jungstein ITE Journal of Neolithic Archaeology

doi 10.12766/jna.2018S.6

Bell Beaker Archers: Warriors or an Ideology?

Jessica Ryan, Jocelyne Desideri, and Marie Besse

Article history:
Received 18 October 2017
Reviewed 17 January 2018
Published 19 December 2018

Key words: European Neolithic, Bell Beaker culture, archery, specialization, socio-economic functioning, archaeology, anthropology, entheseal changes

Cite as: *J. Ryan/ J. Desideri/ M. Besse: Bell Beaker Archers: Warriors or an Ideology? JNA 20, 2018S, 97–122 [doi 10.12766/jna.2018S.6]*

Authors' addresses:
Jessica Ryan, Laboratoire d'archéologie préhistorique et anthropologie, Département F.-A. Forel des sciences de l'environnement et de l'eau, Sciences de la Terre et de l'environnement, Université de Genève, Uni Carl Vogt, 66 boulevard Carl Vogt, CH - 1211 Genève, Switzerland

Acknowledgements
The authors would like to extend their gratitude to Jan Turek, Petra Havelkova, Petr Velemínský, and the Natural History Museum of Prague for allowing access to Bell Beaker individuals. The authors would also like to thank the SPHN Society of Geneva and the Augustin Lombard Grant for assisting in financing this study.

Abstract

In terms of funerary archaeology, the Bell Beaker period in Europe exhibits two main burial complexes: collective burials in the west and single graves in the east. This study focuses on the implication of stone wristguards, as well as other objects associated with archery, included in select single inhumation burials of the Eastern complex. Such stone wristguards are currently interpreted as a piece of protective equipment used by archers; however, their fabrications in stone and the overall lack of evidence for usage raises the question of practicality. Were these wristguards used in the everyday lives of warriors or were they symbolic? And were the individuals interred with these wristguards archers themselves? Answering these questions could address a bigger question concerning the presence of a social class of archers and its implications towards the importance of warfare at a time of transition from the Neolithic to the Bronze Age.

In order to respond to these questions, this paper first examines the evidence and the archaeological perspective on archery and warfare throughout the Neolithic, culminating in the Bell Beaker period. This is followed by an anthropological approach attempting to identify specialized archery from the osteological remains of 27 Bell Beaker individuals from Bohemia (Czech Republic). 10 of the individuals were buried in the presence of archery-related objects, primarily stone wristguards, thus classifying them as "suspected archers".

Anthropological analyses involved integrating the human biomechanics of archery with classifications of entheseal changes in order to postulate on an individual's likelihood of having been a specialized archer. While these analyses revealed minimal differences between specific points on the skeletons of the suspected and non-suspected archers, the suspected archers do share some common characteristics. This study validates the use of anthropological analyses in identifying specialized archers. These results also indicate that the individuals interred with stone wristguards were likely archers themselves. Identifying a specialized archer in the presence of artisanal archery goods provides additional evidence for a class of archers during the Bell Beaker period.

1. Introduction

From the Mesolithic to the Neolithic, arrow points, iconography, and the rarely preserved bow provide evidence for the existence of archery. As the Neolithic period progresses, more and more weapons appear in the archaeological record until arriving at the Bell Beaker period, when flint and copper daggers as well as wristguards, largely in stone though also in other more valuable materials, appear with marked prominence (Strahm 1998; Cauwe et al. 2007). Such items appearing in select single burials are commonly referred to as

the "archer's package", often with additional objects such as bow-shaped pendants, arrowheads, and ceramics.

When looking at these characteristic "archer burials" of the Bell Beaker period, one of the resulting questions is whether or not the individuals buried with archery-related objects were specialized archers themselves (Fig. 1). If the individuals were specialized archers, this justifies the choice of grave goods. However, if they were not archers themselves yet still possessed artisanal archery equipment as part of their funerary ritual, archery then becomes open to interpretation at the familial, occupational (perhaps artisanal), or societal level. In either case, there remains an overarching question pertaining to the importance of archery for these ancient peoples and its impact on everyday life.

Beginning with the basic gender roles outlined by ethnoarchaeology, one can assume that the majority of specialized archers would have been men (Pétrequin/Pétrequin 1990; Gallay 2011). Considering the Mesolithic invention of European archery (Hernández-Pacheco 1918; Bergman 1993) and the fact that fortifications do not appear until roughly the Linear Pottery culture of the Early Neolithic in Europe (Howell 1987; Cauwe et al. 2007), it stands to reason that archery was first used by individual hunting populations and not for warfare. However, by the Final Neolithic period, the Bell Beaker culture witnessed an increase in objects related to archery, a phenomenon possibly driven by the presence of warfare.

Current understanding marks the Neolithic period as the beginning of agriculture in Europe, leading to several economic and

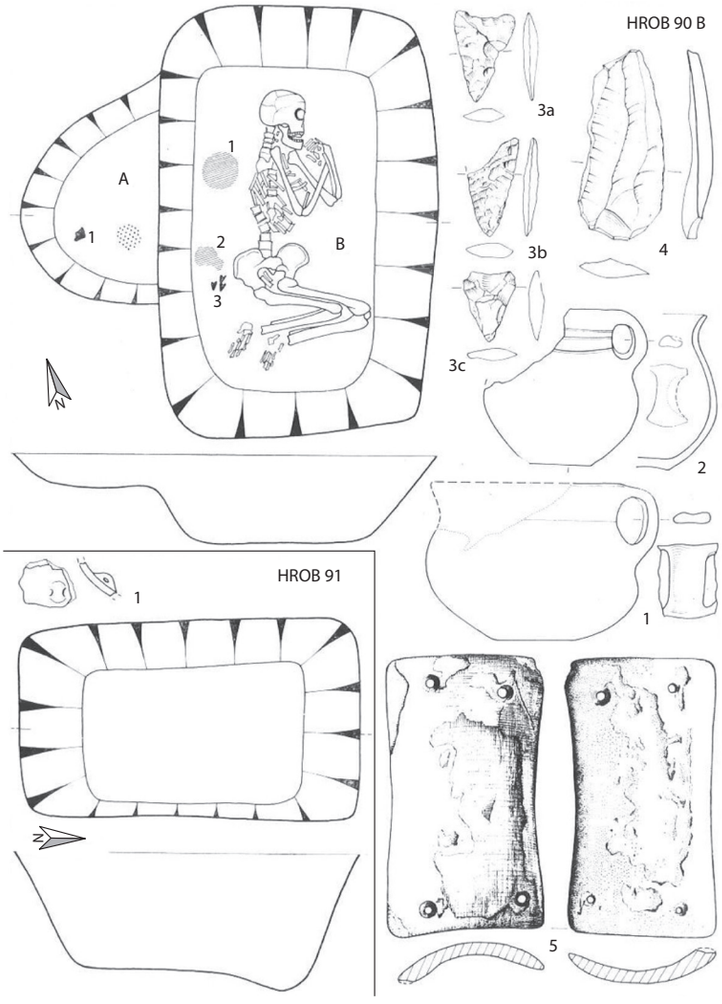

Fig. 1. Example of a Bell Beaker "archer" burial from grave 90B of the Čachovice cemetery near modern-day Prague, Czech Republic (after Neustupny/Smrž 1989).

cultural changes as populations adapt to a non-nomadic way of life. The Middle Neolithic period saw settlers moving farther away from rivers and settling on plateaus, as well as building fortifications or ditches around their dwellings (Howell 1987). Examples of these structures can be seen in cultures such as the Lengyel in Eastern and Central Europe, where circular ditches or palisades encircle either houses or small villages (Fig. 2) (Pavúk 1991; Pažinová 2007). The presence of defensive systems is a clear sign of social unease or instability, perhaps even an indication of warfare, which may have been due to competition for territory and resources. Directly preceding the Lengyel culture in Central and Western Europe was the Linearbandkeramik (LBK) culture. A study from Bentley et al. (2012) found a link between access to fertile soil and the presence of adzes in burials already at this time, as well as a patrilocal society, indicating the existence of a social hierarchy. At the start of the Final Neolithic, technical knowledge had become increasingly important, especially as metal technologies began to take hold (Cattin 2008; Cattin et al. 2011). In addition, artisanal objects, such as jewelry and weaponry, appeared more prevalently in burial contexts of the Eastern complex, aiding in the increased distinction between masculine and feminine burials (Fleckinger 2005). All of these aspects of the Pre- Bell Beaker cultures contribute to the overall assumption that both social hierarchies and warfare were in existence during the Bell Beaker period.

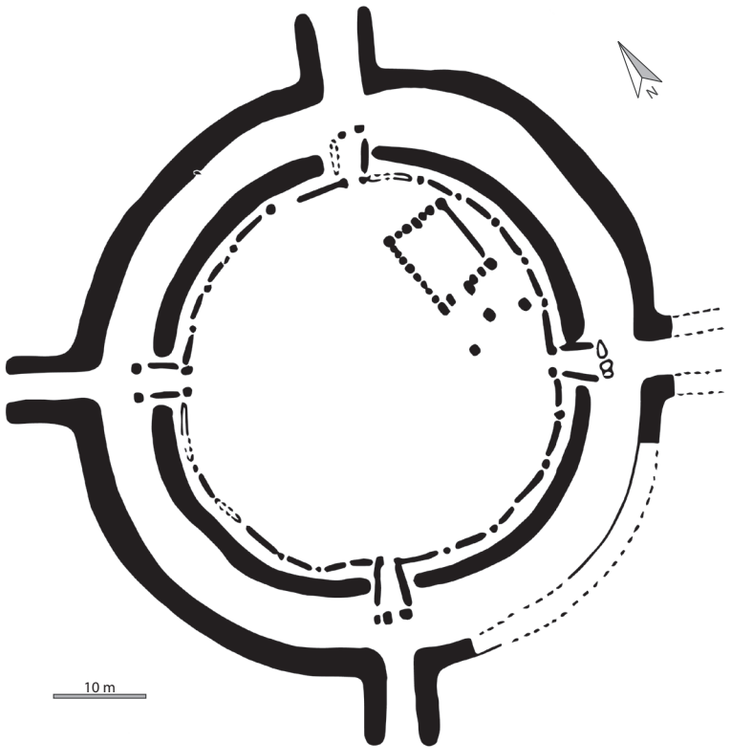

Fig. 2. A settlement site in Bucany (Slovakia), exhibiting fortifications of the Lengyel culture, with two ditches and a palisade surrounding a small village (after Pažinová 2007).

