, 84–85). Here, they have been dated to the III and early II millennia BC (circa 2900–1700 BC), in the local Chalcolithic and Early Bronze Age (Arcà 2010: 21–23).

Fig. 7.12 Flint spearheads of different types that could have provided templates for the re-carved spearheads from Finntorp. All objects shown here are dated to the Late Neolithic/Early Bronze Age, *c*. 2100–1750 BC (cf. Montelius 1917). (Photographs: Swedish History Museum – SHM)

The Waving Spear from Kalleby (Tanum, Bohuslän)

Another relevant example has been discovered on a rock art panel from Kalleby showing three human figures playing bronze lures and two additional, larger figures above them on the panel. The first is horned and carries a scabbard with an artfully designed winged chape (i.e. the metal point of the scabbard) dating to Period V of the Nordic Bronze Age (920–720 BC) based on comparisons with archaeological objects (cf. Coffey 1913, Fig. 67). The second, and larger, human figure holds a hammer-like weapon in his raised right hand. To the left of this figure, an upstanding spear has been carved comprising a well-designed spearhead and a long, narrow shaft (Fig. 7.13). The analysis of the 3D model of the scene obtained using SFM shows that this spearhead resembles the largest spearhead from Litsleby. The comparison was made using the same methodology applied to the Litsleby spearhead carvings including their proportional downscaling. To carry out the comparison, a Långaröd-type spearhead from Scania was first superimposed on the Kalleby carving, but its shape proved to be more slender than the carved spearhead on the lower part of the blade (Fig. 7.14, left). A Valsømagle-type spearhead was then superimposed on it, and this matched the carving extremely well (Fig. 7.14, right). As for the spear shaft, it could be argued that it was intentionally carved as thin and undulating to illustrate the ability of the spear to sway, perhaps as a reference to Odin's spear "Gungnir", or "The Swaying One".

Fig. 7.13 3D model of the rock carving from Kalleby (Tanum, Bohuslän) showing an axe bearer and a spear with a slender, waving shaft. (Source: SHFA: Photo: Ellen Meijer)

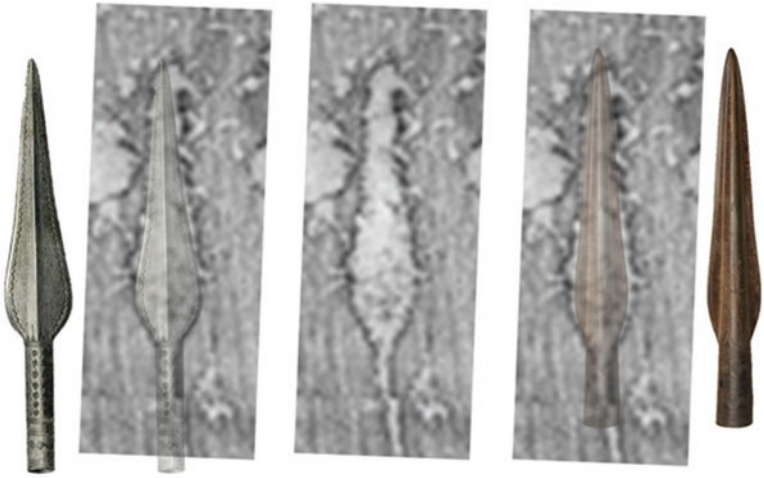

Fig. 7.14 From *left* to *right*: The Valsømagle-type spearhead from Falköping; the same spearhead scaled down and superimposed on the carved spearhead from Kalleby; the carved spearhead, and a spearhead of the Långaröd type from Scania superimposed on the carved spearhead. (Comparative analysis by Christian Horn, Gothenburg University)

The Spear Outlines from Tuna (Bälinge, Uppland)

Another example of the spear's significance during the Nordic Bronze Age is the spear carvings from Tuna (Bälinge, Uppland). On this panel a number of natural striations exist, to which spearheads have artfully been added, if in a rather coarse manner (Janson 1960) (Fig. 7.15). It is noteworthy that two of the spears appear to be held by previously unrecognised human figures with raised arms (Fig. 7.16). The spearheads are simply outlined and show a relatively wide base and rounded shoulders, which overall give them a roughly triangular appearance (Kjellén 1976; Kjellén and Hyenstrand 1977); however, they lack ferrules or any other features that could aid comparison with archaeological objects. It is, therefore, difficult to identify the kind of spearhead that the carvers intended to depict with any degree of certainty.

Fig. 7.15 The spear carvings from Tuna (Bälinge, Uppland). (Photograph: Harald Faith-Ell, after Kjellén 1976)

Fig. 7.16 Rubbing of the central section of the Tuna panel with the spearheads. (Source: SHFA. Rubbing: Dietrich Evers)

Modern recording using SFM has not yet been attained for the Tuna carvings. The sole documentation available consists of black-and-white photographs dating to the late 1940s, as well as rubbings made by Dietrich Evers in the 1970s. Due to heavy overgrowth of lichens, the rock face would now require extensive cleaning prior to documentation with SFM or any other method. Although the weapons are highly stylized, the four spearheads engraved to the right of the panel are reminiscent of Early Bronze Age objects, with the one sitting at the bottom resembling Valsømagle-type spearheads from Period IB of the Nordic Bronze Age, *c*. 1600 BC.

As for the two spearheads to the left of the panel, the bottom one has a rather short shaft and a head shaped differently from the others, which may be taken to represent a Late Bronze Age weapon of the kind schematically depicted on a rock art panel from Åby (Tossene, Bohuslän). It has been suggested that this might be the depiction of a real spearhead found in a nearby tomb (Goldhahn 2014). The carved spear from Tuna seems to be superimposed on one human figure and held by another figure with a horned head. The spear above this scene has an extension added to the shaft that appears to be held by a third human figure (Fig. 7.16). The head of this spear differs from the others in that its shoulders are straighter and a short crossbar has been depicted where one would expect to see a socket. Such a type of spearhead is unknown in Scandinavia and could be later than the four spears to the right of the panel (see above). Objects of this kind are called "barbed spearheads", and date to 900–800 BC in the British Isles (Davis 2015, Nos. 1301 and 1370). Pending a more detailed documentation using modern methods, it can preliminary be suggested that at least four, and possibly five, of the spears were engraved on the Tuna panel before any of the human figures were added. This is, thus, another example illustrating our hypothesis that "in the beginning there was the spear".

Concluding Remarks

The four case studies discussed here constitute remarkable examples of the life histories of ideologically and materially important Bronze Age spearheads and of the complex, long-lived biographies of their rock carvings (Kopytoff 1984; Gosden and Marshall 1999; Melheim 2013; Ling and Bertilsson 2016).

Rock art is an expression of the social value of the objects being engraved, and it may signify a desire to possess the objects. Although warrior scenes can be complex and the message that the carver(s) is trying to convey may not always be immediately evident, it is still possible to suggest that carvings do not merely depict mundane representations of everyday objects. Instead, the act of carving objects on rock surfaces may indicate that they held special significance in cult practices. If we examine carving practices from a historical perspective, we may conclude that the objects displayed on Bronze Age rock art panels reflect core ideological values of the society that expressed them, such as a weapon cult, ideas of warfare, and perhaps the glorification of conflict and violence. Importantly, such values were still dominant in the Viking Age (Bertilsson 1987). It can perhaps be suggested that this ideology became

Table 7.1 Periodisation of the Nordic Bronze Age (Montelius 1917; Olsen et al. 2011)

Period I	1750/1700–1500 BC
Period II	1500–1300 BC
Period III	1300–1100 BC
Period IV	1100–920 BC
Period V	920–720 BC
Period VI	720–550 BC

institutionalized over time and informed both social hierarchies and religious beliefs to which all members of early Scandinavian society would have been exposed from birth. Such ideas would have been reaffirmed through recurrent social action and the recounting of mythological narratives.

If we accept that the rock art reflects a new ideology introduced in southern Scandinavia in the Early Bronze Age, and further developed with the establishment of personified deities during the Late Bronze Age, we must also presume that society would have felt the need to affirm the new ideological order most acutely during the initial phase, and also at later, significant junctures in the evolution of the belief system. This may be the reason behind the abundance of images of weapons and warriors on the rock carvings, which mark the Early Bronze Age beginnings and Late Bronze Age developments of a cultic tradition spanning the best part of two millennia. I argue that it is this tradition that gradually morphed into the mythological narratives related in the Nordic sagas – narratives that remained influential long after the practice of carving weapons on rock panels had ceased to exist.

It so seems that the cult of weapons discussed in this chapter preceded the materialization of the gods wielding them – gods that, if we accept the chronology proposed above, only began to appear in the Late Bronze Age, hundreds of years after the introduction of bronze spears in Scandinavia. It is also possible that ideas of a supernatural spear-bearer may have formed in this early period, only to coalesce into the 'classic' image of Odin as the spear-god *par excellence* from the Late Bronze Age onwards (Table 7.1).

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Chapter 8
Rock Art, Secret Societies, Long-Distance Exchange, and Warfare in Bronze Age Scandinavia

Johan Ling, Richard Chacon, and Yamilette Chacon

Introduction

Scandinavian Bronze Age rock art constitutes one of the world's richest sources of prehistoric carvings (Coles 2005). In no other region in Europe are images so plentiful, varied, and pronounced as in southern Scandinavia (Goldhahn and Ling 2013). This imagery includes warriors in boats (Fig. 8.1) and on the ground along with scenes depicting the act of killing (Ling 2008). These war-related themes seem to suggest an element of theatre or showing-off, but they could also represent real acts of warfare and violence (Fig. 8.2). Since propaganda has always been an important strategy in warfare cross-culturally, it is tempting to interpret these depictions of warriors as a form of advertising or propaganda (Ling and Cornell 2017). We argue that Scandinavian rock art was created by secret societies as part of their ritual practices associated with long-distance exchange activities. This position is supported by ethnographic evidence from various groups in which the relationship between secret societies and the creation of rock art is firmly established.

In general, Scandinavian rock art may be considered as a highly selective representation of a social world (Coles 2005; Cornell and Ling 2010). For instance, activities connected with mundane domestic life are often downplayed in rock carvings in favour of socio-ritual practices connected with the maritime realm, warriorhood, pan-European Bronze Age (thereafter BA) symbolism, and other highly ritualized features (Ling and Cornell 2017). In this context, it is important to stress that warfare

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Fig. 8.1 Bronze Age Scandinavian rock art from Tanum depicting a staged fight in a boat (After T. Högberg. Source SHFA)

Fig. 8.2 The famous complex rock art site at Fossum, Tanum, showing warriors and ships along with a variety of social and ritual activities (Photo: Gerhard Milstreu. Source: SHFA)

is only one of several themes that are present in Scandinavian rock art (Coles 2005; Fredell 2003; Ling 2013). Over the years, many scholars have emphasized the esoteric aspects of BA rock art from this region (Coles 2005; Goldhahn 1999); others, however, have eschewed this approach due to the generally open and accessible location of carved panels (Goldhahn and Ling 2013). This work will explore both these approaches with reference to what role secret societies may have played in the creation of BA Scandinavian rock art.

Most of the carvings that include war-related scenes were created during two separate chronological phases of the BA, period II (*c*.1500–1300 BC) and period V (*c*.900–700 BC; Ling and Cornell 2017). Interestingly, these phases saw the circulation of the greatest amounts of metals throughout Scandinavia. Therefore, the representation of warriors on rock panels coincides with BA society's investment in the long-distance trade of metals that, in turn, bolstered social inequality (Vandkilde 2006; Ling 2008; Earle and Kristiansen 2010). We posit that, in southern Scandinavia, long-distance trade was conducted by warriors. As they formed a specialized segment of BA society, these warriors were likely involved in maritime exchange, warfare, and long-distance travel (Kristiansen and Larsson 2005; Kristiansen 2016). Since the presence of warriors would serve to fend off attacks, trade expeditions which included individuals possessing fighting capabilities were more likely to succeed than expeditions lacking warriors. Thus, coastal rock art depictions of warriors may represent individuals engaging in rituals characteristic of secret societies. Interestingly, these depictions of warriors are often accompanied by images of large ships, specific ritual gear such as bi-horned helmets and bird-like attributes, masks, and other exotic items. We hold that this suggests a connection to a trans-regional network with an exclusive access to specialized knowledge. Thus, we argue that these warriors likely belonged to a type of secret society, and it is entirely possible that secret societies provided an organizational framework for the recruitment of boat crews during the Scandinavian BA (Hayden 2016). Similar practices took place during the Viking Age with the formation of the so-called boat guilds (Jakobsson 1992). Also, ethnographic data exist on North American indigenous boat guilds that were involved in long-distance exchange (Donald 1997; Johnson 2007).

The theoretical approach that we put forth in this study includes comparative perspectives and theory taken from archaeology, cultural anthropology, sociology, and history (Chacon 2014; Malinowski 1922; Hayden 2016; Earle 1997; Vandkilde 2014; Jakobsson 1992; Kristiansen 1998; Gell 1998). For some time now, there has been intense debate within archaeology about how analogies should be applied (Reybrouck 2000; Melheim et al. 2017). However, we hold that it is useful to employ analogies in order to accurately discuss different archaeological models (Melheim and Horn 2014; Melheim et al. 2017). Thus, we believe that it would be wrong to omit or fail to compare our data to certain accounts and theories because there are, indeed, some very specific spatial, social, economic, technological, and environmental conditions that broadly shape humankind's ability to act. For example, living in a coastal location, or living in an antagonistic social environment, gives rise to certain regularly occurring settlement and social patterns. In the following section, we argue that BA Scandinavian rock art was created by a specific societal group that dealt with maritime long-distance trade, warfare, and ritual activity. This task-oriented group can be considered as a "secret society" (more on this below). Furthermore, in line with Gell (1998) and previous studies by Ling and Cornell (2010, 2015), we argue that the rock art served as a kind of "secondary agent", which communicated the goals and desired outcomes of secret societies.

Additionally, we argue that this secret society/guild also created the rock art on a seasonal basis, as part of the ritual process associated with boat building. These carvings formed part of a larger ritual component designed to ensure the seaworthiness of watercraft along with the overall success of ocean voyages (Ling 2008). There is ethnographic evidence from the Trobriand Islands that supports this argument. Malinowski (1922), in particular, documented the rituals that were conducted during the Kula Trade canoe construction process. By analogy, we contend that BA Scandinavian rock art panels feature individuals from boat-building guilds who, in turn, formed an integral part of secret societies whose members fulfilled multiple roles as warriors, traders, mariners, ritual specialists, and boat-building craftsmen who were involved in maritime long-distance exchange.

However, before we delve into this subject, we provide a general account of war-related rock art in BA Scandinavia. Afterwards, we briefly discuss secret societies. In the following sections, we will focus on how the rock art is likely connected to these sodalities, while also providing an overview of the social organization of this region during the BA.

Warriors Depicted in Rock Art

In modern-day southern Scandinavia, localities with high incidences of rock art depicting warriors and weapons are generally found at coastal locations. Areas of particular interest are the west coast of Sweden along with the Norrköping and Uppland regions in the eastern part of the country and Scania in the south-east (Fredell 2003; Ling 2013) (Fig. 8.3). These regions share certain traits in terms of the location of the rock art in the landscape (Fredell 2003; Ling 2013). During the BA, these sites were linked to water, either coastal or riverine. In this context, it is important to stress that the Scandinavian landscape has been transformed by shore displacement (Ling 2008). For example, the Bohuslän region of Sweden faced the North Sea in the BA, while Scania and Uppland faced the Baltic Sea, and even Norrköping was linked directly to the Baltic. Regarding the dating of southern Scandinavian rock art, various techniques have been used over the years (Kaul 1998; Ling 2008, 2013). Currently, a dating sequence of 1700–500 BC is accepted by most scholars (Kaul 1998; Coles 2005; Ling 2008, 2013).

A great number of warriors and combat scenes have been carved alongside boats, thus reflecting a strong association between warriors and watercraft. Additionally, a high percentage of these panels were created close to the BA shoreline. While no Scandinavian BA boats have been recovered, most scholars recognize major similarities between the Hjortspring boat (dated to 340 BC) and the BA boats depicted in Scandinavian rock art, indicating a long boat-building tradition in the region (Crumlin-Pedersen 2003; Kaul 1998). As inferred from rock art depictions, the average BA boat carried a crew of 7–20 individuals, while some images depict larger ships with crews of up to 40–60 individuals. These types of watercraft were likely war canoes and/or ceremonial watercraft (Ling 2008) (Fig. 8.4).

Turning to the topic of depicted warriors on rock art panels, the first known representations of warriors date to about 1500–1300 BC (Ling 2008; Toreld 2012; Ling and Cornell 2015). Over time, martial scenes become more prominent, not the least during period V (900–700 BC). Warriors were also represented during the Pre-Roman Iron Age (PRIA), until about 300 BC (Ling 2008).

The frequency of the depiction of warriors and weapons varies chronologically. For example, in the Norrköping area, panels with representations of weapons, warriors, and ships could be associated to period II (1500–1300 BC) (Nordén 1925; Fredell 2003). Also, in Uppland, such depictions, although less frequent than in Norrköping, coincide with period II (Ling 2013). In contrast, along the coastal areas of western Sweden, warrior depictions dated to period II do appear in many locations but just as frequently as in period V (Ling 2008).

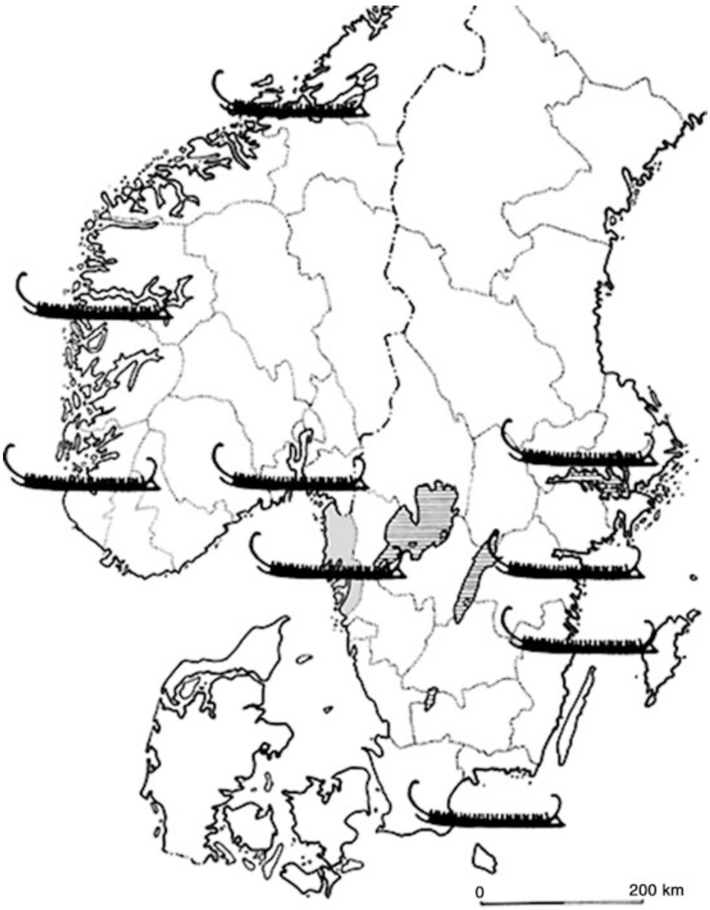

Fig. 8.3 Map of Scandinavia showing rock art regions with ship images (After Ling 2013)

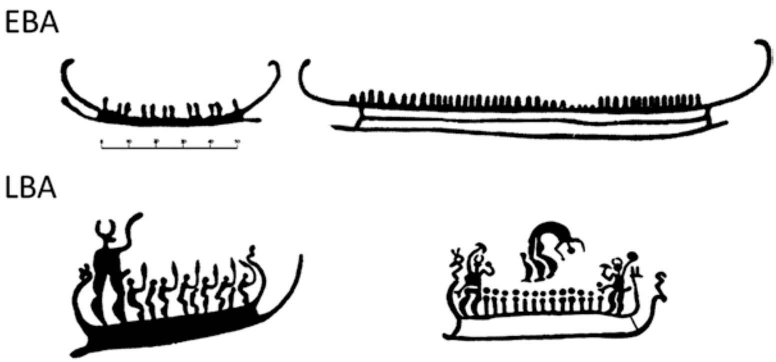

Fig. 8.4 Crewed ships from the Early BA (top) and Late BA (bottom). Documentation by T. Högberg and G. Milstreu at Tanum. Hällristningsmuseum Underslös (Source SHFA)

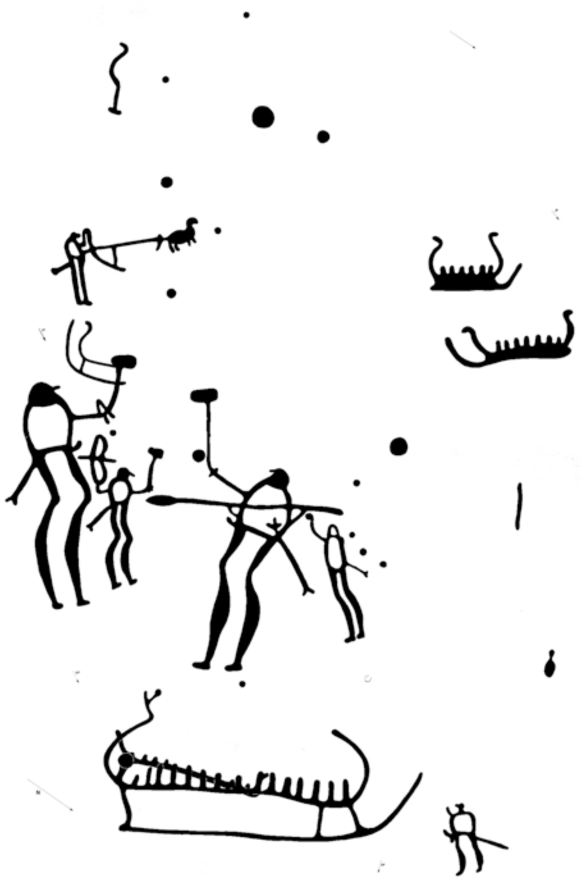

Fig. 8.5 Images of warriors brandishing axes, spears, swords, and bows depicted in BA Scandinavian rock art at Tanum (Documentation by T. Högberg. Source: SHFA)

The weaponry depicted on rock art panels indicates that fighting implements were made from various materials (Harding 2007). Metal weapons are frequently depicted, but weapons made from stone and/or wood are also represented. Likewise, images of axes, clubs, spears, bows, swords, and slings are depicted on BA rock art panels, especially in the Tanum/Bohuslän region (Nordbladh 1989; Harding 2007; Horn 2013) (Fig. 8.5). Rather than showing the outcomes of battles, the rock carvings commonly depict staged encounters with two opponents aiming spears, axes, and bows and in some cases raising swords, against each other. Nevertheless, there are a few instances in which the outcome of the fight is evident (Toreld 2012) (Fig. 8.6).

In terms of armour, shields are frequently depicted in rock art (Fig. 8.7). Traditionally, shield bearers have been associated with Late BA contexts (Coles 2005). However, recent chronological research on shield bearers indicates a dating to periods II–III (1500–1100 BC) (Ling 2013; Ling and Cornell 2015). This suggests that shields could have been present during a major portion of the BA, as was the case in Ireland (Harrison 2004). Throughout Scandinavia, swords are rarely

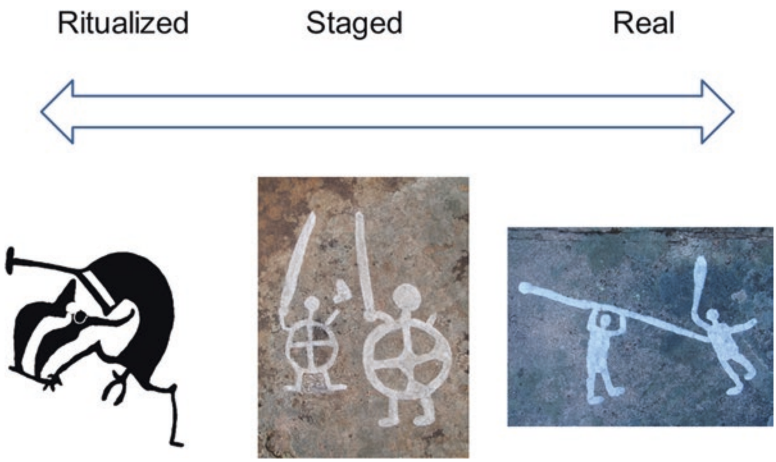

Fig. 8.6 The spectrum of battle scenes depicted in BA Scandinavian rock art includes ritualized, staged, and real battles (Photos by Toreld. Documentation by Stiftelsen för dokumentation av Bohusläns hällristningar. Source SHFA)

Fig. 8.7 Shield bearer with spear from Tanum (3D Documentation by SHFA: Source SHFA)

depicted in use. Most often, these weapons hang passively on the warrior's hip. However, panels showing sword wielders have recently been documented in western Sweden (Toreld 2012; Ling and Cornell 2015; Ling and Bertilsson 2016). New 3D techniques have generated new findings. Previously, metal hilted "ritual" swords were focused on by scholars, but subsequently instances of highly functional flange hilted swords (in action) have come to the forefront (Ling and Bertilsson 2016) (Figs. 8.8a and 8.8b). Thus, new 3D techniques, such as optical laser scanning, digital photography, and structure from motion (SfM), provide a more objective and less

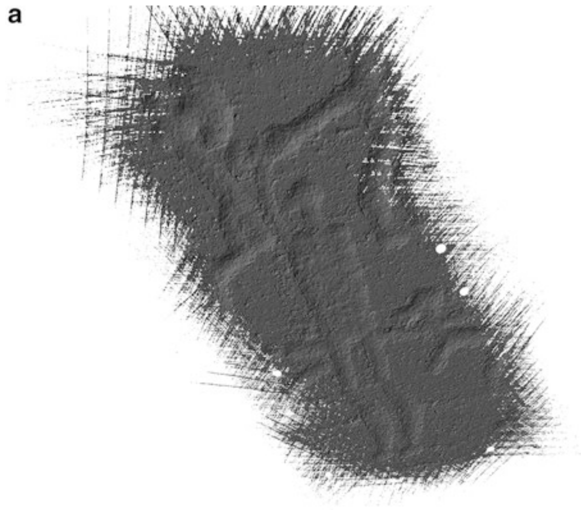

Fig. 8.8a Rock art image showing a sword bearer holding a flange-hilted sword. Laser scanned section of the panel Tanum 255 Laser Scan: Lst V-G län (After Ling and Bertilsson 2016)

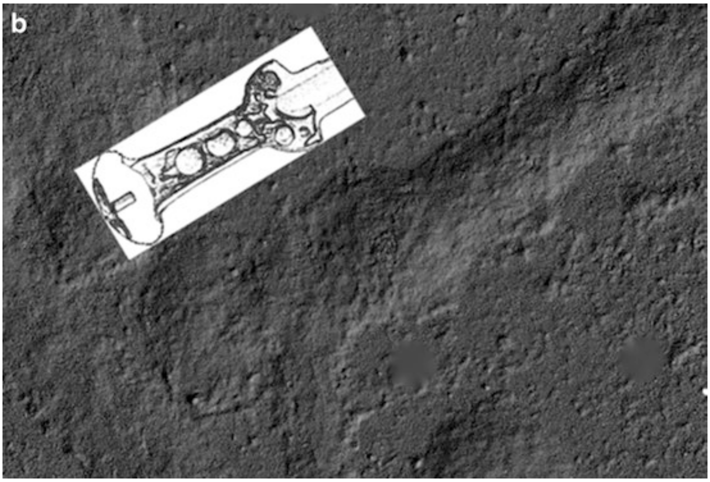

Fig. 8.8b Laser scanned section of the panel Tanum 255 with a flange-hilted sword from Jutland shown next to the carving for comparison. Laser Scan: Lst V-G län (Sword after Kristiansen and Larsson 2005: 276. See also Aner and Kersten 1978. After Ling and Bertilsson 2016)

speculative method of rock art recording than traditional manual approaches. These technological innovations have not only enabled us to re-evaluate and challenge some of the prevailing ideas about rock art, but they have also aided in the development of new interpretations (Ling and Bertilsson 2016).

The war-related rock art may have served as a means of advertising/propaganda or showing-off but may also represent actual violent events (Ling and Cornell 2010, 2017). Advertising and showing-off were and remain important strategies in times of warfare; therefore, it is tempting to see the rock art as a component of military propaganda (Ling and Cornell 2015). To use a contemporary analogy, we should think of large military parades designed to advertise/show-off an army's strength as a type of military propaganda. In this context, it is also important to note that the Scandinavian BA is associated with an increased number of actual weapons being recovered along with a large number of rock art panels depicting conflict (Thrane 2006). Additionally, we argue that rock art may have formed part of secret societies' esoteric ritual practices and shared symbology.

Moreover, some actual BA weapons showing clear traces of wear have been recovered in Scandinavia (Kristiansen 1984; Horn 2013). Small-scale raiding and larger armed conflicts were probably common during this period (Thrane 2006). Recently, skeletal material indicating that large-scale violence and warfare occurred during the BA was found in the Tollense Valley of northern Germany. This finding provides irrefutable evidence of BA violence and killing on a massive scale. The battle of the Tollense Valley likely included 2000–5000 combatants (Jantzen et al. 2011; see also Brinker et al., Chap. 3, this volume). Apparently, a conflict between two factions occurred at this location around 1300 BC. It is important to stress that the Nordic Bronze Age culture was expanding southwards into northern Germany at this time, and this may have been a factor in this conflict (Kristiansen 1998; Sprockhoff 1931).[1]

Rock Art and Bronze Age Scandinavian Society

Whether aggrandizer, ranked leader, or chief are appropriate concepts for use in discussing BA society in Scandinavia is indeed a difficult question to answer. These leadership terms may be problematic as they are based on particular ethnographic contexts, all of which are found outside BA Scandinavia (cf. Godelier 1999). Furthermore, these terms only address particular types of social forms. While political authority is an important factor (Earle 2002), other relevant aspects should also be taken into account. Looking at the evidence, both burials and rock art seem to indicate that southern Scandinavian BA societies were stratified (perhaps at chiefdom level), especially in Denmark and southern Sweden, while chiefdom-level societies appear to have been absent in northern Scandinavia during the same period (Ling 2008).

As mentioned above, certain archaeological finds in southern Scandinavia indicate the presence of a stratified society, perhaps organized as a chiefdom. However, the pertinent question here is the following: How did local elites utilize rock art? Some have argued that the rock art depicted forms of social inequality and, typically, the proponents of this interpretation view rock as a symbolic tool of the elites (Kristiansen 1998; Fredell 2003; Bengtsson 2004; Kristiansen and Larsson 2005).

[1] For archaeological, ethnohistorical, and ethnographic data on traditional warfare and ritual violence in egalitarian and non-egalitarian settings, see Chacon and Dye (2007) and Chacon and Mendoza (2007a, b, 2012, 2017).

However, if rock art was merely a tool of the elites, then rock art sites would be found only in constricted areas that would be easy to close off if necessary (Godelier 1999). In contrast, as far as BA Scandinavian rock art sites are concerned, the opposite seems to have been the case, as rock art panels are frequently found in open locations.

It is important to note that Timothy Earle (2013), a world authority on chiefdoms, does not consider BA Scandinavian rock art as a chiefly medium. Given the open locations of the rock art panels and the simple technologies employed in their production, Scandinavian elites/chiefs could not have monopolized this medium. Rather, we argue that rock art was carved by a sector of society involved in maritime exchange as part of a ritual designed to ensure success on long-distance expeditions. Thus, we concur that BA Scandinavian rock art is a manifestation of individual agency (Ling 2008; Earle 2013). We now turn to the relationship between BA Scandinavian rock art, secret societies, long-distance exchange, and warfare.

Secret Societies

The term "secret society" is, in fact, a misnomer. In reality, a better way to describe this type of sodality would be to refer to it as being "a society with a secret". The term secret society could also roughly be connected to concepts used in warfare studies such as *Gefolgschaft*, or "brotherhood" (Vandkilde 2006; Raffield et al. 2016). Another concept relating to secret societies is that of "ingroup". Raffield and co-workers argue that the formation of the Viking war bands could be seen in light of this concept. "*An ingroup is a social group that is distinguished by a trait or set of trait…The traits that distinguish an ingroup can be genetically inherited or socially learned, and can include dialect, clothing, diet, skin, colour, music, values, beliefs, and attitudes…*" (Raffield et al. 2016: 37).

It is not unreasonable to assume that secret societies generate similar outcomes to those produced by ingroups. Typically, ingroups foster conditions that allow members to forge and maintain bonds beyond biologically based kin networks by way of fictive kin ties (Raffield et al. 2016; Hayden 2016). Conversely, sociological research shows that the presence of exclusionary networks, such as those operating in secret societies, is highly beneficial to high-status actors, such as secret society/ingroup members (Willer 1999; Willer et al. 2014).

The term secret society has been used to describe a special task-oriented group with incipient specialization of labour so as to include war bands, mariners, hunters, herders, smiths, etc. (Hayden 1995; Birx 2006). In this context, it should be stressed that Scandinavian rock art, regardless of age and location, is generally associated with most of the aforementioned activities (Gat 2015; Goldhahn and Ling 2013). Moreover, many scholars have stated that Scandinavian rock art displays a sort of staged social drama that aims to proclaim a certain social order (Coles 2005; Ling 2008; Goldhahn and Ling 2013). Along these lines, Hayden states that "Secret society private *and public performances* constituted ritual theatre in which stage magic proliferated. Like good actors everywhere, they played their roles consummately […]. Shows and claims of power were meant to *impress audiences* and to try to make them believe in the powers claimed by secret society members […]" (Hayden 2016: 12 [emphasis added]).

There are many aspects linking the propagandistic and esoteric nature of BA Scandinavian rock art with Hayden's (2016) statement highlighting the desire on the part of secret societies to *impress audiences*. We will return to this topic shortly; before then, we will examine the nature of secret societies.

Secret Societies Cross-Culturally

Around the world, secret societies are often found in association with the following characteristics/practices, which may also have been present during the Scandinavian BA:

1. Warfare, slavery, and long-distance exchange
2. Boat guilds, long-distance exchange, and warfare
3. The making of rock art (petroglyphs/pictographs)
4. Other ritual activity involving theatre, sacred masks, dances, along with a shared symbology with an esoteric meaning

Warfare, Slavery, and Long-Distance Exchange

Boas (1897: 664) holds that "the origin of the [Kwakiutl secret] societies has a close connection with warfare". Many Northwest Coast secret society rituals often included acts of ritual violence that targeted war captives who often were slaves (Boas 1897; Donald 1997; Drucker 1940).

Moreover, the Haida Indians from the same cultural area of North America also had secret societies that were greatly feared because of their seagoing warriors and devastating slaving raids. Such raids captured slaves who served the chiefs in political exchanges and ceremonial events. Haida polities were ranked with chiefs and noble warriors at the top of the social ladder and slaves at the bottom (Donald 1997). According to Jenness, "The heads of each clan and their kinsmen were the village nobles to whom the common people attached themselves for protection; and under the common people were numerous slaves, hewers of wood and drawers of water, liable to being killed on the slightest pretext" (Jenness 1934: 242–243).

Among the Mano of Liberia, the Poro secret society's initiations, sacred paraphernalia transfers, punishments, purification, and/or public crisis rituals often involved human sacrifice, with slaves often being killed (Harley 1941).

It is very likely that the presence of secret societies greatly facilitated trade which took place between distantly located groups of different ethnic backgrounds, as is indicated by the following quote: "So strong is this power [of the Poro Secret Society] that it is felt even outside tribal limits, and many details of the organization are intertribal, so that a man of high standing will be so recognized even in a distant tribe whose language he cannot speak. An elaborate secret language of signs has thus developed, which is said to be similar to that of freemasonry" (Harley 1968: 3).

Boat Guilds, Long-Distance Exchange, and Warfare

The Chumash Indians of southern California conducted maritime trade using a native plank canoe (*tomol*) that was capable of travelling great distances over the open ocean (Kroeber 1976). Among this indigenous group, there existed a sodality known as the "Brotherhood of the *Tomol*", which afforded safe passage to its members. Given the fact that the Chumash often engaged in war with neighbouring tribes, the presence of this "brotherhood" likely facilitated interethnic trade over long distances (Blackburn 1980; Chacon 2014; Fagan 1995; Johnson 2007).

Additionally, runic inscriptions from Viking Age Scandinavia bear witness to the fact that the Viking war bands were organized in boat guilds (Jakobsson 1992: 81), and we contend that these entities would have formed an integral part of BA Scandinavian secret societies. During this period, free farmers were organized as maritime warriors in various boat guilds (Varenius 1998; Jakobsson 1992). These sodalities foisted fictive kin relationships onto crewmembers as is indicated by the following quote: "…the relations between male members were regulated as if they were family; members identified each other in terms of fathers, brothers and sons" (Varenius 1998: 141). Moreover, this masculine warrior ethos was commonly expressed on runic stones which make reference to "naval brothers" who had died in combat, along with classifying naval officers and their warrior crew members as kin (Jakobsson 1992: 81).

Along these lines, the Haida were considered the "Vikings of the North West Coast" because of their boat guilds that organized trading and raiding expeditions. Large seagoing canoes, made from enormous red cedars and manned by large crews of paddling warriors, were known to cross open waters over great distances (Donald 1997).

In fact, the Haida were known to conduct raids ranging from Sitka, Alaska, to the Fraser River in Canada (a distance of over 1000 km). According to Jenness, "[t]hose were stirring times…when the big Haida war canoes, each hollowed out of a single cedar tree and manned by fifty to sixty warriors traded and raided up and down the coast from Sitka in the north to the delta of the Fraser River in the south. Each [canoe] usually carried a shaman or medicine man to catch and destroy the souls of enemies before an impending battle; and the women who sometimes accompanied the warriors fought as savagely as their husbands. Many a mainland fisherman, as he quietly paddled his family up some inlet in the early morning, heard the dreaded war-shouts of these New World Vikings and saw their canoes dart out from ambush to cut off his retreat. As far away as the delta of the Fraser River the Indians palisaded their villages and kept a watch each summer against the island raiders from the north. One group of Haida even went so far as to pillage an American schooner and enslave its white crew, who were subsequently redeemed by the Hudson Bay Company" (Jenness 1934: 243).

The Making of Rock Art (Petroglyphs/Pictographs)

In North America, there is ethnographic data linking secret societies with rock art. According to Drucker (1940: 221), the *carving of petroglyphs* by initiates was part of the ritual activity required for admission into certain secret societies of the Northwest Coast Tsimshian. Given the nature of secret societies, it is likely that only Northwest Coast Tsimshian secret society members would have possessed the esoteric knowledge to comprehend the underlying meaning and symbology of the rock art. Other scholars also report a link between rock art and secret society initiation rituals as indicated by the following quote: "The magical fraternities of the North American Indians hold a most important place in the social and religious life of the people…Candidates for initiation give much attention to the preparation of the songs and chants sung by members at the lodge meetings or at the public performances of the [secret] societies. By means of elaborate rituals and songs, by *pictographs* and sand paintings, the religious traditions concerning the ancestors of the tribe are carefully preserved" (Webster 1908: 179 [emphasis added]).

Links between rock art and secret society ceremonies can also be found in other parts of the world. For example, the rock art found at the Kanamuget site in Uganda is associated with [Sor] secret society spirit mediums (Namono 2017). Additionally, the Nyau secret society members of central Malawi and eastern Zambia were known for their tradition of creating rock art (Smith 2001). Moreover, some investigators report the existence of a nexus between rock art and "secret male unions" (i.e., secret societies) in Siberia and the lower Amur region (Lapshina 2016: 1331). "In the Lower Amur basin, there are numerous monuments of rock art. They are characterized by the predominance of skull masks. The semantic content of these artifacts allows [us] to identify them as the main attributes of the rituals of the secret male unions [secret societies]…" (Lapshina 2016: 1320).

The connection between rock art and secret societies may be of great antiquity as indicated by the following: "The cave of 'Su Longu Fresu' is one of a group of 9 ritual caves in the…inner mountain region of the Barbagia di Seulo in Central Sardinia… In its central part,…, a human skull, radiocarbon-dated to the final part of the fifth millennium BC, was found in the proximity of a *rock-art* black painted panel depicting an anthropomorphic horned figure holding a bow aimed towards a horned animal…The highly symbolic and restricted space, the presence of natural holes filled with human and animal bones together with 'objects of prestige' like obsidian arrowheads and a small greenstone axe, suggest a secret cult area linked to rites of passage and of initiation into male *secret societies* in which the society power would be reinforced by re-entering into the underworld under the authority of the ancestors" (Gradoli and Meaden 2011: 220 [emphasis added]). Future research will further explore the link between rock art and secret societies cross-culturally.

Other Ritual Activities Involving Theatre, Sacred Masks, and Dances, Along with a Shared Symbology with an Esoteric Meaning

Poro secret society members wore ritual masks and headdresses during dramatic/evocative ceremonies. "Masks were the most sacred objects in the life of a Mano man [of the Liberian Poro secret society]. Death was the penalty for exposing one publicly except when properly worn by an official. They were similar to fetishes in that they were objects of sacrifice and prayer…Even an official entitled to wear a big mask must do obeisance to it before putting it on, by spitting onto it and passing it over its head three times. The fourth time, [he] puts it on" (Harley 1941: 171). Moreover, during rituals, Poro secret society mask wearers felt that they were "possessed with the spirit which dwells in the mask" (Harley 1941: 13).

In the following section, we identify the characteristics/practices of secret societies that could have been in existence in Scandinavia during the BA.

The Warrior/Trader/Ritual Specialist Secret Society

Who created the BA Scandinavian rock art? We believe that the answer to this question is to be found among secret societies which are known to "hold secret knowledge or perform secret ceremonies [rituals] exclusive to that group…During the periods of initiation, esoteric knowledge is gradually revealed to the initiates who gain by degrees the secret knowledge held by the group…They also offer their members a system of mutual aid and assistance" (Birx 2006: 2106–07).

We argue that BA Scandinavian rock art was produced in an apprenticeship system of warriors/ritual specialists and that esoteric knowledge was transmitted by exclusive initiation rites. Such secret society members would also maintain access to local and long-distance exchange networks. It is likely that elites (i.e. chiefs) sponsored many of a secret society's rituals and long-distance trading expeditions.

In this context, we posit that the initiation into a BA Scandinavian warrior guild/secret society would have involved the making of rock art. As previously mentioned, the rock art panels were carved at locations for all to see. This is very much in line with Hayden's assertion that secret societies wish to "*impress audiences* and to try to make them believe in the powers claimed by their members…" (Hayden 2016: 12). Moreover, the carved images include highly selective features such as depictions of war canoes, "warriors", specific ritual gear such as bi-horned helmets and bird-like attributes, masks, and other esoteric items (Ling and Rowlands 2015).

Thus, the war-related rock art appears to be associated with ritual theatre and to the public claims of power and possibly to actual acts of violence and war (Ling and Cornell 2010). Additionally, among the BA Scandinavian warriors, there was social inequality, and we argue that the social position of warriors was not fixed or institutionalized, but, rather, status had to be achieved in praxis through active performance. Advertising and showing-off were important strategies in the context of secret societies, and it is tempting to see the rock art as part of this strategy.

Thus, it is likely that only members of the warrior/trader/ritual specialist secret society would have been allowed to witness and/or take part in esoteric rituals associated with the carving of petroglyphs. This sodality or "brotherhood" would have been the social mechanism by which warriorhood, navigational skills, boat construction methods, and likely rock art symbology and carving techniques were passed from one generation to the next. Moreover, there are other important social traits that should be highlighted in terms of the person being initiated into this warrior/trader/ritual specialist secret society. First of all, during the initiation process, the person seeking admission occupies a "liminal state" characterized by a high degree of social exposure/vulnerability, with an ambivalent position in the social landscape. This means that an initiate must seek out and secure a social position as part of this ritual process. It is likely that initiates would have employed social advertising as an important strategy in this context. Therefore, we hold that BA Scandinavian rock art was a component of this process.

In this context, the term "magic" that Hayden (2016) and others employ refers to an important concept that needs further explanation. For instance, Gell (1998) refers to magic when it comes to the social intentions behind artistic designs on the war canoes used in the Kula ring, as an active praxis for manipulating social positions and social actions. Thus, we ask, could Trobriand Island magic/ritual activity documented by Malinowski (1922) be similar to the magic/ritual activity surrounding the carving of BA Scandinavian rock art? According to scholars such as Malinowski (1922) and Gell (1998), magic is an active social process, which mediates between society's ideological "structure" and pragmatic "individual" action in the landscape. Thus, magic, in contrast to religious rituals, is intended to alter and transform social positions in the landscape, and it is believed to bring about some desired practical result without the interference of supernatural beings (Malinowski 1922: 105). For example, the carvings on Trobriand Island canoe prow boards served a function far beyond aesthetics. They worked actively as "secondary agents" of psychological warfare in the competitive Kula exchange (Gell 1998). More specifically, BA Scandinavian rock art exhibits traits that may reveal the agency of a special task-oriented group that, in turn, can be connected to the topic of this section. In terms of both the content and the location of the rock art in general, the following characteristics are prevalent:

- Rock art panels are found along coastal or maritime locations.
- Boats are the most dominant depiction in rock art.
- Actions and performances are often depicted in association with boats.
- Anthropomorphic figures brandishing weapons are often depicted in rock art.
- There is dominance of figures with equipment generally associated with males.

Bronze Age Scandinavian Slave Raids

We acknowledge that the evidence of slavery in the Scandinavian BA is only suggestive, but the capture and exchange of slaves by warrior/traders are a possibility that should be carefully considered in future research. For instance, the need to secure metal was a major priority for those desiring prestige and power during the BA. Thus, long-distance trading and raiding became imperatives in establishing and maintaining prestige/power networks. In order to conduct such activities, much labour had to be transferred from the agricultural to the voyaging realm. This raises the following question: with such a shift in labour, who filled the agricultural labour gap? Viking era historical documents, as well as ethnographic accounts of maritime ranked societies, indicate that slaves often filled this gap and constituted an important part of the economy (Ling et al. in press). We posit that this also likely took place in the Scandinavian BA. With slaves working the home farms, unencumbered warriors/traders seeking to raise their social standing could now participate in long-distance voyages to take captives for enslavement.

In short, aggrandizing households sponsoring boat building would also reap the many benefits stemming from the capturing of slaves. But could slaves have been a key Scandinavian export commodities? As commodities of high value, slaves would have been desired by local BA communities and by those living further south as well. Slaves would have been captured by warriors/traders plying the coasts of Scandinavia but also the northern German coast and elsewhere. Thus, the coastal populations would have been vulnerable to fast-acting raiders of the type described by Viking era documents. As previously stated, we acknowledge that this scenario is speculative, but there are data which support this view (see below).

As the result of various burial findings in southern Scandinavia, some scholars argue for the existence of slaves in the BA. This has been suggested for the findings from the BA barrows in Scania dated to periods II–III. Barrow burials were restricted to the top segment of the society, likely made up of free farmers (around 20% of the overall population), while commoners and possibly slaves were buried in unfurnished trench and gallery graves (Bergerbrant et al. 2017).

Another indication of the possible existence of slaves in the Scandinavian BA comes from Sund, Norway, where evidence of a brutal massacre of 22 individuals, mostly children, has been recovered from a mass grave. At this site, many of the documented casualties/injuries are commensurate with the types of casualties/injuries one would expect to find among slaves (Fyllingen 2003). Moreover, some scholars argue that some of the Late BA farmsteads were built and organized in order to house slaves within a certain part of the building. That is to say, these structures contained a specific section for "a family of slaves or non-free workers" (Mikkelsen 2013: 62). Mikkelsen argues that this practice goes back to the Late Neolithic (Mikkelsen 2013).

Additional evidence supporting the existence of BA slavery is found on the Island of Thanet in south-eastern England, where a Late BA settlement, thought to have been a trading outpost, has yielded metal ingots and Baltic amber. The analysis

Fig. 8.9 Rock art image from Trondheim, central Norway, illustrating a possible slave caravan (Photo by Ragnar Utne)

of strontium and oxygen isotope signatures in human bone from several graves from the site indicates that, while certain individuals have local signatures, others have Scandinavian and western Mediterranean signatures (McKinley et al. 2013). A female (possibly a slave) who possessed a clear Scandinavian signature had not been properly buried, but, rather, she had been hurled into a pit within a large ring ditch (McKinley et al. 2013: 159). The suggestion that this victim had been a slave in life is supported by ethnographic evidence from the Northwest Coast peoples of North America. In these societies, slaves typically did not receive proper burial. Upon the death of a slave, the corpse was left to decompose in the forest or simply tossed into the sea (Donald 1997). Furthermore, depictions of slaves may appear in several BA Scandinavian rock art panels, in which lines of people are linked together in a manner that may suggest that they were captives and perhaps slaves (Fig. 8.9).

Bronze Age Scandinavian Boat Guilds, Long-Distance Exchange, and Warfare

In line with the argument of boat guilds forming an essential component of BA Scandinavian "secret societies", we propose that the boats depicted on rocks in western Sweden are associated with the actual production and use of boats in the 2nd and 1st millennia BC. Boat building at that time demanded an enormous investment of labour, materials, and technology. A boat like the Hjortspring vessel would have taken about 6500 man-hours to produce (Valbjørn 2003: 235), which is equivalent to one person working 8 h every day for 2 years. Thus, building a boat was a major undertaking. For instance, Solomon Islands war canoes, which had similar technology as the Hjortspring boat (though with considerably more elaborate prows similar to those depicted in BA Scandinavian rock art), took 3 or 4 years to complete, which is perhaps a reasonable labour estimate for large BA vessels. The construction of seagoing canoes in the Solomon Islands was organized in stages, each of which was marked by significant rituals designed to minimize the many risks involved in ocean voyaging (Clausen 1993).

In a similar vein, Malinowski (1922) observed that Melanesian boat builders considered work and magic to be an interwoven praxis that formed an integral part of the technological, social, and spatial stages of Kula canoe building in the Trobriand Island landscape. He stated that "Magical rites must be performed over the seagoing canoe when it is built, in order to make it swift and steady and safe; also magic is done over a canoe to make it lucky in the Kula. Another system of magical rites is done in order to avert the dangers of sailing. The third system of magic connected with overseas expeditions is the *mwasila* or the Kula magic proper" (Malinowski 1922: 102). Thus, the building of a Trobriand Island war canoe included three major production steps: (1) the cutting down of trees on higher ground, (2) the major portion of boat construction that took place in villages, and (3) the final work done on the canoe along the shore along with the launching of the boat (Malinowski 1922: 102).

By analogy, we posit that the spatial distribution of BA Scandinavian rock art reflects the spatial distribution of the various technological and ritual stages in the building and/or launching of vessels. Moreover, we argue that the BA "secret society" boat guilds also created the rock art as part of the ritual process designed to minimize the many risks involved in sea voyaging. For instance, BA rock art in western Sweden was carved in three areas: (1) on higher ground away from settlements on typically chalky soils that were favourable for timber harvests, (2) on higher ground in proximity of BA settlements, and (3) along shoreline/coastal areas (Ling 2008).

In this context, we posit that the rock art formed part of the "magical" or ritual component involved in each of the social and technological stages of boat building and launching. The rock art found on higher ground away from settlements (i.e. area 1) could have formed part of the tree-cutting ritual process. The rock art carved adjacent to settlements (i.e. area 2) likely formed part of the major boat construction ritual process. This is because the area's proximity to settlements would have facilitated the organization of communal work necessary for the building of boats. Lastly, the rock art found along the coast (i.e. area 3) likely formed part of the boat-launching ritual process designed to minimize the risks of long-distance maritime travel. Thus, Scandinavian rock art formed part of a larger ritual component of BA secret societies, designed to ensure the seaworthiness of watercraft along with the overall success of voyages (Ling 2008). We also contend that some rock art found along the coast may have been carved to commemorate particularly successful

Fig. 8.10 Depiction of a possible oxhide ingot on a ship dated to 1400–1300 BC, from a rock panel in Norrköping, Sweden (Photograph by Catarina Bertilsson. Source SHFA)

trading expeditions (Fig. 8.10). In short, we hold that the locations of Scandinavian rock art reflect specific technological and ritual activities associated with boat building and launching. This position finds support in the ethnographic record as Malinowski (1922) noted that magic was engaged in *at every stage* of the Trobriand Island Kula Trade.

Bronze Age Scandinavian Rock Art, Ritual Activity, Sacred Masks, Dances, and Secret Societies

Many of the anthropomorphic beings depicted in Scandinavian rock art appear to be wearing headgear, masks, and other ritual paraphernalia. For instance, the bi-horned warrior is a common figure found in western Swedish rock art panels that could date to period V, the second major period of metal circulation. At Tanum/Bohuslän, for example, there are well-known carvings displaying bi-horned warriors (Fig. 8.11). One of the most spectacular images of this kind comes from the Lövåsen site. It shows an armed, phallic, bi-horned, anthropomorphic being wearing a large bird-like beaked mask. Many images of warriors depict beings wearing bird-like masks. This combination is also evident on the famous bi-horned Viksö bronze helmet, dated to period V. Importantly, this helmet includes a bird beak at the front and stylized depictions of bird heads connected to boats along the side (Kaul 1998), which show remarkable similarities to rock art imagery. Further anthropomorphic beings featuring bird-like attributes can be seen at the famous site of Kallsängen in Bottna; they possess not only beak-shaped masks but also wings (Fig. 8.12). Other depictions record dancing scenes or acts of ritual warfare (see Figs. 8.2, 8.4, 8.5, and 8.6).

Fig. 8.11 One of the most spectacular BA rock art depictions from Tanum, western Sweden, is that of an armed, phallic, bi-horned anthropomorphic being wearing a large bird-like mask (Photograph by Bertil Almgren. Source SHFA)

Conclusions

In this chapter, we have argued that, during the BA, Scandinavian secret society members organized long-distance trading expeditions (which included warrior/traders/ritual specialists and craftsmen) for the purpose of obtaining coveted metal. In effect, images of armed warriors standing in or near watercraft are found throughout this region. Since secret society ritual specialists were charged with ensuring the success of ocean voyages, we believe that they were also responsible for carving the rock art. The carvings likely represent esoteric initiation rituals or specific rites conducted for the success of expeditions and/or actual events that may have taken place during the course of voyages. This argument finds support in the evidence provided by the aforementioned secret societies of the Northwest Coast Tsimshian, where the *carving of petroglyphs* formed part of the initiation process (Drucker 1940: 221).

Additionally, certain Scandinavian BA carvings depict anthropomorphic beings that appear to be wearing masks or headgears – a practice found in many secret societies (Figs. 8.4, 8.5, 8.6, 8.11, and 8.12). Since ritual specialists with rock carving skills likely formed part of crews, they may have carved images of actual events and/or foreign/exotic technologies that they had seen first-hand. This seems to be the case with the oxhide ingots engraved on several rock art panels in Sweden (Ling and Stos-Gale 2015), along with the unequivocal images of chariots, which are very similar to those depicted on contemporary Iberian rock art, as well as those actually used by ancient Mycenaeans (Koch 2013). To date, no evidence indicating the presence of such chariots during the BA has been recovered in Scandinavia. It is possible that chariots such as the one carved at Backa represent a form of technology that a long-distance warrior/trader/ritual/craft specialist (and secret society member) observed and then faithfully rendered on a rock panel upon returning to Scandinavia (Fig. 8.13).

Fig. 8.12 Anthropomorphic beings featuring bird-like attributes at the famous site of Kallsängen in Bottna, western Sweden (Paper rubbing by D Evers. Source SHFA)

Moreover, we have argued that only secret society members would have possessed knowledge of rock carving techniques and would have understood the symbolism and meaning of the designs. This position is supported by the aforementioned esoteric Kwakiutl and Poro secret societies (Boas 1897; Drucker 1940; Harley 1941, 1968). It is also likely that BA Scandinavian secret society members would have formed a type of sodality or "brotherhood", which would have shared practical knowledge involving navigation, boat construction, and watercraft maintenance. Additionally, members of this fraternal society would have likely guaranteed safe passage while travelling through a region occupied by fellow secret society members. This would have greatly facilitated long-distance trade over the trans-regional and interethnic network during the Scandinavian Bronze Age. This argument finds support in the aforementioned Chumash "Brotherhood of the Canoe" (Blackburn 1980; Chacon 2014; Fagan 1995; Johnson 2000, 2007).

Lastly, we have posited the possibility that Scandinavian BA rock art panels may have served as a form of cryptic signalling designed to transmit esoteric information to fellow secret society members. This position finds support in the above-cited elaborate *secret language of signs* that Poro secret society members employed to communicate with associates inhabiting distant locations. Despite being from different

Fig. 8.13 Depictions of chariots from Backa, western Sweden. These BA Scandinavian chariot carvings are very similar to the chariots depicted on Iberian rock art and to archaeologically documented Mycenaean chariots (Paper rubbing by D. Evers. Source SHFA)

ethnic and linguistic backgrounds, these foreign associates nonetheless recognized and honoured the social standing of high-ranking Poro secret society members (Harley 1968). Thus, we conclude that the presence of a trans-regional and interethnic means of communication in the form of highly visible rock art would have greatly facilitated long-distance trade during the Scandinavian Bronze Age.

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Part III
The Material Culture of Conflict

Chapter 9
Body Armour in the European Bronze Age

Marianne Mödlinger

Introduction

The first archaeologically known bronze body armour appeared in Dendra, Greece, in LH II/IIB, around 1400 BC. Whilst Grave 8 contained only a metal shoulder protection, Grave 12 contained a whole set of armour. This includes a cuirass with attachments, greave(s), a possible arm protection, a boar's tusk helmet and possibly an organic shield (Verdelis 1967). Grave 12 is the only burial from the European Bronze Age from which what appears to be a complete set of defensive armour has been recovered. From the initial Late Bronze Age onwards, a high number of pieces of bronze armour rapidly come into use, most of them in the Carpathian Basin. From this region, the idea of the metal armour, and in particular cuirass and greave designs, spread westwards. Several helmets of the 'Western European' series, in contrast, appear to follow a distinct pattern of dispersion to their Eastern European counterparts, as to suggest that the two series of helmets developed from separate organic progenitors. At present, approximately 230 finds of bronze body armour of various shapes and types are known from the European Bronze Age. Of these, roughly 30 cuirasses, 50 Western European helmets and 70 Eastern European helmets are securely dated to the Bronze Age, whilst some of the about 75 greaves found to date, especially those of Type Ilijak and Type Grammichele, are attributed to the initial Iron Age (Mödlinger 2017).

These numbers are astonishingly low when compared to the many thousands of contemporary bronze weapons such as swords, spears and daggers. This might partly be explained by the generalised use of organic body protection that has now

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disappeared (as hinted at by a few fragments of possible linen armour from Mycenae and an organic head protection from Fiavé, Italy). In some areas, moreover, certain categories of armour may simply not have been deposited, or perhaps they were not available to people for sociocultural reasons (e.g., taboos), economic unavailability or traditions harking back to a pre-armoured past. Furthermore, people might have preferred to hand armour down to subsequent generations, as is the case of Odysseus' boar's tusk helmet (Iliad X.266–272), instead of depositing it in graves or hoards. Finally, it is certainly the case that most of the armour made and used in the Bronze Age never entered the archaeological record due to recycling. Another, more unfortunate, reason behind the scarcity of surviving bronze body armour is that objects of this kind are in high demand on the antique market, and much of the armour known today to archaeologists derives from illegal excavations. Therefore, many finds come from unknown sites and contexts and are often held in private collections.[1] Despite their doubtful provenance, these pieces of armour were often sold and resold several times through different auction houses and usually cannot be studied in detail. Certainly, their unknown provenance and find context do not help to clarify the chronological classification and distribution of certain armour types, especially helmets.

The distribution of body armour from the European Bronze Age ranges from Iberia to the west to Cyprus to the east and from Sicily to the south to Sweden to the north. Notable omissions in this distribution range include Britain and Ireland, where no helmets, greaves or cuirasses have ever been recovered. Body armour is also poorly attested in Scandinavia, where again only shields and a small number of bronze helmets are documented. In Germany, the distribution ranges of shields and helmets overlap with one other, but only two greaves and one possible cuirass are known to date from this region. In France, helmets, greaves and cuirasses, but no shields, have hitherto been recovered, whilst in Italy helmets and greaves have been found, but no cuirasses or shields. In the Iberian Peninsula, crested helmets are known from a few recovered fragments, as are bronze shields; both finds are complemented by numerous depictions on stelae. The Iberian stelae also indicate that not all prehistoric warriors were equipped with complete body armour panoplies. In Greece, several greaves, a few cuirasses and some helmets have been brought to light, but most likely no functional metal shields (except for the Delphi shield: Molloy in press). In the central Alpine region, helmets, a small number of greaves and, most recently, a miniature cuirass have been found (Mödlinger 2014a). Only in the Carpathian Basin are all four major categories of defensive armour known, with overlapping distribution ranges.

With the exception of the Greek finds, and those from Volders (Austria) and Čaka (Slovakia), body armour has generally been found either in hoards or as single finds, often from wet contexts. Notwithstanding the existence of alternative burial traditions, the deposition of weaponry in watery places may be related to war-like activities and was perhaps connected with peacemaking, the renewal of alliances, victories or offerings made to gain good fortune in ongoing or future fights. With regard to

[1] At least 17 complete helmets and several greaves from private collections are known to the author.

depositional patterns, as metal armour is rarely found in graves, it may be suggested that protective gear could be transferred from the personal sphere to more explicitly ritual realms more frequently than weapons. However, we have to bear in mind that geographical and chronological variation in weaponry and armour depositional practices might have existed in Bronze Age Europe.

In this chapter, I shall discuss chronological and typological aspects of bronze body armour, also considering their manufacture and use.

Chronology and Typology

Traditional classifications of body armour rarely incorporate the full range of attributes needed to understand both technological and stylistic dimensions of these objects. Only greaves were recently classified by Clausing (2002) according to both criteria. Consequently, a new classification scheme is proposed here for helmets and cuirasses, whilst the classification of greaves broadly follows Clausing's. A hierarchical approach will be used in this chapter to categorise the objects; in this, the armour will be grouped according to technological (class and subclass) and stylistic (type) traits. Since it is the aim of this chapter to focus especially on the manufacture and usage of body armour, chronological details will be touched upon briefly. The chronological classification of the armour follows Mödlinger (2017), which in turn relies on previous studies by Merhart (1941) and Hencken (1971), as presented in Tables 9.1 and 9.2.

Table 9.1 Typo-chronological distribution of Bronze Age body armour in Europe

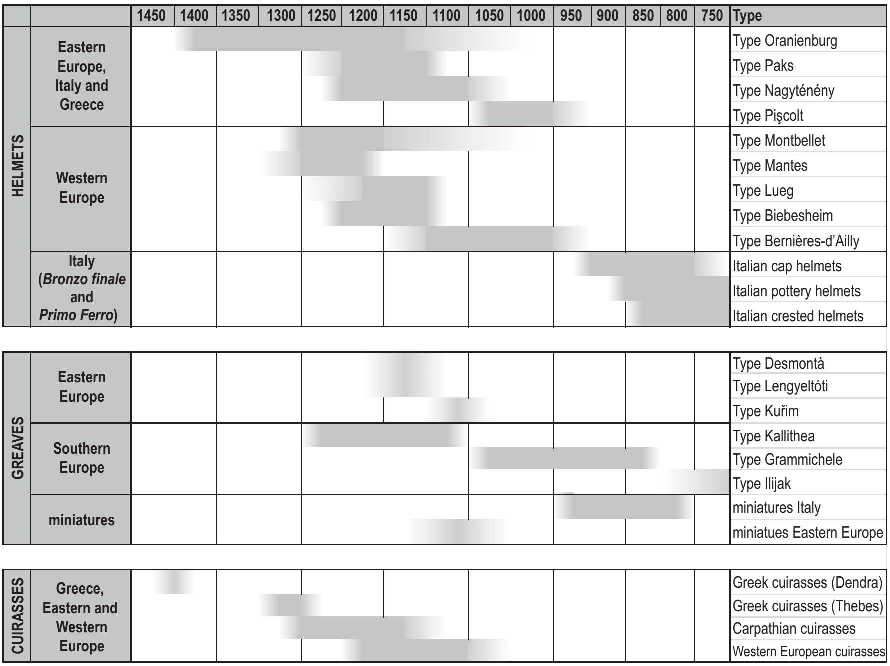

Table 9.2 Synchronised chronology of the Middle and Late Bronze Age in Europe, by region. (After Mödlinger 2017). Iberia (including Monte Sa Idda, Sardinia): Roberts et al. 2013; France: Milcent 2012; Roberts et al. 2013; central Europe: Pare 2008; Sperber 2011; Italy: de Marinis 1999; Iaia 2005; Pare 2008. Aegean: Manning 2010; Uckelmann 2012)

	Iberia		France		Central Europe		Italy (BM &BR Northern Italy; BF Tarquinia/Veii)	Aegean			
	hoards	**general**	**NW / Atlantic**	**Central / East**				**mainland (high)**	**Crete (high)**	**mainland (trad.)**	**Crete (trad.)**
1500					**BzB2**		Bronzo Medio IIA	LH IIA	LM IB	LH IIA	LM IIA
1450			Bronze moyen I (Tréboul)	Bronze moyen	**BzC1**	**Middle Bronze Age**	Bronzo Medio IIB	LH IIB	LM II	LH IIB	LM IIB
1400		Bronzo tardio			**BzC2**			LH / LM IIIA1		LH IIIA1	LM IIIA1
1350			Bronze moyen II (Mont-Saint-Aignan)				Bronzo Medio IIC	LH / LM IIIA2		LH IIIA2	LM IIIA2
1300	Isla de Cheta			Bronze final I	**Bz D1**		Bronzo Recente I	LH / LM IIIB		LH IIIB	LM IIIB
1250			Bronze final I (Rosnoën)		**Bz D2**						
1200	Huerta de Arriba			Bronze final IIa	**Ha A1**		Bronzo Recente II				
1150	Granón				**Ha A2**			LH / LM IIIC		LH IIIC	LH IIIC
1100	Alhama de Aragon			Bronze final IIb			Bronzo Finale I				
1050	Hío	Bronze final	Bronze final II (St.-Brieuc-des-Iffs)		**Ha B1a**	**Urnfield Culture**	Bronzo Finale II	sub-mycenaean	subminoan		
1000	Huelva			Bronze final IIIa	**Ha B1b**		Bronzo Finale IIIa			submy cenaean	subminoan
950					**Ha B2**		Bronzo Finale IIIb transition Primo Ferro IA	protogeometric			
900			Plainseau (Boughton-Venat group)	Bronze final IIIb	**Ha B3a**		Primo Ferro IB1 / IB	early geometric			
850	Monte Sa Idda				**Ha B3b**		Primo Ferro IB2 / IC	middle geometric			
800		Hierro Antiguo	Court-St-Etienne/ Gündlingen	Hallstatt ancien	**Iron Age**	**Iron Age**	Primo Ferro IIA / IIA–B				

Helmets

According to their technological characteristics, metal helmets can be divided into two classes: Class I are helmets made out of a single bronze sheet ('cap helmets'), and Class II are helmets made out of two bronze sheets ('crested helmets'). These classes are further divided into subclasses according to the shape of the helmets' caps (round, conical, crested) and then into types based on stylistic traits (Fig. 9.1).

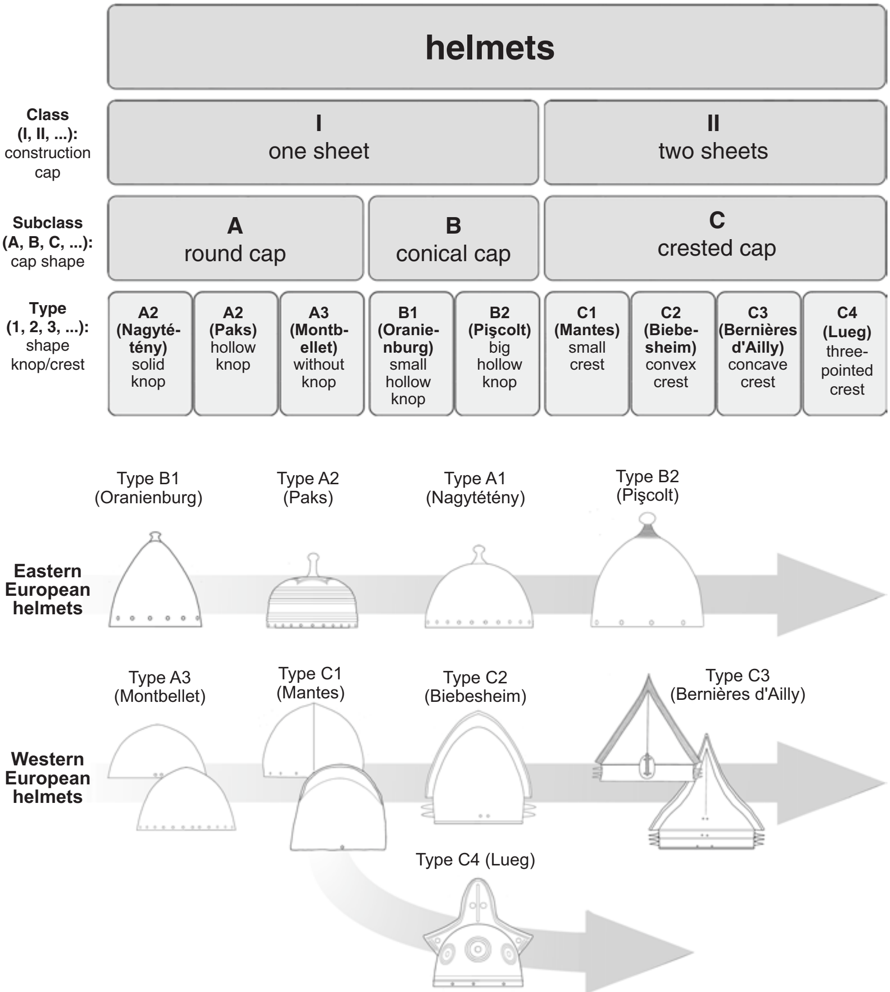

Fig. 9.1 Above: classification and development of Eastern and Western European Bronze Age helmets. The helmets are divided into two classes according to their construction principles: Class I comprises helmets with a cap made of one bronze sheet, while Class II helmets are made of two bronze sheets. Classes I and II are then divided into subclasses according to cap shape (Subclass A with round cap, B with conical cap and C with crested cap). The presence/absence and shape of knobs/crests are described by type. Below: chrono-typology of European Bronze Age helmets. Type Mantes helmets can be considered a hybrid, since the older helmets of this type have a cap made of one sheet, and the more recent helmets have a cap made of two sheets

Fig. 9.2 Geographical distribution of Bronze Age helmets. ○ Class I helmets (cap helmets). □ Plain-cap helmets (Type Montbellet). ▲ Class II helmets (crested helmets). Helmets with unknown or dubious find spots are not mapped

Most Class I helmet types have a central knob and are generally found in Eastern and South Eastern Europe. In contrast, Class I helmets without knobs (i.e. Type Montbellet helmets) and Class II helmets are all found in Western Europe, thus suggesting the existence of separate regional workshops and working traditions. There appears to have been only occasional exchanges of helmets between these macro-regions; this is indicated by rare exemplars found outside their likely area of origin, such as the Type Montbellet helmet from Szikzó, Hungary; the Type Pişcolt helmet from Monte Altino, Italy; and an unprovenanced crested helmet from the antique market, reportedly from Hungary (Mödlinger 2017, cat. no. 100) (Fig. 9.2).

It is apparent that both crested and cap helmets were developed from organic precursors that had been used in different regions, and there is no need to look for Near Eastern ancestors to account for their origins (Mödlinger 2017; Brandherm 2011). Whilst western European helmets seem to derive from local organic head gears, the Eastern European metal helmets may instead have their origins in the Aegean, as we can see from the development of Type Oranienburg helmets, which, unquestionably, are the oldest metal helmets in Europe (Mödlinger 2013). The Knossos helmet and an unprovenanced specimen with boar's tusk decoration (Buchholz et al. 2010; Mödlinger 2013) are amongst the oldest helmets of this type. On the latter helmet, the incised boar's tusk decoration is arranged in the same way as one would expect to see it on an actual boar's tusk helmet; this suggests that the helmet is of a transitional type, even though, as it was bought on the antiquities market, its authenticity has sometimes been questioned. However, both its chemical composition and its metallographic microstructure comprising inter- and intracrystalline corrosion prove its authenticity (Mödlinger 2017). This unique object is dated to a time period predating the Knossos helmet but following that from Dendra; this indicates a rather rapid adoption of metal around 1400 BC for the construction of helmets. The production period of this helmet type is thought to range from the fifteenth century BC in Greece to as late as the thirteenth century BC in Eastern Europe. Type Oranienburg helmets, which are clearly derived from Aegean boar's tusk prototypes, spread quickly into the Carpathian Basin and then further north as far as Biecz in Poland. They were then superseded by helmets of the Paks, Nagytétény and Pişcolt types.

The organic precursors of crested helmets remain unknown archaeologically. However, the four helmets of Type Mantes, which bear a simple crest or central ridge made of one or two bronze sheets (thus being, strictly speaking, a transition type between Class I and Class II), are thought to be the local precursors of Types Biebesheim, Bernières d'Ailly and Lueg crested helmets. We must note that, firstly, the earliest crests develop on Class I helmets (hence helmets made of one sheet, i.e. Type Mantes) and, secondly, that the distribution of plain, undecorated cap helmets made of one bronze sheet (hereafter Type Montbellet helmets) overlaps more with Western European crested helmets than with Eastern European cap helmets (Fig. 9.2). These helmets are most likely older than helmets of Type Mantes and might in fact be considered the oldest helmets in Western Europe; they would have developed locally from organic precursors and would have had a rather extended lifespan (see Mödlinger 2017, chapter 2, for discussion). A very similar development from simple, undecorated cap helmets to crested helmets is also known in Mesopotamia, where a plain cap helmet from Ur (dating to the second half of the 3rd millennium BC) also bears a simple ridge similar to Type Mantes European helmets (Mödlinger 2017).

Greaves

The classification of greaves adopted here largely follows the technical classification proposed by Clausing (2002). Recently, prehistoric bronze greaves were divided, based on technological criteria, into Class I (worn by means of a metal wire) and Class II (perforated along the edge; these comprise Types Dendra, Schäfstall and Winklsaß). Class I comprises Subclass A with built-in metal loops, which in turn includes Types Desmontà (with abstract bird heads), Lengyeltóti (with wheel motifs), Kuřim (with geometric studs and bosses), Canosa and Limone (both with rib and stud decoration); Subclass B with wave-shaped wire (Type Kallithea); Subclass C with separate loops (Type Grammichele) and Subclass D with riveted-on loops (Type Ilijak) (Fig. 9.3). The technological classification of the greaves also reflects their chronological classification (see Table 9.1) and geographical distribution (Mödlinger 2017).

Subclass A greaves are found from the Danube to the east to central France to the west and the Po Valley to the south, whilst Subclass B greaves are known from southern Greece, Cyprus and southern Italy. Subclass C greaves are solely found in

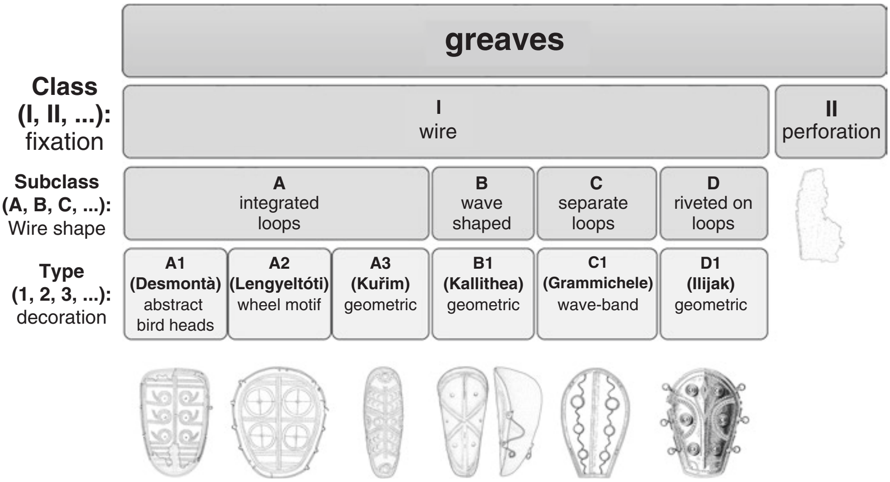

Fig. 9.3 Classification of greaves. Each depicted greave type consists of at least three specimens. Other greave types, represented by less than three specimens, fall under Class IA (Types Canosa and Limone) or Class II (Types Dendra, Schäfstall and Winklsaß)

Fig. 9.4 Geographical distribution of European Bronze Age greaves: ○ Type Desmontà; ○ (*grey*) Type Lengyeltóti; ● Type Kuřim; ◆ Type Kallithea; ▮ Type Grammichele; Δ Type Ilijak; ★ Class II greaves and single objects. Greaves with unknown or dubious find spots are not mapped

southern Italy, whilst Subclass D specimens are known from Albania and Bosnia-Herzegovina, with a single fragment coming from Olympia (Greece). Class II greaves have been grouped based on purely technological criteria and are not chronologically or geographically related. Bronze Age greaves are unknown from northern and Western Europe and the Iberian Peninsula, except for the specimens from Bouclans, Boutigny-sur-Essonne, Cannes-Ècluse (all France) and Beuron (Germany) (Fig. 9.4).

Cuirasses

Bronze Age metal cuirasses are divided into three main groups: Greek, Carpathian and Western European cuirasses (Mödlinger 2014a) (Fig. 9.5). These groups differ from one another in terms of chronology, geographical distribution and decoration (Fig. 9.6). All bronze cuirasses consist of a breast and a back plate, which were usually riveted together on the left-hand side of the chest and over the left shoulder. Only the undecorated Greek cuirasses have additional bronze sheets attached to breast and back plates; these served to protect the neck, shoulders, pelvis and upper legs.

The earliest pieces of metal armour appeared in Greece in the LH II/IIB (Graves 8 and 12, Dendra), although the origins of plate armour might go back to the seventeenth century BC, as indicated by the Mycenaean shaft grave breastplates (Molloy 2013). There are no other precursors of metal cuirasses from other regions, which are known to us. Greek cuirasses are documented from graves (i.e. Dendra and a recently excavated burial from Pylos) as well as settlements (Thebes) (Mödlinger 2014a). Depictions of cuirasses are also known from Linear B tablets, whilst a stone vase from Crete resembles a cuirass in its shape. Carpathian cuirasses are dated to

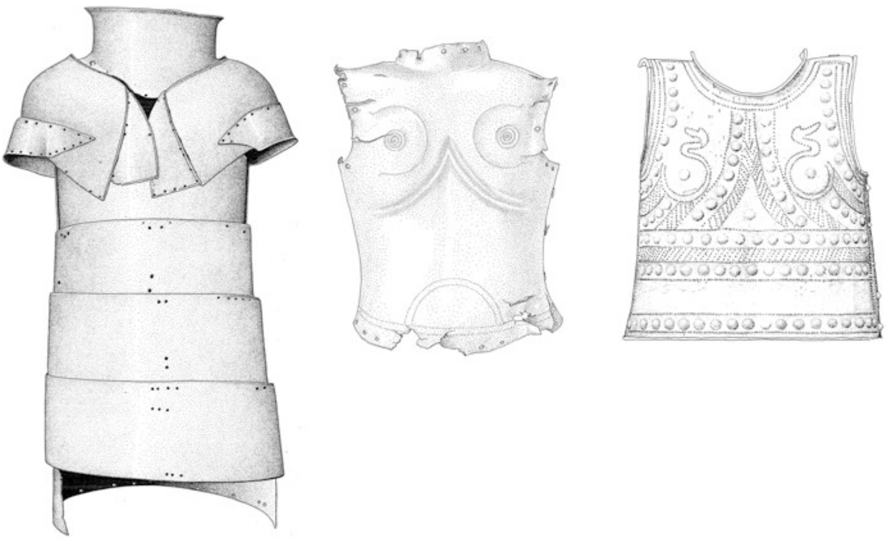

Fig. 9.5 Classification of cuirasses. (*left*) Greek cuirass (Dendra, Greece, Grave 12; after Müller-Karpe 1980). (*centre*) Carpathian cuirass (from the Danube at Pilismarót, Hungary; modified after Petres and Jankovits 2014). (*right*) Western European cuirass (Fillinges, France; after Mottier 1988)

Fig. 9.6 Geographical distribution of European Bronze Age cuirasses. ● Greek cuirasses; ◆ Carpathian cuirasses; ◇ (*grey*) Western European cuirasses; ★ Miniatures; ◇ Possible cuirass fragments; Cuirasses with unknown or dubious find spots are not mapped

BzD–HaA1 according to associated objects and display decoration only occasionally (usually at the edges, together with abstract renderings of nipples and breast muscles). The only complete specimens of these cuirasses are from rivers (at Saint-Germain-du-Plain, France, and in the Danube at Pilismarót, Hungary), whilst hoards have yielded highly fragmented objects and so has a grave from Čaka (Slovakia).

The chronological classification of Western European cuirasses is still a matter of debate. Some have been found complete, whilst others are known as breast or back plates only. All Western European cuirasses whose find spots are recorded are from either Haute-Savoie or Haute-Marne in the north-western Alps, within less than 230 km from one another. Although it lay at the periphery of Atlantic Bronze Age exchange networks, this region lay at the core of a major Bronze Age weaponry and armour trade route, as shown, for example, by Type Monza, Arco and Rixheim swords (Matthews forthcoming; Mödlinger 2017). Since all these cuirasses lack secure associations, they have hitherto been dated based on their decorative elements, consisting of ribs, bosses and embossed studs laid out in *horror vacui* patterns. These are traditionally attributed to the Ha B1 period, which roughly corresponds to the Atlantic Wilburton/Brécy/Hío phases. However, a recent proposal suggests backdating them to Ha A2, as this is the period in which the east-west trade of weapons and sheet metalwork (including cauldrons and shields) reaches its peak (Mödlinger 2014a, 2017).

One route through which technological ideas and objects (including beaten bronzes) may have travelled lays in northern Italy, and in particular in the Po Basin (though no secure cuirass finds are known from this area to date), from whence they could have continued either overland to the Carpathian Basin (as to mirror the distribution of greaves) or across the Mediterranean (as indicated by certain Bz D/Ha A1 rod-tanged swords types, e.g. Pépinville, Arco-Terontola, Grigny and St. Ouen, the latter being exchanged as far as Ugarit, Syria; Matthews forthcoming). Another, more northerly, route may have crossed the north Alpine region (as indicated by the cuirass miniature from Bad Aussee, Austria, and the potential cuirass fragment from Winklsaß, Germany) and continued overland to the Carpathian Basin and then further south into the Aegean (for cauldrons, see Gerloff 2010, 114). Unlike swords, armour and sheet metalwork would have spread from the Aegean into the Carpathian Basin and whence into Western Europe. This scenario is supported by the lack of armour in the Atlantic hoards of this period when compared with finds from the Carpathian Basin, northern Italy and the northern Alps (cf. Mödlinger 2017). The most prominent examples of Eastern European armour reaching the Atlantic seaboard sphere, or at least its periphery, are the cuirass from Saint-Germain-du-Plain, the greaves from Cannes-Écluse II and the earliest western cauldrons (Gerloff 2010). As with shields, helmets and early cauldrons (Gerloff 2010; Mödlinger 2017; Uckelmann 2012), cuirasses too might have been produced locally in Western Europe. This proposal is supported on the one hand by the close proximity between the find spots of the Western European cuirasses and that of the Carpathian cuirass from Saint-Germain-du-Plain and on the other hand by the lack of cuirasses of Western European type from Eastern Europe. On comparing the overlapping distributions of the aforementioned rod-tanged sword types and the cuirasses, one might suggest that the same exchange routes that were used to bring Eastern European cuirasses to the west were also used to bring Western European swords to the east. An important consequence of this reading would be to shift the chronology of the production of Western European cuirasses so as to be more in line with that of the Carpathian cuirasses. Assuming, as this proposal maintains, that both types of cuirasses were produced in Ha A2 closes the extant chronological gap between these and the Carpathian cuirasses, the early metal shields and the greaves from Cannes-Écluse II; it also paints a more convincing picture of the manufacture and exchange of weapons and armour between Eastern and Western Europe.

Manufacture

Helmets

The manufacture of helmets was recently discussed by this author using Type Pişcolt helmets as an example (Mödlinger 2014b); the highlights of this discussion will be outlined here. The initial step in the production of a helmet (and any other sheet bronze object) is the casting of a flat, thin tin-bronze disc, which is then flattened and expanded by several cycles of annealing, quenching – in order to avoid the formation of brittle metal phases – and hammering (Mödlinger and Piccardo 2013). Figure 9.7 indicates the alloy compositions used for producing caps and knobs of different helmet types.

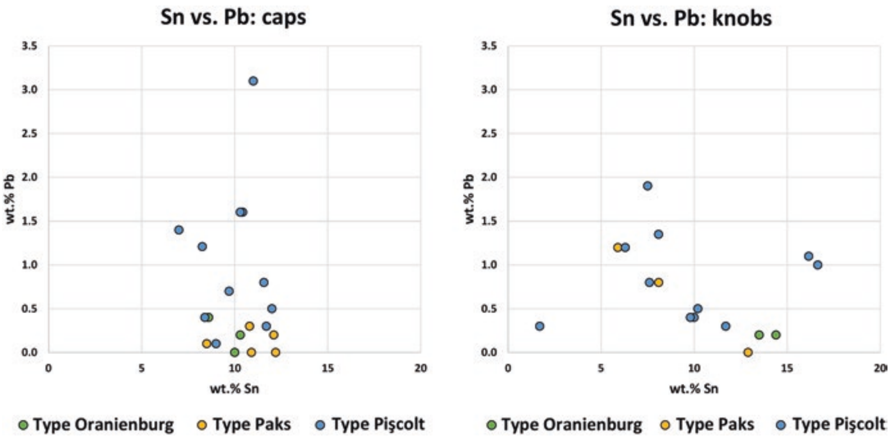

Fig. 9.7 Tin vs. lead content of eastern European Class I helmets; *left*: caps; *right*: knobs. (After Mödlinger 2017)

Notable differences in alloy composition can be observed between helmet caps and knobs. Whereas all caps show an alloy composition with tin ranging from 7 to 12 wt.%, the smaller components of the helmets (such as the knobs) were cast from much more heterogeneous tin alloys. The 7–12 wt.% tin alloy range seen in the caps can be explained, firstly, by the need to achieve optimal fluidity, which enabled the casting of thinner bronze plates and, in turn, shortened significantly any subsequent work needed to reduce the cap's thickness, and secondly, by the need to increase the tensile strength and hardness of the alloy. Relatively high amounts of lead (up to 3 wt.%) are normally found in Type Pişcolt helmets; this is consistent with their dating to the Ha B1 period. In contrast, the helmets from Sehlsdorf (measurements taken on corroded surface), Škocjan and two unprovenanced finds (Mödlinger 2017, nos. 50 and 51) show low amounts of lead. As for tin content, Type Oranienburg helmets contain on average less of this alloyant than Type Paks'. However, it must be borne in mind that only a small number of helmets have hitherto been analysed for their chemical composition and it is thus difficult to highlight trends and tendencies of general validity.

Unlike greaves and cuirasses, Class I helmets, and most likely also Class II helmets, were hammered in an open die. Use of an open die (instead of the more usual high-bowed stake with a rounded face) is suggested by the thickness of their profiles, as Class I helmets have thicker rims, delicate and very thin middle sections and slightly thicker cross-sections at the top of their caps. Once the cap was formed, the rivet holes were applied by punching through the thin metal sheet; this was usually done from the outside of the helmet. Type Pişcolt helmets, in contrast, show clearly deformed, oval rivet holes with smooth edges, which were most likely cast (partly or completely) in the mould and in some cases only widened with a punch. Except for the Knossos helmet, which has a riveted-on knob, and a helmet with boar's tusk decoration, in which the knob was shaped out of the same metal sheet as the cap, helmet knobs were normally cast-on using the lost wax technique. To do so, a wax

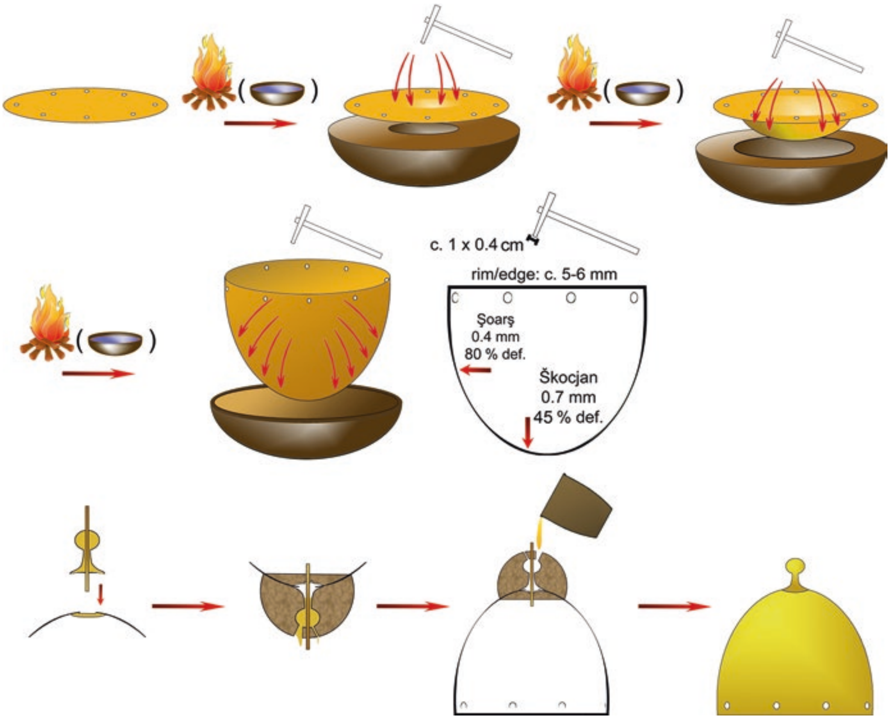

Fig. 9.8 Reconstruction of the manufacturing process of Bronze Age cap helmets, demonstrated on a Type Pişcolt specimen. (After Mödlinger 2017, fig. 2.42)

model of the knob was prepared around a wooden stick and placed on top of the cap. A little wax disc was then applied on the inside on the top of the helmet and punched through. Subsequently, both the wax knob and wax disc were embedded within a clay shell. Once the clay was dry, the object was heated so that the wax could flow out before the resulting void could be filled with molten bronze. Finally, the surface was cleaned, and the helmet's cap was decorated using several punches, as can be seen, for example, on Type Paks helmets. As for the knobs, the decoration was applied on the wax model, whereupon it transferred on the finished objects on casting (Fig. 9.8).

The production of the bronze sheets of Class II helmets followed the same procedure. An open die was also probably used in the production of the two bronze sheets forming crested helmets. In these, one of the two sheets or plates had folds or tabs on the crest, which were then folded over the edge on the other half of the helmet. The two halves were also held together at the front and back by rivets, which were added just above the rim where the two halves overlapped. Additionally, some Type Bernières d'Ailly helmets bear on their sides hollow bronze attachments, which would have held decorative elements made of organic materials, e.g. feathers. Whilst Class II helmets with thin rims had metal sheets folded around a wire in order to reinforce their bases (as noted on Type Lueg, Biebesheim and Bernières d'Ailly helmets), older specimens, such as Type Mantes objects, did not need such a reinforcement as they benefitted from more solid rims.

Once the metal part of the helmet was finished and the cheek plates were attached, either an organic inlay was riveted on the helmet all along the edges (as was the case in most Class I helmets) or a separate organic cap was worn directly on the head (as seems to be the case with most Class II helmets). Only four Western European helmets show rivet holes all along the edges as to indicate that an organic inlay was fixed permanently on the helmet. This is the case with two unprovenanced Type Montbellet helmets; a Type Mantes helmet from Mainz, Germany; and an unprovenanced, decorated helmet akin to Type Biebesheim from the Gutmann collection (Mödlinger 2017).

Greaves

Until recently, only a few greaves have been analysed for their chemical composition, including the ones from Grammichele and those from Kallithea and Kouvarás. Recently, however, further analyses were performed, which add to this scant picture (Mödlinger 2017). Not unlike the caps of Class I helmets, greaves were mainly cast from 7 to 12 wt.% tin-bronze, with the exception of the Kouvarás greaves, which have 14 wt.% tin content. This compositional range is consistent with the amount of tin normally found in European Middle and Late Bronze Age tin-bronzes. Additionally, the Grammichele greaves contain about 1 wt.% lead, whilst those from Kallithea have over 1.8 wt.% lead (see Mödlinger 2017 for references) (Fig. 9.9). We can therefore conclude that it is rather unlikely that greaves were ever made out of pure tin, as is related in the Iliad (e.g. XVIII.613) and controversially discussed in modern scholarship (see Hansen 1994, 17).

Just like helmets, greaves were cast out of thin, flat bronze discs, which were then flattened and expanded through several cycles of annealing, quenching and hammering. Once the bronze sheet had reached the desired shape and thickness (c. 0.2–0.5 mm), the edges were cut out or chiselled off. Finally, the surface was smoothed out and polished so as not to leave any anvil or hammer marks; the last instance of polishing was always carried out vertically. A bronze wire with a round or rectangular cross-section was then placed inside the outwardly bent rim of the greave in order to strengthen the metal sheet. On Subclass A greaves, the bronze sheet was only partially bent around the wire so that the latter could form the side loops, which were then used to attach the greave to the wearer's shin, most likely by means of an organic strip. In addition to the wire, Subclasses B and C greaves exhibit several pairs of holes near the edges, which were utilised for attaching separate wire loops. Once the wire and loops were added, the greaves were decorated – a practice that also served to enhance their stiffness. To place the plastic decoration on straight bands, lines were incised on the inside of greaves; they are still visible today on most specimens. The lines guided the application of the final punched decoration. A single greave from Portes-Kephalovryso displays a chevrons decoration, which was similarly applied with a punch or chisel (Mödlinger 2017).

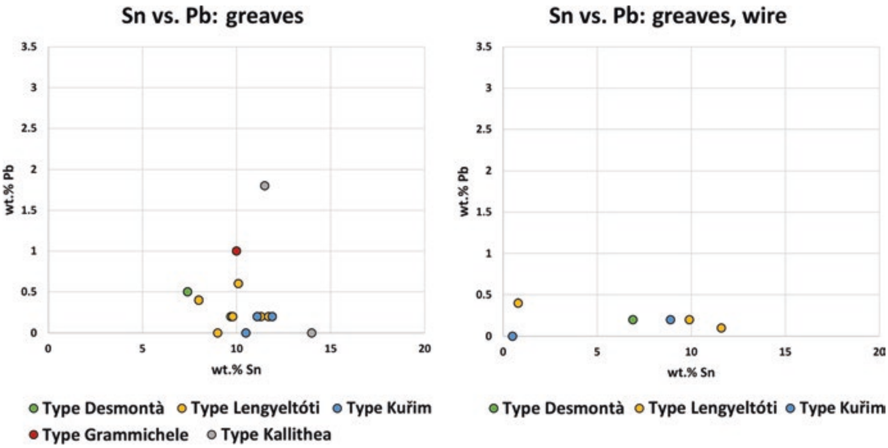

Fig. 9.9 Tin vs. lead content of Bronze Age greaves. (Analytical data after Mödlinger 2017)

Cuirasses

Greek, Carpathian and Western European cuirasses share basic construction principles, based on the production of bronze sheets out of flat, thin, cast tin-bronze discs as explained above. All cuirasses have a back and a breastplate, which were joined together by rivets on the left-hand side and by other joining techniques over the left shoulder. Greek cuirasses, moreover, have additional bronze sheets for the protection of the neck, shoulders, pelvis and upper legs. The construction method of the Dendra panoply has been discussed in detail elsewhere (Verdelis 1967, 8–18). Suffice it to say here that the panoply consists of 15 bronze sheets, which all bear c.2 mm diameter holes positioned every 2–2.5 cm along the edges. Remnants of threads, ostensibly used to attach an organic lining, are still present inside the holes (Verdelis 1967, 8). The same construction principle was used in the Bronze Age cuirasses from Thebes (Verdelis 1967, 21). All Greek cuirasses share a number of features including lack of decoration, their being made from rather thick bronze sheets and their having a permanently fixed organic lining. Carpathian and Western European cuirasses, on the other hand, are rather different in all these aspects, which suggest that they might have been made and used differently.

Due to the generally poor and fragmentary state of most Eastern European cuirasses, only the Carpathian specimens from Saint-Germain-du-Plain, the Danube and Čierna nad Tisou give insights into the manufacturing methods of this class of objects. Whilst the Danube cuirass shares certain technological features with the Greek ones – such as a higher neck protection, rivet holes for fixing an organic lining and lack of reinforcement at the plate rim – the other Carpathian specimens show none of these features. The lack of lining, in particular, indicates that a separate organic coat or jerkin, perhaps similar to the mediaeval gambeson, had to be worn underneath. Furthermore, their bronze sheets are 0.5–1 mm thinner than those of the Greek cuirasses (Mödlinger 2017) and are decorated, if rather simply. Their decorations were not purely aesthetic, but also stiffened the metal plates and increased their resistance against impacts, as was the case with the greaves (see above). Moreover, their base rims and arms and neck openings were reinforced either by a wire passing through the edge of the breast and back plates or by riveted-on bronze sheets, as seen in the objects from Čaka (Slovakia) and Pázmándfalu (Hungary). Western European cuirasses were constructed in a similar way as the Carpathian ones. However, they display a much richer decoration (which also increased the stiffness and resistance of the bronze sheets) and had partly different alloy compositions, characterised by lower amounts of tin and, in some cases, up to 4 wt.% lead (Lehoërff 2008; Chap. 14, this volume).

Use

It is unlikely that bronze armour was worn as a plain metal protection alone: greaves were worn over, or sewn onto, an organic shin guard; helmets had an organic inlay attached underneath or were worn above an organic cap; and cuirasses were worn over a leather, woollen, felt or textile coat or jerkin, which may have been fixed inside the cuirass, as seen in the Carpathian and Western European cuirasses or attached directly to the metal armour as a lining, as seen in the Greek examples.

Consequently, bronze armour cannot be considered less effective than organic armour (see also Crellin et al., Chap. 13, this volume). Instead, the bronze armour would have offered an effective, additional layer of protection to the inlay or under-coat, and their combination would have offered better protection to the wearer than if they had worn just organic armour. Repairs and traces of use on all classes of armour discussed in this chapter indicate that not only weapons but bronze armour were actually used in combat, be it a melee, a duel or a ritual fight. Thus, it can be concluded that bronze armour did not serve just as a high-status ceremonial version of supposedly more effective organic armour, but guaranteed instead a higher level of protection to the wearer. This, of course, does not indicate that bronze armour was merely intended as a practical accoutrement, for it fulfilled the equally important function of being a symbol of wealth, status and power for its owner.

Helmets

Of the around 120 helmets known to us, less than five ostensibly show actual signs of use or combat traces. This is explained, on the one hand, with the fact that only about a third of all helmet finds are complete (and over 17 of these could not be studied in detail as they are held in private collection) and, on the other hand, with the river environment in which most helmets had been deposited, which may have caused marks that could be mistaken for combat marks. This makes interpretation of helmet wear especially difficult. Moreover, weapon damage such as a sword thrusting impact can be easily repaired by cold hammering. Traces that may or may

Fig. 9.10 Type Nagytétény helmet from Brody/Ternopil, Ukraine. The helmet shows thrusting marks left by a sword. Find spot and circumstances are unknown. The helmet was reportedly found buried (as a single find) in a forest, close to a river, at a depth of c. 80–100 cm. It appeared on a Ukrainian Internet forum at the end of 2013, and attempts were made to sell it on 28th November 2013 at *Violity Auctions*. Its current whereabouts are unknown. The Ukrainian authorities have been informed about the illicit provenance of this object

not result from combat encounters have been noted, for instance, on the Type Biebesheim helmets from Auxonne and Montmacq A and B (all France) and on the Type Mantes helmet from Mantes (France). However, unambiguous sword slash marks can be seen on the Type Pişcolt helmet from Hajdúböszérmeny (Hungary) and the Type Nagytétény helmet from Brody/Ternopil (Ukraine) (Fig. 9.10).

Greaves

The uses of prehistoric greaves have long been debated. These objects have variously been interpreted as protections from the wearer's own shield (Schauer 1982, 101), protections for rarely harmed body parts, protections against thorny undergrowth or shrubs (Drews 1993) and protections against enemy arrows (Hansen 1994, 17). However, the shield was usually carried on a person's back whilst walking, arrows were arguably unlikely to hit the lower legs and the only description of the function of greaves we have from the Iliad suggests that they were chiefly intended to protect the wearer against spear attacks (see Iliad XXI. 387–391, where Achilles is protected by his greaves when Agenor throws his spear).

Fig. 9.11 Wear marks on greaves. *Left*: Lengyeltóti, Hungary; crack with two rivet holes punched from the inside. *Right*: Stetten/Teiritzberg, Austria (Prähistorische Abteilung NHM Wien). In this greave, too, the holes were punched from the inside to host a wire holding the two sides of the crack together. (Photographs: M. Mödlinger)

Greaves were never worn directly against the skin. They either had an organic inlay sewn onto them (e.g. in class II greaves and the Type Desmontà specimen from Malpensa), or else an organic backing laced directly to the shin was worn beneath them. The greaves were then attached to the warrior's legs by means of leather laces or strings, which passed through the wire loops or rings seen on some greave types or through the outward-bent loops of the internal wire seen in others (Mödlinger 2017).

No clear combat marks have been identified on greaves on observation. However, evidence of their uses is indicated by the extent of repairs, which were noted on several specimens. In most cases, vertical cracks had formed in antiquity on the top-central part of the greave, which were repaired by means of a wire passing through two holes punched on both sides of the crack (Fig. 9.11). Broken wire loops were also repaired in a similar way (Mödlinger 2017, fig. 4.16). Contemporary imagery including depictions from Greece and warrior figurines from Sardinia give us further insights into the practical function of these objects as well as their variety and manufacturing methods. All strands of evidence indicate that greaves were made to be practical and effective elements of Bronze Age armour panoplies.