In order to have a comprehensive look into Bell Beaker archery, various elements have to be considered, most notably the evolution and morphology of bows and arrows as well as artisanal and artistic references to archery. However, understanding Bell Beaker archery lies not only in the interpretations of archaeological contexts, but also in understanding the corresponding anthropological remains. This can lead to direct implications on the importance and social ramifications of archers during this innovative period of prehistory.

Keeping this in mind, the goal of this project is to use archaeological data combined with anthropological analyses in order to identify specialized archery in Bell Beaker burials. This will begin with a brief look at archery-related imagery, the evolution and adaptations of bows and arrows, and the functionality of stone wristguards. The next step will involve an attempt to decipher skeletal markers of occupation on the remains of individuals associated with such contexts. For this study, these collections include individuals from Bell Beaker cemeteries in the region of modern-day Prague (Czech Republic). Once the presence of specialized archery is identified, these results could then be applied to interpretations of the role of archers within the social structure of a Bell Beaker society.

2. Evidence for archery

In order to better understand the archaeological aspect of Bell Beaker archery, one must first look at its development and evolution throughout the Neolithic period. In doing so, it becomes clear that this practice gained prominence throughout the Neolithic cultures especially in terms of its links to warfare. The primary elements through which archery appears in the archaeological record include artistic representations, bows, arrows, and eventually wristguards. Putting into perspective the development and prevalence of archery-related objects and their artisanal values act as a major indicator for the importance of archery during the Bell Beaker period.

2.1 Pre-Bell Beaker period

In the Northwestern Mediterranean region, depictions of archers appear during the Neolithic in various contexts, such as cave paintings and usually as hunters of cervidae (Hernández-Pacheco 1918; Nash 2005). However, the first images of archers appearing definitively as warriors emerge during the Final Neolithic period (Nash 2005; Vaquer/Maille 2011).

When considering Neolithic archery, surviving bows are rare due to their organic nature. Based on the available information, Neolithic bows were a simple, single segment of yew wood shaped into a curve (Dias-Meirinho 2011). One excellent example of a Neolithic longbow comes from the Swiss Alps (Fig. 3). This bow measures 1.6 m and dates from 2800 to 2500 BCE (Hafner 2012). However, it is important to note that features, such as size and material, alter the functionality of the bow. A small bow is capable of quicker shots as well as being easier to handle and transport. Longer bows are much more stable and fewer vibrations lead to less interference between the fingers and string (Dias-Meirinho 2011). While bows of varying length appear throughout the Neolithic period, Dias-Meirinho (2011) notes that from about 2500 BC only long bows appear to have been constructed, and there is a large reduction in the number of various forms. Contrarily, differences in cross-section continue to emerge throughout the Neolithic, including morphologies that are not necessary for the functioning of the bow (Dias-Meirinho 2011). Such variations and complex fabrication techniques exhibit a rise of artisanal specialization, perhaps even apprenticeships, and by extension the importance of archery.

Looking next at arrowheads, the Neolithic period witnesses an evolution of arrowhead morphologies from the Early Neolithic, when transverse forms were most common (Fig. 4), to the more varied forms of later periods as well as an increase in their overall numbers.

Fig. 3. A Neolithic bow from the Schnidejoch passage in the Swiss Alps (after Hafner 2012).

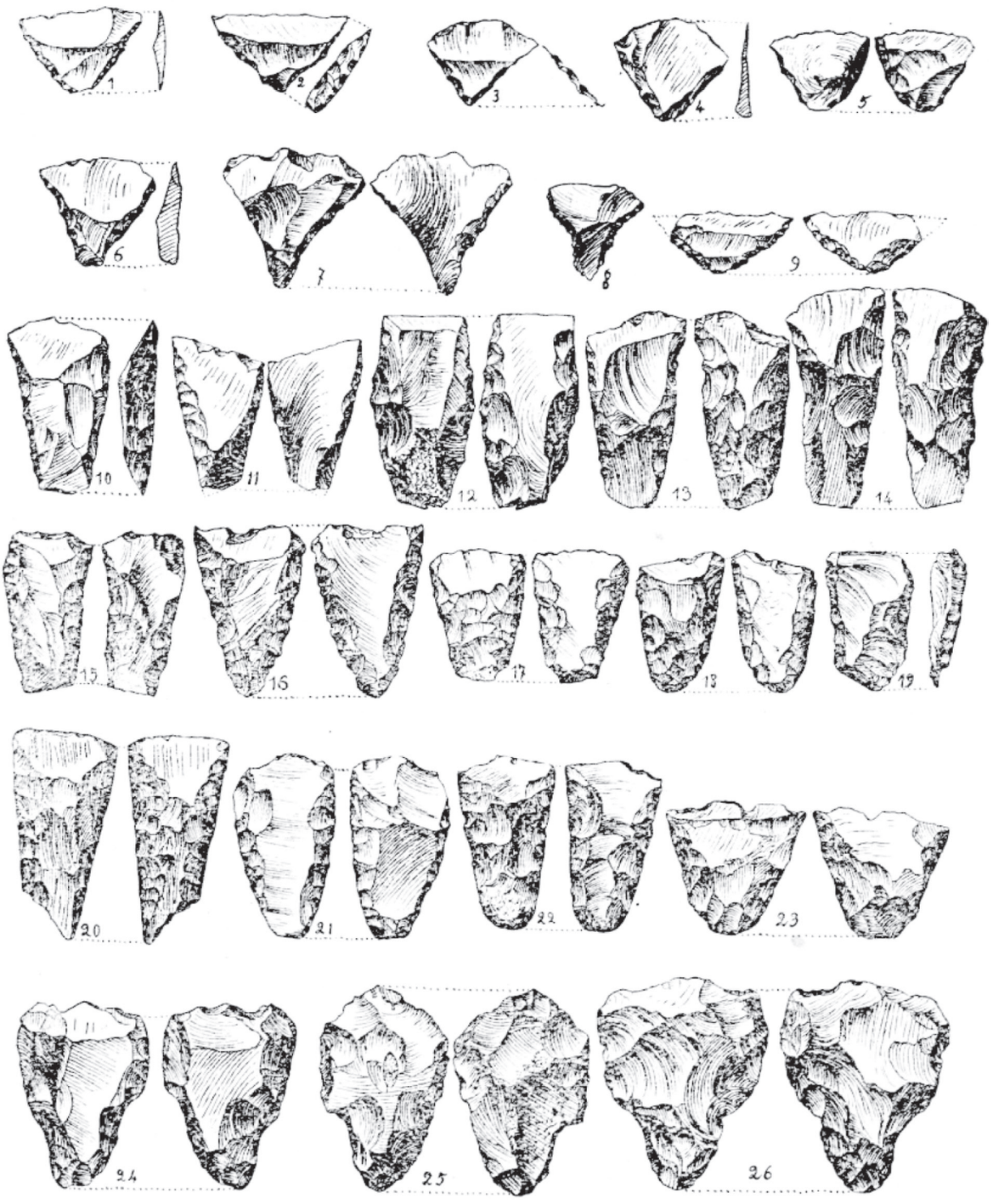

Fig. 4. Transverse arrowhead (after Cheynier 1946).

The importance of arrowheads is often recognized by the care taken in their fabrication and the fact that materials were frequently transported over long distances (Honegger et al. 2011). Reasons for such diversification could be a result of increased interaction with other groups, such as for trading and warfare, as well as an evolution of forms to match specific functions – though it is likely that hunting at this time would have been at a decline thanks to advancements in agriculture and animal husbandry. Data from a study on arrowheads recovered in the Jura region of Eastern France noticed that the points from the Middle Neolithic followed a simple, regional tradition, whereas more complex and symmetrical points dominated the Late Neolithic (Fig. 5) (Saintot 1998). A diverse selection of

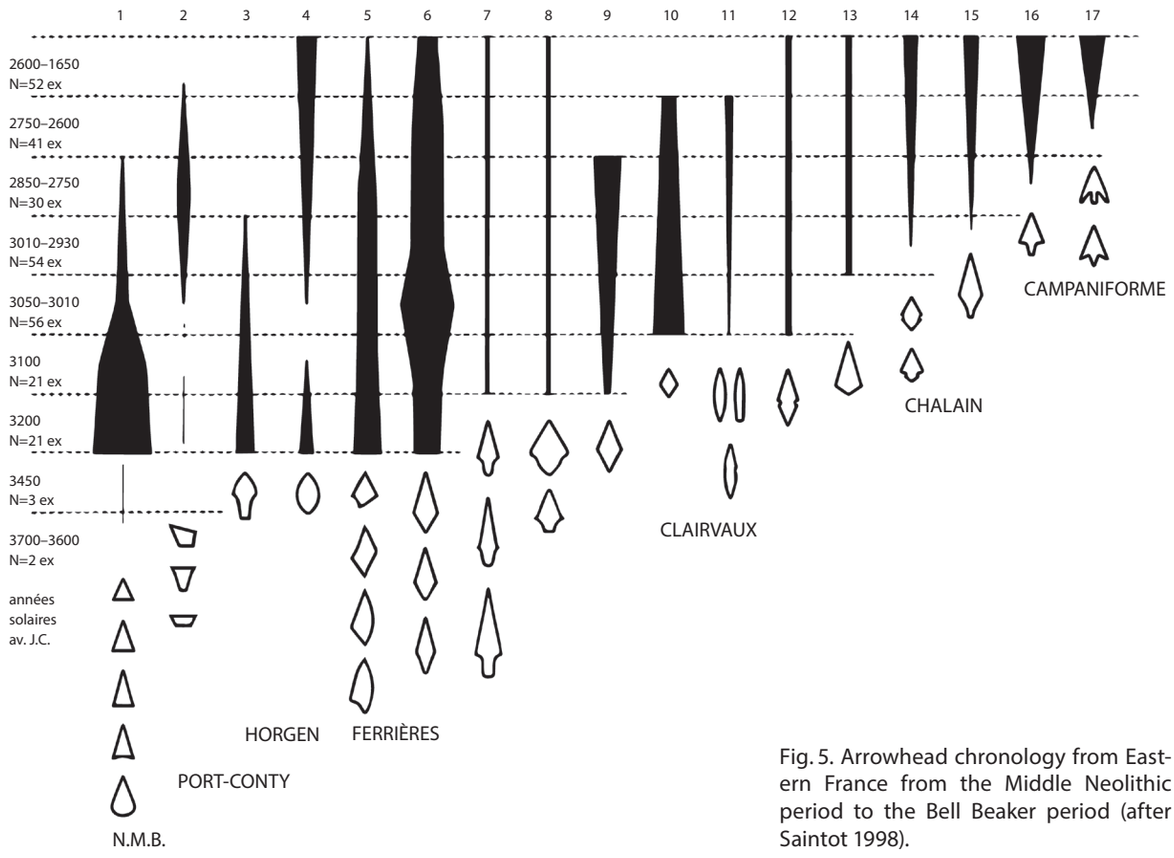

Fig. 5. Arrowhead chronology from Eastern France from the Middle Neolithic period to the Bell Beaker period (after Saintot 1998).

arrowheads as well as an increase in their numbers at the beginning of the Final Neolithic indicated the expansion of the regional Chalain culture and the development of Bell Beaker influence (Fig. 5) (Saintot 1998). This overall increase in arrowhead forms at a time when hunting would have been less common also acts an additional indicator for a rise in warfare.