Cuirasses

Although neither the Dendra panoply nor the two cuirasses from Thebes bear any significant evidence of use-wear or repairs, they (and the Dendra panoply in particular) had always been considered practical and effective pieces of armour – the only point to be discussed was how they might have been used in combat (cf. Mödlinger 2014b with references). In contrast, symbolic and non-functional interpretations were often favoured in the scholarship concerning Central and Western European cuirasses (e.g. Coles 1962; Harding 2000, 2007).

Due to their mostly fragmented state, few use or repair traces have been identified on Carpathian cuirasses including the complete specimen from Saint-

Fig. 9.12 Wear marks on cuirasses. The cuirass from Graye-et-Charnay or Véria, France, (left) shows a sword or spearhead impact mark in the liver area. The Danube cuirass (top right) shows a c.4 cm long mark inflicted by a stabbing weapon, probably a sword. The cuirasses from Marmesse, France (bottom right), show evidence of ancient repairs (left and bottom right: photograph A. Chauvet (C2RMF). Above right: photograph M. Mödlinger, by courtesy of the Szent István király Múzeum, Székesfehérvár, Hungary)

Germain-du-Plain. However, the Danube cuirass displays a 4 cm-long stab mark, probably from a sword, on its breastplate, just above the right clavicle. On the back plate, immediately opposite to the breastplate stab mark, a small impact mark can also be seen, which was ostensibly caused by the tip of the weapon exiting the cuirass having gone through the body of the wearer. The back plate also shows a severe sword impact mark extending from the left-hand side of the neck area to the right-hand side of the spine (Fig. 9.12). This seems to suggest that the warrior, having been stabbed from the front, was then hit and near-beheaded from the back, potentially from a left-handed opponent. However, early suggestions that the warrior fell with his cuirass into the Danube are far-fetched (Petres and Jankovits 2014, 65).

In contrast to their Eastern European counterparts, Western European cuirasses are rich in repair evidence (Mödlinger 2014a), although it is not always possible to distinguish between repairs following combat damage and those motivated by manufacturing problems. However, glaring exception is offered by the cuirass from Graye-et-Charnay or Véria, now in the Musée d'Armée (Paris), which shows a clear impact mark left by a sword or spearhead in the liver area (Fig. 9.12). This is an impressive reminder of the function and uses of Bronze Age armour.

Concluding Remarks

Around 230 pieces of bronze body armour survive from the European Bronze Age. Whilst it is clear from the evidence discussed in these pages that they were made to be used in combat, it is still unclear how many pieces of armour, and in what combination, would have been worn by Bronze Age warriors in any region and if this change is based on circumstances (e.g. duels v. warfare). The only complete set of weapons and armour known to us is from tomb 12 at Dendra (Greece); no other complete or near-complete set has yet been found in a burial or non-burial context from the European Bronze Age.

Whilst all elements of Bronze Age panoplies, including helmets, cuirasses and greaves, show evidence of ancient repair, a few helmets and cuirasses also show weapon impact marks. This reminds us that they had not just been intended for practical uses, but had also been worn, on occasion, in actual combat encounters. Most pieces of armour would have been worn over an organic cap, jerkin or leg protection, rather than directly on the bare skin. Some of them, however (i.e. Greek cuirasses, Class II greaves and helmets with rivet holes punched all along the edges), had permanently sewn-on inlays or linings. Either way, this indicates that metal armour was not meant to replace organic armour, but to be worn over it as to increase the degree of protection it offered. Of course, this does not mean that bronze armour did not fulfil other, nonpractical functions as power statements and prestige objects, especially on considering the significant amount of labour and skill invested in their manufacture. As this study has clearly shown, however, Bronze Age armour smiths put much thought and effort into increasing body protection as much as they could whilst maintaining a degree of mobility for the warriors that would have worn them in combat.

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Chapter 10
Conflict at Europe's Crossroads: Analysing the Social Life of Metal Weaponry in the Bronze Age Balkans

Barry Molloy

Introduction

A remarkable fossil of prehistoric social worlds occurs in the form of bronze weapons. This is because many of these survive today in almost the precise condition they were in when they were deposited in prehistory, save for some tarnishing. This allows us to examine the subtle traces of craftwork and the scars of routine use, providing insights into diverse social practices that are rarely possible with later iron weapons. This paper will explore bronze weaponry from the Central and Western Balkans, because this was an important cultural crossroad in Europe where quite different traditions collided and were made manifest in bronze weapons. The region is very well connected, being transected by major rivers and lying between the Black, Aegean, and Adriatic Seas, thereby creating a physical link between very diverse societies of south-eastern Europe (Fig. 10.1). This therefore provides an interesting context to explore how different influences were mediated in the development of making and using weapons in Bronze Age Europe.

To assess the social roles of this body of material culture, it is important to consider how people engaged with weapons when making them, using them and eventually disposing of. From this perspective, each object can play a different role in a variety of social venues, each of which was important for shaping societal structures. We may, in this sense, consider objects to have distinct and recognisable biographies or life histories that were intertwined, at various stages, with different people (Appadurai 1986; Fontijn 2008; Gosden and Marshall 1999; Hahn and Weiss 2013; Kopytoff 1986; Molloy 2011). It is fortunate for us that many of the steps in this life history cycle can be systematically analysed and compared independently so that, from an analytical perspective, each object can contribute to our understanding of

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Fig. 10.1 Map of sites and geographical features mentioned in the text: *MG* Markovac-Grunjac, *ON* Olmo di Nogara, *DL* Donja Luge, *A* Aleksinac, *T* Tetovo, *I* Iglarevo, *Myc* Mycenae, *D* Dodona, *Ot* Otok, *HK* Hajdukovo and Kevi-Csiker, *GHP* Great Hungarian Plain

various fields of social activity. Weaponry is a particularly interesting category of material culture in this regard. This is because during most steps of their lifecycle, weapons were handled, worn or otherwise engaged with directly by people, many of which leave material traces. They were therefore integral to, and indeed enabled, people to participate in social activities. A broad range of people including traders, smiths, warriors and social leaders or religious intermediaries were potentially involved in the social life of metal objects. Therefore, weapons must be seen as interlocutors between people with quite different identities, many of whom played a role in controlling power relations in society.

Analysing the distinct markers from different stages in the lifecycle of weaponry provides a biographic perspective on the social environment in which such markers were created. It is not necessary to isolate and assess each marker on each object, but more generally this biographic perspective allows us to find meaning in the unpredictable aspects of the lifecycle of objects in a comparative manner. Differences in how objects were made and used, for example, can provide insights into connectivity between workshops and/or regions and in turn allow us to identify deviations from the norm, such as different ways of using similar-looking objects. Archaeology has a range of analytical methods suited to measuring relevant features, often quite precisely (Armbruster 2011; Dolfini and Crellin 2016). This can include analysis of alloy composition, craft traces, functional qualities, use traces, removal/destruction (revealing, for example, a socially mediated 'death') or activities taking place when objects were finally deposited. This is essentially close to a *chaîne opératoire* approach which identifies and evaluates typical steps in the life cycle of particular categories of objects. However, in the approach taken in this study, we are primarily concerned with identifying different patterns of using a particular category of object during particular steps in their general/expected life cycle. This is achieved by evaluating individual biographic markers resulting from human-object (and material) and object-environment interactions in different social and/or physical contexts. Fundamentally, the methodology seeks to balance biographic analyses of the life story of specific objects with life cycle analyses of patterns of consumption of categories of object at different stages of their social life.

Breathing Life into Tools of Death

We could broadly define the expected life path of all weapons as beginning with the decision to make it in a certain shape, embodied by the creation of a stone mould or a wooden template for pressing into a moist clay to form a mould (Fig. 10.2). The choices made prior to doing this are predicated on the knowledge of the mould maker about how an object *should* appear and function, possibly influenced through direct discourse with the warriors who would use the finished weapons. This was an important dialogue, whether direct or indirect, because the living traditions of

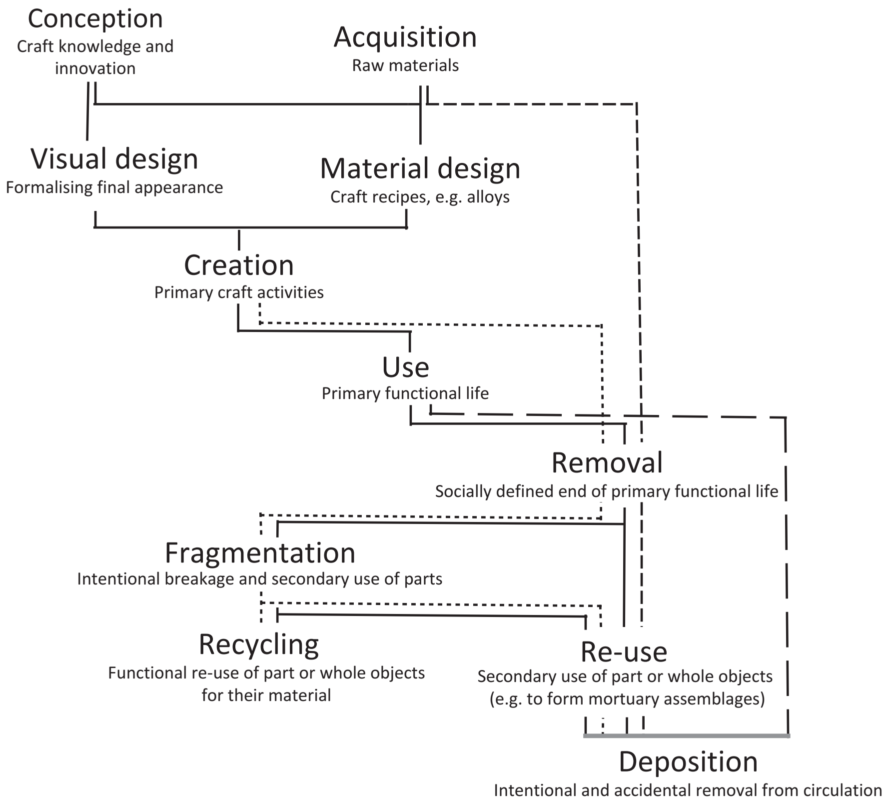


Fig. 10.2 Schematic representation of potential metalwork biographies. (Drawing by author)

martial art practices which weapons shaped, and were shaped by, came together with the skills and knowledge of the smiths in the design and development of material culture. Functional properties were thus embedded at the point of creation into objects that were to define combat practices. In this, we find overlap between two quite different fields of social activity. It is salient that weaponry, from long swords to thin shields, was often at the frontier of the capabilities of smiths and potentially pushing at this frontier at times, thereby linking evolving technical skills and societal developments. As part of this dialogue, designs could be derived from established cultural traditions, the innovative ideas of smiths or warriors, the emulation of the form and/or function of foreign weapons that had been encountered or a blend of all these.

Once the idea was set and the moulds made, the alloy was decided upon and prepared; the metals were melted and then poured into the mould to create the object. The product that emerged was cleaned up and then mechanically manipulated by cold working the edges and then annealing them, often in cycles (Bridgford 1998). This led to a hard edge suited to cutting resistant media supported by a slightly more forgiving body of a weapon that could absorb impacts without breaking (Notis 2014: 58). Following the steps to manipulate the material properties of the metal during casting and post-casting treatment, the weapon would then be cleaned or polished. At that point organic components could be added as desired to complete it, be they the plates of a sword hilt or the haft of an axe.

The smiths making a weapon may well have been cognisant of the factors that could lead to fatigue and failure of objects. Taking this into consideration, presumably in somewhat different terms that we would today, efforts to mitigate the risks of damage and failure would emerge through overall design (metric features), alloy choice, cold working and annealing. Once completed, the object would then be used, presumably for display, training and in some cases for combat. In most cases, this social life of weapons constituted the longest duration during which they were engaged with by ancient users and thereby embedded in social relations. Following the use and presuming it was not lost, decisions were made to remove an object from circulation. The biography of some items may have led to special treatment, whereby they were deposited whole or intentionally damaged, while most appear to have been fragmented into parts for reuse through recycling or incorporation into larger bodies of metalwork (e.g. hoards), thus losing their identity as individual objects and becoming a form of raw material.

Taking Up Arms

It may be helpful to initially mix up the linear trajectory of the life cycle of weapons by looking at the earliest phase of conception of shapes together with the middle phase in which these shapes determined modes of use. These superficial features are traditionally considered in relation to typological categories (Armbruster 2011), although here we incorporate a morphometric approach that addresses the relationship between metric features and functional qualities. We will consider swords first

Fig. 10.3 Selection of swords from the Balkans (Photographs by author); (**a**) Type Apa from Kevi-Csiker, (**b**) Type Indjija from Hajdukovo, (**c**) Type Vatin from Vatin, (**d**) Type Sombor from the Hajdukovo region, (**e**) Type C from Tetovo, (**f**) Type C from Aleksinac, (**g**) Sword from Donje Luge, (**h**) Type Stätzling from Sisak, (**i**) Type Manaccora from Montenegro, (**j**) Type Naue IIA/Reutlingen with faux midrib from Lakavica, (**k**) Type Schwaig from Kovin, (**l**) Type Erlach from Kovin

because they only had minor (now lost) organic elements and so are typically a weapon type that survives virtually complete. They are also perhaps the most intensively studied bronze artefacts from prehistory (Gener 2011; Harding 1995; Jung et al. 2008; Jung and Mehofer 2009; Kilian-Dirlmeier 1993; Kristiansen 2002; Kristiansen and Suchowska-Ducke 2015; Matthews 2011; Molloy 2007, 2008, 2010; Peroni 1970).

The earliest swords in Central Europe and the northern Balkans were the Type Apa (or Hajdúsámson-Apa) and the related Type Kurzschwerter swords, dating to the later seventeenth century BC (Fig. 10.3). Five swords of this family are known from the region (Harding 1995, nos 10, 228–230 and Fig. 10.3a). They are found throughout the Carpathian Basin, and variants occur as far afield as Scandinavia (Vandkilde 2014). This indicates that when tin bronze was first being weaponised in Europe, societies in the Balkans were active participants in this process. The Type Apa sword is very distinctive due to its metal hilt and short tapering blade (around 30 cm). Experiments with replica Irish swords of similar blade geometries (Molloy 2007, 2017) suggest that these short and light blades were suited to light slicing or lacerating cuts and thrusts. By the sixteenth century BC, many other types of sword emerged (e.g. Fig. 10.3b, c) including slightly more robust short swords as well as longer ones, often dubbed rapiers; many of these types were shared in northern Italy and the Carpathian Basin (e.g. Bader 1991; Burgess and Gerloff 1981; Harding 1995; Kemenczei 1988; Peroni 1970; Schauer 1971). These swords typically had organic handles and ranged from close-quarter melee weapons to long and thin ones requiring greater space and more controlled use. This rough functional division is seen in other Bronze Age cultures of Europe (Molloy 2010, 2017).

In Crete, the first swords of Europe had been invented one or two centuries earlier than the Type Apa (Kilian Dirlmeier 1993; Molloy 2010; Georganas 2010). By the sixteenth century BC, new forms were emerging that were to reach their floruit in the fifteenth to fourteenth centuries. These had long and thin blades with midribs to strengthen them, and they occur as far north as the Central Balkans (Fig. 10.3e, f). At this time, in the Carpathian Basin and the northern Adriatic, local swords with long and thin blades emerged that could be used in a manner very similar to the Aegean pieces, called the Type(s) Sauerbrunn-Boiu (Cowen 1966; Harding 1995). The contemporary emergence of long thin swords suited to light draw-cutting and thrusting attacks (Molloy 2008) at the same time in both regions may suggest influences being shared in martial traditions, even if craftspeople were working with local aesthetic ideas. In light of this, a weapon from Tetovo in the southern Balkans is particularly instructive (Fig. 10.3e). This is a local variant of the Aegean Type C sword, the archetypal midribbed sword of this period in the Aegean, but it has a very distinctive form of incised bipartite decoration on its shoulders that is characteristic of Sauerbrunn and Boiu swords in Europe, but absent on Aegean swords. Cowen considered this to be a particularly meaningful design, citing these as "a pair of eyes … of the sword itself, or rather of the spirit within it" (Cowen 1966, 294). The Tetovo sword can be seen as an interlocutor between two traditions, demonstrating exchange of ideas even when objects may not have been moved with regularity between regions. Interaction between members of groups can lead to technical ideas and concepts of practice being shared, which can lead to selective copying of shapes and functions, or mimicry as Fahlander (2007) calls it. Given the social differences between Aegean and Balkan societies, it is unsurprising that influences were partial in their physical manifestation and that European warriors did not wholesale adopt Aegean traditions which would have looked quite alien to them. As Vandkilde (2014, 614) argued, "weapons in comparable and rival styles were not only most assuredly symbolic in terms of social power, but were also practical devices for the clear identification of particular persons and groups".

The potential for the Balkans to be a melting pot of military traditions from the European and Aegean spheres is thus set out. The grip-plate swords of the Aegean region and those of the Balkans appear to have evolved largely bilaterally in the fifteenth to thirteenth century BC, though links between Balkan and Italian metal-working traditions increase considerably. In all regions, there was nonetheless a parallel development of the functional qualities of weapons even when the visual properties in each region remained distinct. This bilateral development continues in a bias towards shorter and more robust swords by the later fourteenth century (e.g. Fig. 10.3d). This begins to change significantly in the thirteenth century BC, when the multifarious swords of both traditions began to be replaced by (or evolved into) robustly proportioned weapons (Fig. 10.3i, k) of a generic Naue II family of full-tanged swords, which continued to be popular well into the early first millennium BC. These were essentially defined by a flanged hilt cast as one with a parallel-edged blade in the region of 0.6–0.7 m length and ca. 0.4–0.7 kg (Jung and Mehofer 2009; Kristiansen and Suchowska-Ducke 2015). Some swords with bronze hilts were used alongside these in the Balkans and had similar functional qualities (e.g. Fig. 10.3l with clear combat induced damage). These were all well-suited to close-quarter collaborative styles of fighting, being short enough to change direction rapidly and robust enough to make light percussive-lacerating cuts, but long enough to strike from a slight distance.

A sword from Donje Luge in Montenegro (Fig. 10.3g) warrants specific mention to explore the often ambiguous ways in which cross-cultural exchanges of traditions may take form (Bulatović et al. 2003). This has a hilt from the general 'Naue II' tradition but a blade that tapers rapidly and has a distinct midrib. It therefore possesses a widely used thirteenth century (and later) hilt with a blade inspired by swords that had gone out of use in the palatial centres of the Aegean by that time. This in turn may suggest that Aegean-type midribbed swords remained in use longer in the Balkans than in the south. The sword illustrates the way in which regions of the Balkans were innovative melting pots of different traditions.

Farther north, local types of this grip-tongue family of swords developed and shared much with examples from the Carpathian Basin and parts of northern Italy (Bader 1991; Kemenczei 1988; Peroni 1970). Two sword fragments from Bingula-Divoš and Brodski-Varoš may hint at influences from the Aegean variant of this family of swords (Molloy in Press; Harding 1995 nos 419, 420). Other types also evolved, which have a very distinctive form of cross-section with stepped ribs, which appear to have been a purely aesthetic feature. This is Harding's (1995) Type Novigrad, which is typical to the lands around the middle Danube and its tributaries, and is particularly interesting as its characteristic ribs are also found on contemporary spearheads, constituting loosely matching fashions for these two weapon types. It is not feasible here to elaborate on each category of sword in relation to their life cycles, but the primary point is that integrated analysis of form and function can be used to differentiate between influences arising from distinct venues of interaction or engagement. This can be illustrated further looking at spearheads.

Spearheads

Since the inception of spearheads in the Balkans (Fig. 10.4), these were typically socketed weapons with broadly leaf-, flame- or teardrop-shaped blades and measured commonly in the region of 15–20 cm, but with longer examples occurring also in excess of 30 cm length (Jovanović 2010; Todorović 1971; Vasić 2015; Vinski-Gasparini 1973). The socket penetrates most of the way to the tip of the blade, which makes these weapons very robust. Most would have been versatile enough to use with two hands on a form of staff weapon, single handed for thrusting, or else they could have been thrown. While a good range of forms emerged over time, some slightly longer than others (e.g. some of Vasić's (2015) 'spearheads with curved blades' (Fig. 10.4m) and 'spearheads with short sockets' (Fig. 10.4k, n), there is a greater consistency in their functional attributes than one may see in the spears of the Aegean in the later Bronze Age (Avila 1983; Molloy 2016; Snodgrass 1974). The socket is generally around 1/3–1/2 the length of the entire spearhead, and the blades have sharp and thin edges. The very distinctive triple ridges of the Type Novigrad swords find stylistic parallels on a category of contemporary spearheads (e.g. Fig. 10.4c, d, f). Another variety of spearheads had a slight swelling in the lower (socket) side of the blade, sometimes called 'violin form', which is characteristic of this region and was to be adopted and much adapted in the Aegean region, particularly north of the Gulf of Corinth (Molloy 2016).

All spearheads were capable of penetrating in stabbing attacks, though it is notable that a distinctive type with proportionately short sockets (Vasić 2015, nos 205–211; Vinski-Gasparini 1973, Table 60.27, 87.5, 94.7, 112.4) had a rounded point (Fig. 10.4k). That this is unlikely to have been a repair to a broken point (e.g. Fig. 10.4i) is indicated by its ubiquity across this type of spearhead, as also seen on a specimen from Kefalonia in Greece (Molloy 2016, Fig. 13.8.3) and examples of the type from Pila del Brancón in Italy (Salzani 1994). The metal is quite thin here so that they could certainly penetrate flesh but would be less useful against armour. Conversely, it was less likely for the (absent) tip to break against such armour or get trapped in an organic shield. The edges of these spearheads were also well-suited to cutting attacks, particularly the longer varieties which had blades, which alone were in excess of 30 cm length. Other spearhead varieties were suited to cutting, although those with a swelling in the base of the blade (Fig. 10.4d, h, l) may have been less effective and more geared towards thrusting because of the abrupt break in the line of the edge. The proportions of most spearheads, and their full-socket design, meant that they were well designed to withstand combat use. However, the many broken pieces in hoards lacking their point and exposing the hollow socket within indicate that any damage to this area rendered a weapon unserviceable. In this sense, they were potentially less 'forgiving' than swords which could be reshaped, to an extent at least, and remain functional.

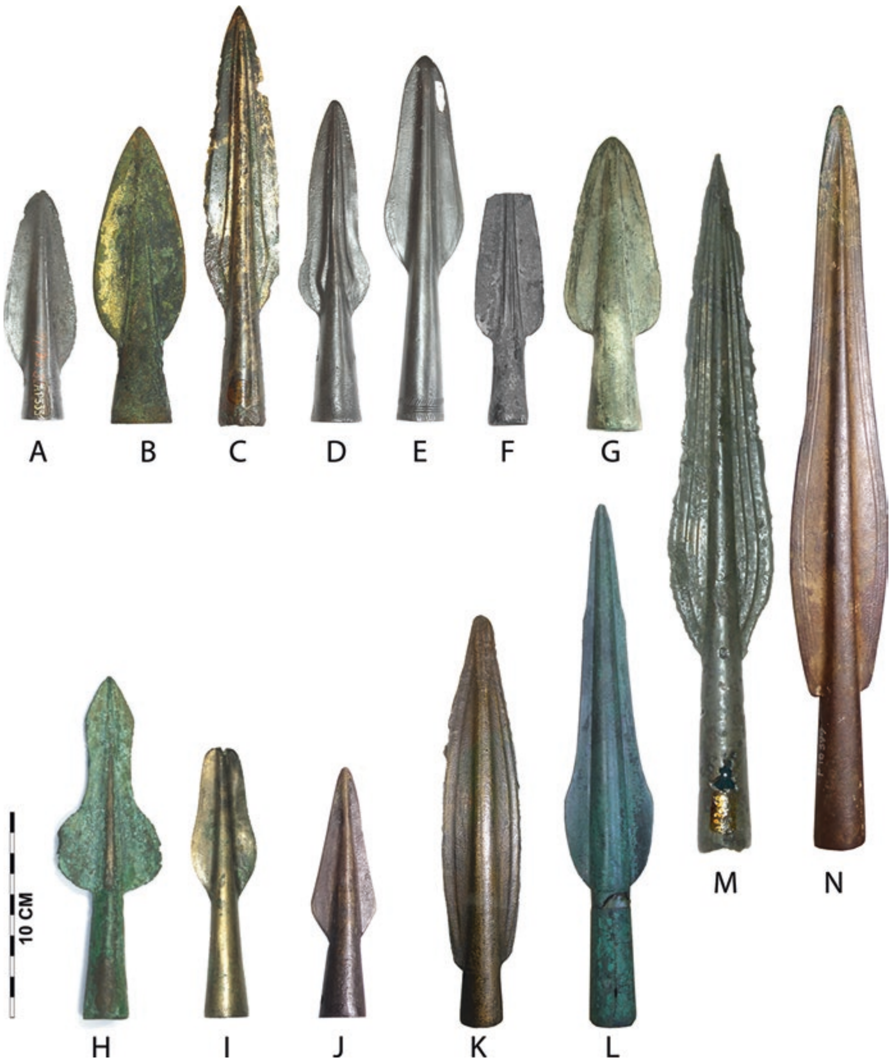


Fig. 10.4 Selection of spears from the Balkans (Photographs by author); (**a**) spearhead with bay leaf-shaped blade from Futog, (**b**) spearhead with profiled blade socket from the Banat region, (**c**) spearhead with curved blade from Hetin, (**d**) spearhead with curved blade from Futog, (**e**) spearhead with rhomboidal blade from Futog, (**f**) spearhead with profiled blade socket from Mali Žam, (**g**) spearhead with willow leaf blade from Krcedin, (**h**) spearhead of Albano-Epirote shape from Thessaly, (**i**) spearhead with rhomboidal blade from Futog, (**j**) spearhead with rhomboidal blade from Ljubljanica river, (**k**) spearhead with bay leaf blade and short socket from the Ljubljanica river, (**l**) spearhead with curved blade from the Korçë region, (**m**) spearhead with curved blade from Hetin, (**n**) spearhead with curved and incised blade from the Ljubljanica river

Fig. 10.5 Above: battle axe from Vatin; Below: Albano-Dalmatian axe from the Skadar region. (Photograph by author)

Axes

It can be debated if axes in many parts of Europe were intended for use as weapons, but in the Balkans and Central Europe, this is less of an issue. A collared shaft-hole battle axe of metal developed there by the fifteenth century BC (Gimbutas 1965: 215–217; 327; Kovács 1977: 39–41) and was in use until the thirteenth century BC or later (Fig. 10.5). These had a variety of spikes, axe bits and hammer edges that were clearly designed for interpersonal combat and not as craft tools. These tomahawk-like weapons had narrow holes and appear to have been suited to single-handed use, but we cannot rule out these being attached to longer pole arms. They are rare in the Balkan Peninsula but are found as far south as the site of Dodona in Greece, where an axe of this type was found, which was an import from further north (Bouzek 1985; Carapanos 1878). A different form of axe of Albano-Dalmatian type emerged in the region of Albania, Montenegro and southern Croatia, which appears also to have been primarily oriented towards combat, with a curved-back single-cutting edge. The far more common winged axes and socketed axes of this region are, like their counterparts in other parts of Europe, ambiguous items that were no doubt designed as tools but could have been readily used as weapons if the need arose and are perhaps best considered tool weapons (Chapman 1999).

Shields and Armour

The only evidence for defensive weaponry (Molloy 2009) occurs in a hoard from Otok, where we find fragments of Type Lommelev-Nyírtura shields (Uckelmann 2012, no. 6). This is a type of shield that was characteristic of the Carpathian Basin and the Balkans and is also known from the Nordic Bronze Age (Uckelmann 2012). The dearth of surviving evidence for shields should not be seen as evidence that they were rarely used, because the simple fact that a consistent type was found at widely dispersed sites indicates that knowledge of the form was widespread. It remains possible that organic shields like those we find in Ireland were more commonly used. The shields of metal were well-suited to combat when they were in excess of 0.7 mm thickness; it is thus probable that the Balkan shields were combat-worthy weapons (Molloy 2009, 2017; Needham et al. 2012). The existence of a Bronze Age shield with Lommelov-Nyírtura and Herzsprung influences at Delphi in Greece may indicate that the idea spread through the Balkans and into Greece.

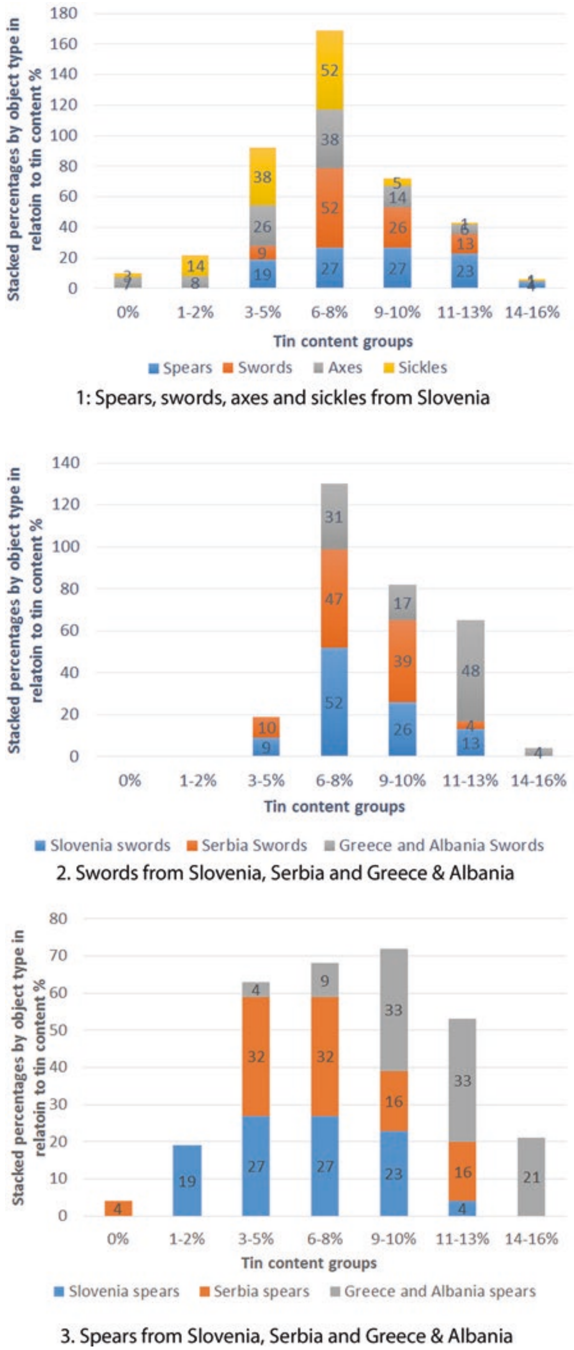
Armour from the Balkans is related to traditions known across central and south-eastern Europe. Greaves are a form of armour used to protect the lower leg, and bronze examples come from the Balkans (Vinski-Gasparini 1973; Karavanić 2009; Mödlinger, Chap. 9, this volume). The distinctive closing mechanisms of Balkan types are shared with Central European forms, but these are all different to the closing mechanisms used for most Aegean greaves, which often otherwise look very similar. The decorative motifs on greaves from the Balkans, including chariot wheel motifs on a recently identified looted piece, are occasionally also found on Aegean pieces, such as the set from the Athenian Acropolis (Clausing 2003). This motif was used on armour, particularly helmets, in central and south-eastern Europe (Mödlinger 2013), suggesting a link between chariots and warriors. Chariot wheels from Árokalja in Hungary (Pare 1987) may support the view that such vehicles were a reality on the battlefields of the Balkans and Carpathian Basin, but this hypothesis cannot be tested.

Metallurgy

Following from these considerations of the functions of weapons as defined by their shapes, we can usefully consider how smiths took technological steps to control the mechanical properties of the metal used. The initial step in this process was deciding what alloy to use. Alloys are intentional recipes, arising from technological choices made by smiths to blend different metals with the intention of controlling material properties so that when the metal is cast into a specific shape it can perform a predetermined function. Such intentionality in alloy design can be seen by comparing the alloys of sickles, axes, swords and spearheads. Using data from published studies and my own ongoing research, Figure 10.6, 1 illustrates that sickles tend to have very low tin contents, whereas axes and (more so) spearheads have a relatively wide range of tin contents, and swords a more restricted range. As far as alloy design is concerned, it is evident that swords were the most carefully controlled of all weapons, while spearheads appear to have had little consideration, or at least standardisation, given to alloys.

In considering why these variances occur, we can return to the relationship between form and function and consider these in relation to the mechanical challenges facing objects by looking at well-published data from Slovenia (Trampuž-Orel 1996). Swords were long castings that would be subjected to a range of potential strains arising from torsional, impact, tensile and sheer (through leverage)

Fig. 10.6 *1* Alloys of sickles, axes, spears and swords from Slovenia (after Trampuž-Orel 1996); *2* alloys of swords from Slovenia (after Trampuž-Orel 1996), Serbia (Molloy in press), Greece (Mangou and Ioannou 1998, 1999; Koui et al. 2006) and Albania (Koui et al. 2006); *3* alloys of spears from Slovenia (after Trampuž-Orel 1996), Serbia (Molloy, in press), Greece (Mangou and Ioannou 1998, 1999; Koui et al. 2006) and Albania (Koui et al. 2006)



mechanical stresses and strains when used. They thus had to meet a balance between increased risk of bending (lower tin) and risk of breakage (higher tin), which could be culturally or even workshop contingent. The challenges faced by swords contrast with spearheads, which would primarily be subjected to impact and torsional stresses within a relatively small item. Many were short enough so that bending was less likely to occur, and even longer pieces had a flexible, tough and impact-absorbing wooden core running almost to their point, making them more or less bi-composite weapons. Sickles faced altogether different forces, having relatively predictable mechanical stresses when cutting fibrous grasses. Axes would have fulfilled a wide range of functions which their basic shapes may not indicate, so alongside cutting and shaping different types of woods, they may also have been used for butchery, skinning animals and preparing foods, for example. In all of this we can see that there were distinct challenges to be considered when making tools and weapons and that for Slovenian smiths, swords were singled out for special treatment. Figure 10.6, 2, 3 show that this same pattern for spearheads and swords is observable in a larger dataset based on analyses by the author of samples from Serbia. It is notable in this regard that only certain objects could be effectively, or at least economically, recycled to create others such that most spearheads were poorly suited to making sickles, for example. This could potentially link into now lost biographies or beliefs of appropriate life cycles for categories of objects, even following fragmentation and recycling.

It is also notable (even accepting the different analytical methods used) that there is a difference between the alloy choices made in the Aegean and European weapon smithing traditions. When Aegean, Albanian and Montenegrin smiths manufactured swords of the general European grip-tongue family, they appear to have been quite conservative in alloy recipes, choosing to use a traditional (for them) higher tin content than other European smiths in most cases (Molloy and Doonan 2015). A similar conservatism is seen in the latter tradition, because the earliest swords have tin contents very similar to the later ones, suggesting little experimentation and a tendency towards slightly lower tin contents than may be expected, with a medium tin alloy of 6–8% being particularly popular (see Fig. 10.7, caption). As well as affecting function, these alloys visibly impact on the colour of the weapons, with higher tin (in this general range) making metal more golden and lower tin increasingly looking like the brownish-orange colour of copper.

It is clear that there were technological choices made when deciding on alloys for weapons but that in cases such as spears, the perception of suitable alloys was either highly variable or there was little concern for precision. For swords, while greater care was evidently taken in selecting alloys, smiths did not use an alloy recipe that was exclusive to weapons. While we must take account of recycling affecting surviving alloys, the above issues may indicate that there were decisions made in recycling relating to the appropriate mixing of fragmented objects to make particular new ones. Steps of ca. 2% tin content are visually recognisable, with experience, when looking at clean bronze (pers. obs.). While alloys are a critical factor in weapon design, how the object is mechanically and thermally worked thereafter can influence the functionality of tools and weapons. We can evaluate this by looking at the microstructures of metals.

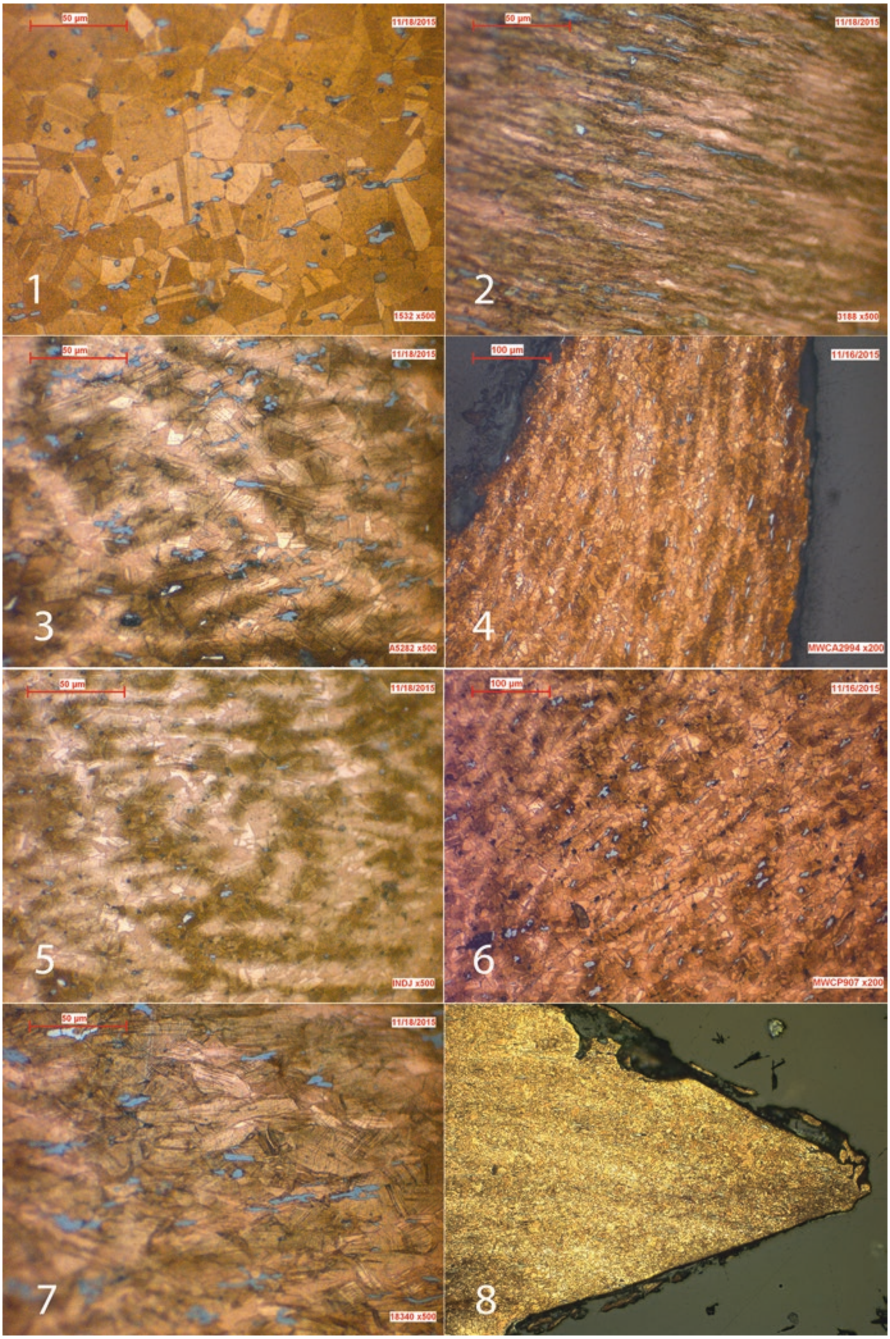


Fig. 10.7 Metallographic sections (Photographed by author and P. Northover); *1* spearhead with moderately cold-worked, well-annealed and complete recrystallised microstructure from Stari Kostolac (1532), tin content ca. 5.5% (SEM-EDX); *2* spearhead with heavily cold-worked, poorly

Microstructures

Metallography is used to examine the microstructures of metalwork, which can inform us about how smiths attempted to alter the material properties of objects made from copper alloys. It is possible to make here concise preliminary comments on the results of analyses of samples taken from 110 swords and spears in Serbia. In very general terms, it is observed that most of the weapons that can be considered to have been finished objects showed some degree of intentional modification. A notable exception is the hoard from Markovac-Grunjac, where most objects appear to be as-cast or having had very minor work done on them, which is consistent with previous studies of these finds (Jovanović 2010). Mechanical modification was most typically conducted in the form of cold forging of the edges, which was observed on both swords and spears. Spearheads were more variable in their treatments, with some receiving considerable post-cast treatment (Fig. 10.7, 1) and others having less cold working performed on them, and being less thoroughly annealed, while some were heavily cold worked but poorly annealed (Fig. 10.7, 2). Most swords have evidence of cold working and annealing from the earliest Type Apa swords down to types from the end of the Bronze Age (Fig. 10.7, 3–8); indeed, as with alloy design, there was little experimentation with this process over time in the region. Cutting across all of these periods, many swords were moderately cold worked but poorly annealed (much residual coring is commonly visible), though exceptions are known which have very skilfully manipulated microstructures (c. 10.7, 8). Overall, there is little to differentiate the technical traditions of designing and modifying the metal of seventeenth century swords from those of twelfth or eleventh centuries BC date.

The extensive analyses of swords and spears from Britain provide interesting comparisons, because Bronze Age smiths from this region also generally gave greater care to swords than spears (Bridgford 1998, 2000). As with alloy choices, this need not relate to a higher status of swords but rather to a response to the more

Fig. 10.7 (continued) annealed with substantial residual coring and minimal recrystallised microstructure from Krcedin (3188), tin content ca. 5% (SEM-EDX); *3* Type Apa sword from blade (at ancient break) with moderately cold-worked and poorly to moderately annealed with substantial coring and partial recrystallised microstructure (strain lines probably from ancient break) from Kevi-Csiker (A5282), tin content ca. 7.5% (SEM-EDX); *4* Type Indjija sword blade with highly cold-worked and moderately annealed with residual coring but high degree of recrystallised microstructure (small crystals) from Hajdukovo (A2994); tin content ca. 6% (SEM-EDX); *5* Type Indjija sword blade near shoulders with little cold-worked and moderately annealed with significant residual coring but high degree of recrystallised microstructure (small crystals) from the Sremska Mitrovica region (Indj), tin content ca. 6.5% (SEM-EDX); *6* Type Reutlingen (probable) sword blade fragment with moderately cold-worked and moderately annealed with substantial coring and high degree of recrystallised microstructure (small crystals) from Dobrinci (P907), tin content ca. 6% (SEM-EDX); *7* Type Reutlingen sword blade near point with moderate to highly cold-worked, annealed and final cycle of cold-worked (visible grain distortion, strain lines) microstructure from Pudavnica (18: 3400), tin content ca. 9% (Surface reading with portable XRF on exposed metal); *8* Type Statzling sword blade near point with substantial cold-worked, very well-annealed and completely recrystallised (small crystals) microstructure from Sisak (17272), tin content ca. 9% (SEM-EDX) diverse and greater physical pressures they would face in use. For swords and spears alike, the cold working was focussed on the edge proper, and though some of the hammered material may have been ground away during sharpening, it is clear that workers were only seeking to materially transform the very cutting edge – often covering less than 3 mm inwards from this. The manipulation of the hardness of blade edges is indicative of a need to enhance their performance for cutting. This related to a trade-off between increasing hardness to enhance cutting and maintaining toughness to withstand brittle failure through cracking or chipping. Looking to blade edges, we can find a variety of damage consistent with combat use.

Metalwork Wear Analysis

The damage to the edges of weapons can indicate aspects of how they were used (Bridgford 1997; Dolfini and Crellin 2016; Horn 2014; Molloy et al. 2016). We can, for example, quantify the general intensity of damage using numerical values, or we can describe the character and causation of instances of damage (Fig. 10.8), or a combination of both. The former option is used here, with values ranging from zero (undamaged) through to five (extreme damage). The method is complicated for this region because many items had been deliberately fragmented, and so the assessment here is to be considered as a general indicator of differences in wear patterns according to states of completeness.

Figure 10.9 shows that there is a disproportionately higher number of fragments of blades with no evident damage than we find in the other categories of 'states of completeness' for swords. The wear analysis suggests that intentional choices led to some swords being fragmented and entering collections of broken things, some of which were deposited together in hoards, while other objects were destined to retain their identity as an object and were buried intact. Spears tell a broadly similar story with the more complete examples having a higher degree of damage visible. For the

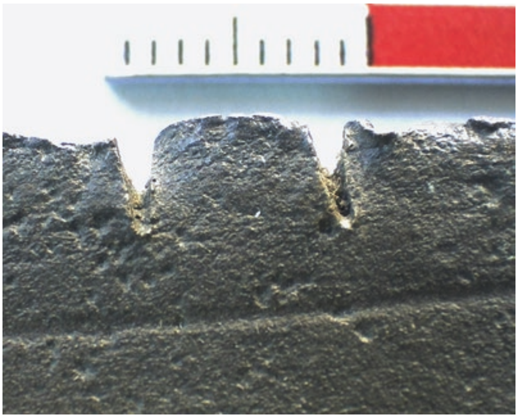


Fig. 10.8 Two sharp v-shaped nicks from blade-on-blade contact. Late Bronze Age sword from Leskovica, Serbian Banat. (Photograph by author)

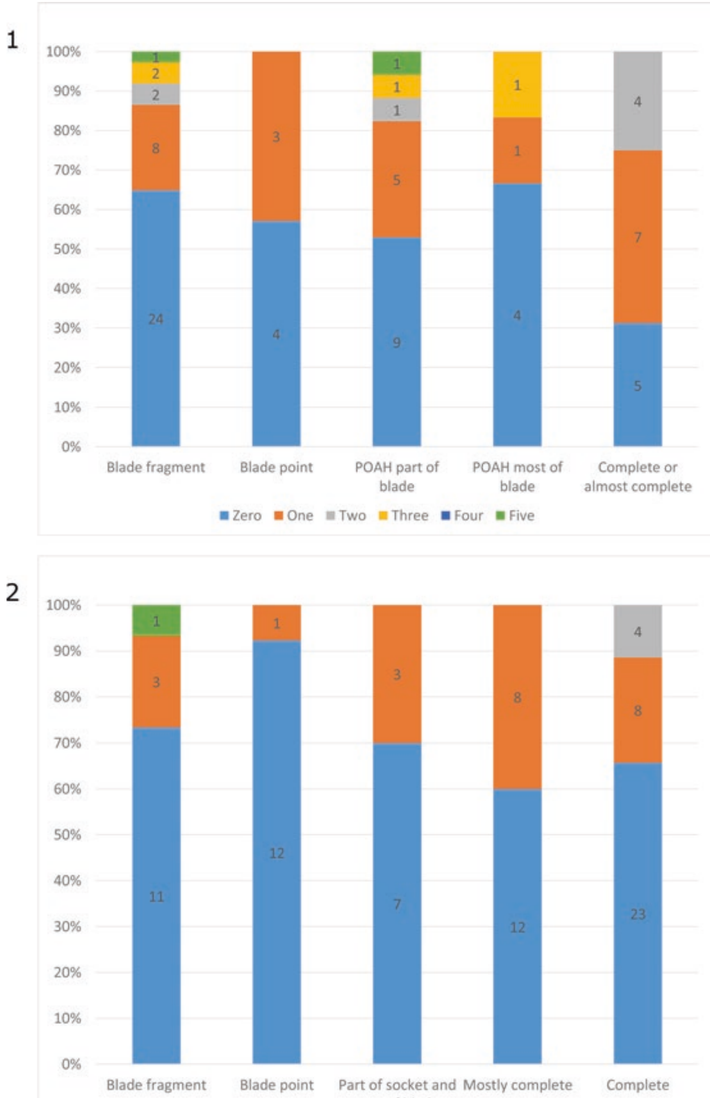


Fig. 10.9 *1* Wear analysis of combat-specific damage on a sample of swords from Serbia (*POAH* = Part or all of handle; most of blade = 50%>); *2* wear analysis of combat-specific damage on a sample of spearheads from Serbia

fragments, the actual breakage of the object was not counted in this study as an instance of wear, which it could well have been, and so these figures are probably under-representing damage caused through use.

Wear analysis is also useful for considering some specific issues. For example, despite visual similarities, swords of Aegean form found in the Balkans have a distinct breakage pattern at the hilt that is not found on pieces in the Aegean. Two

Fig. 10.10 Type Apa swords from Vajska (**a**) with faint traces of incised decoration on the handle and secondary rivets and from Kevi-Csiker (**b**) with clear incised decoration on the handle. (Photograph by author)

swords from Iglarevo and one from Aleksinac (Fig. 10.3f) have either cracking or complete fracturing where the blade meets the handle (and in two cases this was subsequently repaired by re-casting features with molten bronze), while one from Tetovo has a very distinctly bent blade (Filipović 2015; Harding 1995). It could be speculated that Balkan warriors were simply less skilled than Aegean ones, and so they broke the gracile swords that they adopted and adapted, but the fact that there is a pattern to the breakages suggests a distinct local tradition of use. These damage and repair patterns indicate that a more robust form of use was practised in this region than in the Aegean, and that it was considered worthwhile repairing weapons that had suffered catastrophic failure, perhaps hinting at biographical values being linked to these objects.

From a qualitative perspective, the Type Apa sword from Vajska (Fig. 10.10a) is of interest (Harding 1995, no. 230). This blade was bent into a U-shape, which was no doubt intentional given its extreme nature, but we can also compare it to the breakage in the middle of the blade on the same type of sword from Kevi-Csiker (Fig. 10.10b). This suggests that bending to decommission weapons was a tradition of that time to end their functional life. The decoration on the handle on the Vajska sword has been worn away through extensive handling, yet the blade has no obvious evidence for combat damage. This suggests that the present blade may have been a replacement for a damaged one. The use of a different form of rivet to repair the handle-blade join may also indicate that damage had occured and that this wear had been carefully ground away during a repair that also included repairing the handle. However, most forms of damage caused by blade-to-blade impacts consist of a mark of generally less than 2 mm depth, and so such reductive repairs (such as grinding) could only take place a limited number of times before ruining the blade. A lack of obvious use-wear may also be a product of the way the sword was used, for example, targeting soft tissue and avoiding blade-on-blade contact. When present, wear is indicative of intensity and/or character of use, but its absence can never indicate that a weapon was unused because effective striking of the flesh and bone may leave no material traces on the metal.

This metalwork wear data suggests that there was no single logical life cycle for swords or spears and that choices were made for different objects that led to different forms of depositional event. The degree of damage on objects appears to have played a negative (rejected for deposition) or positive (preferentially selected for deposition) role within this relating to contexts of deposition. The greater visibility of damage on the more complete objects may also be tenuously suggested to relate to a closer relationship with the owner or user, whereby combat use led to these weapons being woven into personal narratives and events (Kristiansen 2002). Conversely, some weapons selected for hoarding were being treated more generically, and one factor influencing this may have been that they lacked this personal or historic link.