When looking at arrowhead fabrication, the presence and use of polishing stones also needs to be considered (Fig. 6). These stones, used for sharpening and forming, are identifiable by the presence of grooves on the surface that result from repeated polishing. These stones would have been used for arrowheads as well as larger objects like the battle axes of the preceding Corded Ware culture (Piel-Desruisseaux 2013). Polishing stone tools or weapons makes them more resistant. During the Neolithic, this practice would have required several hours of hard work.

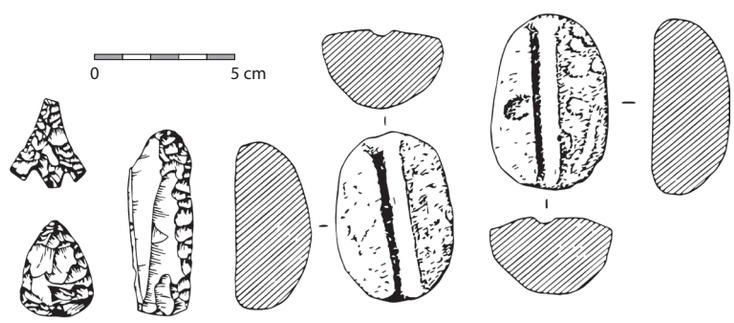

Fig. 6. A small polishing stone, likely used for arrowheads, from the Petit-Chasseur site in Sion, Switzerland (after Bocksberger 1976).

2.2 Bell Beaker period

During the Bell Beaker period, artistic representations of archers appear on funeral stelae, most notably those from the Petit-Chasseur site in Switzerland and Saint-Martin de Corléans in Italy. These images are also important for understanding bow morphologies of the period. The bows depicted on these monuments seem to be short, double-curved composite bows, a style generally associated with hunting or warfare on horseback (Corboud 2009). Combined with the complex geometric motifs, stelae 1, 18, 20, and 25 from Petit-Chasseur are excellent examples of archery iconography as well as an indicator of the wealth or status of the owners (Fig. 7) (Corboud 2009).

Bow-shaped pendants also serve as an example of archery imagery during the Bell Beaker period. These pendants are interpreted as clothing clips, amulets, and decorations, or as basic symbols of social status and are primarily affiliated with masculine inhumation burials (Fig. 8) (Růžičková 2009). They are most commonly found as grave goods and often in a context with ceramics, arrowheads, wristguards, and sometimes daggers (Růžičková 2009). These are interesting artifacts for this case study because they are undoubtedly symbolic and almost certainly linked to archery.

The majority of our current understanding of Bell Beaker bows is derived from imagery, such as those seen on stelae and bow-shaped pendants. Due to these representations, it is largely postulated that composite bows were developed and utilized during the Bell Beaker period (Strahm 2002; Corboud 2009). Composite bows demonstrate an advanced understanding of not only their construction and usage, but also of their physics. They have a wider middle and a curve at both ends; this compresses the bow allowing for it to be shorter, yet with a more efficient transfer of energy to the arrow, thus maintaining the power seen in longbows (Fig. 9) (Christensen 2004). Composite bows were more complicated to make and required a higher degree of know-how than the more simple, single-piece wooden yew bows previously seen. Their shorter lengths would have made them more practical and maneuverable as well as ideal for use from horseback, a warfare technique believed to have been in practice at this time in Eastern Europe (Strahm 2002; Corboud 2009).

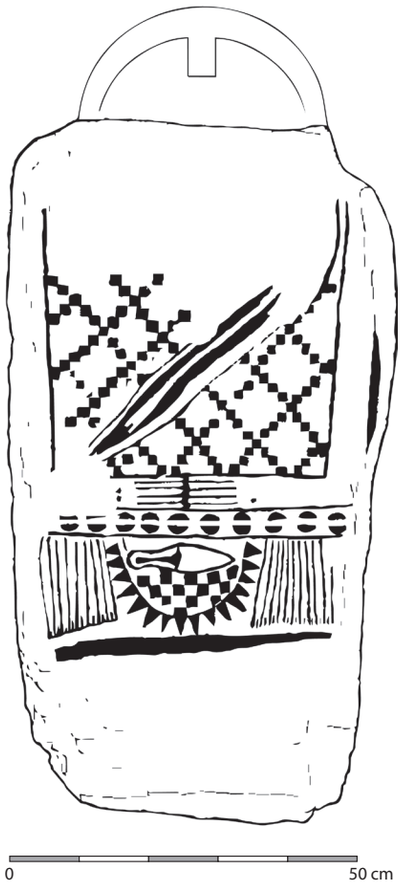

Fig. 7. Stela 18 from the Petit-Chasseur site (Valais, Switzerland) showing a personification with a bow and arrow as well as a dagger (after Favre et al. 1986).

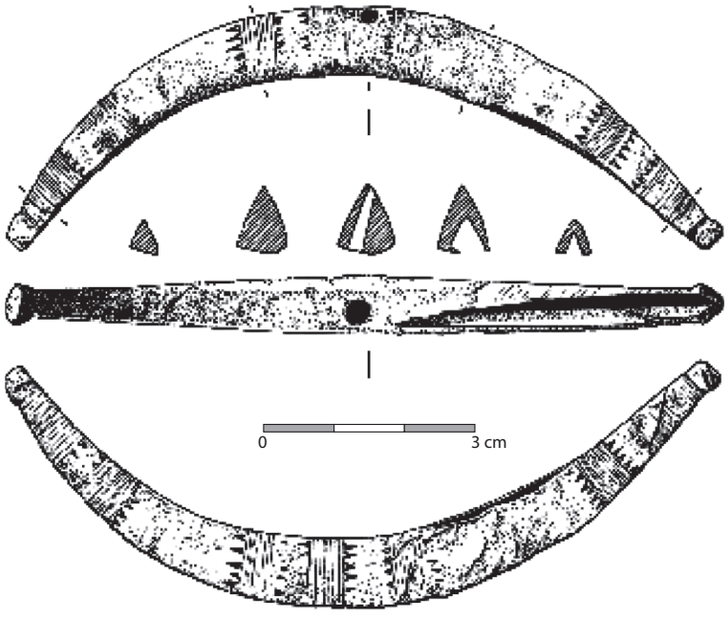

Fig. 8. Bow-shaped Bell Beaker pendant from the Petit-Chasseur site in Sion, Switzerland (after Bocksberger 1976).

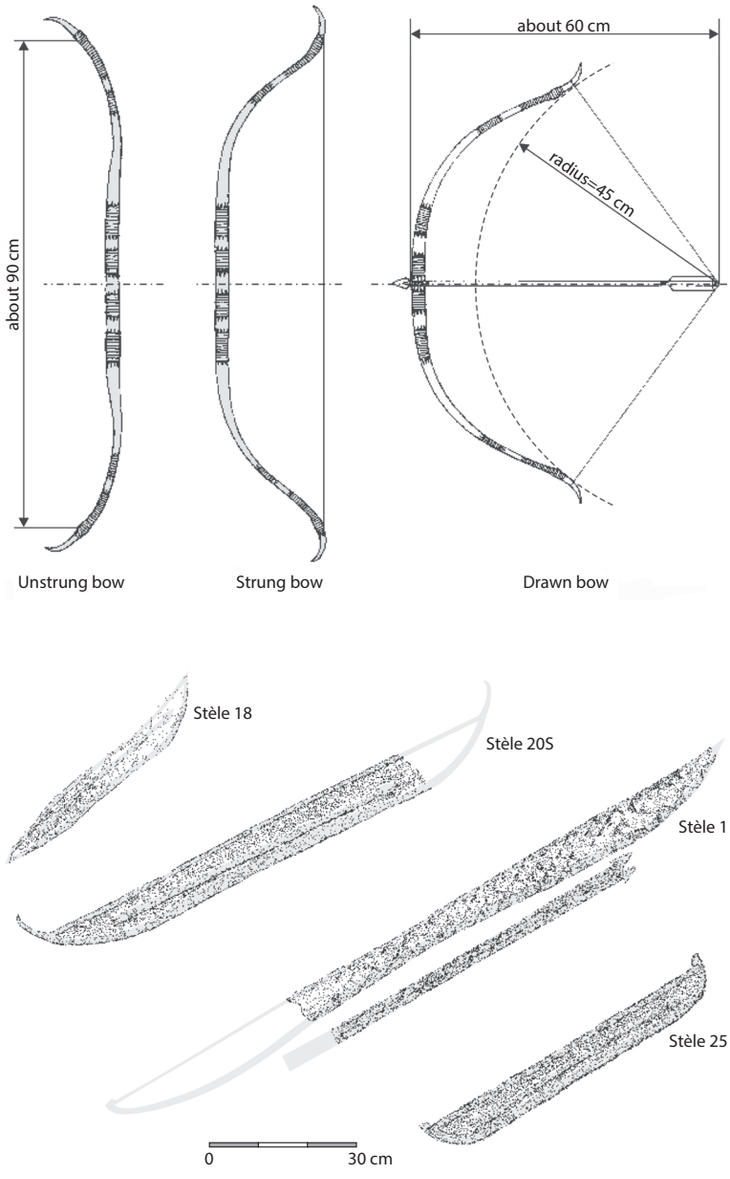

Fig. 9. Hypothetical reconstruction of a composite bow from the Bell Beaker culture (left) (adapted from Corboud 2009) and engraved representations of bows and arrows from the stelae of the Petit-Chasseur site in Sion, Switzerland (right) (after Corboud 2009).

Three primary factors characterize the arrowheads of the Bell Beaker period: ubiquity, morphology, and variation. Arrowhead finds are very common and appear throughout the Bell Beaker complex. At this time, the morphologies are largely barbed and tanged, a technique that is more specialized and time-consuming (Fig. 10) (Christensen 2004; Nicolas 2013; Nicolas 2016). These barbed and tanged arrowheads are largely linked to warfare because their form and attachment to the shaft mean that if the arrow is pulled out of the body, the head will remain inside, a detail unnecessary for hunting but perhaps ideal for the gruesomeness of warfare (Christensen 2004; Nicolas 2013; Nicolas 2016). However, it is important to note that while certain types of arrowheads may lead to interpretations of warfare, there is currently no evidence that there were arrows used uniquely for warfare, even though ethnoarchaeology verifies the possibility (Honegger et al. 2011). Arrowhead classifications in Western Switzerland and Eastern France also note an increase in the diversification of arrowhead types throughout the Bell Beaker period (Saintot 1998; Honegger et al. 2011). For example, in comparison to three classified arrowhead types for the Cortaillod culture of the Middle Neolithic period, the Auvernier-Corded period identifies 18

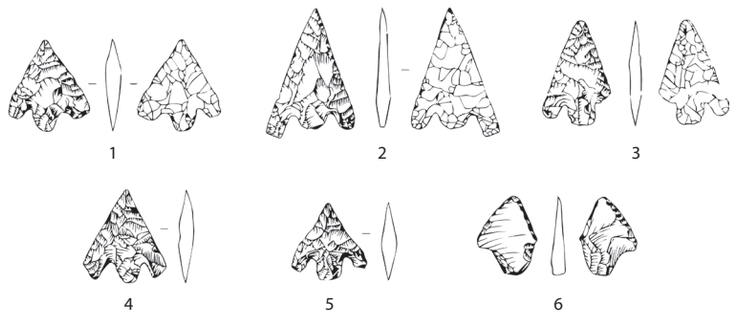

Fig. 10. Bell Beaker barbed and tanged arrowhead (after Furestier 2007).

types (Honegger et al. 2011). Reasons for such variation could be due to interaction and trade with other groups, functionality, or artisanal styles of various makers.

Lastly, and most importantly for this study, one must also consider wristguards. These are a common piece of archery equipment, both ancient and modern, protecting the forearm from the lash of the bow string. A wristguard should be placed on the arm holding the bow, which would be the non-dominant hand for most archers, an important detail when studying a skeleton's handedness. The vast majority of stone wristguards come from funerary contexts throughout the Bell Beaker regions and studies examining the morphologies of various wristguards suggest that differences in size, shape, and number of perforations have been variable since their beginnings (Fig. 11) (Sangmeister 1974; Heyd 2001). It is possible, when looking at the introduction of contemporary bows, that the development of wristguards corresponds to the use of the more powerful composite bows (Christensen 2004).

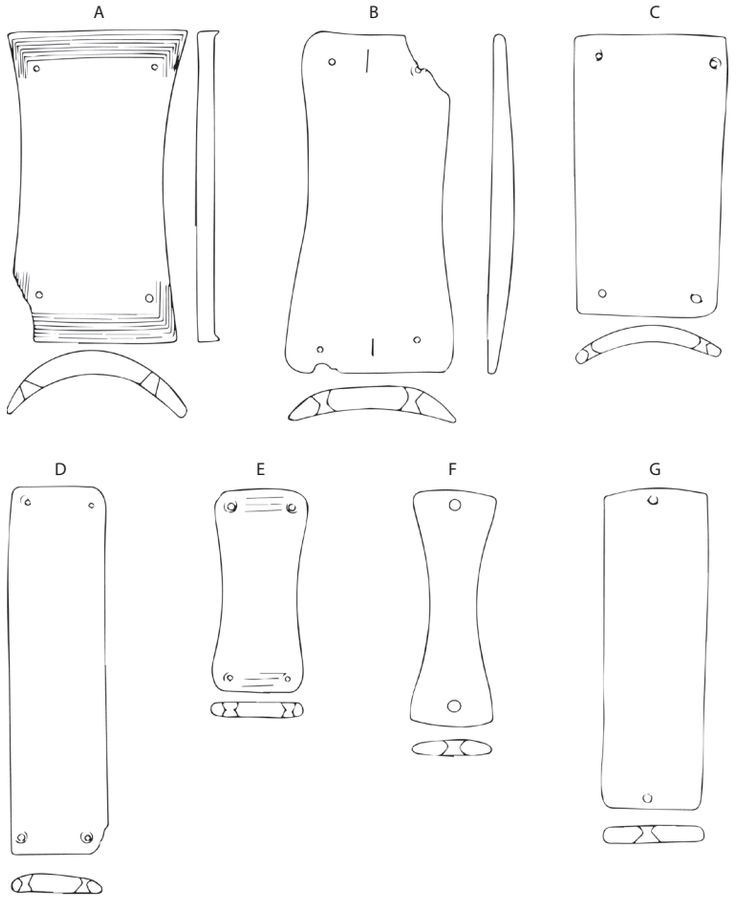

Fig. 11. The seven types of Bell Beaker wristguard as classified by Sangmeister (1974).

Many ancient societies likely used wristguards made from leather or other organic materials since they would have been lighter, more maneuverable, and easier to fabricate, a theory also supported by modern ethnoarchaeological observations (Fokkens et al. 2008). Stone wristguards, on the other hand, occur in a relatively small percentage of burials believed to be possible archers (Turek 2004). Interestingly, a study by Lemercier (2011) found that only about 25 % of burials with a wristguard also contained some sort of weapon, and that generally wristguards are the only object in funerary deposits (Lemercier 2011). Another study by Olivik (2012) found that most burials in Bohemia and Moravia contain either wristguards or arrowheads, but rarely both. This study also found that arrowheads appear more often with animal bones, whereas wristguards occasionally appear with copper daggers (Olivik 2012). It is possible that this difference indicates two different symbolic meanings for the functions of these archery goods: hunters and warriors.

While stone wristguards could have been used as practical equipment, they also could have been decorative. The golden wristguards of Agua Branca in Northern Portugal prove that symbolic objects of this nature did exist (Turek 2004). On the other hand, some studies examining stone wristguards from Bohemia have pointed out evidence for usage, normally in regard to repair, such as the presence of an additional hole that could have been made after another one broke (Turek 2004; Fokkens et al. 2008). However, this is not the case for the majority.

Based on their fabrication in stone and an overall lack of evidence for usage, it is largely agreed that stone wristguards were valuable personal objects and likely symbolic, perhaps even ceremonial (Turek 2015). This inference together with the evolution of bows and arrows as well as numerous iconography indicates a prestige surrounding Bell Beaker archery, begging the question as to just how emblematic archery was represented during this period. Were the individuals buried with such items esteemed archers themselves? Or does the prestige extend beyond the individual into the familial or societal realm?

3. Anthropological evidence

Keeping in mind the complete archaeological context, this study attempts to add a component to the interpretation of specialized or symbolic archery through the analysis of the human skeletal material associated with the "archer" burials of the Eastern Bell Beaker complex. The principle objective of this study is to verify the identity of suspected archers based on his or her osteological remains. In doing so, this also brings to attention the markers of activity associated with specialized archery.

3.1 Funerary context

When looking at Bell Beaker Europe (Fig. 12) with regard to the funerary culture, this complex can, generally speaking, be broken up into three regions: the North, Central, and Western domains. The northern domain, consisting primarily of the United Kingdom and Ireland, exhibits the most variability with instances of both individual burials and the reutilization of megaliths (Besse/Desideri 2005; Desideri 2011). In this region, single burials are often found underneath a small mound and occasionally grouped together forming a necropolis, with most seemingly having been reserved for men.

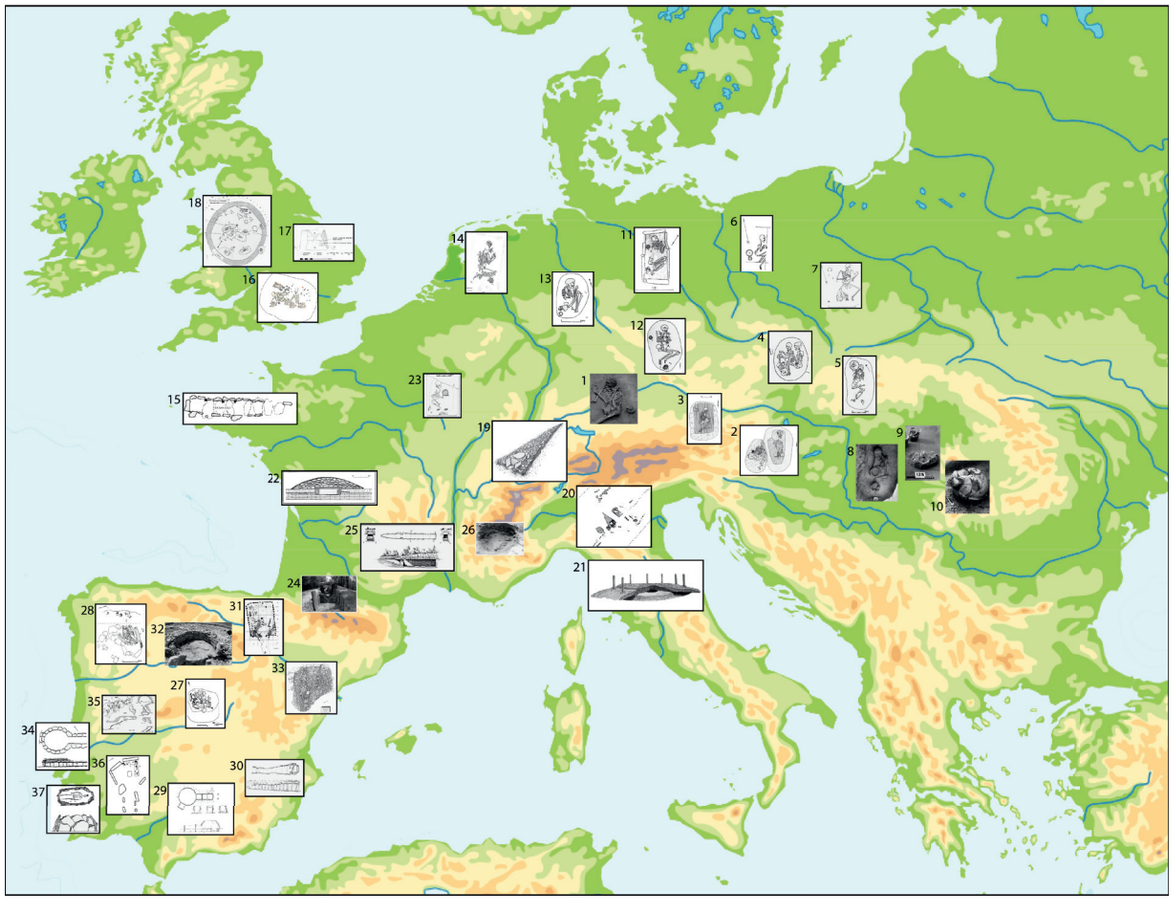

Fig. 12. Distribution of individual and collective burials of continental Europe (after Besse/Desideri 2005).