What Broken Weapons in Hoards Tell Us About Weapon Production

Taking the well-published Slovenian dataset again, we can consider how depositional biases may relate to the ancient allocation of resources for metalwork (Turk 1996, 2001; Turk and Čerče 1996). As Dietrich (2014) makes clear, the circumstances underlying the selection of material for deposition in a hoard are social choices that need not follow a distinct universal pattern. Quantitative analyses of the different categories of objects in hoards therefore relate to choices in the act of deposition; as such, they cannot be taken as face value records of the relative proportions of objects typically in circulation. This said, we must consider how hoards were assembled. Larger items were fragmented, and many smaller items were rendered unusable, so these were not collections of objects stored for simple reuse. The hoard as we discover it was a social creation brought together with intent. The dearth of refitting pieces tells us that the hoard we find is a portion of a larger collection of broken things that had been brought together at a certain place or places. The material that was extracted to be buried for a secondary purpose was therefore a portion of a larger assemblage or assemblages that had been previously been assembled for a purpose distinct from deposition. What we find in Balkan hoards may therefore be a somewhat randomised fraction of this original assemblage. It is of course fully possible that each object was carefully selected for deposition on the basis of its lost identity as a thing in society, but the very act of fragmentation and distortion of objects when they entered into this solid stock pool of metal may be taken to imply that these identities were intentionally deconstructed (Bradley 2013; Dietrich 2014).

Thus, it could be argued that the sample of weaponry that we find in hoards could very broadly be related to the proportions of objects once in circulation by virtue of the random selection process. It must be stressed here that we are speaking of very broad parameters in this case, not specific percentages, and that different hoards were constructed for potentially different purposes and in different ways. With these caveats in mind, looking to the Slovenian hoards of the thirteenth to eleventh centuries BC (Turk and Čerče 1996), only 4.6% of objects in large hoards and 9.5% in small hoards are weapons. Looking only at those "large hoards of mixed composition" that contain any weapons (8 out of 12 of these hoards), their numbers generally constitute 3–10% of the total number of objects, but most often in the 3–5% range. An assessment of how these percentages based on numbers of objects may relate to percentages based on weight is not possible with the current data. It is suggested that these figures can constitute a rough estimate of how much metal in society went into weaponry, which would be somewhere in the region of 5–10% on the basis that weapons and fragments of weapons are heavier than many of the other categories of object counted (e.g. pins, razors, wire). This indicates that investment in military hardware was a significant, but far from dominant, aspect of bronze-using economies in the region, which appears to stand in contrast to the higher proportions of weapons seen in the deposits from Atlantic Europe, for example (Becker 2013).

Warfare

Overall, warriors and smiths of the Balkans were participants in a wider milieu of martial traditions, which encompassed Italy and the Carpathian Basin directly, and the Aegean to an extent, that increased in intensity by the thirteenth century BC. The Central Balkans also appear to have been a potential conduit through which martial practices were filtered between more densely occupied regions. The data discussed in this paper is primarily from the northern Balkans along the Sava-Danube corridor and north of this, because that is where most weapons were deposited. There is a strong degree of choice evident in the forms of weapon used in the fifteenth to thirteenth century BC, though the numbers of finds and the chronological resolution of the development of particular weapon types remain sparse. This changes notably by the thirteenth century BC, when the region is characterised by a stronger degree of uniformity in the proportions of most swords and spears, even if appearances remained diverse. Despite notable exceptions (e.g. in Fig. 10.4), the general pattern is of complementary proportions and functions of weapons between the thirteenth and eleventh centuries BC. For axes that may have been used in battle, there appears to be a wider range of choices and greater regional diversity. Although the evidence for armour is scant, the few pieces that survive, and particularly the motifs used on them, indicate that these were part of a wider tradition of armour that included much of central and south-eastern Europe as well as the Aegean. By the later Bronze Age, combat practices appear to have become increasingly conducive to cooperative fighting traditions as we would find in an organised military system, which would include lines of battle.

It is noteworthy in this context that we have a significant increase in the use of fortifications by the later Bronze Age. Substantial forts enclosing several hectares emerge as a phenomenon in Istria down through Dalmatia from the eighteenth century BC, but became more common by the thirteenth century in the surrounding areas (Hänsel et al. 2015). Defended Middle Bronze Age tell-sites in the northern Balkans were generally modest in size (Gogâltan 2008). It was only by the later Bronze Age that fortifications became much more widespread in the region (Gogâltan and Sava 2012; Kapuran 2009; Molloy et al. in press). With the spread of fortifications which had multiple lines of ditches and palisades, defended central places became an increasing challenge in warfare by the thirteenth century. This raises the logistical requirement for large bodies of men to undertake coordinated attacks on fortifications that were set within densely occupied landscapes and could contain hundreds or thousands of people, and so the potential for actual armies in the Bronze Age emerges. The fact that many fortifications were burnt down (Gogâltan and Sava 2010, 2012) suggests that violent conflict could have been focussed on these places. Whether the burning was the result of actions of combat or an act of subjugation or abasement following combat, it is clear that these forts were a focus for social and perhaps violent conflict. In the northern Balkans, these could be tens of hectares in size (the 1600+ hectare ramparted site of Corneşti-Iarcuri is worthy of special note), indicating large fighting forces (Szentmiklosi et al. 2011). In the Central Balkans, fortifications rarely exceed 1 ha by much (Kapuran 2009), indicating that broadly similar ideas were being exercised but that the expected fighting forces were notably smaller.

Discussion and Conclusion

The weapons of the Balkans were the product of relatively skilled, but rarely exceptional, craftsmanship. The smiths making them were cognisant of balancing the many material challenges that different weapon types would face. In particular, it was argued that swords had a greater degree of effort expended on them during the craft process, and greater attention to alloy contents was paid than to other tools and weapons. In general, the quality of weapons examined does not indicate that they were the product of fundamentally more advanced or elite centres of production than other metal items. A broad estimate of 5–10% of total bronze consumed being used for weapons represents a significant investment in military resources for Balkan communities. It should be mentioned here that it has not been possible to integrate osteological analyses into this overview of weapons and warfare in the Balkans due to a dearth of published material.

By briefly taking account of the scale of fortifications and the character of weaponry, it was possible to suggest that warfare had advanced to a level of organisation that enabled the assembly of what may reasonably be termed armies. These could potentially consist of amalgams of war bands with individual war leaders eliciting the support of their local population (Harding 2007). This said, the construction of fortifications of tens of hectares in some areas suggests a degree of social organisation that took military matters very seriously within specific and physically bounded, or grounded, communities. With such defences creating a requirement to be able to defend them, we must consider that military organisation had developed to a stage whereby specialists in military craft – warriors – operated alongside the other craft specialists of the Bronze Age. It would be suitable to imagine this as emerging at the behest of a chief or small power group, but unfortunately we do not have evidence to support this in terms of differentiated domestic or mortuary spaces or practices. Nonetheless, we need not subscribe to a view that such militarism emerged through egalitarian aspirations for mutual group aggrandisement (Roberts 2013), and so a level of centralisation of authority was surely at work in this region. The coeval spread of Urnfield traditions, notably channelled pottery, along the river corridors of the Balkans and the increased building of forts and growing homogeneity of combat practices are potentially politically driven and of historic importance, but these aspects could not be evaluated in this short paper. It is notable that we find increased standardisation of weaponry, in terms of proportions and craft elements, at this same time. The growing diversity of ways in which weaponry was consumed is also indicative of its importance in a range of different social venues – hoards, river deposits and burials.

It may be expected that the data presented in a paper such as this should be tested against a social framework derived largely from ethnography in order to better socialise it and deal with issues of causation, organisation and social effects. However, such a 'tyranny of ethnography' has weakened the unique contribution that archaeology can contribute to understanding conflict as a formative aspect of our past (Carman 1997; Haas and Piscetelli 2013). We are now at a methodological crossroad, whereby, taking account of the "material turn" in anthropology (Sørensen 2015), we are increasingly seeking to build our understanding of the sociality of prehistoric phenomena such as warfare directly on the basis of the material evidence, using bottom-up approaches. In this paper, we have therefore briefly explored biographic signatures of different stages of the life cycle of many weapons in order to address social practices including craft, combat, resource management and depositional practices. In part, the objective has been to test how a material-based study with no recourse to ethnography can contribute to a bottom-up approach to assessing the role of warfare in the development of European societies. It is clear that a single and robust narrative is not really possible at this point if we follow this line. This is a good thing, because the bare bones of the archaeology of conflict are revealed rather than dressed up in appealing, but ultimately borrowed, clothing – or, as Carman (1997: 221–222) put it, "perceived through the filter of anthropological assumptions". The Balkan region was shown to be very useful to test this approach because it incorporates the material traditions of distinct cultures, which allowed us to provisionally explore different responses to similar technical and social stimuli. Ultimately, to take the study of metalwork beyond a series of subfields such as typological cataloguing, archaeometallurgy, wear analysis or experimental archaeology, it can be fruitful to continue to build our evidential base to better explore social aspects of the life cycle of what were fundamentally very social artefacts – Bronze Age weapons.

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Chapter 11
Ritual or Lethal? Bronze Weapons in Late Shang China

Qin Cao

Introduction

The late Shang period of China (c.1200–1050 B.C.) has long been recognised as a time during which vast quantities of bronze vessels with elaborate decorations were deposited in tombs. These have been the primary material evidence employed in research (e.g. Bagley 1999), and ritual interpretations have dominated our perceptions of the Shang. What is less known is the role and extent of violence and warfare in Shang society, and recent years have seen increasing interest in scholarly explorations of these practices (Yates 1999; Underhill 2006; Campbell 2007, 2014). However, weapons, the principal kind of object most intimately associated with warfare and martial practices, have seldom been at the forefront of such investigations.

Studies of Shang weaponry have hitherto focused on classification and typology. Much effort has been put into establishing the chronological development of individual types of weapons including dagger-axes (Jing 2011) and spearheads (Hu 2011), as well as their regional characteristics (e.g. Shi 2008; Lü 2010; Guo 2014). These studies have laid the foundations of further research, but little has been said regarding the capability of protohistoric bronze weapons as killing implements. Although they have been typologically identified as military equipment, often based on later literary evidence and *comparanda* (e.g. Shi 1950), their practical uses remain for the most part obscure. The mortuary contexts, from which the majority of weapons come, have further encouraged research into their symbolic meaning

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and their roles in ritual practices at the expense of functional studies (e.g. Xu 2015). This contrasts with prehistoric studies in Europe and elsewhere, which have moved away from previous assumptions that weapons, in particular halberds (O'Flaherty 2007; O'Flaherty et al. 2011), were purely ceremonial implements. This has developed hand in hand with a new, generalised acceptance that our prehistoric past might have seen sustained episodes of interpersonal violence and warfare (Keeley 1996).

These studies have frequently benefited from the application of use-wear analysis, a scientific method involving the observation and microscopic analysis of the marks (including combat marks) visible on the surfaces of prehistoric metal tools and weapons (e.g. Kristiansen 1978; Kienlin and Ottaway 1998; Bridgford 2000; Roberts and Ottaway 2003; Dolfini and Crellin 2016). However, this analytical method has never been tested on Chinese Shang weaponry. This chapter presents the first ever application of wear analysis to these objects. It aims to investigate the applicability of this method to late Shang Chinese bronzes, solely relying on direct observation and digital microscopy, without the help of complementary techniques such as metallurgical analysis or experimental archaeology. The objects selected for this pilot study were 12 bronze Shang weapons from the British Museum collections. The project was carried out as part of my DPhil research at the University of Oxford and was generously funded by the Arts and Humanities Research Council Collaborative Doctoral Awards.

The Late Shang at Anyang

Anyang, in the present-day Henan province, has long been identified as the capital of the late Shang dynasty. At the height of its expansion, the city covered an area of over 30 km^2 (Zhongguo shehui kexueyuan kaogu yanjiusuo 1994, 2003) (Fig. 11.1). Abundant material remains have been uncovered from the site in over 80 years of systematic excavations. In particular, large building foundations surrounded by quantities of sacrificial pits were identified and interpreted as 'palatial temple areas'. Divination was widely practised using animal bones. Many of these bones were inscribed, reflecting a mature writing system that distinguished the Shang from other contemporary cultures. Vast amounts of resources were invested in tomb construction and furnishing. Social hierarchy was expressed through tomb sizes, structures and contents. Such funerary monuments provide one of the most valuable sources of data from the period. One of the most remarkable aspects of these burial assemblages lies in the numerous high-quality bronzes, mainly vessels and weapons, which display advanced casting and metalworking technology. Jade was highly treasured and is found almost exclusively in large tombs with rich furnishings. The inhabitants of Anyang actively interacted with neighbouring and far-flung societies, as demonstrated by the horse-drawn chariots introduced into the area from the steppes of central Asia.

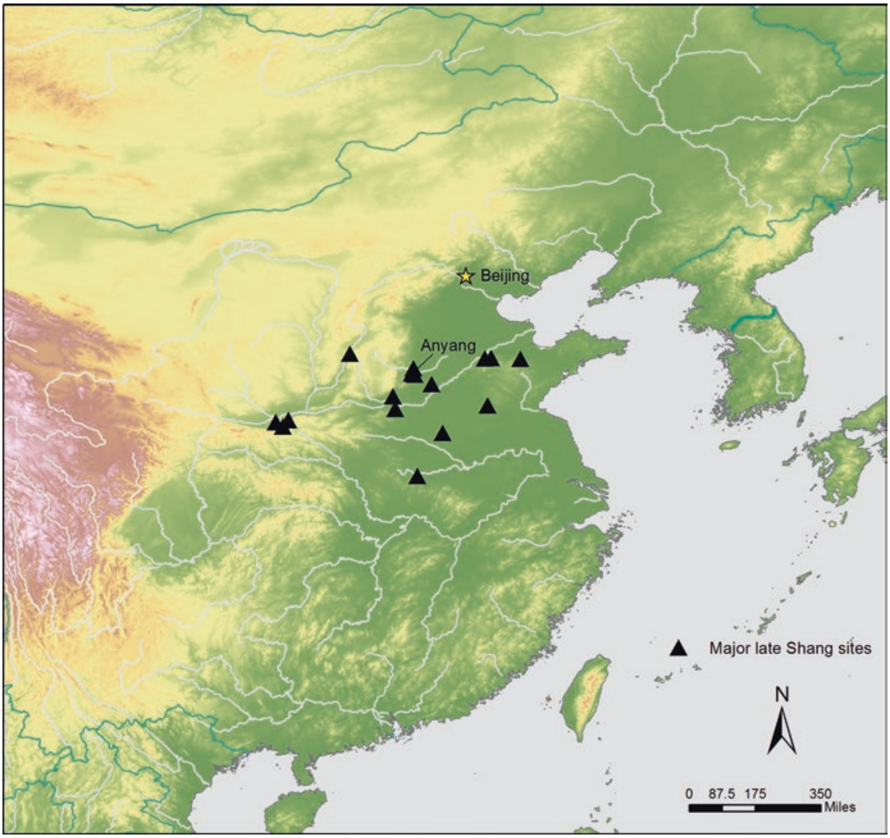


Fig. 11.1 Map of major late Shang sites. (Base map from the CIAT-CSI SRTM website)

Wear Analysis

Past Applications

Wear analysis was initially developed for the study of stone tools from the Palaeolithic (Semenov 1964) and first applied to metalwork (specifically Bronze Age swords and ornaments from Denmark) in the 1970s (Kristiansen 1978). In the last 30 years, the method has been widely employed for the study of European Bronze Age weapons. These studies have generated many stimulating discussions and have advanced our understanding of multiple aspects of the weapons, such as whether or not they were used prior to deposition, how frequently they might have been used, if consistent wear patterns could be discerned on their functional elements (e.g. cutting edges), what activities they had been involved in, their depositional treatment and their manufacturing techniques (e.g. Bridgford 2000; Roberts and Ottaway 2003; Molloy 2004; Bruno 2012; Horn 2013). Wear analysis has also been applied to investigating broader issues including the economic aspects of past social systems (Kristiansen 1978), social structure and political power (Taylor 1993), and warfare and violence (Bridgford 2000). More recently, the focus of the research has shifted from the weapons themselves to the people who fought with them through the adoption of an explicit martial arts perspective (Molloy 2007, 2011).

Depending on the availability of the objects as well as the specific questions informing the research, various methodological approaches have been applied to prehistoric bronze tools and weapons. Some have focused on the identification, recording and classification of wear marks (e.g. York 2002); some have utilised wear analysis as part of object biography studies (e.g. Bruno 2012); others still have employed multidisciplinary approaches integrating metallurgical and metallographic analyses with wear analysis and experiments with replica weapons (e.g. Bridgford 2000; Molloy 2004, 2011). Different terms have been proposed to describe these research approaches including use-wear analysis (e.g. Kienlin and Ottaway 1998), edge-wear study (e.g. Bruno 2012) and edge-damage analysis (e.g. Matthews 2011). A degree of variation can be appreciated in the scope and extent of the wear studies carried out thus far. Most studies have been limited to analysing wear traces related to practical uses, although some have also examined marks resulting from production processes and post-depositional damage (e.g. Roberts and Ottaway 2003). Overall, these research approaches have been useful in exploring the potential of what is still a relatively new field, which, however, is rapidly 'coming to age' as a mature research strand able to bridge artefact studies, archaeological science and experimental archaeology (Dolfini and Crellin 2016).

In a recent work, Dolfini and Crellin (2016) advocate the development of a more nuanced and refined approach to the analysis of prehistoric bronzes and propose a new term, namely, 'metalwork wear analysis', to describe the research approaches discussed above. The new term has two advantages. Firstly, it clarifies that the material being studied is different from stones, bones or ceramics and requires a partly distinct approach to traceological research. Secondly, 'wear analysis' is broader than the commonly used term 'use-wear analysis', which narrowly emphasises the study of use-related marks at the expense of other kinds of traces. A number of studies have disclosed the informative potential of non-use traces, for example, tool marks, which reveal the manufacturing processes of ancient bronze weapons (Mödlinger and Ntaflos 2009; Li et al. 2011). Nevertheless, the inclusion of the word 'wear' in the new term still implies analysis of traces of deterioration of a complete object from a functional perspective. Following Dolfini and Crellin (2016), in this chapter, I use the term metalwork wear analysis so as to reflect the broad scope of the study, which intends to cover all marks (i.e. manufacturing, use-related, depositional and post-recovery) observed on the surfaces of the objects.

Fig. 11.2 Dagger-axe ID 11

Table 11.1 List of the Shang weapons from the British Museum collections examined for this research

ID	British Museum accession number	Object type
#1	1880,0802.85	Dagger-axe
#2	1915,0409.100	Dagger-axe
#3	1932,1014.19	Dagger-axe
#4	1932,1014.20	Dagger-axe
#5	1933,0413.11	Dagger-axe
#6	1936,1118.36	Dagger-axe
#7	1945,1017.189	Curved-spine knife
#8	1947,0712.413	Broad flat axe
#9	1948,0716.40	Dagger-axe
#10	1953,1215.2	Spearhead
#11	1953,1215.1	Dagger-axe
#12	1981,1117.1	Hooked-head knife

The Dataset

The British Museum holds one of the largest collections of Chinese bronzes in Europe. Compared with the bronze vessels, on which scholarly research has long concentrated (e.g. Rawson 1987, 1992; Michaelson and Portal 2006), little is known regarding the bronze weapons from the collection, except for the images of a few objects published in various catalogues (Rawson 1987, 1992). All Shang weapons hosted by the British Museum are of unknown provenance. They were donated, purchased or bequeathed to the museum between the 1880s and the 1980s. Based on their preservation and considering the aim of the analysis, 12 bronze weapons were selected for this study. They were dated to the late Shang period by Jessica Rawson and the author based on typology. The sample includes eight dagger-axes (Fig. 11.2), one spearhead, one broad flat axe, one curved-spine knife and one hooked-head knife (Table 11.1). Although the sample size is small and the archaeological context of the objects is unknown, the weapons selected for the analysis provide an excellent sample as they cover all major weapon types documented for the Shang period.[1]

[1] Except for arrowheads, as their dating is problematic: see Shi 2008.

Analytical Methodology and Protocol

While research into tool marks and manufacturing processes has been carried out on weapons of the Qin Terracotta Army (Li et al. 2011; Li 2012), no use-related microscopic analysis has ever been conducted on Chinese bronzes. Thus, this research has been guided by the methods and analytical protocols developed for the wear analysis of European bronze weapons, including the identification, documentation, classification and interpretation of edge damage. Observations were carried out directly on objects in the British Museum store. The following analytical protocol was applied:

- Macroscopic observation: all weapons were examined individually using the naked eye under an adjustable light source. All wear marks thus identified were described and photographed using Nikon DSLR (D5500) and Panasonic (DMC-LX7) digital cameras.
- Microscopic observation: the objects were further examined using a Dino-Lite Pro AM4115TW digital microscope mounted on a stand (1.3 Megapixels, ×10~×50 magnification and white LED lights). The images were captured using the DinoCapture 2.0 software. The device was calibrated at the start of the analysis.

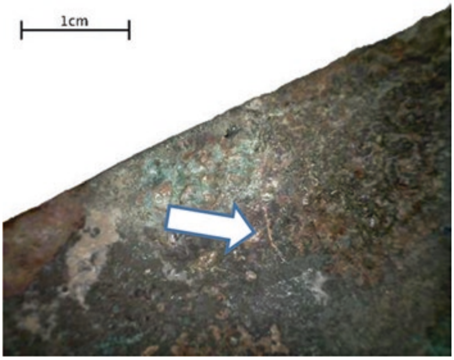
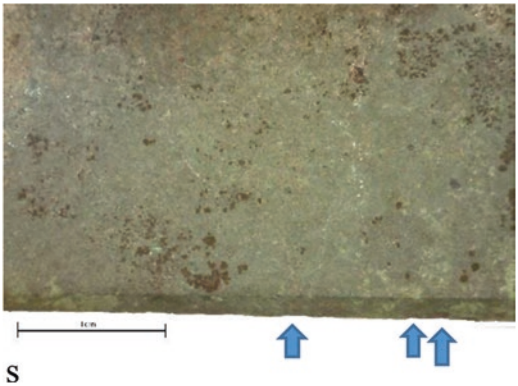
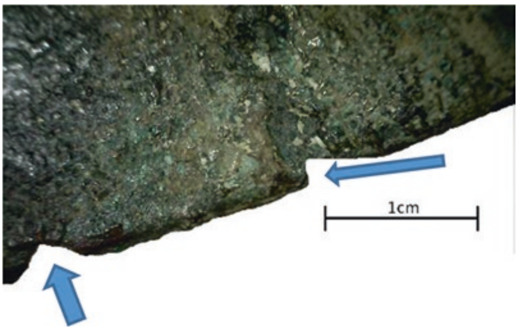
There is currently no standardised methodology for the observation of wear marks on bronzes. Scholars have employed hand-held magnifiers, microscopes (of various types and magnifying powers) or a combination of both. Some have taken dental casts of object surfaces using polyvinyl siloxane or similar silicon-based materials, while others have not. Multiple studies have shown that it is advantageous to observe objects at both macro and micro scales (e.g. Dolfini 2011). The use of a digital microscope, albeit low-power, has been effective in revealing many fine details, such as tool marks that are invisible to the naked eye. Moreover, the LED illumination built into the device allowed for the observation to take place in the museum store with limited lighting. The DinoCapture 2.0 software proved efficient in capturing, managing and producing digital images with scales and other useful details in a way that it is not possible when taking photographs with a traditional camera. As explained above, this was complemented by macro-level observation (by naked eye with adjustable lamp lights), which was especially important for the preliminary appraisal of the objects.

Although wear analysis is relatively straightforward, there is one essential requirement for it – that the object is well-preserved and has limited surface corrosion, as heavy corrosion and surface alteration may mask extant marks. It is also worth noting that the original marks may have been lost during use, especially if this was extensive or if new marks were added as part of resharpening/reworking processes. In addition, one should consider that artefacts may have been subjected to modern alterations including conservation treatments which would now be considered inadequate. These considerations highlight the need to examine the objects in order to select a suitable sample for wear analysis.

Observations and Results

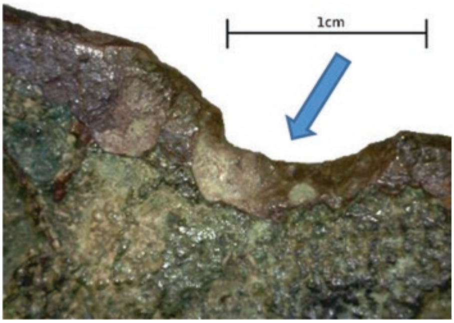
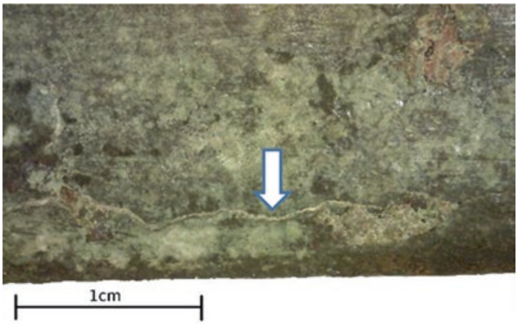
The micro- and macro-analysis of the 12 Shang weapons examined in this research has revealed a wide range of marks, which highlight the untapped potential of wear analysis as applied to ancient Chinese bronzes. In order to consistently describe the marks observed on the objects, a terminology had to be established first (Table 11.2). This has been adapted from Matthews (2011) and O'Flaherty et al. (2011), also

Table 11.2 Terminology of the wear marks with photographs of the marks described

Terms	Images
Scratch: a shallow long mark on the surface (ID 2)	
Nick: a very small cut, usually U-shaped. It involves a small amount of material loss on the edge (ID 4)	
V-shaped notch: a clearly defined V-shaped notch, with a moderate amount of metal loss (ID 6)	

(continued)

Table 11.2 (continued)

Terms	Images
U-shaped notch: a clearly defined U-shaped notch, with a moderate amount of metal loss (ID 6)	
Crack: a line that penetrates the surface but does not cut through to the other side (ID 7)	

The ID numbers in brackets refer to the objects from which the micrographs were taken

taking Untracht's (1968) work on modern metal crafting into account. Of the 12 weapons studied, 11 displayed various surface traces, which have been interpreted and categorised into four types: manufacturing and/or repair marks, use marks, marks caused by depositional treatment and post-recovery alterations (Table 11.3). These categories are discussed below.

Manufacturing and/or Repair Marks

Two types of manufacturing traces have been observed: striations and hafting marks. Although partially corroded, eight weapons out of 12 have dense striations on their surfaces. Two different patterns of striations were noted. The first pattern was mostly found on the body of blades: the lines are coarse, broadly transversal and sometimes cross-cutting each other. One such example is provided by the striations visible on the decorative goat-head motif on the blade of the curved-spine knife (ID 7, Fig. 11.3a). The second type of striations usually occur on the cutting edges of blades; they are normally evenly spaced and diagonally oriented (Fig. 11.4a).

Table 11.3 Summary of the types of mark observed on the Shang weapons examined for this research

Object ID	Manufacture and/or repair	Use	Depositional treatment	Post-recovery alterations
1		X		
2	X	X		X
3	X	X	X	X
4	X	X		
5	X	X		
6		X	X	
7	X	X		X
8		X		
9				X
10	X	X		X
11	X	X		
12	X	X		

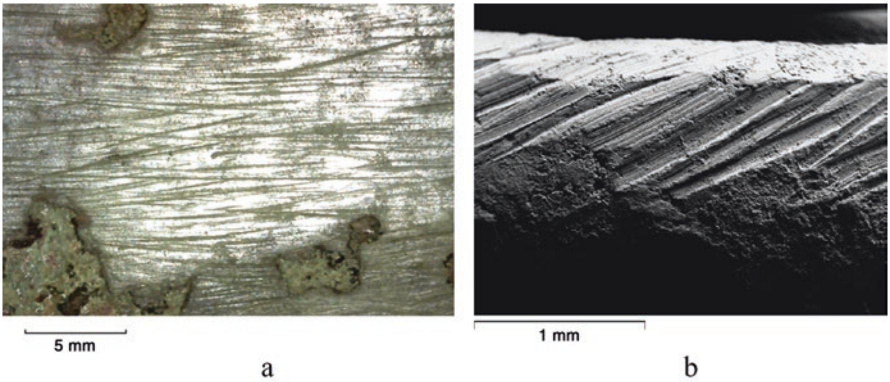


Fig. 11.3 (**a**) Striations on blade body of the curved-spine knife (ID 7) (first type; micrograph by author); (**b**) SEM micrograph of filing marks on the tang of a Qin bronze arrow. (After Li et al. 2011, Fig. 10, 498)

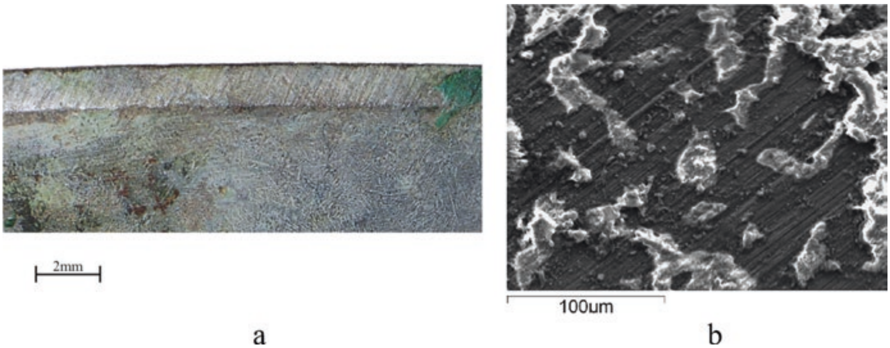


Fig. 11.4 (**a**) Striations on the cutting edge of the dagger-axe ID 5 (second type; micrograph by author); (**b**) SEM micrograph of grinding marks on the surface of a Qin bronze sword. (After Li et al. 2011, Fig. 13, 499)

Unfortunately, little is known regarding surface marks on Shang bronzes. However, research into Chinese weapons from later periods sheds a modicum of light on the problem (e.g. Tan and Lian 1998; Zeng 1993; Dong 1999). One particularly relevant piece of research has revolved around the study of the tool marks visible on swords, lances and arrows of the Terracotta Army of the First Emperor of the Qin dynasty (246–221 B.C.) (Li et al. 2011). SEM and stereomicroscope examination of silicon impressions of the surfaces of these weapons has led to the identification of two types of striations, which were interpreted through targeted experiments. The first type resulted from filing with (possibly) metallic hand-held tools (Fig. 11.3b). In this process, excess metal was removed from the surface, presumably soon after casting. These striations are almost identical to those observed on the blade bodies of the Shang weapons (Fig. 11.3a); they are crude, irregular and cross-cutting each other. These similarities suggest that, on Shang weapons too, striations of the first type can reasonably be interpreted as filing marks produced using hand-held tools. It is, however, difficult to decide whether the files used for the Shang weapons were stone or bronze, until further experimentation is carried out. Furthermore, it is important to acknowledge that these striations have been observed on different parts of different weapons: blade body of a Shang curved-spine knife, the first; and tang of a Qin arrowhead, the second.

Striations of the second type were interpreted by Li et al. (2011) as grinding marks produced as the objects were smoothed out and sharpened using rotary wheels. These marks were similar to those observed on the cutting edges of Shang weapons (Fig. 11.4a); they appear to be finer in comparison with the striations produced by the filing process, as well as being more densely distributed (Fig. 11.4b). The resemblance between the striations found on both Qin and Shang weapons strongly suggests that, in both cases, they were produced using rotary wheels. This proposal is supported by archaeological evidence from Anyang, the late Shang capital site, where a ceramic rotary wheel has been brought to light (Zhonguo shehui kexueyuan kaogu yanjiusuo 1994). The object has been described as a 'partially damaged, grey ceramic [object] with high content of sand, rough surface, resembling a grinding stone, in a round shape with a raised circle and traces of wear on surfaces' (*ibid*, 242, author's translation) (Fig. 11.5); it is 27 cm in diameter and 1 cm thick. Unfortunately, no details are available regarding the find context of the wheel, except that it is non-funerary.

It is worth noting that, on the Qin weapons, the two types of mark co-existed only on arrows (filing marks on arrow tangs and grinding marks on arrow heads), but they were both observed on almost all the Shang weapons examined for this research including several dagger-axes (IDs 2–5 and 11), the spearhead (ID 10), the hooked-head knife (ID 12) and the curved-spine knife (ID 7). It must be presumed that, for all bronze objects, the finishing process required the use of a file to remove excess amounts of metal and create smooth surfaces, and then the rotary wheel was used to grind the surfaces for a finer finish or a sharp edge. It is therefore unclear why there should be such a notable difference between Shang and Qin weapons. One explanation might be that the level of craftsmanship achieved by Qin weapon smiths was greater than that of their Shang predecessors, almost 1,000 years later. Presumably, in order to attain high-quality finishes on swords and lances, the Qin smiths would

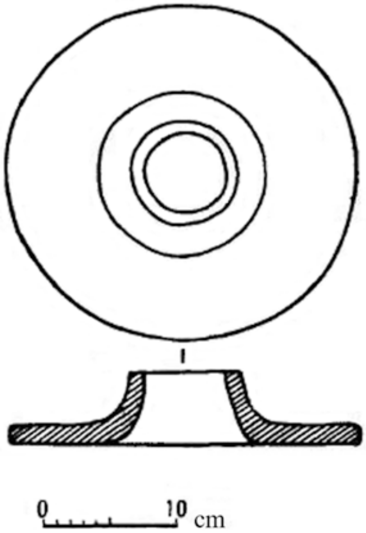


Fig. 11.5 Ceramic rotary wheel (87XTH1:13) from Anyang. (After Zhongguo shehui kexueyuan kaogu yanjiusuo 1994, Fig. 118.2, 241)

have comprehensively ground and sharpened the weapons' blades and cutting edges after filing. This would inevitably have resulted in the removal of any pre-existing filing marks. Furthermore, we can observe that Shang weapon smiths seem to have used rotary wheels only to ground the blade edges to sharpen them, while Qin smiths also used them to smooth out the bodies of the blades.

As all the objects analysed were unprovenanced, there is theoretically a possibility that the striations could be ascribed to post-recovery alterations. However, two independent strands of evidence suggest that this interpretation is to be refuted. Firstly, the eight weapons bearing manufacturing marks were acquired by the British Museum from multiple sources at different times. For example, dagger-axe ID 5 was purchased from the Karlbeck Syndicate in 1933, while the curved-spine knife (ID 7) was bequeathed by Oscar Charles Raphael in 1945. It is unlikely that they all happened to receive the same filing and grinding treatment under different owners. Secondly, some of the striations are partially covered by corrosion products (Fig. 11.6), indicating their pre-depositional origin.

On combining evidence from observation, comparative studies and archaeological data, I argue that rotary wheels were employed by the Shang to sharpen bronze weapons. This is the earliest evidence to date of the use of rotary wheels in China. Although the details of the process are still unclear, we can speculate that utilising rotary wheels for sharpening weapon blades would have been much more efficient than using hand tools. Reportedly, rotary wheels were widely used for the incision and carving of jade during the Spring and Autumn period (770–481 BC) of the Eastern Zhou dynasty (770–256 BC) (Yang 2009). Although further analysis and experimentation are required to firm up this interpretation, the current evidence suggests a degree of continuity in bronze crafting techniques from the late Shang to later periods and the utilisation of similar tools to work several materials including bronze and jade.

Fig. 11.6 Striations partially covered by corrosion products (ID 7)

As for the hafting of Shang weapons, two methods are documented in the sample: tangs (e.g. ID 4) and sockets (e.g. ID 2). None of the shafts or handles of these weapons have survived, but carbonised remains of organic material observed on the surfaces of certain objects (e.g. ID 11) suggest that they were made of either wood or bamboo. Moreover, repair or repolishing work may have taken place at later stages in the life cycles of these weapons in order to extend their use value and maintain their effectiveness. Original tool marks may have been removed or masked during this process, but unfortunately it was not possible to differentiate between primary and secondary tool marks during this study. Microscopic analysis at higher magnification ranges in combination with experimental work might make such a differentiation feasible, but this goes beyond the scope of this research.

This study has further confirmed earlier observations concerning the detrimental effects of surface oxidisation for the identification of manufacturing traces (cf. Roberts and Ottaway 2003; Dolfini 2011). On a dagger-axe (ID 2), for example, the portion of the edge visible beneath a thick layer of corrosion products appears to be blunt. However, a small non-corroded area of the lower blade of the same object reveals sharp cutting edges and clear striations on both body and cutting edge. This urges caution in interpreting manufacturing and wear marks on heavily corroded metalwork.

Use Marks

With the exception of a dagger-axe (ID 9), 11 out of 12 objects display evidence of use, including nicks, notches, cracks and scratches, as defined in Table 11.2. The majority of nicks and notches are concentrated on the cutting edges, but some are on blade tips (e.g. dagger-axe ID 11) or tangs (e.g. dagger-axe ID 1). Cracks and scratches are mostly noticeable on blade bodies. Due to the small sample size of this study, it was not possible to identify any meaningful use patterns on the objects observed. Such patterns might reflect the ways in which a dagger-axe could be wielded in combat, so as to produce consistent marks on certain parts of the blade. As no use experiments have been carried out on Shang weapons, any interpretation of the causes of wear must remain speculative and cannot currently be correlated with any of the activities in which they might have been engaged, e.g. cutting through bone or clashing with other bronze weapons or shields. Another factor to consider is blade hardness, which is related to the alloy composition and post-casting treatment of the weapons. In order to explore the relationships between hardness and the extent of impact and damage, further experimental work is required, along with chemical and metallographic analysis.

Depositional Treatment

The surfaces of two dagger-axes (ID 3 and 6) had large areas covered with traces of mineralised textiles (Fig. 11.7). This has been noted in archaeological reports of many bronze objects, both weapons and vessels. One such example is provided by tomb Qijiazhuangdong M269, Anyang (Anyangshi wenwu gongzuodui 1991). Here, five bronze spearheads were neatly stacked in the southwest corner of the wooden chamber, facing south. The arrangement of the objects and the traces of fabric visible on the surfaces of the upper and lower spearheads have led to the suggestion that they were wrapped in a cloth when deposited in the tomb (*ibid*). The traces of fabric observed on two weapons examined for this research may also bear witness to such a practice. Traces of this kind are important evidence that textiles potentially played a key role in Shang burial and are often the only surviving evidence hinting at their widespread use in mortuary rituals. On occasion, the characteristics of mineralised textiles have been studied in order to identify the types of fabrics used in the Shang period. This is the case, for example, with the five varieties

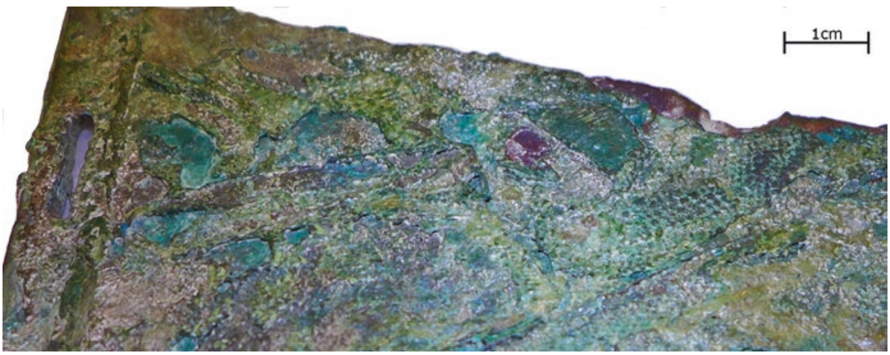


Fig. 11.7 Mineralised textile marks on the surface of dagger-axe ID 6

of fabric identified on bronzes (weapons and vessels) from Fuhao's tomb (Zhongguo shehui kexueyuan kaogu yanjiusuo 1980, 18). Although this kind of study was beyond the scope of this research, the traces observed on the British Museum bronzes may in the future be examined to further our understanding of Shang textiles and their role in funerary practices.

Post-recovery Alterations

Post-recovery alterations include any transformations, accidental or deliberate, which have occurred since an object's recovery, such as conservation treatment and deterioration. For example, a dagger-axe (ID 3) and the curved-spine knife (ID 7) from our sample were repaired by British Museum conservators after accession; the repairs are clearly visible on the objects. In particular, the conservation record of ID 3 (VRA 59178) details the work carried out on the object as well as its condition prior to that. Before entering the British Museum collections, the object had several breakages repaired with lead solder, which was then painted green. The conservation process involved the removal of the paint to reveal the repairs as well as surviving traces of textiles; 'bronze disease' was also treated (British Museum Merlin Collection Database).

Post-recovery damage was also noted on several objects. One common way of identifying this type of damage is observing if the patina, which normally covers pre-depositional marks, has been breached (Roberts and Ottaway 2003, 120). Examples include a scratch on a dagger-axe (ID 2) and a notch on a spearhead (ID 10) (Table 11.3). Both these marks have penetrated through the corrosion products and must therefore have occurred after the corrosion had formed.

Another common type of post-recovery alteration is modern tampering with, and modifications of, the objects. Inscriptions are not common on Shang bronze weapons, and the one found on dagger-axe ID 9 thus raises suspicions regarding its authenticity (Fig. 11.8). Wear analysis can help to assess this problem. Firstly, by looking at the inscription, one has the impression that the incised lines, although partly patinated, cut through the layer of ancient corrosion products (Fig. 11.8). Secondly, the location of the inscription, on the portion of the tang closest to the blade, is unusual. All known inscriptions on Shang bronze dagger-axes from secure archaeological contexts are located near the end of the tang. The part of the tang closest to the blade is normally used for attaching the organic shaft, as seen, for example, in dagger-axe ID 11 (Fig. 11.2). It is hard to see why Shang smiths would inscribe a part of the weapon that would normally be covered by the shaft. Thirdly, while some Shang bronzes have inscriptions incised after casting, the majority of them were cast with the object. If we compare the incised inscriptions of a late Shang drinking vessel (B60B958) in the Avery Brundage Collection, the Asian Art Museum of San Francisco (Strahan and Fenn 2007), with our dagger-axe, the incised lines of the latter appear rather more shallow and ill-defined, thus suggesting inferior craftsmanship on the part of the artisan. All considered, it may be

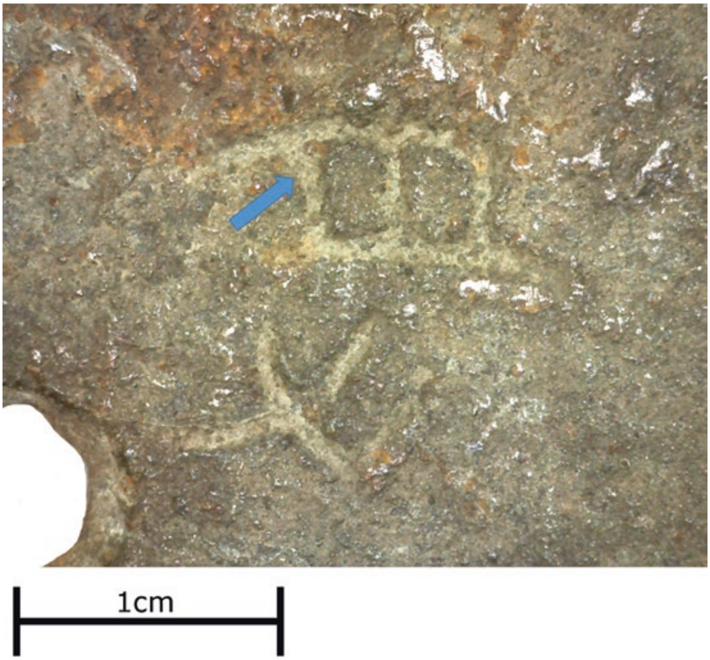


Fig. 11.8 Incised inscription on dagger-axe ID 9. The arrow highlights a line cutting through the patina; this suggests that the inscription is a modern forgery

suggested that this is likely to be a modern forgery, carried out before the object entered the British Museum collections in 1948. Inscribed Chinese bronzes have always been desirable, and commanded higher prices on the antiquities market, compared to those uninscribed, and there was a whole industry in Xi'an in the 1920s and 1930s devoted to this type of forgeries (Deydier 1995, quoted in Strahan and Fenn 2007, 27).

Reassessing the Function of Shang Weapons: A 'Ritual' Object in Focus

The wear analysis discussed above has revealed a range of marks that had not previously been observed on Shang bronzes. This demonstrates the applicability and potential of this method to the examination of ancient Chinese metalwork including Shang weapons. However, observation alone is not sufficient. Wear analysis works best when used in combination with other strands of evidence in order to interpret the objects. In the following pages, I will demonstrate how a multistranded approach enhances interpretation of the objects, and challenges existing conventions, using the curved-spine knife ID 7 as a case study (Fig. 11.9).

Fig. 11.9 Curved-spine knife ID 7

The knife has a spine that curves upwards and ends in a dull tip. The tang is rather short in comparison with the long and wide blade body. The back of the blade has several alternating 90° protrusions. On the upper part of the blade body, there is a band of cast goat heads and geometric patterns. The knife is quite large compared to other objects of this kind – it measures 48.3 cm length and weighs 460 g, while in contrast other dagger-axes from the sample are about 25 cm long on average. Long-curved knives of this type have been found in small numbers at Anyang. They are relatively rare vis-à-vis other types of Shang bronze weapons such as dagger-axes and spears. Those of known provenance are all from a small number of large tombs with rich furnishings. Two such examples are objects M5:1169 and M5:1171 from the tomb of Fu Hao (Zhongguo shehui kexueyuan kaogu yanjiusuo 1980). Fu Hao (died c.1200 BC) was one of the three royal consorts of King Wuding, who ruled in the late thirteenth century BC; he is frequently mentioned in oracle bone inscriptions as a leader of military campaigns (*ibid*, 221–228)[2]. Her tomb was the only intact Shang royal tomb to be scientifically excavated, revealing the largest grave assemblage known from the period. This includes over 8000 bronze, jade, bone, ceramic, stone, shell and ivory artefacts. Various interpretations have been proposed regarding the two curved-spine knives found in Fu Hao's tomb. In the excavation report, M5:1169 and M5:1171 were categorised as 'bronze tools' (*ibid*, 101–102). However, other scholars have suggested that curved-spine knives belong to the 'ritual bronzes' category because of their unusually large size, fine qualities (which set them apart from utilitarian knives) and their ubiquity in large and richly furnished tombs, as to signify the status and rank of the deceased (Liu 1993; Lŭ 2010). Based on his observation of the short handle of curved-spine knives, and depictions of knives of similar forms on bronze inscriptions, Lŭ (2010) suggested that the hafting of these objects would not be secure enough for use in battle; they should therefore be interpreted as ritual implements. However, the application of wear analysis to the curved-spine knife from the British Museum collections (ID 7) tells a different story.

[2] Oracle bone inscriptions are divination records from the late Shang period; they cover a wide variety of issues concerning the Shang elites, from sacrifices and military campaigns, to agriculture, childbirth and disasters/distress/trouble (Keightley 1997, 2000).

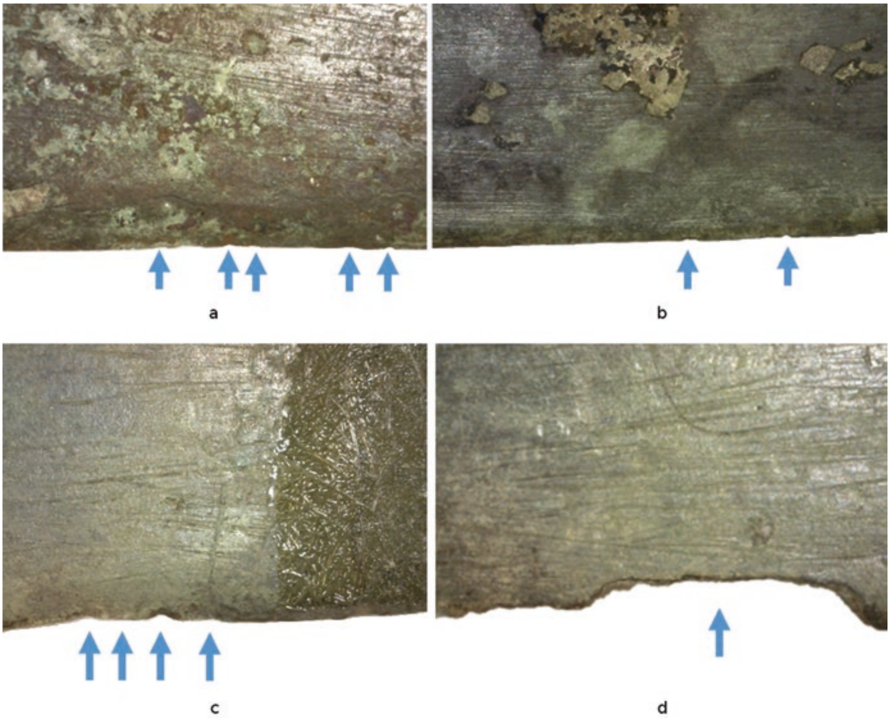


Fig. 11.10 Wear marks on the blade of the curved-spine knife ID 7; (**a–c**) nicks on various parts of the blade; (**d**) U-shaped notch on the blade

The sharp cutting edge and smooth blade body of ID 7 indicate that this is a functional object with the capacity to be an efficient killing implement. Three types of traces have been observed on its surface: manufacture, use and possible post-recovery marks. Tool marks resulting from filing (Fig. 11.3a) and grinding have been observed on the blade body and cutting edge, respectively. A range of wear marks were also noted on the cutting edge in the form of U-shaped notches and small nicks (Fig. 11.10). The type and location of these marks suggest that the knife might have been used as a weapon to some extent, although targeted experiments with replicas would be needed to confirm this hypothesis. This stands in sharp contrast to dagger-axe ID 9, which shows blunt edges and, overall, little evidence of use-related marks (Fig. 11.11). In assessing knife ID 7 at a macro level, it was noted that there was little deformation of the blade's profile. Studies of bronze weapons in Europe have remarked that episodes of repairing and repolishing of the cutting edges will eventually alter the shape of the blade (Roberts and Ottaway 2003). Considering that manufacturing marks including traces of filing and grinding are still visible, it might be suggested that the knife did not have a long use-life, or was utilised in a controlled environment, before it entered the archaeological record. Nevertheless, the presence of sharpening marks on the cutting edge, along with multiple nicks and notches indicating impact damage, strongly suggests that the knife served a practical use.

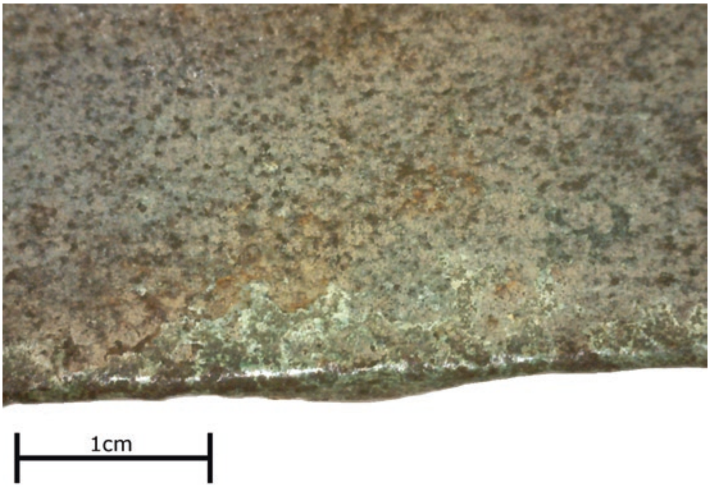


Fig. 11.11 Blunt cutting edge of dagger-axe ID 9

One possible post-recovery alteration can be seen in the breakage occurring a third of the way down the blade from the tang, the cause of which is unknown (Fig. 11.9, just above the 10 cm scale mark). According to British Museum conservation records, the breakage was repaired twice. Whereas there are no records of the first repair, it is known that the second was carried out by museum conservators in 1991; it involved the use of adhesives backed with fibreglass tissue. The breakage might have occurred before the excavation, possibly during use or as part of a deposition ritual.