Most of the masculine grave goods include flint arrowheads, wristguards, and bronze, copper, and flint daggers, indicating high warrior importance (Cauwe et al. 2007).

The western domain is generally known for having reused megaliths and caves, effectively reusing the collective burials of preceding cultures (Besse/Desideri 2005; Desideri 2011). One example comes from the Petit-Chasseur site in Sion, Switzerland at which a previous megalithic tomb was emptied for Bell Beaker burials (Gallay/Chaix 1984). As these sites tend to be collective, the presence of grave goods is much less common and rarely associated with a unique individual.

The eastern domain appears to have almost exclusively hosted individual burials, often grouped in a necropolis or a cemetery. A few examples of tumulus burials and cremations have also been identified, though these are rare (Besse/Desideri 2005; Desideri 2011). Individuals were placed on a north-south axis, with men on their left sides and women on their right sides. Common grave goods for men included goblets, wristguards, arrowheads, daggers, and axes, whereas women had mostly jewellery (Strahm 1998). For these reasons, this study is primarily interested in individuals of the eastern complex, because the single graves and plentiful grave goods allow for a more complete view of the objects associated with a specific individual. This direct association between an individual and his or her burial context is necessary for this study. The examined osteological remains are therefore from single burials found in cemeteries in Bohemia.

3.2 The Bell Beaker study sample

The Bell Beaker culture in Bohemia greatly resembles the preceding Corded Ware culture, though for the latter we currently have more known archaeological sites, indicating that the Bell Beaker culture in the Czech Republic was largely a local development (Turek/Peška 2001). By this time, fortified hilltop settlements were common and spatial organization indicates that occupations were in proximity to the cemeteries (Turek/Peška 2001). The pottery from these regions is largely common ware, including goblets, polypod cups, and handled pitchers (Besse 2003). The decorated ceramics are predominantly maritime goblets and no all-over-ornamented (AOO) or all-over-corded (AOC) vessels have been found (Besse 2003). The primary grave goods of this region include common ware, daggers, arrowheads, bow-shaped pendants, boar tusks, flint tools, and wristguards (Turek 2008; Turek 2015).

This initial study was performed on 27 individuals, both suspected and non-suspected archers, from Bell Beaker cemeteries in the region of Bohemia, Czech Republic (Tab. 1). Overall, there were 10 suspected archers, all of whom were found with a stone wristguard. Only two were associated with a specific arm, and individual 6749

Tab. 1. Each individual examined in this study from Bohemian Bell Beaker cemeteries, including site, individual number, sex, age, and whether or not he or she was a suspected archer based on archaeological context.

Site	Individual	Sex	Age	Suspected Archer?
Tišice (Mělnik, Středočeský)	9900	Female	Adult	Yes
Radovesice (Lovosice, Ústecký)	9325	Male	Adult	Yes
Radovesice (Lovosice, Ústecký)	P7A 9321	Male?	Adult	Yes
Radovesice (Lovosice, Ústecký)	P7A 9320	Male	Adult	Yes
Knezeves (Praha, Praha)	P7A 30766	Male	~14	Yes
Rosnice (Karlovy, Královéhradecký)	P7A 6875	Male	30–50	Yes
Vykan (Nymburk, Středočeský)	P7A 32515	Male	20–39	Yes
Čachovice (Mladá Boleslav, Středočeský)	8555	Male	Adult	Yes
Libochovice (Lovosice, Ústecký)	P7A 32244	Male	Adult	Yes
Pr.8 Kobylisy (Praha, Praha)	6749	Male	Adult	Yes
Mochov (Praha-Vichod, Středočeský)	4066	Female?	~11–14	No
Mochov (Praha-Vichod, Středočeský)	4062	Female?	Adult	No
Mochov (Praha-Vichod, Středočeský)	3810	?	Adult	No
Mochov (Praha-Vichod, Středočeský)	4068	Male	Adult	No
Mochov (Praha-Vichod, Středočeský)	3808	Male	Adult	No
Mochov (Praha-Vichod, Středočeský)	3814	Male	Adult	No
Mochov (Praha-Vichod, Středočeský)	3805	Female?	Adult	No
Brandýsek (Slany, Středočeský)	31677	Male	30–39	No
Brandýsek (Slany, Středočeský)	31675	Female	Adult	No
Brandýsek (Slany, Středočeský)	31676	Male	Adult	No
Brandýsek (Slany, Středočeský)	31478	Male?	Adult	No
Brandýsek (Slany, Středočeský)	31619	Male	~14	No
Brandýsek (Slany, Středočeský)	31631	Female	16–18	No
Brandýsek (Slany, Středočeský)	31632	?	Adult	No
Brandýsek (Slany, Středočeský)	31633	Male	>40	No
Brandýsek (Slany, Středočeský)	31625	Male	16–28	No
Brandýsek (Slany, Středočeský)	31626	Female	20–39	No

from Pr. 8 Kobylisy, who was found with a bow-shaped pendant and a flint bifacial arrowhead (Tab. 2), was also an exception (Turek 2008). All of the individuals in question were under the age of 50 and one of the suspected archers was female. Of the 17 non-suspected archers, 6 were classified as either female or possibly female and all under the age of 50, with two adolescents (Tab. 1, Tab. 2).

Tab. 2. The individuals studied with their associated grave goods. Note that only suspected archers 9900 and 6875 had a stone wristguard associated with a particular arm.

Site	Individual	Grave Goods
Tišice (Mělnik, Středočeský)	9900	2 wristguards (one with left arm, one near the wall), copper dagger, 2 gold hair ornaments, a copper awl, both decorated and undecorated bell beakers (Turek 2002)
Radovesice (Lovosice, Ústecký)	9325	1 stone wristguard, flint arrowheads, bow-shaped pendant, V-perforated buttons (Turek 2000)
Radovesice (Lovosice, Ústecký)	P7A 9321	1 stone wristguard, points, bell beaker ceramics (Turek 2003)
Radovesice (Lovosice, Ústecký)	P7A 9320	lithics, arrow points, retouched antler, 1 stone brassard (Turek 2003)
Knezeves (Praha, Praha)	P7A 30766	bow-shaped pendant, arrowhead, 1 stone wristguard, bell beaker (Turek 2000)
Rosnice (Karlovy, Královéhradecký)	P7A 6875	1 stone wristguard (left forearm), copper dagger, flint flakes, bow-shaped pendant, two handled cups, copper ring ornament (Hájek 1968)
Vykan (Nymburk, Středočeský)	P7A 32515	two bowls, two handled cups, 1 stone wristguard, a bone pendant (Hájek 1968)
Čachovice (Mladá Boleslav, Středočeský)	8555	single-handled pottery, stone blades, arrow heads, 1 stone wristguard (Neustupny and Smrz 1989)
Libochovice (Lovosice, Ústecký)	P7A 32244	1 stone wristguard (Turek 2004)
Pr.8 Kobylisy (Praha, Praha)	6749	bowl, two handled cups, copper dagger, bow-shaped pendant, flint bifacial arrowhead (Turek 2008)
Mochov (Praha-Vichod, Středočeský)	4066	ceramics (wide bowl, jug, pot, mug) (Moucha 1972)
Mochov (Praha-Vichod, Středočeský)	4062	cermaics (bowl, jug) (Moucha 1972)
Mochov (Praha-Vichod, Středočeský)	3810	ceramics (bowl, cup) (Moucha 1972)
Mochov (Praha-Vichod, Středočeský)	4068	ceramics (bowl, cup), animal bone fragments (Moucha 1972)
Mochov (Praha-Vichod, Středočeský)	3808	ceramics (bowl, cup) (Moucha 1972)
Mochov (Praha-Vichod, Středočeský)	3814	ceramics (bowl, cup, bell beaker, plate), copper disc, flint flakes, flint scraper, animal bones (Moucha 1972)
Mochov (Praha-Vichod, Středočeský)	3805	ceramics (2 cups, jug) (Moucha 1972)
Brandýsek (Slany, Středočeský)	31677	bowl, cup, copper dagger, flint flakes (Kytlicová 1960)
Brandýsek (Slany, Středočeský)	31675	bell beaker (Kytlicová 1960)
Brandýsek (Slany, Středočeský)	31676	bowl (Kytlicová 1960)
Brandýsek (Slany, Středočeský)	31478	bell-shaped cup, stone ax, bowl, mug (Kytlicová 1960)
Brandýsek (Slany, Středočeský)	31619	no goods (Kytlicová 1960)
Brandýsek (Slany, Středočeský)	31631	no goods (Kytlicová 1960)
Brandýsek (Slany, Středočeský)	31632	jug, pitcher, two plastic pieces (Kytlicová 1960)
Brandýsek (Slany, Středočeský)	31633	bowl, bone fragment decoration (Kytlicová 1960)
Brandýsek (Slany, Středočeský)	31625	bowl (Kytlicová 1960)
Brandýsek (Slany, Středočeský)	31626	bowl, bell-shaped cup, jug, flint dagger (Kytlicová 1960)

3.3 Methodology

Analyses for each individual firstly included separate determinations of sex and age at death. Estimations for sex involved the protocol established by Bruzek (1991; 2002) as well as a secondary method by Acsádi and Nemeskéri (1970). Calculations for age at death were

based on criteria from Schmitt (2005) and Schaefer et al. (2009). All results for this study concerning the determinations for age and sex were consistent with those previously ascertained by the anthropologists responsible for the collection. Younger adults are the ideal age range for this study due to the fact that entheseal changes begin to appear more naturally with age as bones lose density. At this point, injuries become more common while healing becomes less thorough, therefore making it more difficult to associate entheseal changes with physical activity (Mariotti et al. 2004; Milella et al. 2012). For these reasons, no individual over the age of 50 was used in this study and young children were also avoided from an anthropological perspective; although of course, when examining archery burials from an archaeological perspective, children buried with such specialized items would be quite important. As children could not yet have been specialized archers, the presence of symbolic goods would likely reflect familial or societal values.

Measurements were also taken for each individual, whenever possible, for the purposes of comparisons at the population and individual level. Measurements are also necessary in order to identify handedness. Since archery is an asymmetric activity, this is necessary to determine the dominant hand in order to better understand its function. A total of 23 measurements at the scapula, clavicle, humerus, radius, and ulna were taken according to the body areas most affected by archery (Tab. 3).

The analyses of the entheses are based on two primary concepts: human biomechanics and entheseal changes. The study of human biomechanics aims to understand how the human body moves by

Tab. 3. Measurements taken for each individual (when preservation allowed) according to the standards established in Martin and Saller (1957).