All the evidence discussed above indicates that the knife was unlikely to have been a ceremonial object solely utilised for ritual purposes but was employed as a practical implement and possibly as a weapon. Considering the archaeological contexts of the curved-spine knives found at Anyang, it may be suggested that they were the personal weapons of the high-ranking individuals laid to rest in the large, well-furnished tombs from the site.

Conclusion

Although all the objects examined in this chapter are from museum collections and lack archaeological contexts, this pilot wear analysis study has revealed new evidence regarding the production, use-life, depositional treatment and post-recovery alterations of late Shang weaponry, which could not otherwise be garnered from other sources including oracle bone inscriptions and typological studies.

With regard to the wear analysis, the study has demonstrated that both macro- and micro- levels of observation, used in combination with each other, are necessary to fully appraise the objects. It has also demonstrated that portable digital microscopes are suitable for the wear analysis of ancient bronzes. Although this pilot study did not include any experimental archaeology to independently evaluate the marks and traces identified, it has nonetheless yielded new, and indeed important, results. These include the tentative identification of the earliest uses of rotary wheels to grind and sharpen bronze objects, as well as the first secure identification of use-related marks on the cutting edges of Shang weapons. When used in combination with archaeological evidence, as has been done with the curved-spine knife case study, wear analysis has revealed that Shang weapons could have fulfilled a variety of functions, both practical and symbolic. Not only do these results add to our understanding of early Chinese weaponry; they also help us to move away from the now-prevalent focus on typological classification, towards a holistic view of the life histories of ancient bronzes from production to museum life.

This pilot study has opened up new avenues for research into early Chinese bronzes. It is hoped that, through further applications of wear analysis, combined with metallurgical analysis and experimental archaeology, we can begin to address fundamental questions regarding the ways in which early Chinese weapons were used in conflict and the causes of the damage visible on their blades.

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Chapter 12
Standardised Manufacture of Iron Age Weaponry from Southern Scandinavia: Constructing and Provenancing the Havor Lance

Thomas Birch

Introduction and Archaeological Background

A substantial quantity and variety of weapons from the Late Roman/Early Germanic Iron Age have been found in "war booty sacrifices" known from across southern Scandinavia. The weapons themselves are thought to represent the spoils of war taken from defeated armies and votively deposited as an expression of victory (Jørgensen et al. 2003). The weapon deposits often contain hundreds, if not thousands, of items including weapons and other *militaria*. One of the best recorded weapon deposits, Illerup Ådal, has yielded over 6000 iron objects (out of roughly 15,000 military items) totalling some 500 kg of worked iron, including 748 lances, 661 spears, 150 swords, and 400 shields (Ilkjær 1990a, b, 2000, 2003, 2008). One of the weapon types found in four (out of six) of the main war booty sacrifices investigated in this chapter (i.e. Ejsbøl, Illerup, Nydam, Skedemosse) is the Havor lance, which dates narrowly to around 375–400 CE. A photograph and schematic illustration of the Havor lance can be seen in Fig. 12.1.

The Havor lance has traditionally been considered a standardised product (Ilkjær 1990a). Whilst this may appear so, this study aims to empirically investigate the degree of standardisation of the material(s) and manufacturing technology used to construct it. This chapter follows up from a previous paper that specifically examined the outward appearance of the Havor lance, focusing on traditional metric analysis as well as adopting an innovative approach using geometric morphometric (GMM) analysis (Birch and Martinón-Torres in press). The paper aimed to investigate the degree of similarity or difference between Havor lances in terms of metric dimensions and overall shape. Overall, 123 lances were examined from three of the main weapon deposits (Bemmann and Bemmann 1998a, b; Ilkjær 1990a, b; Ørsnes

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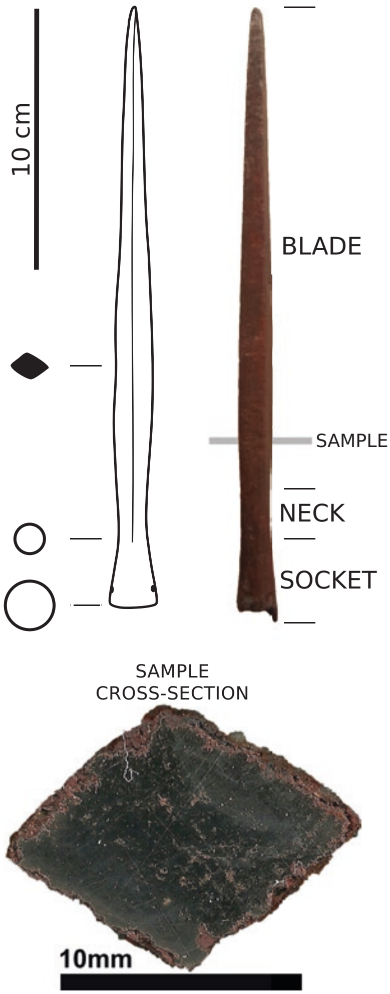

Fig. 12.1 Photograph (right) and schematic illustration (left) of the Havor lance (example E1338), highlighting the area sampled and the cross-section (bottom) obtained

1988), and the results confirmed the Havor lance type to be a highly standardised and symmetrical weapon product, with no significant statistical difference between sites.

This chapter takes the discussion further by examining the relationship between the outward appearance of the lance and its internal make-up, in terms of both material and manufacturing technology. The aim is to assess the degree of internal standardisation of the specimens examined. The results are important for shedding further light on the organisation of weapon manufacturing practices, as well as their material sources, during the Iron Age of southern Scandinavia.

Methods and Materials

Thirteen lances were available for study, twelve newly sampled lanceheads from Ejsbøl (Ørsnes 1988) and an existing sample from Illerup (known as CJN; see Ilkjær et al. 1994). A cross-section sample was obtained from each lancehead just above the neck (i.e. above the socket), as indicated in Fig. 12.1, using a jeweler's saw with a fine steel blade and slow cutting strokes (to reduce any heating of the iron). The samples were embedded in two-component epoxy resin (EpoxiCure) and prepared as standard metallographic blocks, ground (SiC papers 120–4000 grade), and polished (diamond lubricant) to a 0.25 μm finish. The samples were then carbon-coated for chemical analysis by SEM-EDS.

An ISIS ABT-55 scanning electron microscope equipped with an Oxford Link Analytical AN 10/55S energy dispersive spectrometer system (SEM-EDS), with a 15-kV accelerating voltage and ≈40% dead time, was used to determine the composition of entrapped slag inclusions (SI) and the metal phase. Precision and accuracy testing of the instrument was tested using the United States Geological Survey (USGS) basaltic glasses (BCR-2G, BHVO-2G, and BIR-1G). The results from accuracy and precision testing as well as more detail on the SEM-EDS setup can be found in Seetah et al. (2015). The performance of the instrument is extremely good with low quantification errors for both major oxides (around 3%) and minor oxides (around 12%). The instrument can accurately quantify down to around 0.2 wt%, with errors increasing to around 20% for element oxide concentrations at around 0.1 wt%.

The metallographic study was performed after SEM-EDS analyses, removing the carbon coating and etching the samples with nital (1% solution) as per well-established guidelines (cf. Petzo 1978). The macro- and microstructure was assessed using a metallographic optical microscope in plane-polarised light. Photo micrographs supplied in this chapter are provided with a scale bar (in micrometres), mode (BW, black and white; CLR, colour), and magnification (50×, 100×, 200×). All sample preparation and analysis were conducted at the University of Aberdeen, UK. The X-radiography of a single Havor lance and a separate spear were conducted previously by Haderslev Museum with scans provided for this investigation.

Metallographic Analysis

Having concluded that the thirteen lances sampled for this study were made using iron from different production sources (discussed after this section), this section complements the chemical analysis with a detailed metallographic study. The aim of the metallographic study is to establish if the lances were constructed using the same ironworking techniques, based on their integral features relating to manufacture. The results will make it possible to ascertain whether the same technological

Table 12.1 Metallographic summary of microstructural observations of the lance cross-sections

	Construction			Iron alloys observed						
Lance	Spiral form	Piled	Weld lines	Ferrite	Phosphoric	Low-carbon steel	Mid-carbon steel	High-carbon steel	Carburised	SI group (Table 12.3)
E1211	●		●	●	●					1
E1326	○	○	●	●	●	●				1
E1338	○	○	○	●	●	●				1
E1790	○			●	●					1
E11845	○		●	●	○	●				1
CJN	●		●	●	●	●			●	2
E1267	○	○		●		●				2
E1291	●			●	○		●	●	●	2
E1902	●		○	●	○	●				2
E2295	○	○	●	●	○	●	●		○	2
E737				●	●	●	●	●	●	3
E1986	○			●		●	●	●	○	3
E1273	●						●	●	●	4

Unfilled circles represent uncertainty

practices, or smithing tradition, were employed to manufacture the objects. This section provides a detailed synopsis of the macro- and microstructural features of the lances, namely, their construction method, iron type(s), carburisation, and heat treatment(s), a summary of which is provided in Table 12.1. Before looking at these features in detail, a note is made about their state of preservation and unfortunate effects brought about by conservation efforts.

Conservation Effects

Much of the ironwork from Ejsbøl has been conserved using Rosenberg's method, which stabilises the iron and prevents further corrosion. The technique was commonly applied to iron artefacts in Denmark until the 1990s, when it was replaced by electrolytic methods. Rosenberg's method involves first annealing the iron in a furnace at 800 °C for 30–60 min, subsequently boiling it in a solution of $NaCO_3$ and then soaking it in water for up to 2 weeks, after which the artefact is finally dried and stabilised using microcrystalline wax (cf. Buchwald 2005, 203). This method and derivatives thereof can 'clean' the metallographic record of earlier events, as the annealing process may alter original microstructures that bear valuable information concerning the cold-working, hardening, and structural features of an object (Buchwald 2005, 203).

The Havor lances from Ejsbøl were subject to the Rosenberg conservation process, which is supposed to have obliterated their original microstructures. Prolonged annealing at high temperatures, as per Rosenberg's method, should homogenise the microstructure. This level of alteration, however, was not observed in the Ejsbøl lances. Instead, it appears that many of the lances bear remnant microstructures and features from their original state, indicating that any conservation efforts have not altered the original microstructure entirely. The heterogeneity observed in the macro- and microstructural features of the Ejsbøl lances studied must relate to the original metallographic record. This is supported by the consideration that other scholars have successfully gleaned useful information from artefacts altered by Rosenberg's conservation method (Buchwald 2005, 181, 191, 306).

The Illerup lance (CJN) studied here represents the single specimen in the sample to have maintained its microstructural integrity as it was not subjected to the Rosenberg conservation method. It therefore provides a useful comparison for the Ejsbøl lances affected by Rosenberg's method. Two main effects were identified in the Ejsbøl lances resulting from conservation annealing. Firstly, recrystallisation has transformed some of the ferrite into uniform equiaxed grains; secondly, carbon structures have become spheroidised. Some caution is needed when examining recrystallised regions, as some may be related to original annealing events (as highlighted by CJN). The fully annealed microstructure resulting from conservation observed in the Ejsbøl lances is extremely useful when juxtaposed with other observed microstructures. This is because any other observed microstructures, not consistent with full annealing, have survived the conservation process, preserving the original metallographic record and thus exposing the original metalworking that took place.

Construction

The earlier study of the Illerup lance (CJN) by Joutijärvi concluded that the metal was first flattened, bent around, and then welded together, leaving an unclosed internal cavity (Ilkjær et al. 1994, 39). The same process can be observed in the majority of Ejsbøl lances studied here, which can be best described as the 'spiral-forming' technique, owing to its spiral appearance in cross-section. 'Piled' iron refers to the process of 'piling' iron together, which is the more conservative interpretation proposed here where a spiral form is indistinct or not defined.

The spiral-forming technique is illustrated in Fig. 12.2. The iron is first worked out and flattened, then it is bent round into a cylindrical shape with the two opposing edges brought together and forge-welded. What remains unclear is whether the technique was performed for the construction of the socket only, or employed along the whole length of the lancehead. How much of the lancehead was produced from flattened sheet?

Of the thirteen lances examined, five show clear evidence of a spiral construction whilst a further seven provide a strong indication for the same process. The illustrated cross-sections of the samples examined can be seen in Fig. 12.3. The sample cross-sections, all obtained from just above the neck of the lance (minimum socket thickness) with the exception of fragment E11845 (more likely located in the blade

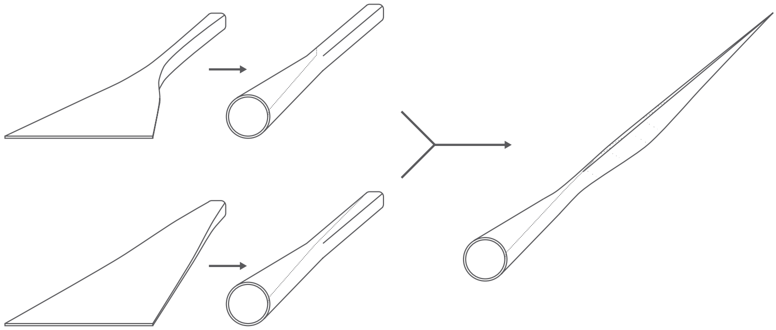

Fig. 12.2 Proposed spiral-forming construction method for the Havor lance, rolling a flattened iron sheet, which may have been used for the socket only (upper) or the whole lancehead (lower)

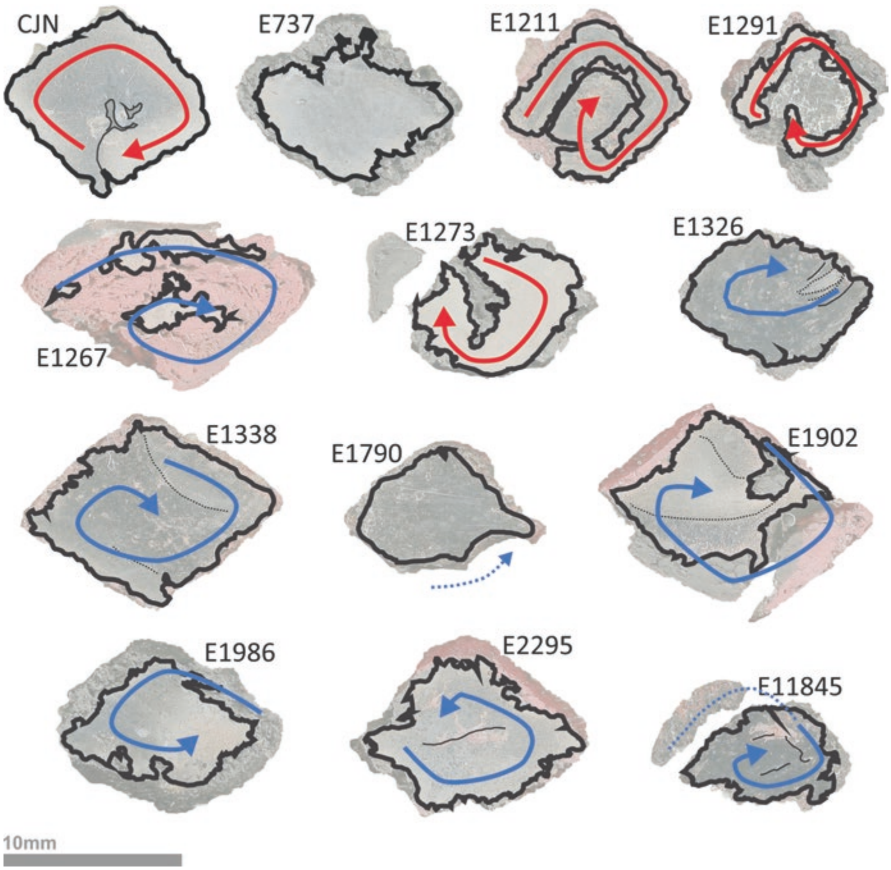

Fig. 12.3 Illustrated lance cross-sections highlighting the spiral-form construction clearly visible in some samples (red) and implied in others (blue). Uncorroded metal is outlined in black

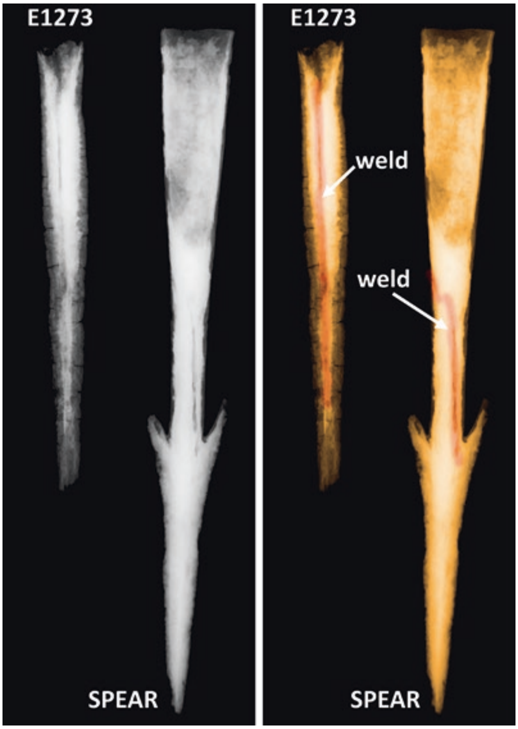

Fig. 12.4 Original (left) and artificially coloured (right) X-radiographs of Havor lance E1273 and a barbed spearhead, highlighting the weld seams visible (shown in red in the right-hand adjusted X-radiograph)

midriff), indicate that the flattened sheet forms not only the socket but also part of the lower lancehead (at least). The limitation of single samples, however, lies in extrapolating the results to an entire object. Further evidence is needed to evaluate whether the iron sheet was used to form just the socket region or the entire lancehead.

X-radiographs were available for the study of two specimens, the first of Havor lance E1273 (in this study) and the second of a long-tanged barbed spearhead, both from Ejsbøl. The original X-radiographs are shown in Fig. 12.4, complemented by identical false-coloured images highlighting the weld seams discussed. In the barbed spear, the X-radiograph reveals that only the socket was produced from flattened sheet, reaching very slightly into the head, where the weld line terminates. The Havor lance (E1273), however, shows a weld line that extends beyond the socket region and far into the lance point, indicating that most (if not all) of the head was produced from a flattened sheet.

Four of the lance cross-sections (E737, E1326, E1338, and E1790) show solid metallic bodies macroscopically (Fig. 12.3). Whilst it could be assumed that these samples were located at the threshold between the spiral-formed socket and the solid head, closer inspection reveals this not to be the case in at least two of the ‘solid’ samples. The heterogeneity observed in the macrostructure and microstructure of E1326 and E1338 provide convincing evidence that these samples were also

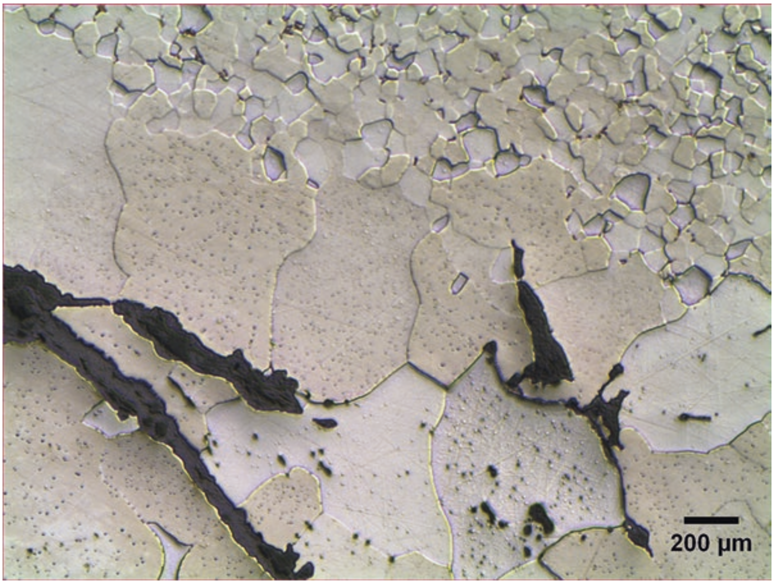

Fig. 12.5 Photo micrograph of a weld line in lance CJN, showing large ferrite grains along the weld seam neighbouring the recrystallised ferrite body (CLR 50×)

spiral-formed, showing a strong similarity to CJN except for the lack of an internal cavity. Although corrosion and cavities may provide indirect evidence for weld line interfaces (CJN, E1211, E1291, E1273, E1902, E1986, E11845), clear weld lines can be observed in the microstructure of seven lances (Table 12.1). Examples of weld lines can be seen in Figs. 12.5 and 12.6 and a piled structure in Fig. 12.7. The weld lines often show curvature, respecting the lance surface and/or spiral form, thus further supporting the proposed construction method (E1326, E1338, E1902, E2295, E11845).

The observations made for the lance cross-sections and X-radiographs show that a spiral-form construction method was used to manufacture the Havor lancehead. The rolled flattened sheet formed at least the socket, if not the point itself, as discussed above (especially in the case of E1273).

Ferritic Iron, Phosphoric Iron, and Steel

Five types of iron were identified in the samples studied: pure ferritic iron, phosphoric iron, low- (0.05–0.3% C), mid- (0.3–0.6% C), and high-carbon (0.6–1.0% C) steel. The iron types/alloys observed in each sample are labelled in Table 12.1. Pure ferritic iron is the main component for nine lances (see Fig. 12.8 for an example of recrystallised ferrite in CJN), whilst the remaining four are made from either low-carbon steel (E737) or mid- to high-carbon steel (E1273, E1291, and E1986).

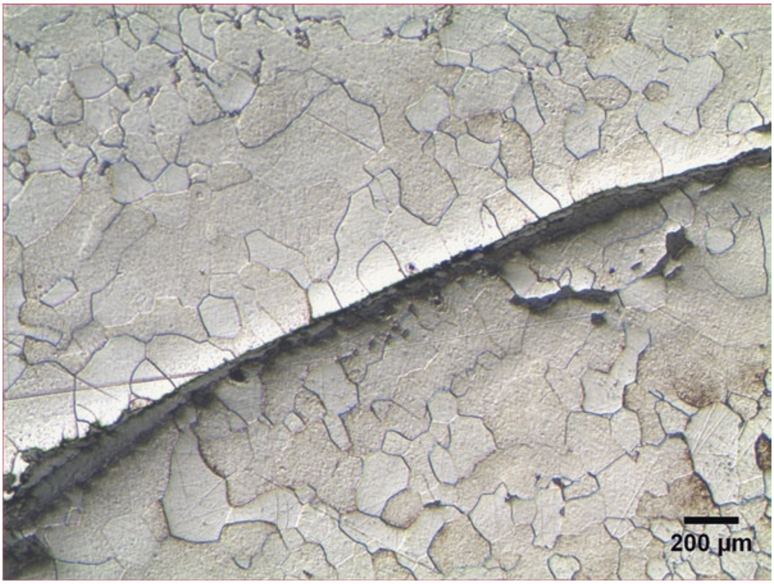

Fig. 12.6 Photo micrograph of a weld line in lance E2295, showing mostly recrystallised ferrite and some agglomerate grains along the seam (CLR 50×)

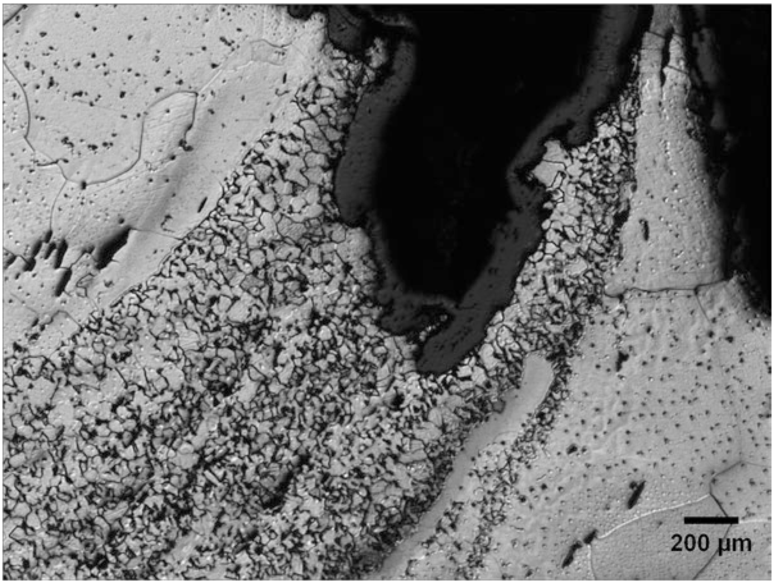

Fig. 12.7 Photo micrograph of three lamellae in a piled structure in lance E1326; the central band is fine grained, situated between larger phosphoric iron grains (BW 50×)

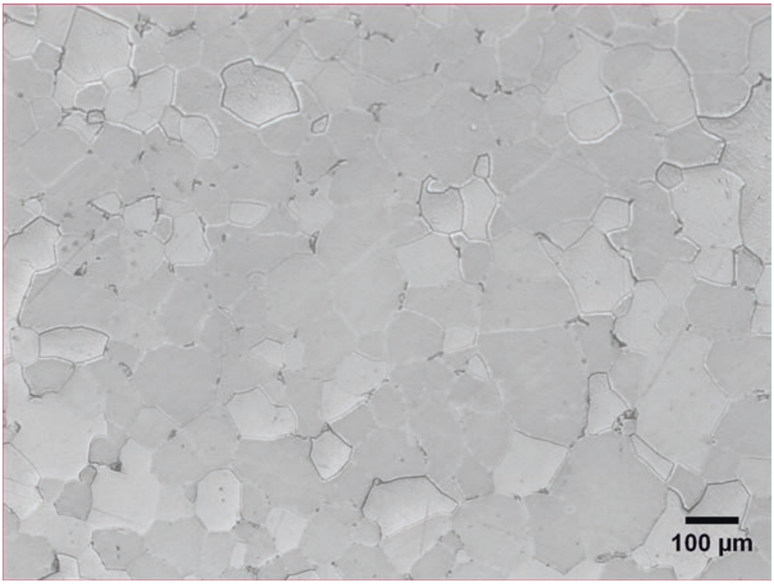

Fig. 12.8 Photo micrograph showing the predominating microstructure of recrystallised ferrite in lance CJN (CLR 100×)

A clear distinction can be made between lances containing phosphoric iron and those made from mid- to high-carbon steel. Those made from high-carbon steel (E1273, E1291, and E1986) contain no phosphorus, and inversely those made from phosphoric iron contain little or no carbon. A possible explanation for this is that phosphorus can inhibit carbon uptake or diffusion, preventing the formation of steel.

At least six of the lances contain appreciable amounts of phosphorus as shown by chemical analysis of the iron (Table 12.2). The presence of phosphoric iron was also confirmed in the microstructures of other lances, visible as 'ghosting' (Sahoo and Balasubramaniam 2007). After etching, ghost structures are visible in iron-containing phosphorus, appearing as bright or dark ghosts that do not respect the grain boundaries. The darker ghosts are phosphorus-poor, whilst the bright ghosts are phosphorus-rich. Examples of phosphoric iron microstructures can be seen in Figs. 12.9, 12.10, and 12.11.

Upon combining the evidence for phosphoric iron from chemical analysis and 'ghost structures' visible in the microstructure, it can be proposed that a possible ten of the total thirteen lances were produced using phosphoric iron. The prevalence of phosphoric iron would suggest that it was selected for the manufacture of most Havor lances due to its beneficial properties. Not only is iron hardened by phosphorus, but phosphoric iron is generally free of inclusions and flaws, produces easy welds, and is soft to work with, making it an ideal blacksmithing material in antiquity (Buchwald 2005, 173–178).

Table 12.2 Normalised SEM-EDS results of the metal composition of the lances, shown in element wt% (blank spaces, i.e. for P, are beneath detection limits)

	Metal (wt%)		
Lance	Fe	P	SI group (Table 12.3)
E1211	99.2	0.8	1
E1326	99.4	0.6	1
E1338	99.6	0.4	1
E1790	99.3	0.7	1
E11845	99.9		1
E1267	100.0		2
E1291	99.9		2
E1902	99.9		2
E2295	100.0		2
E737	99.9	0.1	3
E1986	100.0		3
E1273	99.9		4

Five points analysed per lance (E1267 $n = 13$); CJN not analysed

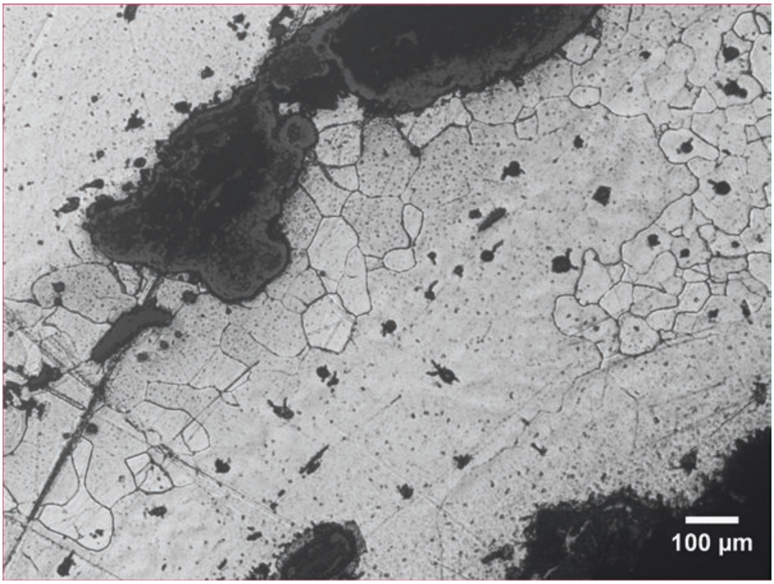

Fig. 12.9 Photo micrograph showing ghost structures (agglomerate grains) of phosphorus in ferrite in lance E1211 (BW 50×)

Many of the lances examined contain low-carbon steel parts or surfaces, which appear to be secondary and imbued during the forging process (rather than being primary to the metal stock). Only three of the lances are made from steel proper (E1273, E1291, and E1986), containing no phosphorus. The fact that three of the Havor lances were made using steel and not phosphoric iron begs the question as to

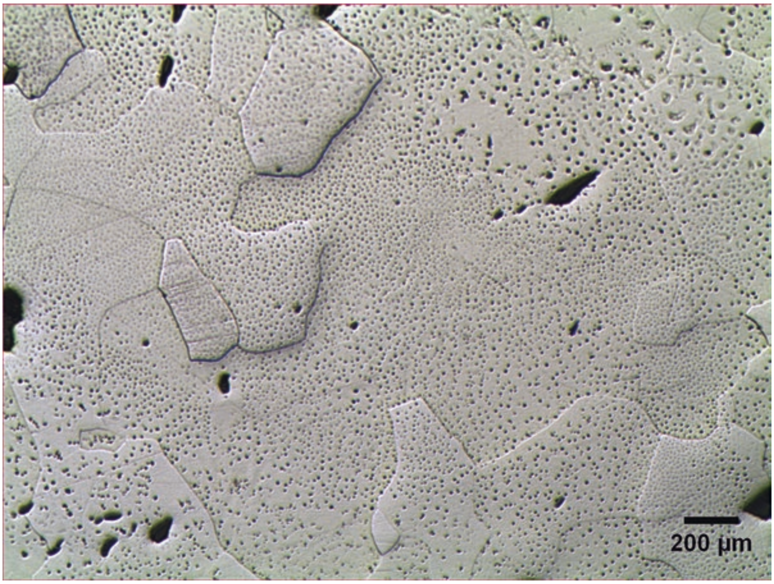

Fig. 12.10 Photo micrograph of phosphoric iron (large agglomerate grains) showing etch pitting in lance E1326 (CLR 50×)

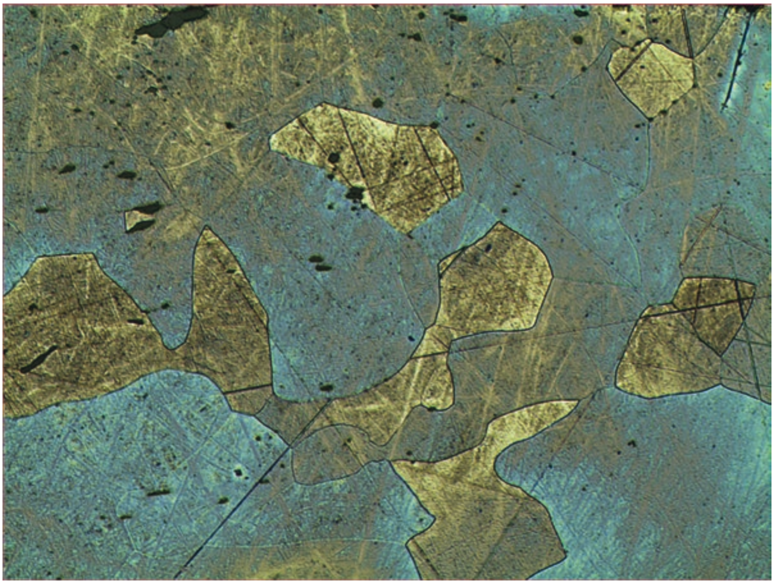

Fig. 12.11 Photo micrograph of lance E1790 showing variable reaction to the etchant, highlighting phosphoric regions in blue (CLR 50×)

Table 12.3 Weighted average composition of lance SI per area analysed (SEM-EDS results) shown in oxide wt% (CJN average calculated from results published by Arne Joutijärvi (in Ilkjær et al. 1994, 39)

			Element oxide (wt%)											
Lance	Area (μm^2)	Group	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	TiO_2	MnO	FeO	BaO
E1211	55,131	1	0.3	0.2	1.7	17.0	16.5	0.3	0.6	1.8	0.1	0.8	60.5	1.0
E1326	56,442	1	bd	0.1	2.6	20.1	3.3	bd	0.2	0.5	bd	0.1	72.9	bd
E1338	254,695	1	0.5	0.3	3.2	21.8	6.3	0.2	0.6	1.0	0.1	3.5	62.1	0.4
E1790	167,205	1	0.2	0.3	2.2	20.6	9.5	0.1	0.8	2.3	0.2	0.7	63.2	0.1
E11845	6857	1	0.9	0.3	4.7	18.6	4.0	0.2	1.3	1.0	0.1	0.9	67.9	0.1
CJN	–	2	0.9	0.8	5.9	26.0	0.4	–	1.1	2.7	0.2	0.3	61.8	–
E1267	11,242	2	1.0	1.3	6.3	18.9	0.5	0.1	0.5	2.3	0.2	0.2	68.8	bd
E1291	1825	2	0.7	0.3	5.6	53.0	0.5	0.3	3.1	1.8	0.2	1.3	32.9	0.3
E1902	4263	2	1.0	1.5	8.6	33.4	1.8	0.3	2.5	2.6	0.5	2.0	45.5	0.3
E2295	9478	2	0.9	1.6	6.7	25.8	0.2	0.1	1.0	1.8	0.2	0.7	60.9	0.1
E737	31,081	3	0.2	0.3	3.0	26.5	2.3	0.1	0.7	1.8	0.1	15.4	48.8	0.9
E1986	34,144	3	0.8	1.9	8.0	32.7	0.6	0.1	2.9	5.9	0.4	17.9	28.5	0.2
E1273	4293	4	2.7	4.8	15.1	58.6	0.1	bd	3.9	11.3	0.7	0.6	2.0	0.2

Dash '–' represents not analysed and 'bd' below detection limits. Group 1, high phosphorus; Group 2, low phosphorus; Group 3, high MnO and BaO; Group 4, high Al_2O_3 and CaO

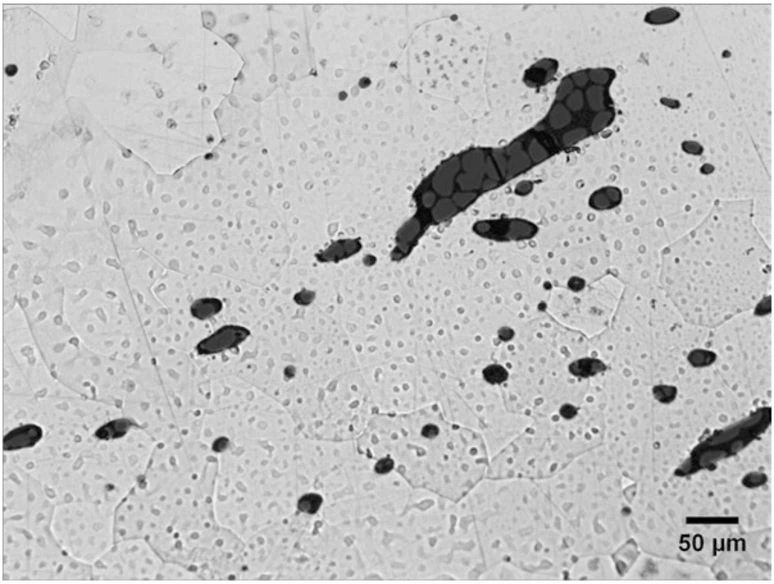

Fig. 12.12 Photo micrograph of lance E11845 showing spheroidised carbides in the microstructure (BW 200×)

why they were not all made from same type of iron. One could speculate that phosphoric iron (used for the majority of the lances) was the smith's metal of choice, and steel was a secondary alternative as it could also achieve the desired hardness.

Carburisation

The identification, location, and distribution of iron-carbon microstructures can be extremely informative, as they provide valuable insights into ancient smithing practices and hardening treatments. Some caution is urged here, however, due to the effects of conservation, which often spheroidises carbides, as is the case with Rosenberg's conservation method (see Fig. 12.12 for an example), although it does not necessarily homogenise their distribution. When iron is heated just below 723 °C for prolonged periods, the cementite (iron-carbon structures) in the iron begins to coalesce and become more rounded (spheroidised) cementite (Scott 1990, 12). It is also important to distinguish between primary carburisation, which is original carburisation from the raw iron bloom, and secondary carburisation, occurring when carbon is introduced into the iron during smithing processes. The Illerup lance (CJN) has a soft iron core with a low-carbon steel surface, providing clear evidence that this lance underwent secondary carburisation in a process known as 'case hardening', in which the iron is carburised and thus hardened from the outer surface (hence 'case') inwards.

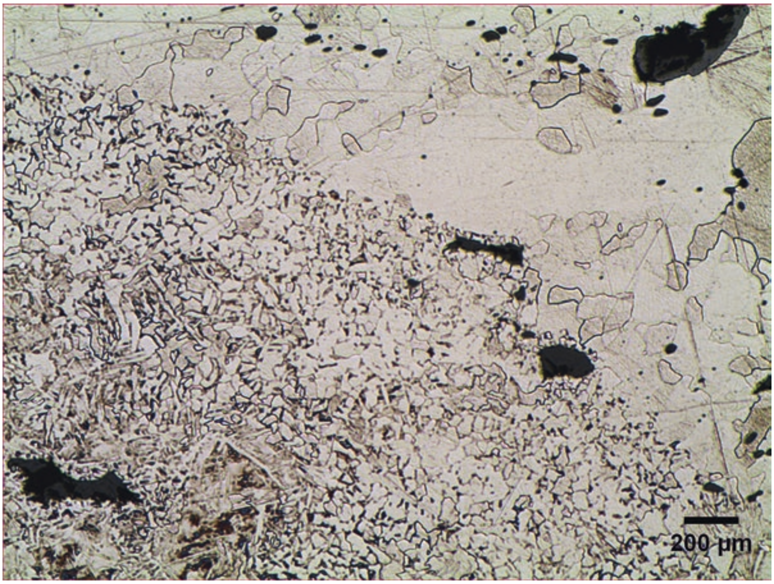

Fig. 12.13 Photo micrograph of lance E737 showing evidence of case hardening, with a fine-grained ferrite and interstitial pearlite surface casing (some visible Widmanstätten structures) surrounding a ferritic core (CLR 50×)

Of the five Ejsbøl lances showing evidence of case hardening, three are similar in character to CJN (Table 12.1). An example of case hardening can be seen in Fig. 12.13. Lance E737 is made from a low-carbon steel core with an inconsistent high-carbon steel encasing, indicating that this lance too was case-hardened. Similarly, lance E1291 has a soft iron core with a mid- to high-carbon steel encasing, showing that it was also carburised at the surface. It is not entirely clear whether carburisation was secondary in E2295, made from ferritic iron with low- to mid-carbon steel parts, as they are not confined to the surface and may thus reflect a heterogeneous distribution from the original stock (primary carburisation), or possible Rosenberg effects.

Less certain is the case of two further lances that also show signs of carburisation. Lance E1902 contains bands of low-carbon steel (fine grained ferrite with interstitial pearlite), while large carbides are prevalent in E11845 at the lance surface.

Finally, two lances are made from steel proper, which is observed throughout the microstructure (no ferritic core). Examples of low-carbon steel structures are shown in Fig. 12.14 and mid-carbon steel in Fig. 12.15. Lance E1273 is made from high-carbon steel and E1986 from mid- to high-carbon steel. This could have been achieved by prolonged carburisation in the reducing part of the hearth, allowing deep penetration, though it is more likely that the metal stock used was steel to begin with (see below).

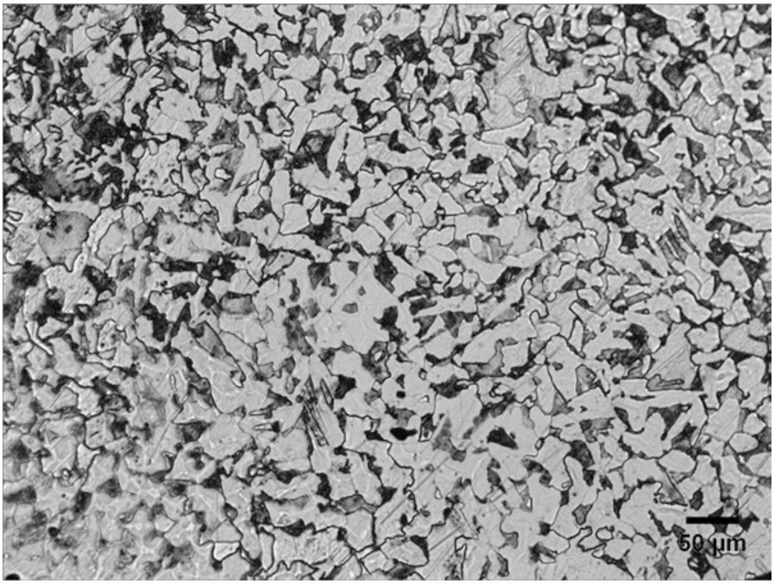

Fig. 12.14 Photo micrograph of low-carbon steel in lance E1902, showing fine-grained ferrite with interstitial pearlite (BW 200×)

Fig. 12.15 Photo micrograph of mid-carbon steel in lance E1291, showing fine-grained ferrite and pearlite (CLR 200×)

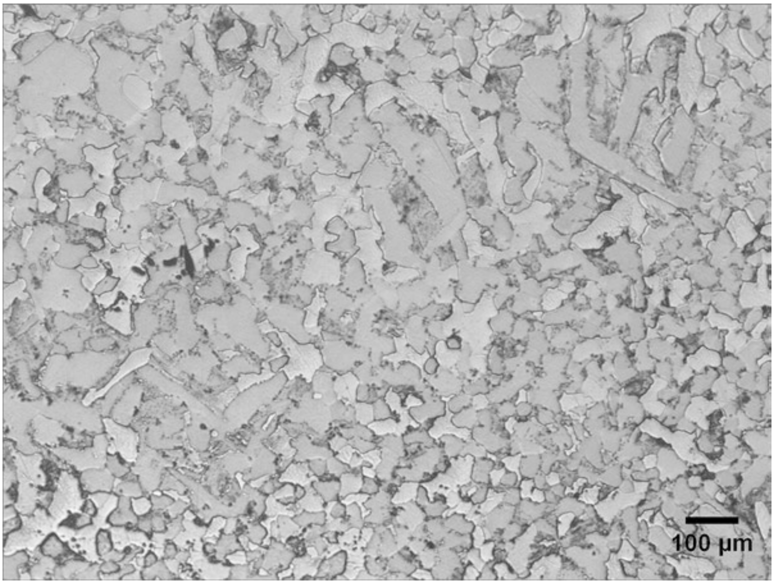

Fig. 12.16 Photo micrograph of remnant Widmanstätten structures in lance CJN, mostly lost due to later annealing (BW 100×)

Heat Treatment

Most of the ferrite observed in the Ejsbøl lances has recrystallised, and the carbon has spheroidised into carbides, both as a result of conservation annealing. Unfortunately, this appears to have removed previous traces of any heat treatment except for some remnant microstructures in the Ejsbøl lances, which are worth discussing.

This short section is devoted mainly to lance CJN, whose microstructure remains unaffected by conservation efforts. The proposed heat treatment steps associated with the ironworking for lance CJN, as interpreted by the microstructure, can be listed in order as:

1. The lance was heated long enough at or above the austenite range to allow for the growth of large ferrite grains, visible in the core of CJN's cross-section. This is probably associated with the main forge welding step of constructing the lance-head (forming the spiral), where high temperatures (around or above 900 °C) are attained during the welding process.
2. The lance was carburised through case hardening. This explains the carbon gradient from the outer surface (carburised) of CJN to the ferritic iron core (carbon-free). The lance would have been placed in the reducing part of the hearth (submerged in charcoal), forcing carbon uptake at the exposed outer surface. The depth of penetration is no more than 4 mm at its maximum, forming a mid-carbon steel surface of around 0.4% carbon. The temperature was sufficiently

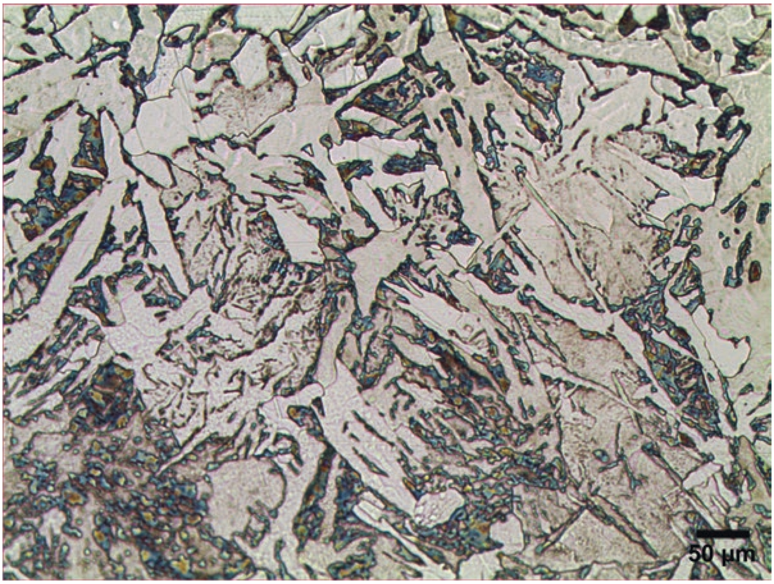

Fig. 12.17 Photo micrograph of Widmanstätten structures in lance E1986 resulting from air-cooling (CLR 200×)

high to produce Widmanstätten ferrite. Widmanstätten ferrite forms in iron-carbon alloys that have been heated in the austenite range (around 900 °C) long enough to allow for the growth of austenite grains, or by heating in the austenite range followed by air-cooling (Scott 1990, 12–14). Examples of Widmanstätten structures are shown in Figs. 12.16 and 12.17. Most of the Widmanstätten ferrite observed has been masked by the following step, leaving only elongated grains remnant of pro-eutectoid Widmanstätten ferrite.

3. The lance was then heated again, producing fine-grained ferrite at the surface, which surrounds the core of larger ferrite grains mentioned previously. This second heating appears to have been conducted at just below the spheroidising temperature (723 °C) as the interstitial pearlite visible in the low- to mid-carbon steel casing appears slightly spheroidised. This temperature would have made the iron appear 'dark cherry red'. This second heating allowed for grain refinement, transforming large ferrite grains and Widmanstätten ferrite into the equiaxed fine-grained ferrite and pearlite visible in CJN. This process of grain refinement is known as 'normalising' (Scott 1990, 12) and leads to a more homogeneous fine-grained structure. Whilst the normalising procedure has promoted grain refinement at the surface of the lance, it did not completely overwrite the former Widmanstätten structures, whose remnant forms can still be observed. The fact that the Widmanstätten ferrite was not entirely removed has helped to interpret the sequential order of heat treatments described here.

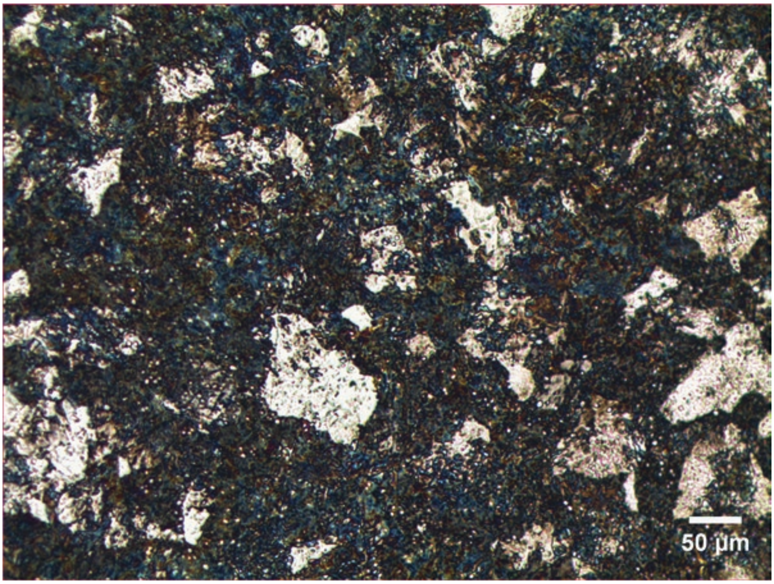

Fig. 12.18 Photo micrograph of coarse pearlite in lance E1273, indicative of slow furnace cooling (CLR 200×)

4. Finally, the lance was allowed to air-cool. The microstructures observed are consistent with air-cooling and no other microstructures indicative of quenching (i.e. martensite) can be observed.

Remnant structures visible in three of the Ejsbøl lances show similar features to CJN. Eutectoid structures with coarse pearlite can be seen in E1273, E1291, and E1986. The coarse pearlite has irresolvable lamellae of ferrite and cementite, which only form after prolonged slow cooling, often observed in furnace-cooled iron. These structures can be seen towards the centre of the lance sections, particularly in the case of E1291 (in the centre). Coarse pearlite structures are shown in Figs. 12.18 and 12.19. Annealing by the Rosenberg conservation method for 30–60 min is too short for such a microstructure to form, making these carbon-iron structures primary to the original microstructure of the lance. Coarse pearlite is commonly associated with bloomery iron, indicating that the high-carbon steel is primary to the original metal stock. This inference is important, for it means that these three lances (E1273, E1291, E1986) were not intentionally carburised as was previously suggested (whereas CJN was deliberately carburised). Lances E1273, E1291, and E1986 were made using steel that was intentionally selected to produce them.