Bone	Measurement	Code
Scapula	Anatomical width	ε1
	Glenoid Height	ε12
	Transverse Diameter of Glenoid Cavity	ε13
	Maximum Thickness of Spinal Crest	-
Clavicle	Maximum Length	δ1
	Vertical Midshaft Diameter	δ4
	Sagittal Midshaft Diameter	δ5
	Midshaft Circumference	δ6
Humerus	Maximum Length	ζ1
	Breadth of Proximal Epiphysis	ζ3
	Maximum Distal Breadth	ζ4
	Maximum Midshaft Diameter	ζ5
	Minimum Midshaft Diameter	ζ6
	Transverse Head Diameter	ζ9
	Vertical Head Diameter	ζ10
	Breadth of Trochlea	ζ11
Radius	Maximum Length	η1
	Minimum Circumference	η3
	Maximum Transverse Shaft Diameter	η4a
	Minimum Sagittal Shaft Diameter	η5a
	Maximum Distal Breadth	η5(6)
Ulna	Maximum Length	θ1
	Minimum Circumference	θ3

combining movement science and mechanics with human biology (Larven 2007). Therefore, a large part of this study involves taking a close look at the parts of the body activated during traditional archery (Fig. 13).

Accordingly, the first step towards establishing the parameters of human biomechanics for archery means identifying the primary muscle groups activated during this activity. From this perspective, archery is an ideal case study because different muscles are activated by the arm drawing the string and the one holding the bow. In this sense, anthropologically speaking one would expect to find non-symmetrical muscular development between the two arms in specialized archers. Drawing a bow string requires scapular retraction in a horizontally abducted position, indicating that the main focus for biomechanical stress is the rotator cuff, scapula, wrist, and fingers. This includes primary muscle involvement from the *supraspinatus, infraspinatus, rhomboids*, upper and middle t*rapezius, latissimus dorsi, biceps*, and *triceps* (Larven 2007; Putz/Pabst 2009; Tihanyi et al. 2015).

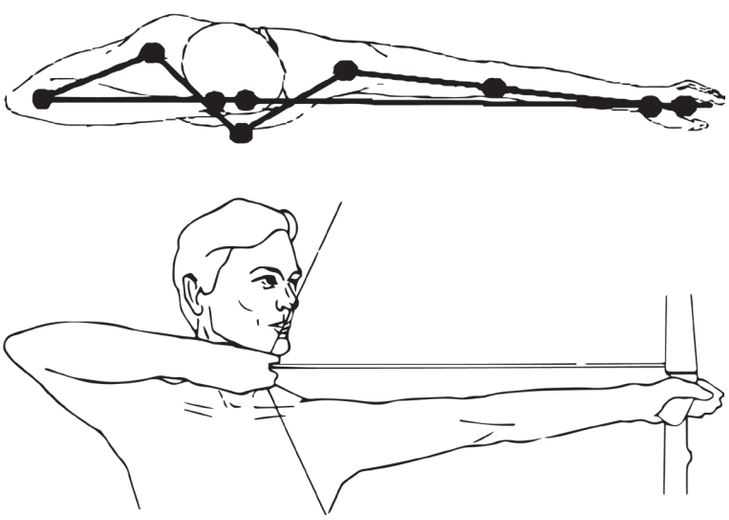

Fig. 13. Ideal shooting position for maximizing biomechanical efficiency (after Larven 2007).

The bow arm should normally be an individual's non-dominant hand, therefore entheseal changes on this arm are more likely associated with a repetitive physical activity than handedness. This arm requires shoulder extension, activating the shoulder muscles with stresses also appearing at the elbow due to the forced supination of the joint. The primary muscle involvement for the bow arm involves the subscapularis, deltoid, coracobrachialis, triceps, and anconeous (Larven 2007; Putz/Pabst 2009; Tihanyi et al. 2015).

The second important concept is the identification and classification of entheseal changes. Entheseal changes are modifications of the surface where tendons and ligaments attach to the bone, known as an enthesis (Fig. 14) (Henderson et al. 2013). Anthropologists have recently begun to examine these points in order to determine muscle use and possible pathologies. A specific application of such a study is the determination of occupation, according to the underlying idea that by identifying muscle usage on an individual, one can identify possible repeated activities performed during life. A study by Benjamin et al. (2006) found that bone alterations appearing at the enthesis likely occur primarily as a result of activity-related stress, mainly repetitive movements. The term enthesopathy is also commonly employed to describe pathological modifications to the

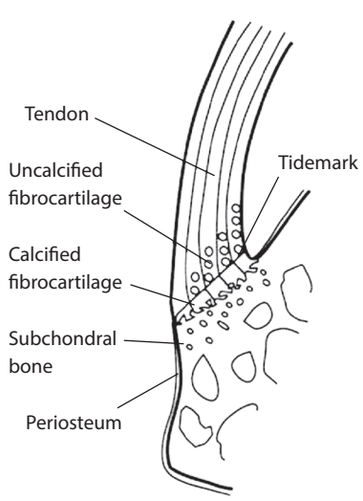

Fig. 14. Illustration of a fibrocartilaginous enthesis (after Villotte 2012).

enthesis. Such pathologies are generally not considered to be caused naturally, but rather reflect the effects of external and internal forces on the body, such as intense muscular activity, trauma, posture, and hygienic or dietary behaviors (Villotte 2006). There are several components that influence adult bone-shape throughout adolescence, and biomechanical loading is one of the main contributors to bone remodeling even through adulthood (Mann/Hunt 2013). In general, when looking at entheseal changes, the presence of enthesophytes (bone spurs) is associated with extreme physical activity and biomechanical stress, whereas lytic areas or lesions demonstrate robustness or extreme overuse (Hawkey/Merbs 1995; Benjamin et al. 2006).

Classifications of the entheses are based on two different scoring methods: the Villotte (2006) and Mariotti et al. (2007) methods. Classifications with the Villotte (2006) method firstly categorize the enthesis as either fibrous or fibrocartilaginous and then propose four distinct groups of sites with separate scoring systems. This method is ideal because it recognizes the different natures of the tissue that attaches to the bone, whereby the separate scoring systems specific to each group increases reliability and repeatability (Villotte 2006). The Mariotti et al. (2007) method does not make this distinction between the type of insertion, but rather the bone's response to stress: proliferation or erosion. This method also takes into account robustness, for an overall scoring system based on three aspects: robustness, osteophytic/enthesophytic development (bone modeling), and osteolytic development (bone destruction) (Mariotti et al. 2007). The application of both methods for this study helps to better understand both the pathological and non-pathological entheseal changes appearing throughout a skeleton due to physical activity. A complete list of observed and scored points along a skeleton can be seen intable 4.

Tab. 4. The evaluated attachment sites. The "code" refers to the author's shorthand for each site. M = muscle, L = ligament, J = joint.

Location	Enthesis	Code
Scapula	Insertion of M. trapezius	MtrSc
	Insertion of M. rhomboideus major	MRmaj
	Insertion of M. rhomboideus minor	MRmin
	Os acromiale	OA
Clavicle	Insertion of M. trapezius	MTrC
	Insertion of L. costoclavicular	LCc
Humerus	Insertion of M. supraspinatus	MSs
	Insertion of M. infraspinatus	MIs
	Insertion of M. teres minor	MTM
	Insertion of M. pectoralis major	MPM
	Insertion of M. latissimus dorsi	MLD
	Insertion of M. deltoideus	MD
	Insertion of M. coracobrachialis	MCb
Radius	Insertion of M. biceps brachii	MBB
Ulna	Insertion of M. triceps brachii	MT
	Insertion of M. anconeous	MAn
2nd Metacarpal	Insertion of M. ext. carpi radialis longus	MECRL
3rd Metacarpal	Insertion of M. ext. carpi radialis brevis	MECRB
5th Metacarpal	Insertion of M. carpi ulnaris	MECU
Phalanges 2 and 3	Joint between proximal and intermediate	JPh

A student's t-test was performed with a confidence interval of 95 % on all available measurement data sets presenting an n ≥ 3 as well as an analysis of data ranges and average values for specific measurements. For stages of entheseal development classified using the Villotte (2006) method of scoring, a Mann-Whitney U-test for attachment site scorings with an n ≥ 5 was taken at a significance level of 0.05 in order to better compare the groups of non-suspected archers and suspected archers for each enthesis on the left and right sides. An additional Mann-Whitney U-test was performed in order to compare any differences between the left and right sides of suspected archers. For reasons of compatibility and limited data, no statistical analyses were performed on the results of the Mariotti et al. (2007) method.

3.4 Results

Of the 27 Bell Beaker individuals examined, 10 were suspected archers based on their burial contexts. Among the 10 suspected archers, 5 were not preserved well enough to yield sufficient comparable anthropological results, 4 were classified as anthropologically likely archers, and 1 as an anthropologically unlikely archer (Fig. 15).

Due to limited and varying degrees of preservation for each individual, statistical analyses were not possible for all measurements and entheses. The student's t-test showed very few statistically significant differences between measurements of the archers and the non-archers. The measurements for which a difference between groups is observable at a confidence interval of 95 % include the left humerus minimum body diameter, the right humerus minimum body diameter, and the left radius maximum length. The right transverse diameter of the glenoid cavity was significant at a confidence interval of 90 %. For these values, each one favored the suspected archers (Tab. 5–7).

The results of the Mann-Whitney test for the Villotte (2006) scorings revealed no statistical differences between any of the enthesis locations for archers and non-archers (Tab. 8). However, this was not possible for all attachment sites due to a lack of data. An additional test was performed on the suspected archer group in order to

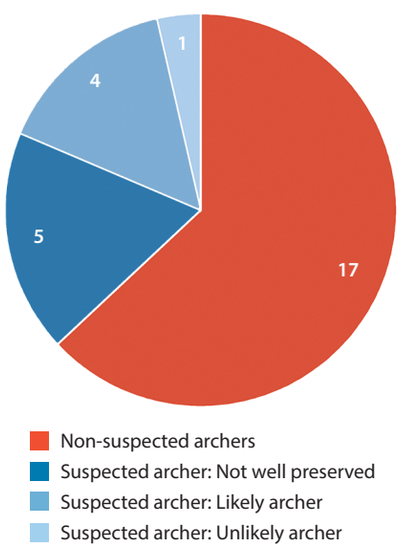

Fig. 15. Results of the examined Bohemian Bell Beaker individuals. A total of 27 individuals. Red indicates non-suspected archers, blue indicates suspected archers based on the archaeological context.