Lance E1986 displays a variety of microstructures relating to its ancient and recent history of heat treatments. The recrystallised ferrite is largely due to the Rosenberg conservation method. Within the recrystallised regions, remnant Widmanstätten ferrite and lath martensite can be seen. Whilst Widmanstätten ferrite is indicative of air-cooling, martensite is characteristic of rapid cooling, which can

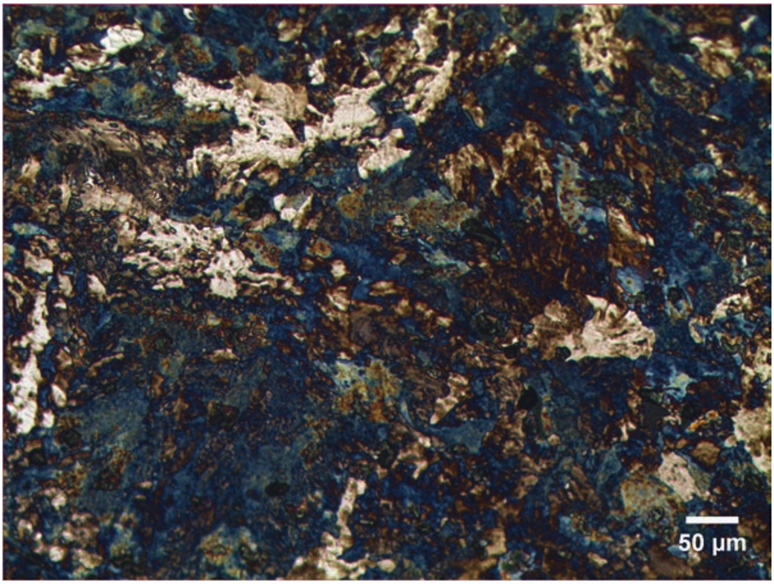

Fig. 12.19 Photo micrograph of coarse pearlite in lance E1986, indicative of slow furnace cooling (CLR 200×)

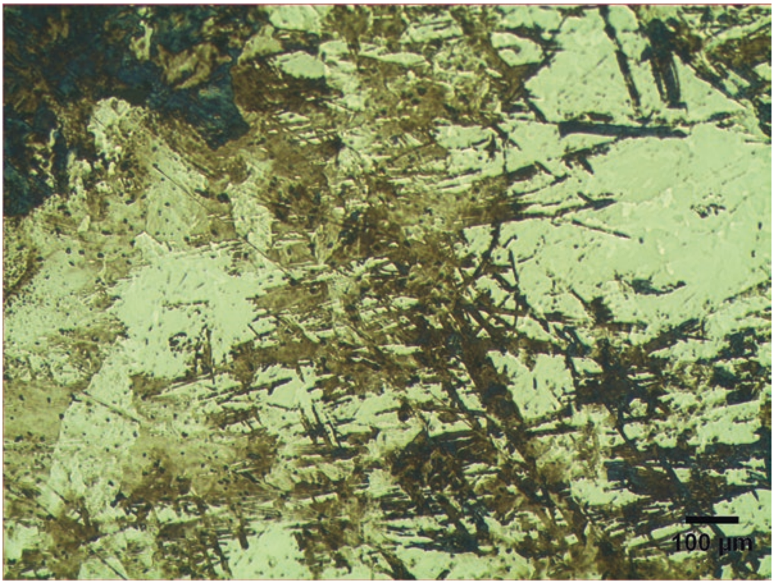

Fig. 12.20 Photo micrograph of martensite structures in lance E1986, resulting from rapid cooling, most likely quenching (CLR 100×)

only be achieved through quenching. It is unclear whether the martensite survives from the original microstructure or potentially from being quenched (in the salt bath) during Rosenberg's conservation method. Martensite is not observed in other lances >0.3% C, which would be expected if they had also been subject to the same salt bath treatment, making it more likely that the martensite observed in E1986 relates to the original ironworking. Martensite can be seen in Fig. 12.20. The lath martensite and areas of 'tempered' martensite, therefore, indicate that the iron was further heat-treated after quenching. This is consistent with Rosenberg's annealing. Using the evidence gathered thus far to formulate a reasonable working hypothesis, one could suggest that E1986 was air-cooled upon completion of forging, before being heated and quenched rapidly in some liquid (presumably water). Subsequent conservation efforts recrystallised the ferrite, though not long enough to homogenise the microstructure fully, leaving remnant microstructures such as tempered martensite.

It is difficult to arrive at a universal Havor lance heat treatment process from four Ejsbøl lances as well as CJN, and no attempt will be made here to interpret the results further. The original microstructures from CJN as well as the remnant microstructures from the Ejsbøl lances examined have provided interesting insights. Both lances CJN and E1986 were air-cooled during/after forging, while E1986 was quenched and possibly further annealed. The coarse pearlite (E1273, E1292, E1986) discussed above does not relate to any final heat treatments and only confirms these three lances to have been produced from selected steel.

Slag Inclusion Analysis

During the Late Roman/Early Germanic Iron Age, iron was produced by the 'direct' method, also known as bloomery iron smelting. This solid-state reduction process creates a by-product, slag, which is normally found in great quantities at iron production sites. Slag inclusions (SI), however, often remain entrapped in the iron produced, allowing for iron objects to be related to their production sites. By comparing the chemical composition of entrapped SI with smelting slag from iron production sites, it is possible to build provenance hypotheses, exclude possible sources, or even directly confirm an iron production source.

New and improved analytical and statistical methods have been developed over the last decade for iron provenancing by the SI method (Birch et al. 2014; Birch and Martinón-Torres 2013; Blakelock et al. 2009; Charlton et al. 2012; Charlton 2015; Coustures et al. 2003; Desaulty et al. 2009a, b; Dillman and L'Héritier 2007; Leroy et al. 2012). Whilst it is not always possible to link an iron object to a specific production source, the SI method has proved extremely useful for comparing objects with one another as well as identifying compositional groups (i.e. iron objects from the same smelting system).

One of the main issues with iron provenancing is deciding which potential sources one has to reference for comparison with the iron objects and their entrapped

SI. For the Roman Iron Age in Denmark, it has been suggested that iron, by the large part, was consumed locally near to where it was being extracted (Lyngstrøm 2008, 231). However, the distance to which iron travelled should not be underestimated. Long-distance iron bar trade is well-attested archaeologically during the Iron Age (Buchwald 2005, 102–105). One example of particular relevance from the Roman Iron Age is the site of Snorup (Jutland), where locally produced phosphoric iron bars were found along with over 200 steel bars that likely originated from the Oppland region of southern Norway (Høst-Madsen and Buchwald 1999, 64).

The context of the weapons under investigation indicates that the immediate and neighbouring regions should be investigated as potential sources of iron. This mode of investigation has previously been conducted on other iron artefacts from Iron Age Denmark, for which provenance hypotheses have been formulated using SI analysis compared to Danish iron production sites as well as other iron production areas in Scandinavia (Buchwald and Wivel 1998; Høst-Madsen and Buchwald 1999). This work has recently been reviewed and retested using multivariate statistical approaches, which demonstrate the real potential for provenancing iron more broadly by re-analysing published chemical data of iron production slags and SI using new statistical techniques (Charlton et al. 2012). Fortunately, the composition of iron production slags from Jutland are well characterised and can be distinguished from other production areas in Scandinavia.

It is important to consider, however, that iron bars may have been "traded over long distances before they reached their final destination" (Buchwald 2005, 102), which is why it is necessary to be open-minded about potential sources of iron in the widest possible terms. Therefore, the wider Northwest European region should also be considered when making provenance hypotheses, including Britain (Paynter 2006, Table 1), Germany (Ganzelewski 2000, Table 4; Heimann et al. 2001, Tables 3, 4; Spazier 2003, Table 7.1), the Netherlands (Joosten 2004, Tables 14–16), and the wider Baltic area including Poland (Buchwald 2005) and Lithuania (Navasaitis et al. 2003, Tables 16.3, 16.4; Navasaitis and Selskienė 2007, Table 4).

The analysis conducted here first proceeds by investigating possible lance groups as characterised by the chemical composition of their SI. This is followed by a comparison of the SI with iron production sources from Scandinavia in order to construct provenance hypotheses for the origins of the iron used to manufacture the Havor lance.

Identifying Compositional Groups

Lance SI compositions are characterised by several noteworthy differences that distinguish four broad groups. The weighted average SI composition (cf: Dillman and L'Héritier 2007, 1816) for each lance is given in Table 12.3. Before outlining these groups, it is worth briefly describing the likely origins of the different element oxide components in the SI compositions being discussed. During iron smelting, the three oxides heavily influenced by clay furnace lining contributions are TiO_2, Al_2O_3, and

SiO_2, whilst the alkali earth compounds (K_2O, MgO, CaO) are enriched by fuel ash contributions. P_2O_5, MnO, and BaO, on the other hand, most likely originate from the iron ore being smelted.

The first and most notable quantitative difference is the range of MnO and BaO values. Lances E737 (15.4 wt%) and E1986 (17.9 wt%) have notably high MnO concentrations, followed by E1338 (3.5 wt%), whilst the remainder are generally around or below 1 wt%. Similarly, lances E737 (0.9 wt%) and E1338 (0.4 wt%) show some of the highest BaO values in the sample, with E1211 (1.0 wt%) having the highest concentration. As MnO and BaO derive largely from iron ore contributions to SI composition, these immediately apparent differences preclude a single-source production hypothesis. The results almost certainly indicate a high-Mn ore used for at least two lances (E737, E1986), which may also correspond with BaO. It is interesting that these two lances, labelled here as 'Group 3' (high MnO and BaO), correspond directly with the high-carbon steel microstructure discussed above.

Another characteristic trait worth noting is phosphorus content. Five lances (E1211, E1326, E1338, E1790, and E11845) show elevated P_2O_5 concentrations in their SI composition ranging from 3.5 wt% to around 16.5 wt%. These five lances, labelled here as 'Group 1' (high phosphorus), all correspond directly with the phosphoric iron microstructures observed in the metallographic study. With the exception of two intermediate values (E737, E1902) with around 2 wt% P_2O_5, the remainder of the lances are phosphorus-poor and contain around/less than 0.5 wt%.

The other main group consists of the five phosphorus-poor lances (CJN, E1267, E1291, E1902, E2295), labelled here as 'Group 2', which appear to be relatively consistent in their alumina (6–9 wt%) content, as well as lime (CaO) content of around 2–3 wt%. This group is generally more enriched in MgO, K_2O, and TiO_2 when compared to the phosphorus-rich (Group 1) lances. It is also worth noting that the phosphorus-poor Group 2 lances, whilst having phosphoric iron microstructures, can be distinguished from Group 1 lances by their microstructure. Group 1 lances contain low-carbon alloy microstructures only, whilst Group 2 lances show evidence for carburisation and the presence of mid- to high-carbon alloy microstructures.

Lance E1273 has a unique SI composition that sets it apart from all the other lances analysed: it is the most enriched in MgO (4.8 wt%), K_2O (3.9 wt%), and CaO (11.3 wt%) and is also characterised by a high alumina (aluminium oxide) content (15.1 wt%), most likely from furnace lining contributions.

Overall, the chemical composition of lance SI strongly suggests that these objects were produced using different stock iron originating from different smelting systems. In other words, the iron used in their making does not derive from the same iron production site.

Preliminary Provenance Hypotheses

In order to provenance the iron used for lance manufacture, Buchwald's (2005; Buchwald and Wivel 1998; Høst-Madsen and Buchwald 1999) bivariate approach is used here, which compares K_2O/MgO and SiO_2/Al_2O_3 ratios of the weighted

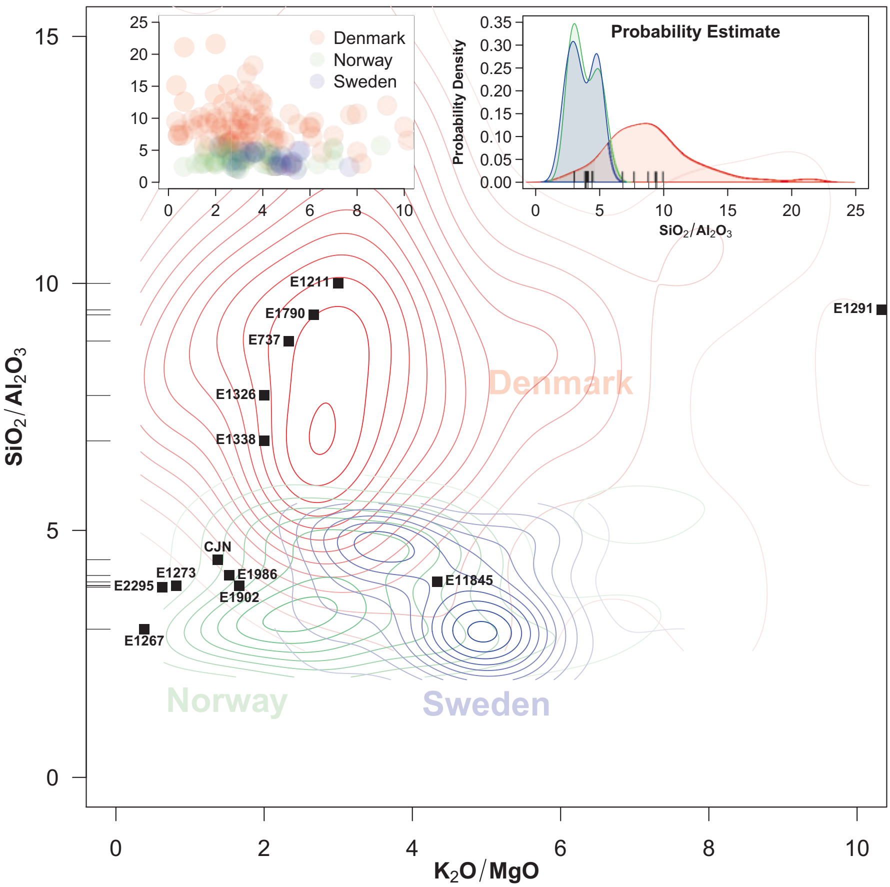

Fig. 12.21 Bivariate scatterplot of SiO_2/Al_2O_3 against K_2O/MgO with weighted average lance SI plotted as points and iron production sources represented as a contour plot (raw data points shown in the embedded plot, top left). Probability density plot of iron production regions (embedded, top right) with rug marks along the x axis (SiO_2/Al_2O_3) corresponding with lances; the same rug marks shown in the main plot along the y axis

average lance SI compositions against iron production slags, as shown in Fig. 12.21. The iron production slags used as reference data to produce Figs. 12.21 and 12.22 are published in Buchwald (2005, Tables 6.2, 6.4, 7.1, 7.6, 8.1, 8.2, 8.4, 9.1, 9.3, 9.4, 9.5, 10.1, 10.5, 10.7, 10.8, 12.8, 12.11). As Fig. 12.21 shows, iron production sites from Jutland (and wider Denmark) can be relatively well-distinguished from iron production sites in Norway and Sweden.

Eleven of the thirteen lances plot in two different areas in the bivariate scatterplot, corresponding to two different regional provenances (Fig. 12.21). Five lances (E737, E1211, E1326, E1338, E1790) plot in the Danish region along the highest probability of the SiO_2/Al_2O_3 density curve (Fig. 12.21), with four corresponding nicely with the phosphorus-rich Group 1 previously identified. Phosphoric iron,

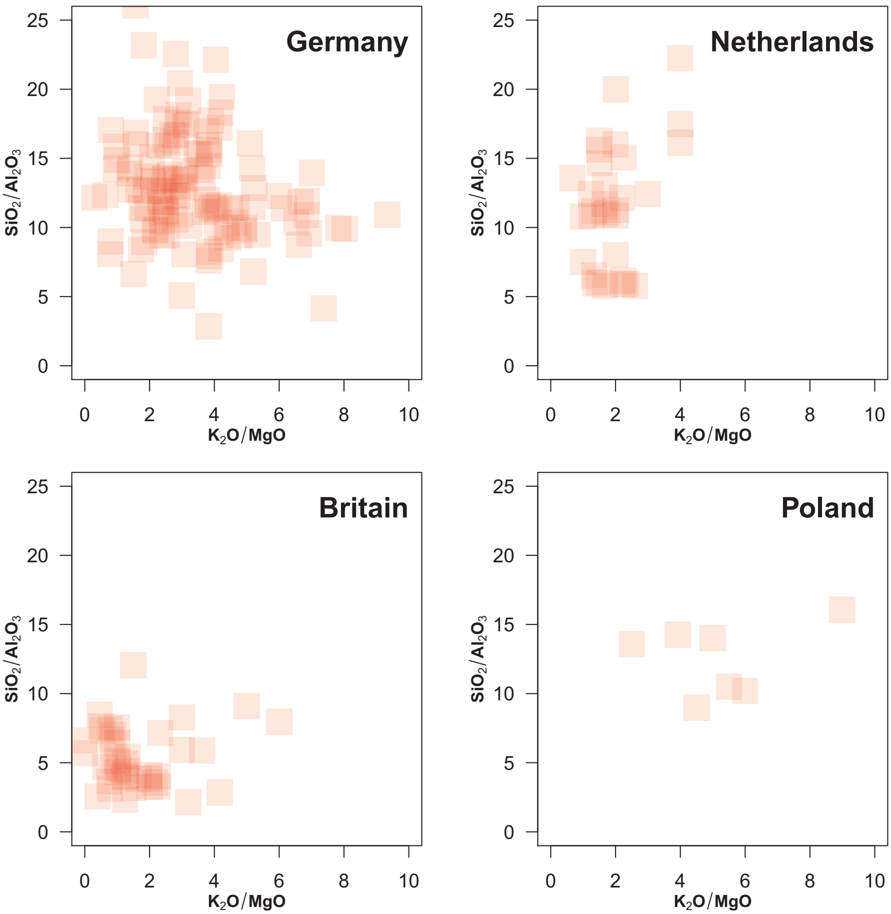

Fig. 12.22 Bivariate scatterplot of SiO_2/Al_2O_3 against K_2O/MgO for other iron production sites in Northern Europe, highlighting overlaps with Denmark, Norway, and Sweden

such as that used for this group of lances, is known to have been produced in Denmark during the Roman Iron Age (Høst-Madsen and Buchwald 1999).

Six lances (CJN, E1273, E1267, E1902, E1986, E2295) plot in the Norwegian region of the K_2O/MgO ratio. However, their position in the probability density curve for SiO_2/Al_2O_3 can be characterised as the Scandinavian Peninsula more generally due to the overlap of Norway and Sweden. These lances correspond well with the Group 2 (phosphorus-poor) and Group 3 (high MnO and BaO) lances, which represent mid- to high-carbon steel alloys. Steel, such as that used for this group of lances, was produced in southern Norway during the Roman Iron Age (Høst-Madsen and Buchwald 1999).

Lance E1291 can tentatively be ascribed to Denmark based on its close proximity to Danish iron production slags. Lance E11845 could possibly be ascribed to the

Scandinavian Peninsula based on its position in the SiO_2/Al_2O_3 probability density curve. However, its composition is more comparable to the Group 1 (phosphorus-rich) lances, and its position in the scatterplot is also in close proximity with iron production slags from Denmark.

When additional areas outside Scandinavia are incorporated into the analysis, the interpretation is further complicated due to overlapping data. The published data for Britain, Germany, the Netherlands, and Poland (previously referenced) are shown in Fig. 12.22. As is clear from this figure, the production slags from Germany, the Netherlands, and Poland are indistinct from Denmark, as Britain is from Norway, making it impossible to exclude these areas as potential sources, based on the analysis of the major and minor oxide components alone. Future work using trace element composition will help to refine subregional provenance hypotheses. The major and minor oxide components presented here are sufficient for making the initial argument that the iron used to produce these lances come from multiple sources.

Conclusion

This study has provided new insights into the organisation and practices of weapon manufacture in Iron Age southern Scandinavia. Although the study is limited to only thirteen lances (twelve from the same site), the figure represents nearly 10% of the total Havor lances known to date, and the results provide invaluable information about the material available to weapon smiths, as well as their smithing practices.

The metallographic and slag inclusion (SI) analysis has broadly identified four different groups, corresponding partly with the types of iron being used. The apparent inverse correlation between phosphoric iron and steel, highlighted by the SI analysis, is especially worth noting. Those lances made using mid-to high-carbon steel do not show any real evidence for internal weld lines or piling, indicating that they were each made from a single steel stock. The microstructure of the steel also indicates this to be directly produced from the furnace (primary carburisation). Conversely, those lances made with phosphoric or ferritic iron (or low-carbon steel) show increased evidence for weld lines and piling.

The metallographic investigation shows that the Havor lances share the same spiral-form construction method as well as other similarities in ironworking practices. This further supports the findings of a previous paper of mine, which suggests that the standardised appearance and form of the lance is matched by a standard construction technique (Birch and Martinón-Torres in press). For this paper, a traditional metric analysis of Havor lance dimensions was conducted on over 120 examples from three different archaeological sites, further complemented by a geometric morphometric (GMM) analysis of their overall two-dimensional shape and their symmetry.

If the Havor lances were to have been produced by different smiths or workshops, this should be shown by the metric, GMM, or metallographic analysis in the form of different construction methods or high degrees of variation associated with human copy errors. Instead, the results from the metric analysis depict a highly standardised weapon (based on the coefficient of variation of different measurements), while the GMM analysis was unable to find any statistically significant difference between lances from different sites (based on their shape). These results point towards a scenario in which all Havor lances were manufactured in a single, or very few, specialised workshops. The data discussed in this chapter add depth to this picture by showing that, whilst all lances were likely manufactured in a specialised workshop, the iron used to make them came from multiple sources.

It now appears that the workshop(s) would have produced near-identical Havor lances using phosphoric iron, ferritic iron (or low-carbon steel) as well as steel proper. The provenance hypotheses discussed above suggest that multiple sources from across southern Scandinavia were used to supply iron for constructing the lances. In general, the data seem to suggest that two different iron alloys from two distinct regional sources were being used: phosphoric iron from Denmark and steel from southern Norway. The SI analysis not only supports the differences observed in the microstructure of the objects but has also helped to trace the material origins of the iron to the wider region.

Based on the combined results of the previous and present research, it appears that the Havor lance embodies a juxtaposition of technological standardisation and difference. The overall construction, form, and appearance of the lance are highly standardised, whilst the material used in its making is not. There is thus a clear dichotomy between the non-uniform material with which the Havor lance was made and its uniform appearance and manufacturing process.

One of the most interesting results of the research lies in the implications that such a standardised manufacture has for the interpretation of iron trade during this time. The uniform appearance and manufacture of the Havor lance is at odds with the chemical analysis of SI and the microstructures observed, which reveal that they were not all constructed using the same stock iron. Why they were not made from the same metal remains unclear. The different types of iron being used may attest to differential availability of, or access to, the raw materials used to make the same weapon product. One could speculate that this pattern reflects a demand for iron that could not be met by a single supplier, which would have led to the need to diversify procurement strategies as to include iron from multiple sources, some of which lay further afield from the workshop. This in turn reflects even more positively on the capability and practices of the weapon smiths, for they were able to produce the same standardised product using different raw materials with inherently different chemical compositions and mechanical properties.

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Part IV
Intergroup Violence in Archaeological Discourse

Chapter 13
An Experimental Approach to Prehistoric Violence and Warfare?

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Introduction

In 1997 John Carman observed that violence was something that surrounded us, yet we found it abnormal, unacceptable and unpleasant to talk about (Carman 1997: 2). At the time of writing, an increasing number of journalists are calling for the global community to stop ignoring the violence in Syria, whilst Europe is struggling to deal with the large numbers of refugees seeking shelter from war: 20 years might have passed, but in many ways Carman's observation, that we do not like to talk about violence, still seems pertinent.

What has changed since Carman's poignant remark is the amount of research into the archaeology of war and violence. Carman (1997: 6) argued that violence is a '…material event with material consequences' and called for more archaeologists to address this area of human existence. His plea has been heeded: the last 20 years have seen a renewed interest in prehistoric interpersonal violence in Europe (e.g. Armit et al. 2013; Carman 1997; Harding 2007; Parker Pearson and Thorpe 2005; Ralph 2013; Schulting and Fibiger 2012; Thorpe 2003, 2013; Uckelmann and Mödlinger 2011). With regard to the Bronze Age, the subject has been approached from different angles including the study of combat injuries detectable on human skeletons and how these can shed light on the nature and frequency of interpersonal violence (Dočkalová 1990; Fyllingen 2003, 2006; Jantzen et al. 2011); reappraisals of the image and self-understanding of the Bronze Age warrior from funerary

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evidence, rock art and contemporary body theory (Harrison 2004; Treherne 1995); and, more interestingly for the purpose of this chapter, martial-arts approaches that tested possible uses of prehistoric weaponry and armour in controlled field experiments and tried to validate the test results through the examination of the combat marks found on actual Bronze Age weapons (Anderson 2011; Bridgford 1997; Kristiansen 2002; Molloy 2004; 2008; 2011; O'Flaherty et al. 2011). The *Bronze Age Combat project*, discussed in this chapter, adds to, and complements, this growing field of research.

The *Bronze Age Combat Project* was launched in 2013 to explore fighting styles and techniques in second-millennium BC Europe. It seeks to investigate uses of Bronze Age swords, shields and spears based on a combination of metalwork wear analysis and tests with replica weapons.[1] The aim of the project is to understand how prehistoric bronze weapons were used, in what kind of combat situations, and with what weapon strikes and bodily engagements. One of the main objectives was to explore the possibility of linking distinctive combat marks with specific uses of the weapons including strikes, parries, stabs, and throws. The project involves four researchers at three UK universities (plus one from the British Museum), each with differing areas of expertise, which has allowed us to develop a multi-faceted and complex project.

Our research project was designed to address two overarching problems that, we felt, were limiting experimental research on Bronze Age fighting styles. The first problem is experimental design: how exactly should we conduct experiments using prehistoric weapons? Experimental fighting with weapons that are no longer in use, such as the Bronze Age halberd, presents a clear problem to researchers: we cannot necessarily know how the object was used. We argue, however, that it is equally difficult to design meaningful experiments with swords, shields and spears precisely because we *believe* we know how to use these objects. The second problem relates to the poor comparability of existing studies of ancient combat-related wear marks due to the lack of clearly defined and replicable analytical protocols employed by most researchers. The growing body of experimental research on the subject is informing a related (and growing) body of papers that discuss wear analysis of prehistoric weapons (e.g. Brandherm 2011; Colquhoun 2011; Horn 2011, 2013, 2014; Matthews 2011; Melheim and Horn 2014; Mödlinger 2011; Uckelmann 2011). Yet it is unclear how comparable the experimental studies informing these wear analysis publications are and thereby how comparable the wear analysis is. Different analysts use different experiments to inform their research, and in some cases, they use experiments on different classes of objects from those they are examining for wear.

Our aim in writing this contribution is to discuss the process of designing the *Bronze Age Combat Project*. We offer a detailed account of our own methodology in order to complement other publications that focus on the project results (Crellin et al. in preparation; Dolfini et al. in press, in preparation; Hermann et al. in press; Uckelmann et al. in preparation). This chapter serves two purposes: firstly to provide

[1]More information about the project can be found here: https://sites.google.com/site/bronzeagecombat/.

an open account of our methodology for others to use and critique and secondly to self-reflexively consider the strengths and shortcomings of our own approach to experimentation.

Thinking About Weapons and Violence in Bronze Age Contexts

Space does not permit a thorough review of archaeological research into violence and warfare in this chapter. There are, however, two key issues which have influenced how we have thought about this project and designed our experimental methodology and testing protocols: firstly, the issue of how weapons were used by different historical communities and the related issue of what fighting, warfare and violence were perceived to have been within a given context; and secondly, the issue of planned versus contingent violence in Bronze Age society. Both these issues relate to ideas about violence and, in particular, what it meant to be a warrior in the European Bronze Age.

Considering the first issue, many of us think that we 'know' how to use a sword or a spear. During this project we have used the replica weapons at numerous outreach events – most people pick up the replica swords and swish them through the air 'instinctively' believing that they know what they are for and how they were used on the basis of our long-standing social knowledge about swords. Once they have wielded the swords, they usually comment that the hilt feels too small and that this must be because prehistoric people were smaller than we are today. The question of how Bronze Age swords were held has received academic attention. Kristiansen (2002: 320) observed that many people assume that the hilt is too small to be comfortable and went on to propose an appropriate manner for gripping the sword. In his view, a tight grip was required, and both the shoulder and the hilt would be gripped using the whole hand. He also argued for the presence, on some swords, of a leather strap attached to the hilt, which would have been wrapped around the hand and thumb (Kristiansen 2002: 320–2; Fig. 1 and 2) (Fig. 13.1). Bridgford (1997: 105), drawing on Oakeshott (1999 [1960]), argued that hilts were held with three fingers and the thumb, with the forefinger extended over the hilt; she argued that this 'felt natural' and explains the presence of the ricasso (a non-sharpened portion of the cutting edge just above the hilt) (Fig. 13.1). Both authors are using analogy based on a combination of their own intuitive ideas about what 'feels right' and the shape and design of the sword to propose a 'correct' way in which to use it.

Captured in the debate about the size of the hilt and the correct way to hold a Bronze Age sword is a key issue regarding the design of meaningful experiments using prehistoric weapons: as researchers we must debate both the many ways in which a weapon *could* have been used and the 'correct' way (or indeed ways) in which a weapon was used by a given community. As Melheim and Horn (2014: 22;

Fig. 13.1 Swords held in the manner suggested by Kristiansen (2002) (left) and Bridgford (1997) (right). (Image R.J. Crellin)

25) have argued, drawing on Mauss' (1973) notion of *technique du corps*, learning to use a weapon involves the incorporation of socially specific bodily techniques. Both bodies and weapons work together and relationally come to shape one another in socially specific ways (Melheim and Horn 2014: 25; Molloy 2008). Relying on intuition or preconceptions about what 'feels right' to us today is not necessarily going to inform us about what 'felt right' in prehistory. There is also a broader issue here of formal analogy, which often drives the presumption that, because a sword looks familiar to us today, we believe we understand how it was used in the Bronze Age. It is, however, anachronistic and problematic to assume that historic combat styles developed for steel swords could uncritically be applied to swords from a different age and made from a material – bronze – with different mechanical properties, regardless of their formal similarities.

This brings us to the related issue of thinking about weapons and violence in a contextually specific way. Many authors talk about Bronze Age combat on a pan-European scale (see, e.g. Harding 1999; Kristiansen 1999). Whilst there are clearly unifying aspects of the archaeological record across Bronze Age Europe, there are also clear regional differences. Weapons and combat (like any other phenomena) are understood and employed in relation to their given context. Given the regional differences we see across Europe more broadly, it is not unreasonable to assume that weapons may have been used in different ways across the continent. Mauss' (1973) famous discussion of the *technique du corps* contrasted shovel use in France and Britain during the twentieth century, a time when mass production and communication were increasing. Considering how much more localised production would have been in the Bronze Age, and communication constrained, we urge caution over assumptions that combat, fighting and weapon usage relied on similar bodily movements and styles in communities spread across a large swathe of land.

The problem of understanding how to use a weapon extends beyond simple 'know-how' to the wider issue of historically contingent ideas about fighting, warfare and violence. What fighting is, and how it is carried out, is specific to each community. Today there are a multitude of possible examples of socially specific forms of violence ranging from ritualised dance-like performances of sanctioned violence to score-settling small-group violence, large-scale warfare, and violence aimed at non-combatants. We argue that a wide variety of forms of violence existed in prehistory and kept this in mind as we designed our experiments.

The variety in forms of violence makes the study of prehistoric warfare and combat a complex field. The Bronze Age is marked by the emergence and proliferation of specialised weapons, the inclusion of such weapons in graves and hoards, and their depiction on stelae and rock art panels. This material evidence has been used to support the idea of so-called warrior chiefs as a specific category of gendered identity in the period (see, e.g. Harding 1999; Harrison 2004; Kristiansen 1999, 2002; Treherne 1995). Such a conceptualisation of the male warrior plays a role in many discussions of violence and weapons from this period, sometimes explicitly (e.g. Kristiansen 2002; Melheim and Horn 2014; Molloy 2006, 2011) and at other times implicitly in the very clear gendering that surrounds discussion of weapons. In one sense this is to be expected, as the material evidence certainly points towards the importance of violence in the Bronze Age and weapons clearly played a central role in the construction of male identities at the time (for an excellent discussion, see Harris et al. 2013: 74–78). Yet, there is little reason to believe that this period was any more violent than the preceding Neolithic. Moreover, presuming that all violence was enacted by warriors, and all weapons were used by warriors in 'heroic' combat, is problematic. The relationship between the gendered warrior identities that were being presented and manipulated in graves, rock art and stelae, and the types of violence that actually occurred, is not a simple one.

We can explore this relationship further by comparing the images of violence observed in southern Scandinavian rock art and the evidence of violence recovered from the site of Tollense, Germany. The rock art sites suggest that violence was the preserve of males and was primarily enacted with bronze bladed weapons such as swords and spears (see Bertilsson, Chap. 7, this volume; Horn, Chap. 6, this volume; Ling et al., Chap. 8, this volume). In contrast, the evidence from the Bronze Age battle site at Tollense shows that many of those who died suffered blunt force trauma and sustained injuries from flint arrowheads (Brinker et al. 2015, this volume; Jantzen et al. 2011). At Tollense, clubs, bows and arrows, and spears are identified as the primary weapons: to date limited evidence of injuries from bladed bronze weapons has been identified, and the authors suggest that the osteological data '…challenges the traditional picture of the Bronze Age warrior elite' (Jantzen et al. 2011: 431). Two key points emerge from this contrast: firstly, the relationship between male warrior identity and violence in the Bronze Age is not a simple one; and secondly, multiple kinds of violence existed in multiple kinds of social context. We cannot, and should not, presume that violence was the preserve of male warriors alone, nor should we presume that the male warrior identities presented in Bronze Age burial and rock art tally with lived reality.

This brings us to the second issue: planned as opposed to contingent violence. Jones (1980: 98) draws a contrast between institutionalised combat and impromptu ‘scraps’. During institutionalised violence (e.g. a duel or nation states going to war), clear rules exist, which must be followed, lest the combatants lose social respect and standing (Jones 1980: 98–101). Impromptu scraps, in contrast, are not governed by the same rule system. We postulate that both forms of violence occurred during the Bronze Age but potentially followed different kinds of rules and were associated with different kinds of material culture. Whether the violence associated with so-called warriors and some of the weapons we find from the Bronze Age was the same as the kind of violence that might have happened following a disagreement is unclear. The different roles played by specialised weapons designed to kill, in contrast to improvised weapons (e.g. the shaft of an axe or a large rock), need to be borne in mind when considering prehistoric violence.

It is clear that there were potentially many different forms of violence during the Bronze Age, each with its own contextual background, as well as potentially different forms of weapons, and different rules regarding what was socially acceptable. Therefore, we can make no simple assumptions about how weapons were used, what violence was, and who was involved in it. A far more complex and nuanced approach is necessary if we are to make any real gains in this field of study. Bronze Age warriors should only constitute one part of our narratives surrounding violence in this period, and our interpretation of weapons needs to take account of this.

Using Metalwork to Learn About Violence and Warfare

Metalwork wear analysis provides an innovative avenue into the study of prehistoric weapons and thereby violence and warfare. The technique is characterised by an approach involving experimentation with replica metal objects, followed by the observation (using various optical microscopy techniques) of the wear marks resulting from the experiments. The experimental marks then form a reference point, which analysts use to interpret the surfaces of prehistoric metal objects to understand how they might have been used (Dolfini and Crellin 2016).

Much existing research into bronze metalwork, including weapons, focuses on their typological classification. This is best exemplified by the *Prähistorische Bronzefunde* monograph series. The series is an invaluable tool for Bronze Age specialists as it allows the building of relative chronologies and comparison of metal objects across Europe. The *Prähistorische Bronzefunde* series forms the foundation for the majority of metalwork studies across Europe, but, as Sørensen (2015: 88) argues, the primary function of this type of research has been to fix the various classes of objects into a typological order rather than to understand their uses. Metalwork wear analysis can be added to our typological understandings of the various categories of metalwork to allow us to consider how different types of objects were used over time. Wear analysis demands that we think not just about the formal morphological differences of objects but also consider how they *could* have been used, the evidence for how they *were* used, and how this does or does not vary between types.

Metalwork wear analysis allows us to open up new portions of the so-called object biography (e.g. Appadurai 1986; Gosden and Marshall 1999; Holtorf 2008; Hoskins 1998; Joy 2009; Kopytoff 1986; but see Jones et al. 2016 and Joyce and Gillespie 2015 for different approaches). Traditional typological analysis usually focuses on the form of the object at the time of production, whilst an alternative strand of Bronze Age studies researches the endpoint of an object's life cycle, which tends to be presented as a 'ritualised' process, potentially involving destruction or intentional damage and placement in hoards or graves (e.g. Bradley 1990; Fontijn 2007, 2008). Whilst giving us additional information about both production and deposition, metalwork wear analysis also provides us with invaluable data concerning the use or, more commonly, the uses of an object. It allows us to think about how the same 'type' of tool might be used in different ways during its life cycle and how different 'types' of tool might be used in similar ways. Adding metalwork wear analysis to the spectrum of archaeological and scientific methods we use to study material culture allows us to reveal the often complex and multiple nature of metal objects in a new, data-led way.

There are two ways in which metalwork wear analysis is having the largest impact on the study of prehistoric weapons: firstly, in overturning assumptions about the lack of functionality of early metal tools and weapons (e.g. Dolfini 2011), and secondly in questioning perceived wisdom about how weapons were used in the past. Earlier research on prehistoric weapons questioned their true combat potential and often suggested that they had a ritual or display-based function (Harding 2007). However, wear analysis has shown, time and again, that the desire to dichotomise bronze tools and weapons as either 'ceremonial' or 'practical' cannot be sustained. The reality is far more complex, and only by appreciating all sides of an object's production, use and deposition can we hope to understand it more fully (e.g. halberds: O'Flaherty 2007a, b; O'Flaherty et al. 2008, 2011; axes: Moyler 2008; spears: Anderson 2011; Horn 2014; swords: Kristiansen 2002; Molloy 2008; Mödlinger 2011).

Research into spearheads provides one such example of the value of metalwork wear analysis. Anderson (2011: 599) notes that the division of spears into those perceived to be used for throwing versus those used for thrusting was based on morphology rather than research focusing on evidence for use (e.g. Osgood 1998; Osgood et al. 2000). Anderson (2011: 599) has argued that this received wisdom has delayed research considering how spears might have been used in alternative ways. Her own observation of prehistoric spearheads from northern Britain indicates that many of them show wear marks similar to those visible on swords (see also Horn 2014 for similar remarks). Interestingly, she notes that this is something Bridgford (2000) also observed but attributed to either accidental use or pre-depositional ritual damage. This example suggests that the weight of perceived wisdom, which suggests function follows form, has hampered our understandings of prehistoric bronze weapons. The work of Anderson (2011) and Horn (2014) has overturned long-standing assumptions about the lack of functionality of early bronze spears and argued convincingly for the existence of elaborate fighting styles including, at least for large spearheads, sword-like slashing strikes that could not be identified by purely morphological studies.

A parallel example comes from research into the development of swords: common conceptions of sword fighting have been largely based on Mediaeval and Renaissance manuscripts (Molloy 2011: 74) as well as dramatised representations of swordplay in Hollywood movies. Academics have traditionally argued that Middle Bronze Age rapiers (i.e. swords with straight, narrow blades) were designed primarily for stabbing. These early weapons later evolved into broader leaf-shaped swords, which were often claimed to be technologically 'superior' and better suited to more effective slashing attacks. Yet wear analysis has highlighted the presence of similar combat marks on both categories of swords, whilst combat tests with replica weapons showed that both rapiers and leaf-shaped swords could effectively be used for both stabbing and cutting/slashing (Clements 2007; Molloy 2007, 2008, 2011). Moreover, the argument glosses over the fact that, whatever its shape, manufacturing material and manner of use, a blade is often far more lethal if used in a stabbing than in a slashing strike. Again, we can see here how experimental research and wear analysis have overturned long-held assumptions positing a simplistic relationship between form and function. The potential for experimental work paired with metalwork wear analysis to cast new light on Bronze Age fighting styles is clear.

Experiments with Weapons

Various experiments, with different goals, have been conducted with replica Bronze Age weapons. Inspired by Ottaway and Kienlin's (1998) pioneering research into the wear analysis of copper-alloy objects, Bridgford was the first to apply the method to swords. She examined a total of 499 prehistoric swords and sword fragments from the later Bronze Age (Bridgford 2000: 117). Bridgford's aim was to assess whether the swords had been used in combat or not. To achieve this, she created a reference collection of replica swords to use in experiments in order to recreate the kinds of marks one might expect to be produced in combat. These marks were then arranged in categories and compared with the prehistoric swords to observe and quantify the extent of similar marks on originals. Although certainly innovative, Bridgford's approach to creating reference marks was in many respects problematic. She acquired seven copper-alloy cast blade segments, which were then work-hardened and sharpened by herself and her team. The segments were produced using different techniques, utilising both modern tools (e.g. sharpening wheels) in some cases and experimenting with copper hammers and whetstones in others (Bridgford 2000: 93–100). Whilst this method yielded interesting results in terms of understanding ancient manufacturing processes, the consequence was that the segments had mechanical properties unlike those of Bronze Age swords. In addition, the blade segments will have behaved differently from whole swords during experimental tests and therefore are unlikely to accurately reflect combat damage. The sword fragments were tested using a *Monsanto Tensometer Balanced*

Impact Machine. Each sword segment was fixed to a wooden cube and then either mounted on a table or attached to the arm of the machine. The machine was then used to clash the two sword segments at 45° (Bridgford 2000: 103). The experiments allowed Bridgford (2000: 103–105) to devise a total of six different types of wear marks, namely, bowed, chipped, notched, nicked, scored and torn. The use of a machine in laboratory conditions has clear advantages in terms of making experiments more controllable and limiting the effect of variables, but the artificial action of the machine does not account for the various motions of a whole sword used by a human fencer (e.g. twisting and turning of the blade, different angles of contact, etc.).

Molloy has conducted extensive experiments primarily with Type C and Di Aegean swords (Molloy 2008) and Middle and Late Bronze Age British/Irish swords (Molloy 2007), as well as with a range of shields (Molloy 2009). Molloy (2008: 117) states that his methodology '…places a strong emphasis on physical interpretation and experiential learning' and focuses on the actions of individuals in combat rather than strategic group fighting. He emphasises not only the production of results from his experimental work but also the expertise he has gained. He describes experiments investigating the cutting potential of swords against specially made test materials (including leather, bronze and straw matting) and pig carcasses (Molloy 2007, 2008). His work produced interesting results focused on the ability of the swords, rather than the production of wear marks, to aid interpretation of prehistoric weapons and fighting styles. Molloy (2007) has examined a large number of prehistoric swords and interprets their use in relation to the understanding he has gained of their properties and behaviour through experiments rather than through specific reference to marks left on the swords from experimental work.

The work of O'Flaherty (2007a, b) and O'Flaherty et al. (2011) has the advantage of combining both field and laboratory tests in trying to understand the Early Bronze Age Irish and Scottish halberds. O'Flaherty (2007a, b) began with field tests to investigate the function of the halberd; initial tests used a sheep's skull to prove the strength and efficacy of the weapon. Later experiments (O'Flaherty et al. 2011) brought together these field tests with knowledge gained from examining the wear on prehistoric halberds (O'Flaherty et al. 2008) to design a series of laboratory tests. In these, a drop-test facility was used to apply a controlled amount of force to drop different objects (a bronze axe, a bronze dagger, stone axes and wooden shafts) onto a halberd blade: the aim was to re-create the marks observed on the prehistoric blades. The halberd blades were made of arsenical copper and edge-hardened to make them as authentic as possible. The tests were carried out in 'yielding' and 'unyielding' environments. In a yielding environment, the halberd was allowed to move slightly as the other object was dropped onto it, whilst in an unyielding environment it was not. 'Yielding' experiments are suggested to be more akin to true combat in that both weapons would be moving, whilst 'unyielding' tests were perhaps more akin to incidences of deliberate destruction. This combination of field tests, examination of museum collections and laboratory tests has led to real gains in our understanding of both the functionality of these objects and the wear marks that can be observed on prehistoric specimens.

Following Molloy (2007), Anderson (2011) considered the sword-like use of spearheads. Her experiments included a 30-strike repertoire in which each move was repeated by experienced fighters testing replica weapons in the field. Although sometimes they lack detail regarding how each mark was recorded, her experiments were extensive and played a key role in shaping the design of our own protocols (see below). Davis (2006) also mentions experiments with spears carried out in conjunction with the Royal Armouries in Leeds (UK), but both the description of the experiments and the appraisal of their results are scant. Experiments involving copper-alloy projectile points have also been conducted (e.g. Gutiérrez-Sáez et al. 2010), but these are not discussed here.

Experiments with shields are amongst the oldest carried out with Bronze Age replica objects. John Coles, one of the pioneers of experimental archaeology, conducted a detailed study of Bronze Age shields in the 1960s, which for the first time incorporated combat experiments with these objects. Unfortunately, the original shield on which Coles modelled his replica, just 0.3 mm thick, was one of the thinnest known from the European Bronze Age. He selected this shield due to the availability of 0.3-mm-thick copper sheet to purchase on the market. He then used this sheet copper to build a suitable replica. In a time before health and safety rules, he conducted courageous combat tests in which he and his colleague, equipped with a sword and a bronze shield first and a leather shield later, thrusted the swords at the shields. Whilst the thin copper shield was easily cut through (except for the rolled rim), the leather shield withstood the blows effectively and was therefore considered to be more suitable for defensive purposes than the metal shield (Coles 1962). Consequently, Coles suggested that prehistoric bronze shields were not functional but would mainly be used for display and conspicuous consumption. Despite the obvious shortcomings with the materials tested, and the conditions in which the experiments were carried out, Coles' early interpretation went largely unchallenged and shaped scholarly understandings of Bronze Age shields until recently.

More recently, Molloy (2009) carried out new combat tests with prehistoric bronze shields. His tests revealed that some of the shields, especially the sturdier ones, were perfectly capable of protecting their bearers. Not unlike Coles, he built his replicas out of copper sheet but this time of 0.9 mm thickness, which is akin to the thickness of a large number of Bronze Age shields (Uckelmann 2012); he built three shields of different sizes, two of which had a rolled-over rim. He then tested the shields with replica swords and spears: they withstood the tests without being damaged significantly, and, in most cases, only minor dents and scratches were produced (Molloy 2009). His experiments have marked a turning point in prehistoric studies; they ushered in a wholesale change of perception regarding the role of bronze shields as practical, and indeed effective, weapons. Anderson (2011) also conducted Bronze Age shield testing, in which she struck replica leather and bronze shields with spears. The bronze shield was manufactured using industrial sheet bronze and, like the leather shield, turned out to be quite capable of protecting the fighter.

All shield experiments conducted thus far have aimed to test the functionality of either the shield or the offensive weapons. Apart from Molloy (2009), who links his results to traces visible on prehistoric shields, no wear analysis has ever been conducted on experimental shields. However, in her recent in-depth survey of European Bronze Age shields, Uckelmann (2012) examined the traces of wear visible on these objects including probable combat marks. It is from this seminal study that one aspect of the *Bronze Age Combat Project* grew: the production of a replica bronze shield from a cast blank, using high-tin bronze and prehistoric manufacturing techniques, and its testing with replica weapons in order to compare the resulting wear traces with the marks found on Bronze Age shields.

Strengths and Shortcomings of Experimental Research into Violence and Warfare

The experiments carried out with replica Bronze Age weapons can be broken down into two main groups: those carried out in laboratory settings and those carried out in the field. Laboratory-based tests, such as those conducted by O'Flaherty et al. (2011) and Bridgford (2000), have the advantage of being more controllable and repeatable than those carried out in the field. In the laboratory, recording can be more easily completed and variables more easily controlled. Using a drop tester or other mechanism to test the weapons allows for clear control of force and replicability but also limits our understanding of the role of the human body in the use of tools and weapons. As Molloy (2008: 199) has argued, laboratory-based testing allows us to effectively understand the mechanical properties of a weapon but always falls short as it fails to address the role of the human body using it.

It may appear that utilising field tests overcomes this weakness. In tests such as those completed by Anderson (2011) and Molloy (2004, 2006, 2007, 2008), the human body is placed at the centre of the experiment. Such experiments produce not only physical results but also a corpus of knowledge for participants who have witnessed and experienced what bronze tools and weapons are capable of (Molloy 2008). However, the shortcomings of such field tests are the lack of control they allow for variables. If combatants fight for extended periods of time, as we presume would have happened in prehistory, it is not possible to consider the formation of individual wear marks. Yet, this kind of field test can be seen as a potentially 'more meaningful' type of experiment as it is believed to be closer to what we presume real-life conditions were like; it certainly looks more 'authentic', but whether it actually is more accurate is debatable. Having a 'body' rather than a machine do the experiments allows us to address the crucial role that human bodies play in the use of weapons but also adds another variable that is not necessarily easy to account for. We cannot presume that Bronze Age bodies and modern bodies would act in the same ways whilst fighting because fighting is a socially constituted activity, which is predicated upon a corpus of embodied knowledge specific for each period and social context. Ultimately, we must accept that both field and laboratory experiments have their own strengths and weaknesses, and both can contribute to our understanding of extinct combat practices.

An important issue affecting weapon testing in both settings is how alloy composition and post-casting treatments of the objects impact on wear formation processes. Pioneering tests have been conducted on axes and knives (Soriano-Llopis and Gutiérrez-Sáez 2009), but no such work has ever been carried out on swords. Given the role of work-hardening in the preparation of prehistoric blades, this is a clear shortcoming of existing experiments. With the exception of Anderson (2011), another key shortcoming is the lack of tests involving a broad spectrum of weapons (Molloy 2011 calls for more such testing). Until we consider how weapons can and cannot be used together, we will fall short when it comes to thinking about prehistoric combat on a wider scale. A related issue is the amount of attention that bronze weapons have received – this leaves little space to explore the relationship between bronze and other materials such as wood, leather and stone during combat.

The Bronze Age Combat Project

Designing the Bronze Age Combat Project

We turn now to discuss the design of our own experiments. The key issues outlined above, of how weapons were used in historically contingent ways and how violence and combat might have been perceived during the Bronze Age, were at the fore of our minds when we began designing these experiments. We also spent time considering the advantages and disadvantages of field versus laboratory tests in order to design a methodology that would 'bridge the gap' between the two. This led to designing a three-stage approach to the research. The project began with a series of rigorous field experiments with replica weapons in which wear marks were preliminarily recorded in the field; these were complemented by more 'fluid' weapon tests based on historic fighting techniques which, however, are not discussed in this chapter. The marks left on the replica weapons were then examined more thoroughly in the laboratory. Finally, a selection of prehistoric weapons held in several UK museums were examined for combat-related edge damage. We designed these field tests drawing on existing experiments as well as our knowledge of the kinds of marks found on prehistoric swords, spears and shields. The project has developed over the last 5 years, and there have been multiple rounds of field testing and analysis, which have allowed us to develop our experiments and refine our results. The interpretations we have reached in the laboratory have informed not only our analyses but also later experiments. Moreover, what we have observed whilst analysing museum collections has helped us to understand where our experiments have had shortcomings and allowed us to conduct further weapon tests. This iterative process has allowed us to develop our interpretations beyond what a single round of experiments would have allowed. Furthermore, the contribution of several specialists to the experiments and wear analysis has led to truly interdisciplinary work, which in turn has allowed us to think about weapons and combat in new ways.