Tab. 5. Measurement results for suspected and non-suspected archers for the measurements as listed in Table 3. (l) = left, (r) = right, A = suspected archer, N = non-suspected archer. Values (in millimeters) from left include: n (number of individuals), Mean, Standard Deviation, Highest Measure, Lowest Measure, Median, Average Absolute Deviation from Median (AADM).

	n		Mean		sdev		Hi		Low		Med.		AADM	
	A	N	A	N	A	N	A	N	A	N	A	N	A	N
S12(l)	5	4	34,2	31,9	2,31	3,78	37,3	36,4	30,8	31,7	34,3	31,7	1,38	3,03
S13(l)	6	5	26,5	24,4	2,06	4,11	29,7	29	23,3	19	26,4	23,6	1,32	3,1
H1(l)	4	4	321	301	14,6	33	338	332	304	259	322	306	11,2	26
H6(l)	8	14	17,7	15,4	0,842	1,89	19,1	18,2	16,5	12,2	17,7	15,1	0,65	1,51
R1(l)	5	4	253	229	6,67	19,3	262	246	245	202	252	234	5	13,2
	A	N	A	N	A	N	A	N	A	N	A	N	A	N
S12(r)	5	4	35,2	33,7	1,99	3,75	37	37,7	32,3	29,1	35,7	34	1,48	2,93
S13(r)	6	3	27,7	24,9	1,1	2,54	28,8	27,7	25,6	22,7	27,9	24,4	0,683	1,67
H1(r)	5	4	324	300	8,91	31,9	339	323	317	254	322	310	6	22
H6(r)	6	11	18,2	15,4	0,737	1,67	19,3	17,6	17,4	12,6	18,2	15,8	0,567	1,36
R1(r)	3	3	258	228	6,93	38,6	266	254	254	184	254	247	4	23,3

Tab. 6. Results of the Student's *t*-test performed at a 95 % confidence interval for select measurements (whenever n ≥ 3) between suspected *archers and non-suspected archers* (Tab. 3). Results are significant for H6(l), H6(r), and R1(l) (asterisked). (l) = left, (r) = right; values from left: *t*-value, standard deviation, degrees of freedom, *p*-value.

	t-value	sdev	df	*p*-value
S12(l)	1,14	3,03	7	0,292
S13(l)	1,09	3,14	9	0,306
H1(l)	1,12	25,50	6	0,305
H6(l)*	3,22	1,61	20	0,004
R1(l)*	2,60	13,60	7	0,035
	***t*-value**	**sdev(r)**	**df**	***p*-value**
S12(r)	0,801	2,88	7	0,449
S13(r)	2,33	1,65	7	0,052
H1(r)	1,69	21,90	7	0,13
H6(r)*	3,89	1,43	15	0,0015
R1(r)	1,31	27,70	4	0,26

Tab. 7. Results of the Student's *t*-test performed at a 95 % confidence interval for select measurements (Tab. 4) between the *right and left sides of suspected archers*. No results are significant. Values from left: *t*-value, standard deviation, degrees of freedom, *p*-value.

	t-value	sdev	df	*p*-value
S12	0,7193	1,362	8	0,4924
S13	1,2238	0,953	10	0,2491
H1	0,4018	7,839	7	0,6998
H4	0,3231	2,270	6	0,7576
H6	1,2350	0,432	12	0,2405
R1	1,0131	4,935	6	0,3501

Tab. 8. Results of the Mann-Whitney test performed at a significance level of 0.05 for select attachment sites *comparing suspected archers and non-suspected archers* classified using the Villotte (2006) method (codes from Table 4). No results are significant. (l) = left, (r) = right; values from left: U-value, Critical Value of U, Z-Score, *p*-value.

	U-value	Crit. Val. U	Z-Score	*p*-value
MTrC(l)	11	8	–1,65341	0,09894
MSc(l)	6	2	1,25336	0,21130
MPM(l)	21	14	–1,35805	0,17384
MLD(l)	28	14	0,72440	0,48392
MD(l)	42	26	–0,92141	0,35758
MCb(l)	49	22	0,03730	0,96810
MBB(l)	16	8	–1,04103	0,29834
	U-Value	**Crit.V. U**	**Z-Score**	***p*-value**
MTrC(r)	10,5	6	1,42857	0,15272
MSc(r)	13	3	0,27386	0,78716
MPM(r)	22	11	–0,81349	0,41794
MLD(r)	17,5	10	1,06066	0,28914
MD(r)	19,5	10	–0,82496	0,41222
MCb(r)	25,5	10	–0,11785	0,90448
MBB(r)	11	3	–0,63901	0,52218

compare the development of left and right sides and again no statistically significant differences were found (Tab. 9).

The overall results from the Villotte (2006) (Appendix 1) and Mariotti et al. (2007) (Appendix 2) methods reveal similar patterns. The rotator cuff region, pectoralis major, latissimus dorsi, and deltoid attachments tend to present higher levels of robustness among the archers than the non-archers. However, for the large muscle insertions of the humerus, the non-archers tend to exhibit more enthesopathic development than the archers. Other characteristics found consistently among the suspected archers include: enthesopathies of the trapezius insertion, lipping of the glenoid cavity, osteolytes of the costoclavicular ligament insertion, osteophytes and arthritis of the elbow, and overall exceptional robustness throughout the upper limbs.

While modifications to studies such as this investigation are necessary in order to increase the likelihood of statistically significant results, it is important to recognize that these tests function as a comparison between populations. When looking at the individual, in general, this study found that the archers are overall more robust and demonstrate slightly higher levels of enthesophytic

Tab. 9. Results of the Mann-Whitney test performed at a significance level of 0.05 for select attachment sites *comparing the left and right sides of the suspected archer group* as classified using the Villotte (2006) method. No results are significant. Values from left: U-value, Critical Value of U, Z-Score, *p*-value.

	U-value	Crit. Val. U	Z-Score	*p*-value
MTrC	15,5	5	0,2436	0,81034
MSc	12,5	3	–0,36515	0,71138
MPM	18	5	0,08006	0,93624
MLD	18	5	0,08006	0,93624
MD	21,5	8	–0,2582	0,79486
MCb	20,5	6	0	1
MBB	10,5	2	0,31334	0,75656
MT	18	5	0,08006	0,93624

Appendix 1. Distribution of individuals classified with each development stage using the Villotte (2006) method. Enthesis codes from Table 4.

Group 1

Suspected Archers						
	A (l)	A (r)	B (l)	B (r)	C (l)	C (r)
MSs	1	0	3	4	0	2
MIs	0	0	3	5	0	0
MSc	0	1	3	2	2	3
MTM	0	0	0	5	0	1
MBB	0	1	4	3	1	1
Non-Suspected Archers						
	A (l)	A (r)	B (l)	B (r)	C (l)	C (r)
MSs	1	1	3	2	0	1
MIs	2	3	2	1	0	0
MSc	1	1	4	3	0	1
MTM	1	0	1	2	0	0
MBB	1	2	0	5	9	0

Appendix 2. Distribution of individuals classified using the Mariotti et al. (2007) method. Rob. = Robustness, OPF = Osteophytic Formation, OLF = Osteolytic Formation, (l) = left, (r) = right, SA = Suspected Archers, NA = Non-suspected Archers. Enthesis codes from Table 4.

Groups 2, 4

Suspected Archers										
	A (l)	A (r)	Ba (l)	Ba (r)	Bb (l)	Bb (r)	Ca (l)	Ca (r)	Cb (l)	Cb (r)
MPM	0	0	5	3	0	1	2	2	0	0
MLD	4	4	1	1	0	0	1	1	0	0
MD	2	1	5	4	0	0	1	1	0	0
MCb	6	5	1	1	0	0	0	0	0	0
MT	1	1	3	3	1	1	1	1	0	0
MTrC	1	1	3	4	0	0	2	2	0	0
MAn	1	0	6	5	0	1	0	1	0	0

Non-Suspected Archers										
	A (l)	A (r)	Ba (l)	Ba (r)	Bb (l)	Bb (r)	Ca (l)	Ca (r)	Cb (l)	Cb (r)
MPM	3	2	9	5	2	3	1	1	0	1
MLD	4	2	5	4	4	2	0	0	0	1
MD	6	2	7	7	2	0	0	0	0	0
MCb	11	8	2	1	1	1	1	1	0	1
MTrC	5	3	5	4	1	0	0	0	0	0
MAn	2	2	4	4	3	0	1	2	0	1

development whereas the non-archers are also robust, but tend to have slightly higher levels of osteolytic development. However, at a population level these differences are not statistically significant.

At the individual level, nine out of the ten suspected archers presented the anticipated markers associated with specialized archery, though of those nine, only four were complete enough for a complete analysis. Therefore, for this study of Bell Beaker archery, it seems very likely that for this collection, the archery burial context of these individuals is reflective of their occupations: specialized archery. This creates a direct link between the individual and the object, indicating that the individuals interred with archery-related artisanal grave goods were archers themselves.

4. Discussion

Attempting to identify occupation from the skeleton is not done arbitrarily on every recovered individual. Analyses at this level are not independent and rely heavily on archaeological context and interpretation. This study is an initial look into the possibility of identifying occupation from the skeleton in association with archaeological context with the aim of better understanding the importance of archery during the Bell Beaker period. This idea is currently being extended into a thesis project aimed at a more extensive look into specialized archers throughout the Eastern Bell Beaker complex. This initial study was not an attempt to identify individuals without an archery context, however, both suspected and non-suspected archers were examined for the purposes of comparative osteology. In this case, it would be misleading and unfounded to assume that an individual without an archaeological archer's context was not an archer, when perhaps, for example, he or she was simply of a lower rank or a poorer class. For this reason, it is not ideal to compare populations of

"non-archers" and "archers" in the identification of a single individual because, for the parameters of this study, "non-archer" simply means no archery context. This in turn also renders statistical analyses between these groups less reliable.

At the same time, trying to find patterns and calculate statistics between the entheses of suspected and non-suspected archers is also unreliable. For this study, the attempt to compare each individual enthesis of the non-archer group with the archer group yielded no results and this is not surprising. A large part of this study involves utilizing human biomechanics in order to better understand the muscles most activated during archery. In this sense, one muscular origin or insertion will not indicate specialized archery, it is rather the combination of several of these theorized muscular developments appearing and working together. For this reason, while the statistical analyses indicate little difference between the suspected archers and the non-suspected archers on a population level, a closer look at the individual reveals evidence of physical activity. In order to improve upon this process of data analysis, techniques need to be developed in order to evaluate the presence of various markers at the level of the individual rather than as simply a grand comparison between populations. Identification of a specialized activity, such as archery, happens at the level of the individual and how his or her muscles developed according to unique life experiences. It is therefore misleading to compare only populations because interpretations need to be made first in reference to a unique individual before attempting to place that same individual within a population. In addition, measurement analyses comparing suspected and non-suspected archers do not take into account sex, age, or genetics. There is currently no evidence, now or historically, that stature is linked to archery or archery performance.