The guiding principle in the design of the experimental protocol was to create *meaningful yet formalised* tests; we wanted to combine the advantages of both laboratory- and field-based experiments and, by doing so, seek to overcome some of the weaknesses of both. This was achieved by designing a protocol that utilised field experiments using experienced and well-informed combatants and the best replica weapons available, but breaking the combat down into single movements and recording the marks left after each one. By breaking down 'live combat' into a series of controlled and repeatable movements, we were able to begin to investigate whether there is a direct linkage between specific combat moves and specific marks left on the weapons.

We utilised the experience of our combatants (who are also archaeologists) in the design of the field tests. One combatant (R. Hermann) has a background in fencing, hunting, martial arts and re-enactment, and another (J. Allison) is an ex-British infantry soldier and amateur javelin thrower. Their perspectives were combined with the expertise and knowledge of prehistoric weapons of the other members of the project team; this allowed us to think about a range of different ways of using the weapons. We also worked through simulated group combat situations, in which we used different weapons in diverse ways; we did not create any use-wear marks during these tests but instead used them to widen the scope of how we were thinking about the weapons. By bringing together this expertise, we designed a wide range of strikes (described in Table 13.1) without relying on Mediaeval or post-Mediaeval texts. During the experiments, it became clear which specific kinds of strikes were inappropriate with the replica weapons and conversely which were feasible and indeed effective.

The extensive protocol we designed was not based on textual descriptions of various kinds of sword fighting but instead on what kinds of attacks might be possible with the specific replica swords we used. The protocol not only included a range of different weapon strikes but also different defensive blocks, or 'parries' (Table 13.1). These were carried out in three different ways, either as static, kinetic or dynamic parries. A 'dynamic' parry most closely mirrors what we would describe as a 'true live combat' situation, in which both fighters are placing force and speed behind the weapons as one would in a real fight. A 'static' parry, on the other hand, involved holding the defensive weapon completely still to simply receive the attacking strike, whilst during a 'kinetic' parry the defender met the attack with a controlled movement towards the incoming weapon. This protocol was designed in order to consider what marks from purposeful destruction might look like compared to marks generated in live combat. Considering the ongoing debate about so-called ritual killing or purposeful destruction of weapons in prehistory (e.g. Horn 2011 concerning halberds), these tests were designed to provide the first rigorous investigation of what such marks might look like on swords, spears and shields. Conducting static and kinetic tests also allowed us to make our experiments comparable to the work of O'Flaherty et al. (2011), whose laboratory tests encompassed both 'yielding' (akin to our kinetic parries) and unyielding (akin to our static parries) environments.

Table 13.1 Weapon strikes and blocks (or 'parries') tested by the Bronze Age Combat Project

Strikes	
Leg strike	The attacker swings the weapon with its tip facing downwards in a low-angled arc to strike the other weapon near the defender's legs, in the region of the knee area. The attack is parried with the defending sword pointing downwards at an angle
Hip strike	The attacker swings the weapon horizontally in an arc to strike the defender's weapon near the hip. The defending sword is held almost vertically pointing upwards in front of the hip. To counter the height of the blow, the defender has to crouch slightly
Shoulder strike	The attacker swings the weapon in a diagonal arc from above to strike the defender's weapon near the shoulder or neck. The defender holds the weapon diagonally in front of the body, slightly raised towards the shoulder, with the tip pointing upwards towards the shoulder opposite the sword hand, to cover the upper body
Head strike	An overhead strike, coming straight down onto the defender's weapon in the head area. The defending sword is held horizontally above the defender's head
Parries	
Static edge parry	The defending weapon is held in place to block the attacker's strike with the cutting edge
Static flat parry	The defending weapon is held in place to block the attacker's strike with the flat of the blade
Kinetic edge parry	The defending weapon is moving away from the defender's body, forcefully meeting the incoming strike with the cutting edge
Kinetic flat parry	The defending weapon is moving away from the defender's body, forcefully meeting the incoming strike with the flat of the blade
Dynamic edge parry	A kinetic parry carried out with so much force and momentum that it catches the attacking blade on the cutting edge and knocks it off its course. This parry may be best described as a weapon attack met by another weapon attack
Dynamic flat parry	As per above but the parry is executed with the flat of the blade

Repeats of every experiment were built into the protocol so that we could investigate the reliability of our results. We used this combination of strikes and parries to investigate not only sword-on-sword (as shown in Table 13.1) but also sword-on-spearhead, sword-on-spear shaft, sword-on-shield (bronze, leather and wood), spear-on-spear, spear-on-spear shaft, spear-on-shield, as well as various throwing and stabbing experiments with the spears. Many of our experiments were designed to mirror those described by scholars including Anderson (2011), so that we might investigate the replicability of their results. In all cases, the aim of the experiments was to create a wide range of combat marks that could be used as a reference collection to interpret the marks observed on the prehistoric weapons; the advantages and disadvantages of our approach are explored below.

All the weapons used in the Bronze Age Combat project, as well as the bronze and leather shields, were made by Neil Burridge (www.bronze-age-craft.com), a traditional bronzesmith. Jake Newman, a Durham archaeology student who is also a skilled woodcarver, made the wooden shield using purpose-made bronze tools (Figs. 13.2, 13.3, and 13.4). All objects were based on extant British and continental

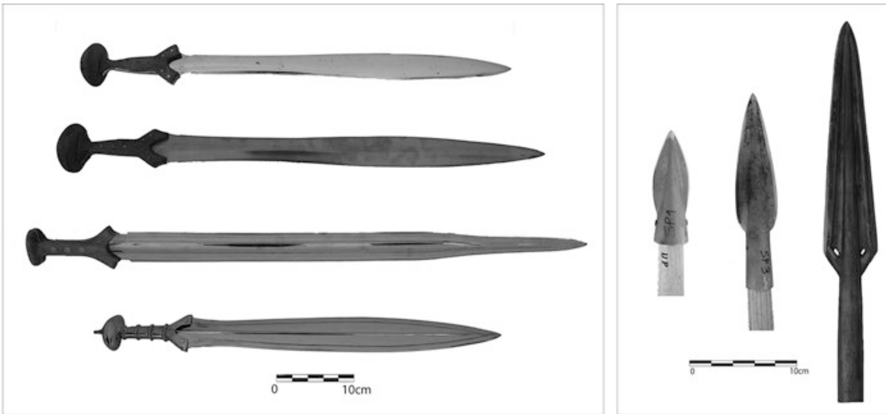

Fig. 13.2 A selection of the weapons used in the experiments. Swords: top, type Wilburton; upper middle, type Ewart Park; lower middle, type carp's tongue; lower, Kemenczei's type S Vollgriffschwert. Spears: left, group 11C 'leaf-shaped blade' spearhead; centre, group 11A 'flame-shaped blade' spearhead; right, type 8B 'triangular basal-looped' spearhead, according to Davis' typology (Davis 2012, 2015). Scale bars 10 cm. (Image: D. Horan and R.J. Crellin)

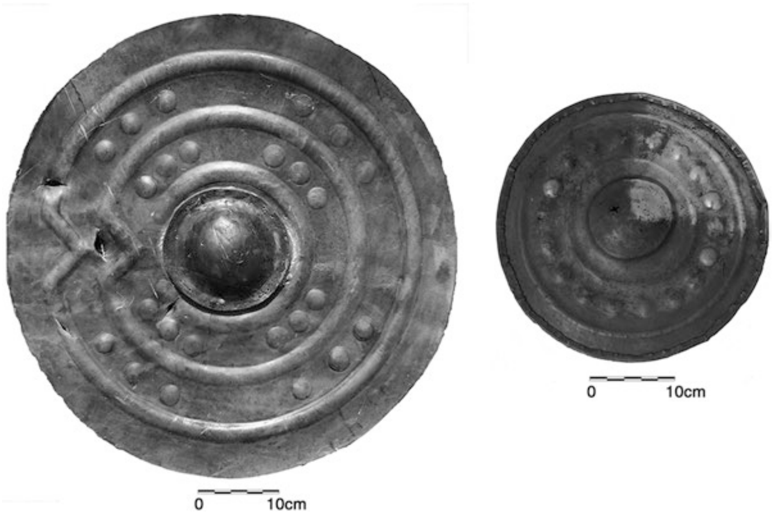

Fig. 13.3 A selection of the shields used in the experiments. Left: replica leather shield after an original from Cloonbrin, Ireland. Right: replica bronze shield after a template comprising elements of Athenry-Eynsham- and Nipperwiese-type shields. Scale bars 10 cm. (Image: R.J. Crellin and M. Uckelmann)

templates. We had seven swords cast, ten spearheads, two leather shields, a bronze shield and a shield made of alder wood. Following the observations of Soriano-Llopis and Gutiérrez-Sáez (2009) that objects with different alloy compositions and different post-casting treatments produce quantitatively (though not qualitatively)

Fig. 13.4 Examples of Bronze Age Combat project sword tests. (Image: R.J. Crellin)

different wear marks, all swords and spears were produced using a 12% tin-bronze alloy.[2] The swords were also subjected to a single cycle of work-hardening before being sharpened mechanically.

We designed our wide-ranging protocol to meet our experimental needs before having extensive consultation with a health and safety expert. It was a case of mak-

[2] This alloy composition sits near the higher end of the spectrum documented for British Late Bronze Age swords (Northover 1988); it was chosen as it improves the fluidity of the cast and reduces the risk of potentially dangerous casting defects developing within the objects.

ing the experiments we wished to carry out safe rather than designing safe experiments and then attempting to link them to what we required from the perspective of our research aims. Yet the safety of the combatants was one of our foremost concerns; they wore full *personal protective equipment* including gambesons, steel-clad gauntlets and fencing masks. Weapons were checked for damage that might result in them behaving differently during combat. Each individual move was discussed first so that both combatants were completely clear on what was involved; the moves were then practised with wooden weapons and mimed with the real weapons. The observers and recorders were all stood at a safe distance to avoid injury from splintering or broken weapons.

Experimental Design to Experimental Reality

Despite the level of research and preparation that went into the design of our protocol, the reality of carrying out the experiments differed slightly from our expectations. Most significantly, the planned strikes and parries were far more damaging to the replica weapons than we had expected. All the swords were slightly bent during every 'dynamic' parry we carried out, and one sword was bent so much that we felt it was unsafe to continue to use it. As a result of this high level of damage, we were unable to complete as many repeats of the different strikes and parries as we had planned. Although it would sometimes have been possible to bend the swords back into their original shape, this would have introduced additional unnecessary risk to the combatants. Furthermore, rebending the swords would have changed their physical properties and reduced the repeatability and comparability of our experiments.[3]

The recording work involved in these experiments was extensive and time-consuming but has allowed us to make real gains in our understanding of use-wear from combat. Each individual strike, and each parry, was filmed and photographed using high-speed shutter mode on digital cameras. This data has proved very useful in the post-experimental phase as it allowed us to check each move again, to see exactly what the weapons did in slow motion and how the edge marks were created. Afterwards, the location and shape of each resulting mark were recorded on both weapons, marked on illustrations and entered into record sheets. Macro-photos of each mark were also taken immediately after the tests. This data provided the foundation for the subsequent laboratory-based analysis of the marks. Recording both weapons in such a detailed way has allowed us to differentiate between attacking and defending marks and to establish a linkage between specific combat moves and specific instances of use-wear.

[3] We plan future work examining the effects of rebending swords on how they behave in combat and the resultant wear marks.

Evaluating the Bronze Age Combat Project

Our experiments have produced a vast amount of data, challenged our own assumptions about the performance of the various weapons and allowed us to draw new interpretations about prehistoric weapons and Bronze Age combat. Rather than focusing on the results and interpretations, which will be discussed in detail elsewhere, in this chapter we want to focus on the accomplishments and shortcomings of the experiments themselves. As discussed above, any experimental work is limited by our inability to know whether we are using the weapons in a historically appropriate manner and whether we can understand, and account for, the socially specific understandings of what warfare, violence and combat were in the European Bronze Age. Leaving aside these concerns, some of which we attempted to address in the experimental design (see above), there are four main areas in which we have identified key successes of our experimental design and four areas in which there are clear shortcomings.

The first key strength of our experimental design is that it has allowed us to connect specific kinds of combat moves with specific use-wear marks as a result of breaking down combat into single moves and recording each of these, and the resultant marks, separately. This methodology also produced a second key strength in the identification of some marks that can be used, in certain cases, to separate attacking and defending weapon (Fig. 13.5).

The extensive protocol we designed gave rise to other key strengths. The combination of different types of weapons used during our experiments has effectively allowed us to move beyond some of the sword-centric work carried out in the past and has led us to think clearly about how different weapons can be used in combination with one other (e.g. in a melee) and their complementary strengths. In turn, this has allowed us to move towards a new understanding of the relative role of different weapons in Bronze Age combat. Moreover, the inclusion of 'static' parries in the experimental protocol has allowed us to begin to investigate the grey area that exists between marks originating from use and those derived from acts of deliberate destruction of weapons. Whilst such research has been conducted on halberds (O'Flaherty et al. 2011), we are not aware of similar tests having been conducted on swords and spears. Such experimental data is crucial in interpreting whether or not we can tell the difference between marks left through use in combat and those that may be indicators of the wider role and ontological understanding of metalwork and weapons in this period.

Moving from the strengths of the experimental methodology to its weaknesses, the first problematic area we have identified relates to the replica weapons themselves. Whilst conceiving the project, we selected a variety of different types of sword as we thought that this would give our tests broader scope. However, this also introduced an extra element of variability that, though accounted for, somewhat limited comparability between sword tests. On reflection, it would have been preferable to have only one or two types of sword so that each experiment could be carried out against a weapon of the same type. Whilst having a larger range allowed us to

Fig. 13.5 Upper: wear mark to the attacking blade from a static shoulder strike. Lower: wear mark to the defending blade from the same shoulder strike. Scale bar 2 mm. (Image: R.J. Crellin)

consider how typological differences might relate to functional ones, it also limited the number of repeatable experiments we could carry out due to the level of damage created during the experiments.

The second area of weakness relates to the in-field recording. We felt that it was vital to break down combat sequences into single encounters and to record each individually, in order to examine the linkage between specific combat moves and specific marks on the weapons. We chose field testing (as opposed to laboratory experiments) as this gave us the necessary space and flexibility to carry out the experiments safely and meaningfully. On reflection, there were several drawbacks to this. Recording in the field came with all the problems one might expect to be caused by an open environment. However, more problematic still were the instances in which different combat moves resulted in damage to the same area of a specific weapon (Fig. 13.6). Whilst each individual instance of edge damage was recorded in the field to the highest possible standard, there is no substitute for proper microscopic recording, and when later marks obliterated earlier ones, we lost this opportunity. There would be a real advantage to conducting future experiments in a large indoor space near a laboratory (or where a temporary laboratory could be established) to improve the accuracy of the recording further.

Fig. 13.6 Sword displaying two instances of damage to the same area of the edge, resulting from two different combat actions. Scale bar: 2 mm. (Image: R.J. Crellin)

The third weakness concerns one of the fundamental goals of our experiment, which was to leave a mark on the weapons being tested. This is quite different from a true combat encounter, in which the combatants are aiming not to leave marks on each other's weapons but rather to preserve their own weapon and to potentially wound or kill their opponent. As such, the marks that we created during our tests may in fact represent instances of 'failed combat', in which unplanned strikes or parries are carried out and weapons clash against the will of the combatants. By and large, our tests failed to capture the kinds of marks that might arise from weapons hitting human bodies or the armour they would be covered with (although this was partly achieved in our shield tests). In the context of our project, this methodological approach was the correct one as it has allowed us to investigate the wear marks left on prehistoric weapons; indeed, our success in linking marks from our experiments to those visible on prehistoric weapons is testament to the methodology's strength. However, we also accept that there are multiple other ways for weapons to develop combat marks and that there is a whole range of combat moves and weapon uses that are not being captured in tests of this kind.

Whilst our experiments have been extensive (148 weapon tests) and time-consuming (6 days overall), they have not been as comprehensive as we had first envisioned; this is the final area of weakness. As discussed above, this is a result of the extent of the damage done to the weapons during the field tests. Brandherm (2011: 24) has called for more extensive and comprehensive experiments to aid in the interpretation of wear marks on halberds, based on the amount of tests that were needed in early axe research to reach significant results (Kienlin and Ottaway 1998; Roberts and Ottaway 2003). We fully agree with Brandherm about the need for extensive and comprehensive weapon tests, and we are firm in our belief that such experimental programmes should be designed to include repeats. However, following our own experience, we are left wondering about the practicability of this. Our own test has involved seven swords with an approximate market value of £2800 (about $3800): the cost of replica swords, combined with the level of damage they exhibit during testing, makes the kind of comprehensive and repeated experiments we would like to see extremely costly. The issue with the costs of experimental work involving replicas of prehistoric metal objects is one of several reasons why two of the authors have elsewhere called for the publication of experimental data in full (Dolfini and Crellin 2016), in the belief that this makes for good science, increases the potential to interrogate results, but would also allow practitioners across the world to work cumulatively to expand the experimental work of others, rather than having to start from 'ground zero'. Accordingly, data and results from this project will be made open access online at the end of the research.

Connecting the Experiments with Prehistoric Weapons

We turn finally to the issue of connecting the kinds of marks left on the experimental weapons with those observed on the prehistoric specimens. In many respects, this has been a key area of success as we have been able to identify on prehistoric weapons comparator marks for a broad range of combat marks created during the experiments. In some instances, we have been able to link particular combat actions with distinctive traces and occasionally to separate attacking from defensive marks. Most rewardingly, on occasion, we have been able to create marks, or combinations of marks, that match exactly those visible on museum specimens and which we were previously unable to interpret (Hermann et al. in press).

Alongside these achievements, however, we are left with a notable shortcoming: the marks produced in our experiments were often far larger than those observed on the prehistoric weapons (Fig. 13.7). There are several possible causes for this divergence. One possibility is that the differences are due to the specific alloy used and/or the cold working and finishing techniques applied to our swords (paralleling the observations of Soriano-Llopis and Gutiérrez-Sáez 2009). A second possibility is that this difference emerges from the experimental design that characterised our project – we were trying to make marks rather than truly fighting. Focusing our effort on making marks rather than truly attacking or defending may have resulted in differing forces and strengths and, therefore, larger and more pronounced marks than those observed on the prehistoric weapons. However, this problem was tempered by our 'fluid' tests based on historic fighting styles, which will be discussed in future publications. A third, and related, possibility is that the size of the marks actually tells us more about the nature and style of combat with these weapons in the Bronze Age.

Fig. 13.7 Upper: wear mark from an experimental replica sword. Lower: wear mark from a prehistoric sword from the Isle of Man. (Image: R.J. Crellin)

Conclusion

In this chapter, we have discussed the development of the experimental methodology applied to the 'Bronze Age Combat project' and reflexively considered its advantages and shortcomings. Designing a project that seeks to consider the nature of combat in the European Bronze Age is far from simple: a good project has to be grounded in an understanding of multiple context-specific factors including what violence was, who was involved, what weapons were used and how those weapons were used. In addition, a good project has to recognise that many different forms of violence exist in any given society, with differing rules, arenas and material cultures for their enactment. Our project aimed to explore Bronze Age combat styles and the wear marks that these styles may have left on prehistoric weapons. We identified the shortcomings and advantages of what we saw as one of the key differentiating factors in previous research in this area: conducting experiments in a laboratory setting versus a field environment. Experiments in laboratories present us with fewer variables, and their results are easier to control, but they often fail to consider the complex role of the human body in combat. In contrast, field experiments normally involve a far greater number of variables, control over which can be poor. Our experiments were designed to bridge this gap: we worked in the field in a way that allowed the role of the human body to be accounted for, but – crucially – we broke combat down into individual moves, which could be recorded independently in order for us to understand the formation of wear marks accurately. This methodology has both advantages and shortcomings. In terms of shortcomings, the sheer scale of combat damage to the weapons has meant that we could not carry out as extensive a range of experiments as we had first envisioned. Whilst working in the field allowed us to centre the experimental work on the human body and the unique synergies created by the body-weapon unit, we encountered recording difficulties resulting from the working environment. As for the advantages of our approach to weapon testing, by breaking down combat into single moves, we have been able to link specific moves with specific wear marks. Furthermore, by using multiple weapons in different combinations, we have been able to consider the relative merits of different weapon types, thereby developing ideas about their affordances and the resulting combat styles. These ideas were further explored in sets of 'fluid' combat tests based on Mediaeval fencing manuals, which, however, have not been discussed in this chapter. Finally, the design of our experiments has allowed us to begin to consider how marks from deliberate destruction might vary from those created through 'normal' use. Our experiments were specifically focused on the production of wear marks. This has meant that our field tests could never truly reflect real combat encounters, in which the combatants concentrate on their own survival and the defeat of the opponent. It was, however, this focus on the controlled production and understanding of combat marks that gave the *Bronze Age Combat Project* its distinctiveness and 'edge' over previous experiments with prehistoric weapons.

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Chapter 14
Value, Craftsmanship and Use in Late Bronze Age Cuirasses

Anne Lehoërff

Introduction

The subject of warfare has been an emerging theme over the last 15 years, having been long neglected despite its obvious relevance due to the widespread weaponry and armour in archaeological contexts (e.g. Carman and Harding 2004; Guilaine and Zammit 2001; Guilaine and Sémelin 2016; Keeley 1996; Osgood and Monks 2000; Patou-Matis 2013; Ralph 2013; Thorpe 2013; Uckelman and Mödlinger 2012). The history of archaeology, in the context of the wars of the nineteenth and the twentieth centuries, as well as the personal, social and political perspectives of many researchers, has long led to a general reluctance to consider the violent nature of most European prehistoric societies (Keeley 1996). Although the archaeological record provides a wealth of data regarding ancient combat and fighting, ideas of violence and warfare in prehistoric societies remain difficult to address by researchers.

For archaeologists, weapons provide one of the key categories of data to unlock Bronze Age violence and warfare. Until recently, early bronze weapons (such as swords) and armour (such as helmets) were studied essentially in terms of typo-chronology (Muller-Karpe 1959, 1962). This approach is obviously important (and was especially so before radiocarbon dating), but typo-chronology alone is not sufficient to help us understand warfare as a central component of past societies. Anthropologists researched warfare and violence long before archaeologists turned their attention to the subject (e.g. Clastres 1977; Levi-Strauss 1943). Archaeologists, on the other hand, have posed new and different research questions and have developed

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methodologies that are specific to their discipline (Harding 2007; Otto et al. 2006). Weapons are still central to current archaeological approaches to warfare, but in recent years, the discipline has shifted away from typo-chronology to consider the technical aspects of weapons and their social context more broadly.

It is in this context, I argue that technological questions regarding early bronze weapons and armour can be approached from two angles, firstly, to provide new data regarding production and function itself (Lehoërff 2017a, b) and, secondly, to explore the concept of value. Value is a topic that has received relatively limited attention within archaeology. In this chapter, I intend to show how one can link material culture, such as weaponry and armour, to its social context and how this can shed light on past ideas of value. The technical and practical investment necessary to produce a given object and the investment of labour and other resources directed at warfare more broadly express something of the values that structure a society. By using the material culture of combat to understand the social concept of value, I hope to open up a new area for future research. This chapter does not offer my final thoughts on this subject but instead aims to lay the groundwork for a discipline-wide debate on past concepts of value.

This chapter seeks to explore the relationship between warfare and value. It considers the amount of effort that Bronze Age societies 'invested' in weapons and armour in order to explore the value attributed to combat and warfare more broadly. To explore this concept, I discuss Bronze Age cuirasses as a case study. Cuirasses embody a very high level of craftsmanship and a significant investment of time and labour, thereby allowing us to explore the concept of value. This discussion will refer to the results of studies of a number of iconic cuirasses (i.e. Marmesse, Saint-Germain-du-Plain and Grenoble; Lehoërff 2017b), along with the practices associated with the life cycles of these objects from manufacture to deposition. By exploring the specific choices that craftspeople made whilst producing these cuirasses (through a *chaîne opératoire* approach: Leroi-Gourhan 1943, 1945), we can begin to consider the kinds of values that may have lain behind specific technical decisions. Bronze cuirasses are chosen here because they materially embody high-tech realities that are 'strategic', and therefore significant, for Bronze Age society (for the distinction between 'strategic' and 'nonstrategic' production, see Lemonnier 1983). Having explored cuirasses as a case study, later in the chapter, I shall reflect on the concept of value and its relationship to Bronze Age warfare and violence.

Metallurgy in Warfare

Warfare was not created by the invention of metallurgy, nor does warfare have its origins in the invention of bronze specifically. Bronze is an alloy of copper and tin, which allows one to make both harder and mechanically more resistant objects compared to pure copper objects, by adapting production techniques and knowingly changing the composition of the alloy. Whilst the development of bronze metallurgy did not cause the development of warfare, it did lead to significant changes in the shapes and mechanical properties of weapons and thereby in the nature of combat itself.

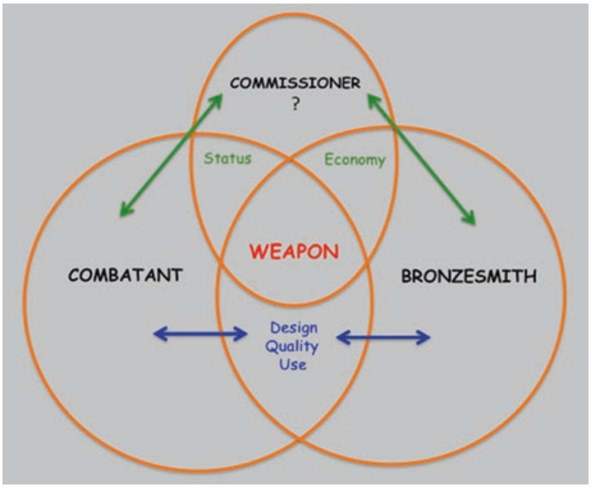

Fig. 14.1 Diagram showing the relationship between user (the combatant), manufacturer (the bronzesmith) and a hypothesised commissioner in the production of Bronze Age metal arms and armour, as discussed in this chapter (Image: A. Lehoërff)

I argue that the evolution of warfare was made possible by the existence of two categories of individuals in Bronze Age society: combatants and bronzesmiths. This argument (preliminary presented at colloquia and seminars and still largely unpublished: Lehoërff 2017b, fig. 12, 2018) stems from a consideration of the technical data from the study of weapons and armour from the period. In addition to arguing for these categories, I suggest that one might imagine a possible third actor whom I shall christen the commissioner (Fig. 14.1; Lehoërff 2012, fig. 71). The commissioner is not strictly necessary for the manufacture of weapons and armour as such (this is the role of the craftsperson) and cannot be confused with the combatant (the user). However, in the context of the large-scale production of bronzes taking place in most of Europe from mid-late second millennium BC, one can indeed imagine the presence of a commissioner as part of the network involved in the organisation, distribution and structuring of the craft system.

The weapons thus produced were intended to be used by combatants; as such, they needed to possess certain material qualities and technological standards. For centuries, combatants could fight at a distance from each other, using bows and arrows as well as other projectiles. The evolution of specialised metal weaponry in the Bronze Age changed fighting tactics for good and, in many instances, brought the warriors closer together. In this context, the emergence of the sword was a major breakthrough, which caused significant changes in prehistoric combat styles and warfare tactics. As a technical product, the sword is entirely dependent on the mastery of bronze metallurgy. The sword is generally considered to have derived from the dagger, although its origin was probably more complex and was perhaps influenced by both axes and halberds, which were made from bronze since the late Neolithic (Harding 2007; Kristiansen 2002; Vandkilde 1996; Lehoërff, in press a). Just as importantly, the sword is also the result of the *creativity* of the bronzesmith (Lehoërff 2017b).

Who was the one who first conceived of the sword, the warrior or the craftsman? It is impossible to know for certain, but this object must surely have arisen out of a multifaceted dialogue between people and matter and in particular between warrior and smith. The process clearly required the imagination and innovation of the craftsperson. Without their knowledge and mastery of sophisticated metallurgical knowledge, the birth of the sword is unimaginable. Similarly, the development of hammered sheet metal for the manufacture of defensive armour cannot be understood without the role of the bronzesmith. Even so, it is difficult to imagine that smiths could work outside their social context and without specific demand from users and/or commissioners. To understand this process, the challenge for us archaeologists lies in assessing the relationship between the actors involved in the process (i.e. smiths, combatants and commissioners) and the society to which they belonged, as well as the nature of its structuring values.

Iconic Cuirasses

Bronze Age cuirasses have often been studied from various perspectives, which may or may not have included scientific and technological approaches (e.g. Mödlinger 2012, 2013; Petres and Jankovits 2014; Lehoërff 2008; 2017b). In this chapter, I wish to discuss how the results of scientific and technological studies can be used to identify certain criteria, which in turn may help us understand prehistoric ideas of value and enable us to distinguish 'strategic' from 'nonstrategic' production (Lemonnier 1983).

Putting aside debates on typological attribution, which are of limited interest here, scientific and technological studies of cuirasses have frequently focused on a series of key questions:

What was the *chaîne opératoire* of their manufacture?
What alloy was used?
What links exist between the material used, the fabrication method and the use of these objects as defensive armour?
Can one suggest a quantitative assessment of working time and an estimate of the quality of the artisan's work?
What conclusions can be drawn about the techniques used in its manufacture?
And what proposals can one make about the technical knowledge of the societies that made and used these cuirasses?

Of course, some of these questions may be difficult to address due to the partial and fragmentary nature of the archaeological data. Seen from a broader perspective, however, Bronze Age cuirasses allow us to address key questions about the importance that past societies accorded to skilled craft production, which was itself driven by the values of those societies (Kuijpers 2017).

Consider, for example, the Marmesse (Haute-Marne) cuirasses from Late Bronze Age France (Figs. 14.2a, 14.2b, and 14.3): they form an exceptional assemblage of eight pieces of body armour. They were found by chance in several phases (we cannot speak of real 'excavations' given the problematic history of their discovery;

Fig. 14.2a Marmesse cuirass no. 86756, front view; Musée d'archéologie nationale, Saint-Germain-en-Laye, France (Photo: A. Lehoërff).

Fig. 14.2b Marmesse cuirass no. 86756, rear view; Musée d'archéologie nationale, Saint-Germain-en-Laye, France (Photo: A. Lehoërff)

Lehoërff 2008, 96–97) and were reassembled at a later stage. Observations made during their technological study by this author indicate that there may be a problem of reassembly with the back of cuirass number 83753 (Lehoërff's personal observations made in 2008 with J.-P. Guillaumet; see also Lehoërff 2016, 326–327). The reassembly issue suggests that there may have been an additional backpiece in the hoard and therefore one more cuirass within the assemblage.

Fig. 14.3 Detail of Marmesse cuirass no. 86756 from the inside. The riveting and assembly system is clearly visible, including instances of hammering (bottom of the cuirass) not followed by polishing, which was seemingly considered unnecessary in a hidden part of the cuirass (Photo: A. Lehoërff)

This observation is given further weight by considering the composition of Late Bronze Age armour hoards more broadly, as these tend to consist of nine objects each. Take, for example, the group of helmets from Bernières-d'Ailly (Normandy; Coutil 1911), consisting of nine items. Similarly, a hoard discovered in Paris in 1628, dated to around 1000 BC (but it may be older: see Mödlinger, Chap. 9, this volume), comprised nine cuirasses (Bulard 2008). Considering the aforementioned issue of reassembly and the recurrence of nine pieces of armour in several French hoards, it might be possible to suggest that the Marmesse hoard would originally comprise nine cuirasses.

Further observations seem to confirm this proposal. Marmesse constitutes a coherent assemblage of deliberately abandoned pieces of armour, which were seemingly deposited intact, like the helmets from Bernières-d'Ailly. At Bernières-d'Ailly, the description of the discovery allows us to appreciate the arrangement of the hoard as three sets of three helmets, making nine in total – a situation which is impossible to ascertain for Marmesse because of the unclear circumstances of the discovery. However, Bernières-d'Ailly offers a useful template for understanding the structured practices that would have regulated the deposition of armour in Late Bronze Age Europe.

The Marmesse cuirasses were subjected to technological analysis by this author (Lehoërff 2008, 2015, 2016, 326–327, 2017b); the main results are summarised below. The study was carried out according to standard archaeometallurgical practices. These included the visual examination of the objects, focusing in particular on the manufacturing evidence (e.g. traces of hammering and the technique of assembly; Fig. 14.4). This was followed by the visual inspection of the area to be sampled (Figs. 14.5a and 14.5b), which allowed us to avoid the risks of analysing corroded metal, where the tin content might be higher than in the sound metal matrix (Lehoërff 2015). By kind permission of the National Archaeology Museum of Saint-Germain-

Fig. 14.4 Side view of Marmesse cuirass no. 86756, showing a repair made by adding a piece of sheet metal, cut to size and riveted on. Given its quality, the repair might have been performed during manufacture, although it cannot be excluded that it followed use, possibly to mend a weapon impact damage. In any case, the accurate replication of the cuirass decoration and riveting system suggests that extreme care was taken in making the mending as discreet as possible (Photo: A. Lehoërff)

Fig. 14.5a Location of one of the samples taken from Marmesse cuirass no. 86756 for compositional and microstructural analysis (Photo: A. Lehoërff)

en-Laye (France), 17 samples were subsequently taken from different parts of the cuirasses for SEM-EDX compositional analysis and metallography. The analysis showed that the bronze was heavily, and rather meticulously, hammered into thin sheets from relatively thick blanks (thickness reduction is estimated at more than 90%). The smith was able to overcome the risk of cracking the sheets by knowingly stopping the hammering before it was too late and also by softening the metal through several cycles of annealing (see below).

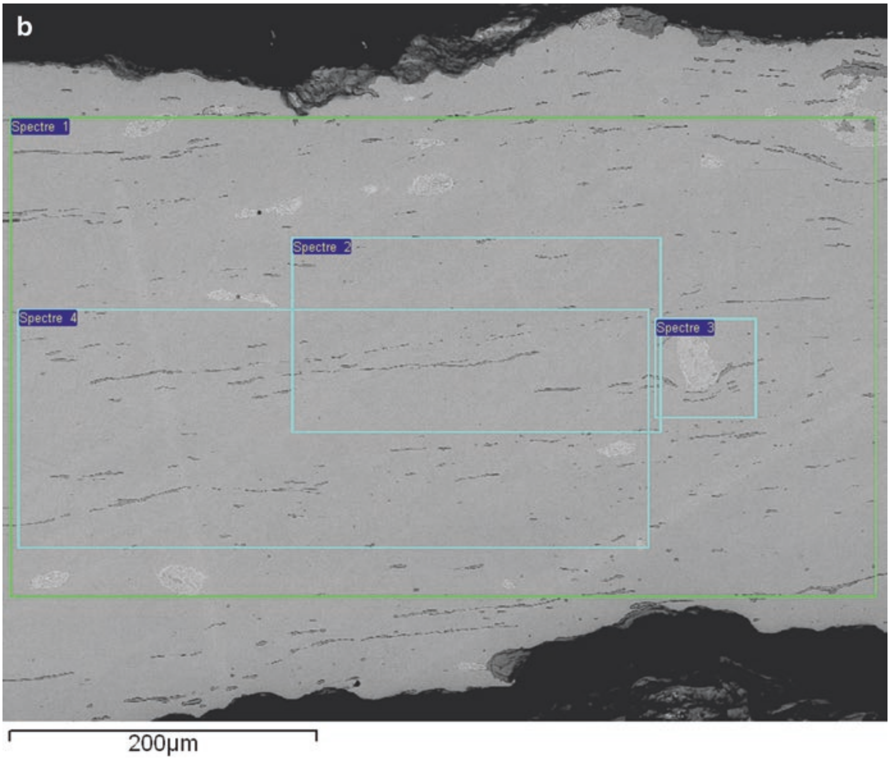

Fig. 14.5b Microstructure of one of the samples taken from Marmesse cuirass no. 86756 as revealed by scanning electron microscopy. The zones of metallic matrix are clearly visible in the micrograph including elongated inclusions of sulphides in black (attesting to considerable hammering) and, atypically, many eutectoids, which can be identified in the micrograph as light grey areas (Micrograph: A. Lehoërff)

Unexpectedly, certain bronze sheets (cuirasses 86197, 63754 and 83758) show an unusual level of secondary eutectoid segregation (Lehoërff 2008, 98 and 102); this would have been detrimental during plastic deformation by hammering, and it would certainly have forced the craftsperson to carry out several cycles of annealing between the hammering episodes in order to recrystallise the metal matrix. Moreover, relatively numerous sulphide inclusions were observed in the samples. This suggests that hammering may have been especially difficult as sulphide inclusions increase the risk of cracking, thereby forcing the craftsperson to work carefully, paying special attention not to reach the limits of plastic deformation. It is thus evident from the analysis that a thorough process of painstaking shaping would have been required to make these objects.

The cuirasses are made of a bronze alloy with around 9% tin; this is quite common for objects of this kind (Lehoërff 2008, 100–101) and suggests that these objects were intended as functional pieces of defensive armour. Tin contents below 5% would be detrimental to the functionality of the armour as would amounts of tin

Fig. 14.6 Bronze cuirass from Saint-Germain-du-Plain, front view; Musée d'archéologie nationale, Saint-Germain-en-Laye, France (Photo: A. Lehoërff)

above 20%, which would cause the sheet metal to be too brittle and increasingly hard to hammer into shape. Interestingly, however, the beading set around the edges of the cuirass plates contains lower amounts of tin and a significant percentage of lead. This would have made the manufacturing process of the beading easier, as well as increasing their functionality. It also shows that tin presumably was a rare material, not to be wasted for parts of the cuirasses that did not have a pre-eminently defensive function (Lehoërff 2008, 101).

In addition to the craftsmanship involved in the primary shaping (i.e. casting followed by careful hammering and annealing of the blanks), to reconstruct the complete *chaîne opératoire* of the Marmesse cuirasses, one must also consider the assembling and finishing work. Taking account of these steps, details of which have been discussed with a modern bronzesmith (Dubos 2017), I estimate the amount of time required for making each cuirass, from casting to finishing (under Bronze Age working conditions), at around 150 h. If one multiplies this time by the nine corselets in the assemblage, it would take at least 1350 h of work to construct all pieces of armour in the hoard. Allowing that the bronzesmith worked around 8 h a day, it would have taken about five person months to make the nine Marmesse cuirasses. This time is further increased by taking account of the repairs visible on all the cuirasses. This includes both the remedial work that occurred during fabrication and the repairs that were carried out as consequence of use damage.

A similar approach to research was applied to the study of the cuirass from Saint-Germain-du-Plain (Saône-et-Loire; Figs. 14.6 and 14.7). This piece of armour, also dating to the Late Bronze Age, has relatively similar technical characteristics to the Marmesse cuirasses. It was made from a similar tin-rich alloy (Lehoërff 2017b), although metallographic analysis shows slightly less plastic deformation on average vis-à-vis cast blank thickness, but (contrary to the Marmesse corselets) no atypical

Fig. 14.7 Bronze cuirass from Saint-Germain-du-Plain, side view; Musée d'archéologie nationale, Saint-Germain-en-Laye, France (Photo: A. Lehoërff)

presence of eutectoid segregation due to quenching. There is also a significant presence of sulphides, as is normal in copper alloys dating to this period (Fig. 14.8). Upon considering that the manufacture of this corselet involved a little less plastic deformation than for the Marmesse cuirasses, one could estimate a slightly shorter working time for its construction, but not significantly so. One can doubtlessly assume that other known specimens of Bronze Age cuirasses (such as Fillinges and Grenoble; Mottier 1988; Michel and Mohen 1970, 65–67; Fig. 14.9) have similar characteristics, which would result from similar fabrication processes. It follows that all Bronze Age cuirasses must be considered as exceptional pieces of craftsmanship, which demanded high-level expertise and considerable construction time on the part of bronzesmiths. The smiths clearly made technical choices appropriate for each stage of their production, including the rapid cooling of the blanks in the foundry – as is the case at Marmesse – as opposed to slow cooling, which would be the most rational choice in such an instance.

In order for Bronze Age smiths to be able to manufacture these cuirasses, we must assume that they would have been able to tap into extensive exchange networks for the procurement of the raw materials including several kilogrammes of copper and several hundred grammes of tin and other metals, which were necessary to create objects weighing 3–4 kg each (27–36 kg in total for the Marmesse hoard). However, such a considerable amount of metal pales to insignificance if compared to other bronze hoards from the period, comprising hundreds of kilogrammes of bronze each (e.g. the hoards from Guşteriţa and Uioara de Sus in Romania; Reissenberger 1872, 35; Petrescu-Dîmbovita 1977, 114–116). It is also notable that, despite the difficulties inherent in such an elaborate and time-consuming production process as the one described above, the bronzesmith would likely have carried out

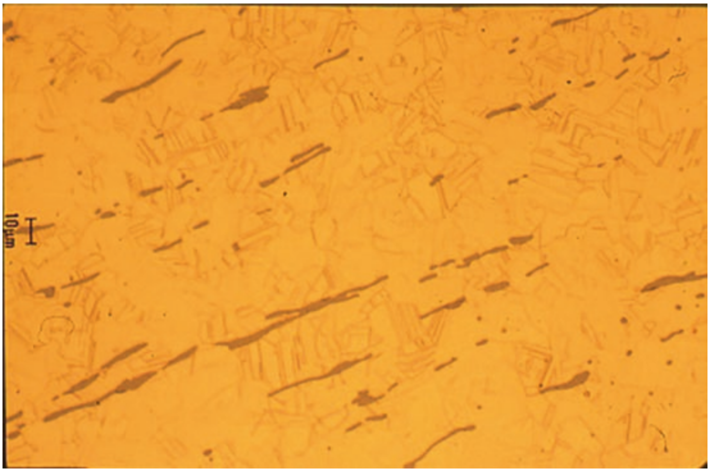

Fig. 14.8 Microstructure of one of the samples taken from Marmesse cuirass no. 83756 as revealed by scanning electron microscopy. The photograph shows elongated sulphide inclusions and round lead nodules within a microstructural matrix typical of beaten bronzes that underwent significant plastic deformation (Micrograph: A. Lehoërff)

Fig. 14.9 Bronze Age cuirass from 'Grenoble' (probably found in the Jura region, France, around 1860), front view. Musée de l'Armée, Paris (Photo: A. Lehoërff)

the entire *chaîne opératoire* of cuirass making from casting to finishing, proving, if proof were needed, the high level of their skill and technical knowledge.

Turning now to depositional practices, it is clear that hoards with complete objects and single-type hoard (i.e. hoards containing multiple items of the same type of object) are the product of a particular logic. Despite being the product of many hours of hard labour, the cuirasses found in Bronze Age hoards were disposed of as part of deliberate ritualised practices, which consciously denied the possibility of recycling the metal.[1] The economic and technological investment required in their manufacture would thus seem to stand in stark contradiction with their fate. In order to make sense of such apparent contradiction, one should turn to the social logic underpinning prehistoric depositional practices. Cuirasses can be considered unsurpassed technological feats of Bronze Age metallurgical craftsmanship, a sort of *L'An Mil BC*, to use a now-classic French phrase (Bonnassie 2001; Boucheron 2010). Cuirasses, and hoards of cuirasses, find their meanings at the nexus between maker and user, perhaps including the commissioner too. Such a relationship between bronzesmiths, combatants and commissioners must have been formalised in the context of a society that invested people and objects with specific meanings – a society that, for example, recognised and indeed promoted an adequate investment in time, knowledge and resources to make 'high-tech' metallurgical products. We must thus presume that bronze cuirasses made sense for the society that made them; which is to say, their production was driven by the concepts of value underpinning that society. By considering the cuirasses as a case study, one might be able to gain a foothold into the notion of value as a structuring social concept.

Exploring the Concept of Value in Archaeology

This chapter is concerned with the concept of value in a prehistoric context. But why discuss value in a paper on metallurgy and warfare? Let us take a moment to consider the word and concept. The term 'value' is ambiguous and multilayered. Until recently, the concept of value was closely associated with the economic domain, in which it had first found its place in the eighteenth century. From the 1960s, the concept of value was also explored within the context of Marxist historiography (Marx 1885), and, for about two decades, the disciplines of history, anthropology, sociology and philosophy discussed it from various theoretical perspectives (Belshaw 1959; Firth 1953; Sahlins 1972). With the end of the post-war global order in the 1990s and the ensuing social and political readjustments caused by increasing globalisation, scholars from multiple intellectual standpoints have tried to redefine the terms of the debate regarding value (Charbonnat 2007; Perret and Roustang 1993). By contrast, the term 'value' was practically abandoned in the humanities in general, including anthropology, where it had held an important place during the twentieth century (Dumont 1980; Godelier 2007; Graeber 2001). Today, in a post-modern world characterised by the lack of overarching interpretative models, the concept of value is no longer seen as an intellectual taboo and is slowly, but surely, regaining centre stage as a tool for the analysis of contemporary society (Bailey 1998; Barraud et al. 2016; Eiss and Pederson 2002; Lejeune 2015). This is partly due to new forms of lateral thinking focusing on present-day action,

[1] However, there may be cases of partial deposition, in which one fragment was deposited in a hoard and the rest returned to the smith's crucible, following a *pars pro toto* logic (Lehoërff 2017b).

where value is used as an analytical or heuristic concept (Boltanski and Thévenot 1991; Graeber 2001).

In this context, what may value mean? First and foremost, value is still defined today from an economic, if not downright monetary, standpoint (Johnson 1994; Orlean 2011). This is value as price or cost, something that is quantifiable in terms of labour or time investment. However, value has many other dimensions to it including the importance given by a society to goods, gestures or actions from a religious, cultural or symbolic perspective. Such a definition does not stem from a strictly economic logic but is still intimately connected to it. According to this reading, value acts as a guiding principle for the conduct of daily life, which may be expressed in the management of funerary practices as well as attitudes to people, places and beliefs. Value becomes here a corollary of respect, of standards and of social conventions. Above all, value can be understood as a foundational principle of society or as a socially structuring concept, and this is as true today as it was in prehistoric times. The values that a society applies to different domains of action affect how people act and live in the world, for they may abide to (or reject) these values, or else follow their own logic and perspective in discursive relationship to socially sanctioned beliefs (Boltanski and Thévenot 1991; Godelier 1996, 2007; Lehoërff in press b; Miller 2008).

How then do we link value, an immaterial concept, with the materiality of archaeology? Before putting forward any hypothesis, it is necessary to look at the place that value has held in the history of archaeology. Just as other disciplines in the humanities and social sciences, archaeology has long been suspicious of the notion of 'value' to the point of excluding the term from its vocabulary (both in prehistory, i.e. the Palaeolithic, and protohistory, i.e. the Neolithic and metal ages; Lehoërff 2009). The subject is often indirectly approached via other concepts such as 'prestige goods', which is often applied to rare, exotic or exceptional artefacts from prehistoric graves and hoards. In this context, bronze weapons are often considered as 'prestige goods' (Brück and Fontijn 2013; Harding 2007; Mödlinger 2013).

Following anthropological approaches to the problem, archaeologists have often explored the immaterial dimensions of value (Maquet 1993; Godelier 1984, 1996; Graeber 2001, 64–89; Testard 2006). More often than not, those who have done so have treated value as a socially structuring concept, either relationally or organisationally. Others, however, have uncritically applied modern ideas of value to past material culture. For example, metal fragments gathered together in prehistoric times were understood as being destined for recycling and thus uncritically dubbed 'founders' hoards'. This is because, in late nineteenth-century Europe, they could have had no other destination than the crucible. These readings were grounded in unspoken assumptions about the nature of value, which would have been fundamentally unchanging from the second millennium BC to the present day (Bradley 1990; Osborne 2004; Testard 2013).

The time has now come to reject uncritical readings of this kind and newly assess the notion of value in terms of its relation to the materiality of the archaeological evidence (Fig. 14.10). Today, as anthropology reappropriates and reinvents

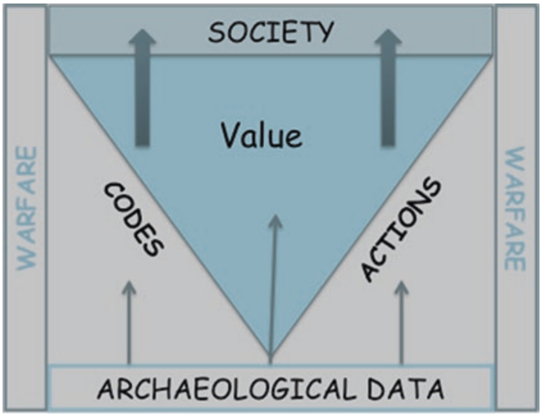

Fig. 14.10 Diagram showing how past notions of value can be accessed via archaeological data and how in turn these lead to broader inferences about prehistoric societies in the context of sanctioned violence and warfare (Image: A. Lehoërff)

the concept of value, archaeology must take up the challenge and do the same. The insights afforded by our discipline are critical in this respect, because archaeology is grounded in the study of material culture, which in itself lies at the heart of the definition of value. For these reasons, it is essential that we reconnect the notion of value to broader archaeological debates through the concept of materiality. Archaeology must now reconsider the notion of value, not only to question itself (see, e.g. the recent debate on the value *of* archaeology as a science dedicated to cultural heritage – as opposed to value *in* archaeology; Lafrenz Samuels 2008) but also to create original knowledge about the past. By doing so, not only will archaeologists gain new heuristic tools for the study of past societies; they will also acquire new tools for reflecting on a concept that is universal in nature but multifaceted in its definitions and applications.

The questions are the following:

How can we study value from an archaeological perspective?
What kind of results might we achieve by doing this?
What can we learn from the archaeological study of value, which might help us reflect on the philosophical and economic dimensions of the concept (Earle 2002; Flad and Hruby 2007)?
Moreover, what lessons can we take from the archaeological study of value, which may be useful for today's world but also help us build the world of tomorrow?

Dealing with the concept of value in the oral societies characterising our prehistoric past is a multidisciplinary challenge, and archaeologists must work alongside other specialists if they are to achieve any lasting results in this field.

In many oral societies, the notion of value is intimately tied to that of identity (Sofaer 2007; Thomas 1996). Given the lack of written sources, our interpretative work may be complex as it requires not only proficiency in the methods of archaeological enquiry but also materials science skills and a constant theoretical dialogue with anthropology (Johnson 1994; Otto et al. 2006; Testard 2006). Exactly what value a past society may have imparted onto materials, objects or places will vary depending on the society itself, but it is structured by social organisation.

Value is defined here as a foundational or structuring principle of human societies. As such, it can explain behaviours, gestures and choices. However, unlocking ideas of value in the oral societies of the past may be difficult and must be achieved through careful analysis of the archaeological evidence. In this context, not all data bear the same informative potential, as some categories of data are more helpful than others. High-tech craftsmanship such as the one discussed in this chapter falls into the category of 'strategic' data through which to explore structuring societal values. Metallurgy, and in particular the manufacture of arms and armour, is especially informative in this respect. Seen from this angle, bronze cuirasses lie at the apex of prehistoric technological performance and must thus be understood as a major social investment. Therefore, they represent an ideal case study for the exploration of past notions of value. To further develop my argument, I now wish to turn to the relationship between people and matter.

The Dialogue Between Archaeology and Materiality

Addressing the question of value in archaeology involves engaging directly with the primary data, which are material. The dialogue between archaeologist and matter was initiated by prehistorians of the Palaeolithic, organised in one school of thought in France by André Leroi-Gourhan (1943, 1945; see also Delage 2017). He first introduced the *chaîne opératoire* concept as a tool applicable to all manufacturing processes and all materials. However, the core of his argument hinged on the relationship between the material and the immaterial, i.e. the immaterial gestures of the craftspeople vis-à-vis the material traces they left on the physical objects. This did not involve any exploration of the concept of value.

Due to the influence that Leroi-Gourhan exerted on technological studies, in the last 50 years, scholars have rarely approached technical gestures and actions in terms of value. Yet this is central to our understanding of past technological practices. To return to our case study, every action and choice made by the three actors lying at the core of the Bronze Age cuirass making and using process (i.e. bronzesmith, combatant and commissioner) was shaped by the values inherent in their society. Anthropologists and sociologists (e.g. Pierre Bourdieu), as well as philosophers (e.g. Michel Foucault), have seized more willingly on this issue, but of course not from an archaeological perspective. This has been attempted by other researchers, who have more directly approached the relationship between technical choice and value (e.g. Firth 1953; Belshaw 1959), including the material dynamics of the process (e.g. Godelier 1984; Sahlins 1972).

What I propose here is that it is possible to use technological data from archaeology and materials science to shed light on specific technical choices and actions that took place whilst producing an object and in turn use these choices to shed light on prehistoric ideas of value. I argue that it is now high time to do so by reconnecting with a research strand developed in France half a century ago (i.e. *chaîne opératoire* studies) and renew it by originally linking it to the concept of value. The link is grounded in the idea that the relationship between person and matter is two-way and dynamic: people choose, organise, work with, combine, acquire and exchange materials; at the same time, however, the materials impose their own constraints and possibilities on the choices of the artisans. All materials have their own affordances, as all craftspeople are well aware of. Craftspeople do not passively constrain the materials; they experiment with, and adapt, the technology in hand to both reach the desired outcomes and fulfil social expectations, taking account of the affordances and capabilities of the material they work with. Empirically, patiently, the craftsperson experiments, discovers and adapts, working within the constraints of both individual and socially sanctioned creativity (Lehoërff 2015, 2017b). In this way, people and matter come together in finding solutions to achieve the goal that they themselves have set and society expects of them. Our goal, in contrast, is to measure, understand and get closer to the subject matter, never forgetting the people behind the objects, the *ideél* behind the *matériel* (sensu Godelier 1984).

When we approach the study of the *chaîne opératoire* from this perspective, we must ask ourselves how we will evaluate the investment of a society in the manufacturing process and also go further to include questions regarding the acquisition of materials and finished objects, as well as their subsequent usage. ‘Strategic’ materials and key activities are especially interesting for an analysis of value as a structuring element in a society. Furthermore, materials and material culture, which engage with issues of power, knowledge and skills, are all the more informative in that they are key indicators of practices, which are themselves structuring social realities at multiple levels: organisational, technical and economic. This kind of social investment may be evaluated by the rigorous data analysis of archaeological materials science.

Concluding Remarks: Metal, Value and Warfare

As I have argued above, at the heart of this chapter lies an attempt to link technological choices (as revealed by archaeological and materials analysis) to social concepts of value. The aim of the exercise is to explore technical choices from a social perspective, going beyond narrowly technological readings. It has been argued throughout the chapter that value is a central structuring component of society as it shapes social and technological practices. Past notions of value can thus be revealed via the technical choices made during the operational sequence of object production. In this way, a largely immaterial concept such as value can positively be explored in prehistoric contexts by looking at the material choices made during the production, use and deposition of material culture.

At this point, we must turn to a partly new, and deceptively simple, question: how could the study of Bronze Age cuirasses reveal the concept of value in its broadest sense? The answer lies in the logic of sequences: the technical study of cuirasses shows that the objects were the product of high-end technological knowledge and considerable time investment. These forms of investment would not occur if the societies concerned did not attach a crucial importance to the crafts and activities concerned with their production, use and deposition. Seen from this angle, the study of Bronze Age cuirasses has the capability of shedding light on broader societal norms and values. The interpretative framework proposed here, which entails using archaeological science to explore past technical choices that can unlock ancient ideas of value, may not be easy to put into practice but is certainly worth pursuing. Translating analytical data into social history may not be a straightforward procedure; yet it is one that opens new, and indeed stimulating, research perspectives.

Metal is emblematic of the European Bronze Age, and it has been at the forefront of prehistoric studies since the nineteenth century. A century ago, metal objects were normally considered to be 'prestige goods'; this was self-evident to early researchers and did not warrant further explorations. Bronze swords emerged around 1700–1600 BC all across Europe (Harding 2007, 73). They were not directly responsible for the creation of warfare, but they did have a significant impact on its evolution and societal role. From the late second millennium BC, the production of sheet metal armour provided a further medium for social engagement in terms of power, knowledge, skills and practices. The considerable amount of technical, economic and social investment required for the production of sheet metal armour suggests that the practices involved in this craft can reveal structuring principles of Late Bronze Age society. Therefore, technological studies of these iconic cuirasses (for which see Lehoërff 2008, 2015, 2017a) provide us with important new data to study prehistoric concepts of value. Bronze Age smiths would have innovated and adapted technological *savoir-faire* to conform to the expectations of the commissioner and user, in discursive relationship with social expectations and the physical constraints and affordances of the material (Lehoërff 2017a, b). Getting to know the operational sequence lying behind the production of an object is critical for us to estimate the social investment required in terms of material, skills and standards of the finished product. In turn, this is informative about the structuring values informing the society that made, used and deposited these objects.

'High-tech' metallurgical practices for the production of arms and armour are particularly suited to revealing ideas of value in Bronze Age Europe. The archaeological and scientific study of sheet bronze armour, for example, sheds light on the social importance of the craft, the level of expertise required and the role of artisanal creativity in Late Bronze Age society. Each and any of the Marmesse cuirasses needed about 150 h of work from casting to finishing, without taking account of the preparation and organisation work that must have preceded actual production. Does this mean that such an object would have been more important than, say, one which only took 2 h of work to be manufactured? Does the time spent, and the associated expertise, directly contribute to the value of the object? Surely, the analysis of a single cuirass is not sufficient to answer this question; not even the study of all sheet metal armour from the European Bronze Age would. Here, the role of the scholar is not to arrive at a definite answer but to search for an answer through the quantitative and qualitative study of bronze production techniques, including estimates of the amount of time required to produce a given object. These data provide useful indicators for the testing of theoretical hypotheses and the development of new ones. One cannot simply ignore the lessons of the technical study of sheet armour, as the societal investment made in their production is considerable.

Value is a critical component of human behaviour, both today and in the past. Critically, by studying archaeological data quantitatively, we can establish an empirical, science-based foundation for studying the notion of value in past societies and how it changed over time. This is a novel research avenue which shall open a new chapter of academic research and deepen, as well as enrich, our understanding of human behaviour.

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Chapter 15
Untangling Bronze Age Warfare: The Case of Argaric Society

Gonzalo Aranda Jiménez

Introduction

Science and history replace myth as a discourse of legitimation and order in those more individualised societies which exert a greater material control over nature. This form of reality-building based on scientific knowledge only became dominant from the nineteenth century, as part of so-called modernity. The scientific study of past societies became a key goal for displaying how modernity resulted from a process of continuous cultural innovation. Values such as reason, individuality, power, self-control, violence, change, technological innovation, masculinity, and competitiveness have influenced the way in which historical discourses have since been constructed (Hernando Gonzalo 2013, 2015). Narratives of past societies have emphasised these values, which still characterise Western understandings of the world. These values have long dominated, and continue to dominate, the research agenda and are especially persistent in academic traditions such as that of Spain, where postmodern thought has barely had any influence at all.

It is therefore unsurprising that violence, and warfare in particular, has emerged over time as one of the most significant foci in the study of past societies. Violence and warfare lie at the heart of the interests and values of modernity, of what Foucault (1985) called the "power-knowledge regime". Such emphasis on warfare studies has contributed to reinforcing those cultural expressions of power, male individuality, competitiveness and wealth, and, therefore, the socio-political order of Western societies. But is this warlike image of prehistoric societies in general, and of the Bronze Age in particular, a true reflection of the social and cultural dynamics of the

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past? In societies with limited material control over nature, such as those of Late European Prehistory, was warfare such a decisive element in the social dynamics? What role did kinship play vis-à-vis values such as collectiveness and reciprocity? And, overall, are we not imposing our own Western narratives on prehistoric societies? In the following pages, I will try to answer some of these questions using the Bronze Age of the Iberian Peninsula as a case study.

Iberian Bronze Age Societies

The Bronze Age of the Iberian Peninsula is characterised by a number of cultural changes entailing the interruption of the process of growing complexity begun in the Chalcolithic period. During the Copper Age (*c.*3200–2200 BC), important social and material changes took place in the southern half of the Peninsula, including population growth and aggregation, the appearance of large settlements monumentalised by impressive stonewalls and ditched enclosures, the development of copper metallurgy, the intensification of regional and supra-regional trade networks (encompassing exotic commodities such as amber, ivory, and ostrich eggs), and the appearance of complex funerary rituals carried out in megalithic tombs, rock-cut tombs, and caves (García Sanjuán and Murillo-Barroso 2013).

These changes led to intercommunity tensions and resistance to the then-growing social inequality (Cruz Berrocal et al. 2013). If we take into account the diverse social trajectories characterising the later Bronze Age in Iberia, these forms of resistance, which were ultimately grounded in mechanisms of social division typical of kinship-based societies, appear to have largely been successful. There is, however, one clear exception to the general trend: the Early Bronze Age societies of southeast Iberia, best known as the Argaric culture (*c.*2200–1550 BC). In stark opposition to most contemporary communities, Argaric societies are characterised by the intensification of social inequalities that led to the appearance of new political structures. Most scholars argue that Argaric societies reached a degree of complexity previously unknown in Iberia (Aranda Jiménez et al. 2015: 150–154). The most important dynamics shaping such profound social changes are described below.

The emergence of the Argaric culture in the Early Bronze Age marks a profound discontinuity with Chalcolithic settlement and society. Valley-bottom and lowland villages were abandoned, and the population moved to newly built settlements on hilltops and artificially terraced hill slopes (Fig. 15.1). Moreover, communities ceased to carry out substantial collective building projects, including megalithic tombs, ditches, and walled enclosures, and concentrated instead on the construction and shaping of the villages, which acquired a new landscape dimension. The Argaric village became a salient feature in the Bronze Age landscape due to its pre-eminent location and its consisting of tightly packed buildings (Aranda Jiménez 2015).

The Argaric house can be considered truly revolutionary compared to Chalcolithic dwellings. Houses were now rectangular or trapezoidal in shape with internal divisions; they greatly differed from the circular buildings separated by areas of open space characterising the previous phase. In Argaric villages, buildings were densely

Fig. 15.1 The hilltop settlement at Peñalosa. (By courtesy of Francisco Contreras)

packed together, and the open spaces typical of earlier villages were replaced by narrow streets. Argaric houses were built according to new concepts of spatial partitioning, which created a sense of "privacy" that had been absent in Chalcolithic circular buildings. Notions of collectiveness, which are integral to open spaces and circular structures, were replaced by new construction principles that emphasised fragmentation and restricted access. The new Argaric house was conceived of as a social space that incorporated not only the living but also the dead. This can be appreciated in the new custom of placing the dead inside settlements, normally as individual inhumations underneath house floors (Fig. 15.2).

Metallurgical craft specialisation can also be considered a major feature of Argaric societies (Montero Ruiz 1993, 1994). The number of metal objects increased almost fivefold in comparison to the previous Chalcolithic period, with most objects being intended for personal adornment (e.g. bracelets, earrings, pendants, rings, diadems, and beads). The growing demand for metals also stimulated significant innovations, such as the remarkable development of silver metallurgy (Bartelheim et al. 2012; Murillo-Barroso 2013). Another major innovation was the appearance

Fig. 15.2 Argaric individual tombs located below dwellings at the site of Cerro de la Encina, Southeast Spain. (After Aranda Jimenez et al. 2008)

of the first specialised weapons such as swords and halberds, while metal tools including awls, axes, knives, and saws acquired a new relevance as they replaced the Chalcolithic stone and bone tools used for similar purposes (Lull Santiago et al. 2009, 2010). The metal objects deposited in Argaric burials allow us to identify a select group of men, women, and children, who are normally considered to be part of the social elites of their time (Fig. 15.3). Within this select group, metals were used to further demarcate gender relations: women were accompanied by diadems and awls and men by swords and halberds (Montón-Subías 2007, 2010; Sánchez Romero 2008a, b; Aranda Jiménez et al. 2009a).

The suggestion that Argaric society was especially warlike dates back to the nineteenth century, when Enrique and Luis Siret cited "fear of the enemy" as an explanation for "the particular [i.e. violent] nature of the Argar civilisation" (Siret and Siret 1890: 324; *translated by the author*). They argued that the enemy, coveting the wealth of the land (in particular silver), would have waged war upon the Argaric peoples, causing their withdrawal to areas difficult to access, and giving rise to new customs such as the intramural burial of the dead. Thereafter, scholars have taken the warlike nature of Argaric society for granted and have largely failed to investigate the evidential basis of this inference. This generalised conviction has often been used – not always explicitly – to explain changes in settlement patterns, craft specialisation, and social organisation. In line with this trend, research into the European Bronze

Fig. 15.3 Male burial with two bracelets and an earring from the Argaric settlement of Cerro de la Encina, Southeast Spain. (After Aranda Jiménez et al. 2008)

Age has frequently considered the appearance of complex societies as the outcome of the emergence of new, individualistic, and self-interested warrior elites competing for political control (Harding 2000, 2007; Kristiansen and Larson 2005).

Untangling the Evidence of Conflict and Warfare

The emergence of specialised weaponry in the Iberian Bronze Age has been deemed conclusive proof of the rise of this new, warlike male elite. The other main source of empirical support for this view is provided by the alleged defensive structures of the Argaric settlements themselves (Siret and Siret 1890; Cuadrado 1950; Schubart 1973; Gilman 1976; Castro et al. 1993–94; Lull Santiago et al. 2014; Moreno and Contreras 2015). Recently, however, there has been a move towards re-evaluating the evidence supporting the warlike character of Argaric society (Sanahuja 2007; Aranda Jiménez et al. 2009b; Brandherm et al. 2012). Based on a recent critical review of the settlement patterns, specialised weaponry, and human skeletal remains (Aranda Jimenez et al. 2009b), it seems that violence was in fact present in Argaric societies, but not in the way that scholars would expect to see. The new interpretation and especially the debate that followed the aforementioned work are discussed below.

Settlement Patterns and Fortifications

Argaric sites tended to be strategically located on mountains and hills with natural defensive features and commanding views over the surrounding areas. This change in the preferred location of sites in the landscape has traditionally been interpreted as evidence of the need to control and defend the territory, if necessary by violent means. Alternative interpretations are possible, however. As mentioned above, the Argaric house is situated at the centre of a new way of understanding reality and the social order. In this period, the domestic unit emerges as the social space par excellence, in which both the living and the dead would partake. Accordingly, the house was reconceptualised as the principal space in the village to embody kin ties and genealogical relations. The form and features of the Argaric house emphasise fragmentation and division away from earlier inclusive domestic architecture. In this context, hilltops could have been chosen for settlement not because of their defensive features but as a way to highlight the landscape dimension of, and the new social structures materialised by, the Argaric house. Instead of places from which to control the surroundings, hilltops could have been acknowledged as locations enhancing the visual dimension of settlements and dwellings.

The commonly held view that fortifications arose in this period as a result of widespread violence can also be challenged. Despite intensive excavations at numerous hilltop settlements, structures such as walls, towers, and bastions enclosing large parts of the inhabited areas have only been identified at very few sites, such as Peñalosa (Contreras and Cámara 2002) and La Bastida (Lull Santiago et al. 2014). The latter is a recently discovered, and in many respects exceptional, stone-built fortification; it consists of parallel walls with towers shaped like truncated pyramids and bastions flanking a narrow entrance corridor. The defensive nature of this monumental construction seems indisputable. Nevertheless, the exceptionality of such a site in the Western Mediterranean Bronze Age must be emphasised. As stated by the excavators: "The innovative architectural elements – the solid square towers and water cistern – have no parallels in this period in Iberia, in the Western and Central Mediterranean or in Western Europe" (Lull Santiago et al. 2014: 405).

Specialised Weaponry

Central to our discussion is the emergence of specialised weaponry in the form of halberds and swords, which are often considered as irrefutable proof for the existence of warriors and warfare (Fig. 15.4). Closer inspection, however, reveals major

Fig. 15.4 A selection of Argaric halberds. (After Schubart 1973)

problems with such an interpretation. Dirk Brandherm (2003, 2011, 2012), for instance, found combat-related use-wear on only 10% of the halberds and swords examined in his research. In quantitative terms, this means that only five halberds and four swords revealed marks which were possibly caused by violent metal-on-metal strikes. These figures are all the more remarkable if one takes into account the very small number of specialised weapons found so far, just 1.7% of the total number of metal items known from the period, which in turn constitutes less than 10% of the overall metal used by Argaric smiths (Montero 1993, 1994). We should bear in mind that only 76 halberds (Lull Santiago et al. 2017) and 14 swords have been found to date, for a time span of *c.*700 years, in a region of *c.*45,000km^2, about the size of present-day Holland or Denmark (Aranda Jiménez et al. 2009b, 2015). Recycling has been proposed as an explanation for the low incidence of metal. However, recent studies have challenged the notion of intensive recycling of scrap

Fig. 15.5 Argaric sword with silver rivets. (After Moreno and Contreras 2015)

metal. In particular, the presence in the objects of volatile elements such as arsenic, which tends to disappear through remelting, has been considered as evidence of low recycling rates in Argaric metallurgy (Montero Ruiz and Burillo-Barroso 2010).

Experimental studies replicating the use of swords have also cast doubt on the efficiency of these weapons in combat (Carrion et al. 2002). As for the functional qualities of early metal weapons, it is worth noting that the sole halberd handle surviving from the Argaric Bronze Age is made of willow, a wood renowned for its lightness and flexibility – not necessarily the most appropriate qualities in a weapon (Hernández Pérez 1990). Silver rivets are also relatively common in Argaric swords and halberds, one such example being a sword from Peñalosa (Fig. 15.5) (Moreno Onorato and Contreras Cortés 2015). Micro-hardness analysis carried out on one of the rivets has returned a value of just 39.9 Hv, less than the average 56.3 Hv found in silver ornaments. If we compare this figure to copper rivets, which have an average hardness value of 153 Hv, doubts about this object being an actual, usable weapon are only accentuated (Murillo-Barroso 2013).

Axes and daggers should be considered separately, as these objects are found in large numbers (*c*.30% of all metal finds) and were seemingly important in Argaric society (Montero Ruiz 1993, 1994). Their possible uses as weapons cannot be ruled out, but the central role they may have played in more mundane tasks should also be emphasised. In particular, the frequent evidence of repair, maintenance, and sharpening seen on daggers, as well as size reduction, is consistent with their uses as tools (Brandherm 2003). During the Argaric period, the replacement of cutting and perforating items made of stone and bone with those made of metal highlights the importance of the latter in a wide range of craft activities. Such evidence has led to daggers being differentiated from weaponry proper (Aranda Jiménez et al. 2009b). Taking all the above into account, it is hard to imagine a context of generalised interpersonal violence in which metal weapons would have played a decisive role.

Human Remains

Evidence of trauma on archaeological skeletons may reflect interpersonal violence and aggression. Of course instances of prehistoric violence may have greatly outnumbered those revealed by the skeletal material as wounds may have solely affected now-decayed soft tissues. Furthermore, those who died in violent encounters may not have been buried in their home villages, thus reducing the dataset further (Milner 1999; Vencl 1999; Osgood et al. 2000; Vandkilde 2003). Even so, if Argaric communities had been subjected to a high degree of violence, we would expect to see clear evidence of weapon trauma on the bodies recovered from inhumation burials.

Fortunately, the Argaric period has yielded some of the most numerous and significant osteological collections in Iberian prehistory. The location of tombs below houses and inside settlements has favoured the preservation of burials. To date, several hundred skeletons have been studied from several sites located throughout southeast Iberia (Aranda Jiménez et al. 2015: 137). Unexpectedly, no injuries caused by sharp metal blades have so far been identified, with the exception of a mark on child skull which, however, may have been caused by an accident (Cloquell and Aguilar 1986). A systematic examination of markers of violence in a sample of 155 individuals from the Argaric period has revealed that only 16.7% of them display lesions of a clear traumatic origin, taking both cranial (7.7%) and postcranial (11.6%) injuries into consideration (Jiménez-Brobeil et al. 1995, 2009) (Table 15.1).

Instead of injuries caused by sharp bladed weapons such as swords and halberds, the skeletal sample shows patterns of blunt force cranial trauma, which was probably caused by maces or clubs. The trauma normally consists of depressed fractures of the outer deck of the cranial vault, whose location and severity ultimately depends on the force of the blow and the weapon used to inflict it (Fig. 15.6). Only adult, mature, and senile individuals show this kind of fractures (and, in some cases, more than one); they all display signs of healing. In terms of gender differentiation, males exhibit a much higher occurrence of blunt force trauma than females (20.8% v. 4%),

Table 15.1 Frequency of cranial injuries by sex and age. Number of individuals/injuries/frequency of injuries shown as %

Age category	Males	Females	Unidentified	Total
Infantile I (0–6)	–	–	29/0/0	29/0/0
Infantile II (7–13)	–	–	15/0/0	15/0/0
Juvenile (13–20)	1/1/100	–	11/0/0	12/1/8.3
Adults (21–40)	31/4/12.9	32/2/6.2	2/0/0	65/6/9
Mature (41–60)	13/3/23.1	17/0/0	–	30/3/10
Senile (60–)	3/2/66.6	1/0/0	–	4/2/50
	48/10/20.8	50/2/4	57/0/0	155/12/7.7

Fig. 15.6 Cranial blunt force trauma in a male individual from the Argaric settlement of Castellón Alto. (After Aranda Jimenez et al 2009b)

and the significance of the evidence is corroborated by chi-square analysis ($P = 0.02$). Interestingly, the shape of the injuries shows a high degree of standardisation: 79% of the fractures are circular or oval-shaped and measure *c*.20 mm in diameter. Depending on the impact force, the depression can be more or less severe, ranging, as it does, from 0.5 to 4 mm. These fractures are most commonly located on the frontal (57.9%) and parietal (21%) areas of the cranium, with a higher incidence on the right side (57.9%) than on the left (31.6%). Again, these differences are statistically significant as P values in males were $P = 0.05$ for the location of trauma (on the frontal area versus parietal area) and $P = 0.001$ for the lateral distribution (on the right side versus left side). This suggests a non-random explanation for these patterns, which is all the more notable considering that intentional injuries are only seen on cranial bone (mostly in men) and that their frequency is higher on the right side of the cranial vault.

Discussion

A critical review of the empirical evidence does not confirm the accepted orthodoxy, namely, that widespread warfare was the root cause of the development of Argaric social complexity. Firstly, the first appearance of specialised weaponry contrasts with the low number of swords and halberds known for the period. Secondly, combat experiments with replica weapons, the analysis of wear marks on swords and halberds, and the lack of blade injuries on skeletons, all point towards the limited incidence of violence in Argaric society. Finally, site locations and structures traditionally considered to be defensive do not provide conclusive evidence, as there are very few settlements in which the fortifications enclose large portions of the inhabited areas.

Surprisingly, the sole notable signs of interpersonal violence come in the form of depressed fractures of the cranial vault. The type and shape of the lesions are consistent with hand-to-hand fighting and suggest that the trauma may have been caused by blunt weapons such as maces or clubs (Aranda Jiménez et al. 2009b). Interestingly, this kind of evidence is being increasingly found in other European regions during the Bronze Age. For example, burials of the Nitra and Únêtice cultures from Slovakia and Moravia show evidence of blunt force cranial fractures seemingly caused by stone or wooden clubs (Hårde 2005). Especially noteworthy in this respect is the case of the Tollense Valley battlefield site in Germany, in which around 100 individuals were found, mostly young adult males. Amongst the many injuries identified on the human remains from the site, many are blunt force traumas on cranial vaults, although penetrating injuries from bronze arrowpoints or spearheads have also been recognised (Brinker et al., Chap. 3, this volume; Jantzen et al. 2011). Significantly, two wooden clubs were found at Tollense, intermingled with the human remains (Fig. 15.7).

The lack of perimortem cranial injuries, together with evidence of healing, in Argaric skeletons suggests that violence took place in a context of ritualised or highly regulated resolution of conflict, characterised by few or no fatalities. In general, there is scarce evidence of violence-related mortality from the period, and no human remains displaying lethal injuries have been found to date. Age and gender were significant factors in determining who should take part in the fights (as shown by the greater incidence of violent trauma in men as opposed to women, and lack of injuries in children). It seems likely that Argaric communities would have been characterised by normative rules about *when*, *where*, *how*, and *by whom* the violence should be enacted, which possibly included taboos about killing the opponent. In light of this evidence, it seems legitimate to question the conventional wisdom seeing Argaric warfare as common and widespread. Violence did occur in Argaric society, but in a very different form to that pictured in traditional accounts.

Fig. 15.7 Wooden clubs from the Tollense Valley battlefield site. (By courtesy of LAKD M-V, Landesarchäologie, S. Suhr)

Conclusions

The emergence of institutionalised violence and warfare has traditionally been thought to lie at the core of processes of increasing social complexity (Lull Santiago et al. 2011; 2014, 2017; Cámara Serrano y Molina González 2011; Moreno Onorato and Contreras Cortes 2015). Long-standing assumptions about the existence and social significance of conflict in Argaric society have discouraged in-depth scholarly debate on the subject, as well as a systematic search for supporting evidence. As a result, concepts such as *warriors*, *conflict*, *instability*, *warfare*, and *militarism* are commonly found in the subject literature, but are poorly theorised. Perhaps because violence and warfare lie at the core of current "power-knowledge regimes" in Western societies, values such as competitiveness, masculinity, power, and conflict have been projected onto the past to create narratives that legitimate the present.

It is hardly a coincidence that the traditional image of Iberian Bronze Age elites embodies many characteristics of individual identities in modern Western societies. Take, for example, the idea of the warrior chief concerned with his own political ambitions sitting atop the social pyramid, or the idea that social change and innovation were based on the construction of individual identities through craft specialisation, the intensification of agriculture, and competition for resources. Moreover, in keeping with current discourses of modernity, these readings always present the warrior as a male. Although women were also buried with objects of the highest social relevance in the Argaric period, it is often presumed that they would not have attained positions of political power, nor would have they fulfilled significant social functions within their own communities. This view normally considers women to be socially passive, e.g. as objects to be exchanged in marriage agreements. This contrasts with the allegedly active nature of men, who are frequently seen as engaged in social and political competition.

However, alternative narratives have shown that, in traditional societies, the self is often constructed in a more fluid way. If we consider the limited control that Bronze Age communities would have exerted over nature, it seems likely that identities would have been built from a relational perspective in this period, too (Fowler 2004, 2013, 2016; Hernando Gonzalo 2013). By thinking of personhood as relational, it is possible to reconceptualise violence in more balanced terms. If people are constituted through their ties with others, agency cannot be separated from their relationships. According to this reading, human action is situated within the wider set of social relations and the notion of the self, for an autonomous agent no longer exists. This allows for new explorations into the construction of identity and the social regulation of conflict from a relational viewpoint, in which the person is recognised as composite and multiply-authored (Fowler 2004; Brück 2004; Budja 2012).

The presence of traumatic injuries resulting from socially and culturally regulated practices could be linked to such a way of understanding reality, which is structurally associated with limited control over nature. Ritualised combat may have been the answer to events that placed the social equilibrium in question – a way of restoring the social order akin to that documented in many ethnographic societies (Cowell 1973). The profound social changes characterising Early Bronze Age communities in southeast Iberia would have involved a process of increasing social inequality that ultimately led to the appearance of new social elites. These dynamics might have increased social tensions to the extent that conflict would have developed into an explicit means of regulating disputes, rivalries, and enmities through well-regulated fights in which both men and women seemingly participated. In this context, interpersonal violence would have been enacted as a social practice aimed at maintaining the social and cosmological order, not as a way of promoting the self-interest of aggrandising warriors.

The presence of swords and halberds in burial can also be explained from this perspective. As mentioned above, specialised weapons accompanied a limited number of male individuals in Argaric burials. They might have been used as individualising attributes designed to differentiate a group of people from the rest of the community. Swords and halberds would have embodied a new set of social relations that contributed to the reinforcement of new relational identities. Although solely exhibited by certain individuals, these objects would have symbolised broader attempts to configure a new collective identity and cultural order which might have been shared on a pan-European scale, considering that weapons are widespread in Bronze Age Europe.

Notable differences in the shape, size, and weight of Argaric weapons, as well as repair marks and the use of different metals in the same sword or halberd − silver or copper for the rivets, silver or gold for the hilts, and arsenical copper or tin-bronze for the blades – are informative about the particular biography of each weapon. This variability shows that weapons were laden with a set of intangible meanings linked to the different social interactions they were involved in during their life cycles. Weapons were made from different parts as a result of their multiple social relationships. They would have been imbued with ontological values relating to the construction of the self. Human beings are constituted as persons through the multiple relationships they build with nonhuman features to which they are intimately tied (González Ruibal et al. 2011). Personal and artefactual biographies would have been interconnected insofar as people make weapons, but weapons also make people. Weapons thus became an essential part of people's identities in Argaric society.

Three main conclusions can be drawn from the foregoing discussion. Firstly, the radical individualism and liberal political theory typical of Western societies, based on the construction of an autonomous subject who is separate from the objectified natural world, has found in the self-interested warrior-like character of Bronze Age societies the perfect locus for its foundation. Secondly, the empirical evidence discussed in this chapter shows how weapons, monumental constructions, settlement locations, and skeletal injuries cannot be explained by a single "warfare-and-complexity" social model. In fact, only cranial trauma can clearly be ascribed to interpersonal violence, but not in the way most scholars presume, since injuries were not caused by sharp metal blades but by blunt weapons such as maces or clubs. Thirdly, based on relational personhood models, prehistoric violence can newly be interpreted as a social strategy aimed at regulating conflict in a context of growing social inequality. As argued throughout this chapter, alternative explorations of the self can provide new, and indeed more useful, models for understanding violence and warfare in European prehistory.

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Chapter 16
Conclusion: The Science of Conflict

Rick J. Schulting

Introduction

With a rapidly growing number of papers and edited volumes addressing the topic of conflict in prehistory, violence is definitely back on the agenda. There are now more than enough case studies of both individual and group conflict to demonstrate beyond any doubt that the past was not always a peaceful, harmonious place – if indeed anyone ever thought that it was. What is less clear is the extent to which this (re)turn to the bellicose has been integrated with other aspects of prehistory, such as trade, exchange and settlement patterns, as well as the construction of local and regional identities, and how it has impacted on our broader narratives. There are various means of approaching this. It is proposed here that recent and ongoing developments in the archaeological sciences provide a powerful means of integrating different types of social and biological data, thereby providing a framework within which to develop and test hypotheses concerning the nature and impact of conflicts in prehistory.

The Contribution of the Archaeological Sciences

Though sometimes more narrowly defined as research undertaken in a laboratory using scientific methods, often involving molecular- and submolecular-scale analyses, 'scientific archaeology' is also an umbrella term for a wide range of approaches, including many that would often be seen as 'traditional' archaeology such as human osteology, zooarchaeology, palaeobotany, ceramic petrology, metallurgy, etc.

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(Torrence et al. 2015). It is a reflection of the history of the discipline that these are now seen as mainstream (though see Albarella 2001), when originally of course they were nothing of the sort and their application to archaeology was highly innovative (Taylor 1957). While not intending to exclude these approaches, the main focus here is on the contribution of biomolecular archaeology, partly because it is a field with which I am more familiar but also because of the impressive recent advances in this area and because of its integrative potential (cf. Kristiansen 2017). Other approaches, however, are also touched upon.

Identity and Origins

One of the perennial questions when faced with cases of violent injuries on skeletal remains is the identity of the victims, particularly when these resulted in the individual's death. This is fundamental to understanding the nature of the encounter: did it occur within the community (however defined) or between two or more communities? If the former, then homicide, punishment or feud is implicated, whereas the latter fulfils one of the standard criteria for the definition of 'war': conflict between distinct sociopolitical groups (Otterbein 2009, 117). Traditionally this question has proven nearly intractable in prehistoric contexts. In rare cases a projectile point found embedded in a skeleton might be of a style and/or material not found locally, but generally arrowheads and spearheads are too widely shared stylistically and in terms of raw material for this to be of much use in distinguishing conflict with outsiders in prehistoric Europe. A possible exception is seen with the arrowhead shot into a body at the LBK cemetery of Mulhouse-Est, eastern France. This was not of a type known locally, suggesting that this may have been the victim of a raid by a party coming from some distance (Jeunesse et al. 2014). Another approach is to use isotopic analyses to investigate whether or not those who died violently were 'local'. Of course, this relies on the existence of sufficient differences in the given isotopic system at the regional or supra-regional level. Because these systems often do not map onto one another in the same way, a multi-isotope approach may provide more information than any single system on its own. Oxygen and strontium isotopes have seen the most use in studies of prehistoric human mobility (Bentley et al. 2002, 2012; Price et al. 1998, 2004; Pellegrini et al. 2016), but stable carbon and nitrogen isotopes may also prove useful in cases where dietary differences exist between locals and non-locals (Müldner et al. 2011; Weber and Goriunova 2013).

Understandably, massacre sites have been at the forefront of isotopic approaches to the question of local/non-local identity in contexts in which violence is implicated. The first such study on prehistoric European material was undertaken on human skeletal remains from the late LBK enclosure at Asparn/Schletz in Austria (Latkoczy et al. 1998; Teschler-Nicola et al. 1999). Strontium isotope analysis suggested that all the victims were 'local', though the comparative sample used was from a site 100 km to the west. An important consideration in isotopic studies is the extent of the 'catchment' that will yield results that appear 'local' (Snoeck et al.

2016). Depending primarily on geological variability (in the case of strontium), it may not be possible to distinguish outsiders from less than many tens of kilometres distant. Another early study was that done on the late LBK mass grave at Talheim, southern Germany (Price et al. 2006), appropriately enough given the importance of this site in originally raising awareness of the existence of extreme violent events in the Neolithic (Wahl and König 1987). The results here were ambiguous, since while the strontium isotope signatures of some individuals suggest non-local origins, this would not be out of place for other central European Neolithic communities, where it may relate more to patterns of individual mobility, for example, through marriage exchanges (Bentley et al. 2002, 2012), on which more below. The authors concluded that the victims in this case were most likely all members of a local community (Price et al. 2006). Additional detail emerged in the subsequent comparison of strontium and oxygen isotope ratios, alongside epigenetic skeletal markers, leading to the identification of three subgroups with differing life histories (Bentley et al. 2008).

Other studies combine isotopic and ancient DNA analyses, offering the potential to investigate origins at very different scales, that of the individual's life history, and that of their genetic ancestry. At the Corded Ware site of Eulau, east-central Germany, a total of 13 individuals were found in four graves, including men, women and children. Evidence for perimortem injuries on at least one individual in each grave, together with the osteological evidence for their being primary burials made at the same time, suggests that they were interred in a single event, i.e. a massacre (Meyer et al. 2009). Ancient DNA analysis revealed a number of close familial relationships, including a direct parent-child relationship in one burial (Haak et al. 2008). While the children and adult males fell within the local strontium isotope range, the three adult females were clearly non-local, originating from a much more radiogenic area, the closest of which occurs some 60 km distant (Haak et al. 2008). This is consistent with patrilocal marriage and residence, a pattern suggested to extend back into the Early Neolithic – based on both strontium isotopes and DNA analyses (Bentley 2013; Bentley et al. 2012) – and would have favoured the formation of fraternal interest groups that have been linked with higher levels of intergroup conflict in cross-cultural anthropological studies (Otterbein 1968, 2000a, 2004, 60–62). However, other studies have suggested that the relationship is not necessarily a straightforward one and that other factors come into play (Macfarlan et al. 2014; Ross 1985).

The remarkable site of Tollense in northeast Germany is continuing to yield more victims of a Bronze Age battle, with the remains of over 130 individuals recovered thus far (Brinker et al., Chap. 3, this volume; Jantzen et al. 2011). A multi-isotope study indicates that the deceased originated from at least two quite distinct regions, including locals and non-locals (Price et al. 2017). The former are represented by enamel stable carbon isotope ($\delta^{13}C_{en}$) values centring on −10‰ and strontium isotope ratios ($^{87}Sr/^{86}Sr$) centring on 0.709, while the non-locals centre on *c.*–5‰ and 0.713, respectively. Stable carbon isotope values of −5‰ must reflect a considerably dietary contribution from C_4 crops, which in a Bronze Age European context can only be millet (marine foods would be another option, but values this high are not recorded from any contemporary coastal sites). Millet did not feature in Germany at this time and points to a location to the south or southeast (cf. Tafuri et al. 2009). Personal adornment and weaponry at the site – most notably the socketed bronze arrowheads – also support origins to the south or southeast for some individuals (Price et al. 2017). In an attempt to confirm whether two or more populations were involved in the battle of Tollense, next-generation sequencing was undertaken on 21 individuals. Perhaps not surprisingly, the results are as yet unable to tease apart population relationships at the spatiotemporal scale under consideration here, but continuing advances in the field of ancient DNA clearly hold much promise (Sell 2017).

The emerging isotopic and genetic data regarding the origins and identity of the victims of massacres and battles have the potential to yield insights into the contexts of prehistoric violence (and historic – e.g. see Chenery et al. 2014; Pollard et al. 2012; Price et al. 2011). The isotopic data are arguably still limited by what are largely site-based approaches, when the scale of both peaceful and antagonistic interactions included much wider-scale regional and supra-regional contexts. The presence of non-local women, for example, is implicitly taken to reflect marriage exchanges, as at Eulau. This may well be true in the majority of cases. But it is also possible, indeed probable, that women were sometimes taken by force. The dearth of young females among the victims at Asparn-Schletz, for example, has been interpreted in just this way (Teschler-Nicola et al. 1999; Teschler-Nicola 2012), as has the lack of adolescent and adult women in one of the subgroups identified at Talheim (Bentley et al. 2008). Given that such raids are perhaps more likely to be carried out by groups from some distance away – making it more difficult for captives to escape or be rescued – then it might be expected that they would yield different isotopic signatures (again, contingent upon the presence of appropriate geological variation at the regional/supra-regional level).

Slaves, often captured in war, feature in the earliest historic accounts of most societies worldwide, including those of Europe. No doubt slavery was present in earlier times as well (Aldhouse-Green 2005; Briggs 2003; Gronenborn 2001), and tracing its origins is important both at the societal level – given the practice's concomitant economic, social and ideological implications – and at the level of the individual, understanding who slaves were and the lives they led. This is a highly challenging enterprise. Nevertheless, the identification of slaves as burial offerings has been suggested on the basis of isotopic and DNA analyses in Viking Age Norway (Naumann et al. 2014). Combining these analyses with osteological studies of skeletal health in a life history approach would be a particularly powerful combination.

As well as humans, mobility has also been investigated isotopically for animals. The results have been interpreted as support for the wide extent of exchange networks and interactions spheres, bringing animals together from far-flung locations (Minniti et al. 2014; Sjögren and Price 2013; Viner et al. 2010). This has been presented predominately within a context of peaceful exchanges, with a ceremonial basis in the Neolithic, and a more strictly economic basis in the Iron Age (though such a division might be debated on both accounts). As with humans, however, another way to interpret the presence of animals from distant locations is through raiding. Animals, particularly cattle, are a prime target for theft for both economic and sociopolitical reasons and are intimately linked with status in herding societies (Abbink 2001; Barfield 1993; Thomas 1965). Long distance cattle raids are at the very core of the earliest Irish historical accounts, in the form of the Táin Bó Cúailnge, the written form of a much older oral tradition possibly with roots extending back to the Iron Age (Kelly 1997; Lucas 1989; Mallory 1992; Patterson 1994). They also feature prominently in the Annals of Ulster, which for the year 821 also record the capture of women: 'Étar was plundered by the heathens, and they carried off a great number of women into captivity' (Mac Airt and Mac Niocaill 1983). It is very probable that this is part of a cultural pattern with deeper historical antecedents, given the abundant evidence of the cultural and economic importance of domestic cattle beginning with their arrival in the Neolithic (Mercer 1989; Ray and Thomas 2003; Schulting 2008). Again, the implications of the increasing evidence for conflict have not been fully appreciated and integrated into our accounts of prehistoric societies.

Another aspect of identity involves that of 'warriorhood', i.e. the creation of a specialised warrior image or status (Frieman et al. 2017; Treherne 1995; Vankilde 2006). Specifically, when can it first be identified, what does it entail, and what are its wider consequences for a society? Classic examples would be the appearance of formalised weaponry, such as the swords, halberds, shields and armour of Bronze Age Europe (Lehoërff, Chap. 14, this volume; Mödlinger, Chap. 9, this volume), and images of weapons and combat scenes found in European prehistoric rock art spanning the Spanish Levant to northern Europe (Bertilsson, Chap. 7, this volume; Ling et al., Chap. 8, this volume). Both lines of evidence, however, suffer from uncertainties regarding the extent to which the weapons were actually used in combat (see Aranda Jiménez, Chap. 15, this volume; Cao, Chap. 11, this volume; López-Montalvo, Chap. 5, this volume; Molloy, Chap. 10, this volume, 2007, 2011) and the extent to which images represent 'reality'. Osteological analysis of upper limb asymmetry, together with grave offerings, has been producing some very interesting results, in some – though not all – cases demonstrating a clear link between marked humeral asymmetry in adult males in graves accompanied by swords (Gentile et al., Chap. 4, this volume; Sparacello et al. 2015). Of course warriors need not always be male; it would be interesting to extend this approach to female burials recovered with swords and other weaponry, the interpretation of which has often been controversial. This has been highlighted recently by the use of ancient DNA to confirm the female osteological identification of an élite warrior grave from the Viking Age town of Birka, Sweden (Hedenstierna-Jonson et al. 2017).

Importantly, this kind of integrated material culture and bioarchaeological analysis also addresses the post-processual debate concerning the 'reality' of the mortuary rite in relation to representing, in some form, the actual activities undertaken by a person during their lifetime (Quinn and Beck 2016; Robb et al. 2001). There is clear potential to take this further, investigating other aspects of the life histories of these individuals, including their exposure to childhood stresses, their nursing and weaning history and other aspects of diet from infancy to adulthood. Under what circumstances did 'warriors' receive preferential or differential treatment, possibly implying a relationship between institutionalised violence and structural inequality within communities (see papers in Martin and Harrod 2012)?

Dates and Demography

The increasing resolution of radiocarbon dating and Bayesian modelling is another area with the potential to make a contribution to the study of past conflict, particularly in prehistory. This takes two aspects. The first relates to matching the changing intensity of evidence for violence with its wider cultural and environmental milieu. The recent demonstration of a significant genetic impact on Chalcolithic/Early Bronze Age Europe of populations with steppe ancestry, for example (Allentoft et al. 2015; Haak et al. 2015; Kristiansen et al. 2017; Mathieson et al. 2015; Olalde et al. 2017), raises the possibility of new social and political tensions that might have resulted in elevated levels of conflict. A similar situation appears to be indicated for the earliest farmers (Brandt et al. 2013; Lazaridis et al. 2016; Mathieson et al. 2015; Olalde et al. 2017). While not involving the same degree of genetic replacement, large-scale ethnic migrations and the foundation of colonies (e.g. the Greek colony of Massalia/Marseilles) are well documented in the protohistoric and classical periods (Hodge 1998). In terms of the environmental context, there has been a resurgence of interest in the impacts of climate change on human societies in both the present and the past (Barnett and Adger 2007; Flohr et al. 2016; Gronenborn 2006). It might be argued that the new possibilities for more robust chronologies on both archaeological and palaeoenvironmental datasets are , at least in part, driving this interest. In other words, with higher-resolution chronologies, there is a better opportunity of actually being able to correlate these events more precisely than has been the case previously. Of course this is not sufficient to demonstrate a causal relationship (correlation ≠ causation), but it is a necessary condition for even having the discussion (cf. Schulting 2010).

The second contribution of improvements in radiocarbon dating, combined with Bayesian modelling, is in the identification of large-scale violent events, including battles and massacres. There are a number of examples of potential ‘war graves’ in the European Neolithic and Bronze Age, but to date very few have been subjected to the degree of chronometric analysis required to assess them properly as regards their status as single events. In some cases, such as the mass grave at Talheim, the archaeological context together with the osteological evidence for articulation and decomposition in a closed space (cf. Duday 2009) is sufficient to be accepted as a massacre event (Wahl and Trautmann 2012). The Bronze Age battlefield at the abovementioned site of Tollense, with disarticulated human remains spread over a distance of kilometres, is another matter entirely. Here, a convincing interpretation as a battlefield relies heavily on radiocarbon dating and modelling (Jantzen et al. 2017). This also applies – albeit to a somewhat lesser degree given their more tightly constrained archaeological contexts – to other sites previously discussed, including Asparn-Schletz (Wild et al. 2004). In other cases multiple burials in caves, with some individuals showing projectile injuries, have been proposed as evidence for large-scale battles, including the more than 300 individuals at San Juan ante Portam Latinam in northeast Spain (Vegas et al. 2012) or the ‘war layer’ comprising some

50 individuals at Roaix, southern France (Courtin 1974). In these cases the jury is still out pending the necessary chronological resolution.

As well as ‘war graves’, conflict events can sometimes be identified using Bayesian modelling in relation to fortifications or the destruction layers of settlements. Examples of the former include the Early Neolithic causewayed enclosures of Hambledon Hill and Crickley Hill in South West England, both of which appear to have been attacked as seen in burning layers and, in the case of Crickley, a distinctive distribution of some 400 leaf-shaped arrowheads concentrated at and through the entrances into the interior of the enclosure, implying that the defences were breached (Dixon 1988; Mercer and Healy 2008). Bayesian modelling has placed one of the two major identified episodes of conflict at Hambledon Hill at *c*.3600 BC (Healy et al. 2011) and that at Crickley Hill at *c*.3450 BC (Dixon et al. 2011). In the case of Crickley Hill, this event seems to have effectively ended use of the enclosure. These sites and others like them are very important in providing a sense of the scale of conflict, especially in the Neolithic. The numbers of individuals involved – likely to be in the hundreds – in both the construction and destruction of these enclosures provide some of the best evidence for warfare, since it is hard to imagine this representing only small-scale inter-group conflict or conflict within the community (Schulting 2006, 2013).

In some cases the results of Bayesian have proved unexpected, for example, at the Early Neolithic long barrow of Wayland’s Smithy I (WS I) in south-central England. These monuments were generally thought to have seen use spanning several centuries before being closed, in this case decisively so by the construction of a second, large mound (WS II) over the first (Atkinson 1965; Whittle 1991). The remains of 14 individuals were recovered from WS I, many maintaining a high degree of articulation – unusual for these monuments – and with some directly superimposed over one another. All 14 individuals were directly AMS ^{14}C dated, along with antler picks and the smaller number of individuals (four) surviving from the overlying WS II. The results of a Bayesian model permit the possibility of a single event, though equally burial may have occurred over some decades (Whittle et al. 2007). What makes this particularly relevant in the present context is that three adult males in this group were closely associated with flint arrowheads with broken tips, one of which was found embedded in the pelvis (Whittle et al. 2007) (Fig. 16.1), the implication being that the other two were probably embedded in the body as well. Moreover, the demographics are skewed, with 11 of the 14 individuals being adult males. Combined with the dating evidence, then, this assemblage could represent the dead of a single battle or alternatively perhaps of a series of raids occurring over a period of some decades. This would not be unusual in terms of a cycle of revenge killings, which can continue over generations, particularly in the absence of a strong central authority with the power to forcibly end hostilities (Boehm 1984; Otterbein 2000b).

This last point raises the question of the demography of mortuary assemblages, already touched upon above in regard to a number of sites. At Asparn, the dearth of

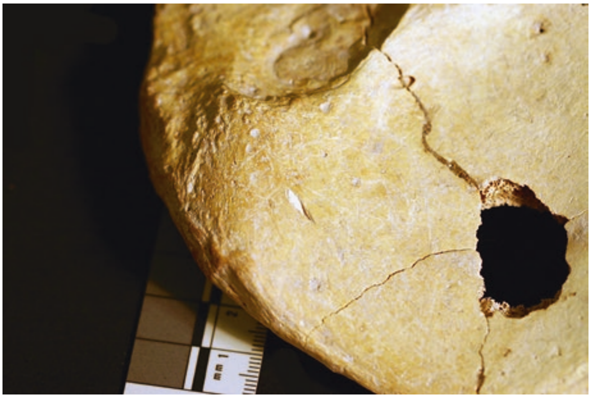

Fig. 16.1 Tip of a flint arrowhead embedded in a male right innominate from Wayland's Smith I, with no signs of healing (Reading Museum; photo courtesy of Mick Wysocki)

women was used to infer their capture during raiding or warfare. More commonly, a 'surfeit' of adult males – particularly young adult males – exhibiting evidence for violence is interpreted as indicating the deceased of a battle, in which young adult males are expected to be the principal participants. This demographic bias is seen at Tollense, San Juan ante Portam Latinam and Wayland's Smithy. Yet this is only one particular type of conflict and indeed may not be the most common form seen in the past; women and children may be seen as legitimate targets in revenge killings, for example (Schulting 2013). Another approach, with entirely different implications, is to identify a catastrophic mortality profile, comprising a cross-section of a living, pre-industrial community. In combination with evidence for violence, this can be used to infer a massacre event, such as that seen at Talheim, where agent-based modelling has been employed recently to provide a more robust interpretation (Duering and Wahl 2014).

On a wider scale, palaeodemography can also be linked with some of the previously discussed supra-regional cultural and environmental processes. Rapid environmental downturns, for example, would clearly have the potential for large demographic impacts, as would recovery from such events (e.g. Jones et al. 1999). Combining this with ancient DNA analyses could prove very informative in terms of identifying genetic bottlenecks and subsequent expansions, which may at least on occasion be directly or indirectly related to large-scale conflict.

Conclusions

The greatly expanding capacity of the archaeological sciences in recent years is opening up many new possibilities for exploring conflict in the past. As highlighted in this contribution, some of the areas currently being explored include the ability to address questions of identity at levels ranging from the single individual to the wider community (and beyond in the case of genetic ancestry) and how these link to evidence for those involved in violence or buried with weapons. Advances in radiocarbon dating and statistical modelling of dates are providing the possibility of identifying *events* in the prehistoric archaeological record and of linking these to broader cultural and environmental processes. The full potential of these developments is only beginning to be appreciated and implemented. In and of themselves, however, methodological advances do not improve our understanding of the human past. More than ever, we require an interdisciplinary approach combining these new avenues of enquiry with 'traditional' archaeological and osteological evidence, as well as with engagement with the large and highly varied approaches – both theoretical and methodological – to conflict seen in the anthropological, sociological and historical literature. An important future line of enquiry will be the ability to take a more nuanced approach to identifying less overt forms of interpersonal violence, such as those relating to socioeconomic disadvantage, political subjugation and intimidation and structural gender and age inequality, all of which might be expected to have both short- and long-term health consequences (Dahlberg and Krug 2002).

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