In this sense, it will be easier to classify an individual as a non-specialized archer than as a specialized archer. Using a bow would have been a physically strenuous activity and simply competence, let alone specialization, would have required training and practice. Such levels of practice performing a physically strenuous activity would develop the activated muscles, and this would be reflected on the bone. For this reason, a recovered skeleton with little or no robustness or presence of entheseal changes would indicate a lack of supplementary muscular development and therefore would likely not have been a specialized archer. In contrast, an all-around robust individual with clear entheseal changes could definitely have been a specialized archer, though depending on the regions of development, numerous suspected activities could theoretically be possible from an anthropological standpoint. This is also the reason why the archaeological context is vital for these interpretations.

This initial study contained both males and females. In future studies, it would be prudent to differentiate them. Since one suspected archer (Tišice 9900) was a female, non-suspected archer females were also included in this study. However, due to differences in bone development affecting osteological comparisons, and the fact that both archaeological and ethnological female specialized archers are rare, it is perhaps methodologically ideal to keep study samples to males with the exception of the female suspected archers. Combining such data in an outlook on the population makes analyses on comparative osteology less reliable due to differences in an individual's size as well as the likely culture-related developmental differences. Moreover, in the case of Tišice 9900, she unfortunately was not well enough preserved to allow for sufficient detailed observations.

While the symbolic or practical function of archery-related grave goods, namely wristguards, is unsure, their artisanal value is not.

These objects necessitated long fabrication times and crafting know-how, and all of this for an object that would have been cumbersome and impractical. This leaves little doubt that these objects were in some way valued either by the society, individual, or both. Linking these objects to specialized archers implies that the value is most likely associated with the activity itself and therefore the individuals performing it. Artisanal production of archery goods not only implies a demand, but also a willingness to meet it. Knowing that these goods were probably for archers themselves reveals the importance not only of archery to the community, but also of archers. This puts into perspective the presence of a class of archers and based on the archaeological context, this class of individuals would have been prominent, perhaps even dominant. A social class of archers reflects not only the existence of warfare in Bell Beaker culture but also its significance in the daily lives of the people.

5. Conclusion

First and foremost, markers on osteological remains can indicate specialized archery or not. However, this must be considered in terms of the individual being examined rather than as a sweeping comparison between suspected archers and non-suspected archers based on the archaeological context. Studying non-suspected archers alongside suspected archers is valuable for an understanding of the distribution of certain characteristics and the overall placement within a population, but separate processes need to be applied to the interpretation at the individual level. Using entheseal changes as a means in order to better understand daily life remains a worthwhile area of study that should be taken into account for all burials with an archaeological context.

Most of the individuals from this study, even those with too little information to provide an in-depth classification, presented the muscular development categorizing them as possible archers. Since the selection of these individuals was based on having been buried with an artisanal stone wrist-guard, this does provide further evidence for a class of specialized archers during the Bell Beaker period.

This was a first step hoping to explore the possibility of osteology-based classifications of specialized archery. The next step is for these processes to be applied to more individuals with similar archery burial contexts throughout the Bell Beaker domain and to develop a method to analyse individuals both separately and as entities within a greater population. Such a project is currently underway as a PhD thesis extending from this current study. The results of these investigations will be important to enhance the current understanding of warfare during the transition from the Neolithic to the Bronze Age as well as to better realise the functional significance of artisanal objects of war.

References

Acsádi/Nemeskéri 1970: G. Acsádi/ J. Nemeskéri, History of Human Life Span and Mortality. (Budapest 1970).

Benjamin et al. 2006: M. Benjamin/ H. Toumi/ J.R. Ralphs/ G. Bydder/ T.M. Best/ S. Milz, Where tendons and ligaments meet bone: attachment sites ('entheses') in relation to exercise and/or mechanical load. Journal of Anatomy 208, 2006, 471–490.

Bentley et al. 2012: R.A. Bentley/ P. Bickle/ L. Fibiger/ G.M. Nowell/ C.W. Dale/ R.E.M. Hedges/ J. Hamilton/ J. Wahl/ M. Francken/ G. Grupe/ E. Lenneis/ M. Teschler-Nicola/ R.-M. Arbogast/ D. Hofmann/ A. Whittle, Community differentiation and kinship among Europe's first farmers. PNAS 109, 2012, 9326–9330.

Bergman 1993: C.A. Bergman, The Development of the Bow in Western Europe: A Technological and Functional Perspective. Archaeological Papers of the American Anthropological Association 4, 1993, 95–105.

Besse 2003: M. Besse, Les céramiques communes des Campaniformes européens. Gallia préhistoire 45, 2003, 205–258.

Besse/Desideri 2005: M. Besse/ J. Desideri, La diversidad campaniforme: hábitats, sepulturas y cerámicas. In: M.A. Rojo-Guerra/ R. Garrido-Pena/ I. García-Martínez de Lagrán (eds.) El Campaniforme en la Península Ibérica y su Contexto Europeo = Bell Beakers in the Iberian Peninsula and their European Context (Valladolid 2005), 61–106.

Bocksberger 1976: O.J. Bocksberger, Le site préhistorique du Petit-Chasseur (Sion, Valais). 1 et 2. Le dolmen MVI, texte, catalogue et planches. (Lausanne 1976).

Bruzek 1991: J. Bruzek, Fiabilité des procédés de détermination du sexe à partir de l'os coxal. Implications à l'étude du dimorphisme sexuel de l'homme fossile. (PhD Thesis Muséum National d'Histoire Naturelle 1991).

Bruzek 2002: J. Bruzek, A method for visual determination of sex, using the human hip bone. American Journal of Physical Anthropology 117, 2002, 157–168.

Cattin 2008: F. Cattin, Modalités d'approvisionnement et modalités de consommation du cuivre dans les Alpes au 3e millénaire avant notre ère: apport des analyses métalliques à la connaissance des peuplements du Néolitique final, du Campaniforme et du Bronze ancien. University of Geneva 2008).

Cattin et al. 2011: F. Cattin/ B. Guénette-Beck/ P. Curdy/ N. Meisser/ S. Ansermet/ B. Hofmann/ R. Kündig/ V. Hubert/ M. Wörle/ K. Hametner/ D. Günther/ A. Wichser/ A. Ulrich/ I.M. Villa/ M. Besse, Provenance of Early Bronze Age metal artefacts in Western Switzerland using elemental and lead isotopic compositions and their possible relation with copper minerals of the nearby Valais. Journal of Archaeological Science 38, 2011, 1221–1233.

Cauwe et al. 2007: N. Cauwe/ P.M. Dolukhanov/ P. Kozłowski/ P.-L. Van Berg, Le Néolithique en Europe. (Paris 2007).

Cheynier 1946: A. Cheynier, Les flèches à tranchant transversal. Bulletin de la Société préhistorique de France 43, 1946, 208–211.

Christensen 2004: J. Christensen, Warfare in the European Neolithic. Acta Archaeologica 75, 2004, 129–156.

Corboud 2009: P. Corboud, Les stèles anthropomorphes de la nécropole néolithique du Petit-Chasseur à Sion. Bulletin d'études préhistoriques et archéologiques alpines 20, 2009, 1–89.

Desideri 2011: J. Desideri, When Beakers met Bell Beakers, An analysis of dental remains British Archaeological Reports: International Series 2292 (Oxford 2011).

Dias-Meirinho 2011: M.-H. Dias-Meirinho, Des Armes et des Hommes. L'archerie à la transition fin du Néolithique - Age du Bronze en Europe occidentale. Université de Toulouse 2011).

Favre et al. 1986: S. Favre/ A. Gallay/ K. Farjon/ B.d. Peyer, Stèles et monuments du Petit-Chasseur : un site néolithique du Valais (Suisse). (Genève 1986).

Fleckinger 2005: A. Fleckinger, Ötzi, the Iceman: The Full Facts at a Glance. (Vienna/Bolzana 2005).

Fokkens et al. 2008: H. Fokkens/ Y. Achterkamp/ M.H.G. Kuijpers, Bracers or bracelets? About the functionality and meaning of Bell beaker wrist guards. Proceedings of the Prehistoric Society 74, 2008, 109–140.

Furestier 2007: R. Furestier, Les industries lithiques campaniformes du sud-est de la France. British Archaeological Reports: International Series 1684 (Oxford 2007).

Gallay 2011: A. Gallay, Pour une ethnoarchéologie théorique: mérites et limites de l'analogie ethnographique. (Paris 2011).

Gallay/Chaix 1984: A. Gallay/ L. Chaix, Le site préhistorique du Petit Chasseur (Sion, Valais), 5. Le Dolmen M XI. Texte et planches. (Lausanne 1984).

Hafner 2012: A. Hafner, Archaeological discoveries on Schnidejoch and at other ice sites in the European Alps. Arctic 65, 2012, 189–202.

Hájek 1968: L. Hájek, Die Glockenbecherkultur in Böhmen. Archeologické studijní materiály 5 (Praha 1968).

Hawkey/Merbs 1995: D.E. Hawkey/ C.F. Merbs, Activity-induced musculoskeletal stress markers (MSM) and subsistence strategy changes among ancient Hudson Bay Eskimos. International Journal of Osteoarchaeology 5, 1995, 324–338.

Henderson et al. 2013: C.Y. Henderson/ V. Mariotti/ D. Pany-Kucera/ S. Villotte/ C. Wilczak, Recording Specific Entheseal Changes of Fibrocartilaginous Entheses: Initial Tests Using the Coimbra Method. International Journal of Osteoarchaeology 23, 2013, 152–162.

Hernández-Pacheco 1918: E. Hernández-Pacheco, Estudios de arte prehistórico. Junta para Ampliación de Estudios e Investigaciones Científicas 1918, 62–84.

Heyd 2001: V. Heyd, On the earliest Bell Beakers along the Danube. In: F. Nicolis (ed.) Bell beakers today. Pottery, people, culture, symbols in prehistoric Europe. Proceedings of the International Colloquium Riva del Garda (Trento, Italy), 11–16 May 1998 (Trento 2001), 387–409.

Honegger et al. 2011: M. Honegger/ P. De Montmollin/ C. Joye, Un essai sur les premières armes de guerre du Néolithique : flèches, poignards et haches de combat au nord-ouest des Alpes. In: Actes de la Table ronde internationale et interdisciplinaire, Sens, 4–5 juin 2009 (Dijon 2011), 71–102.

Howell 1987: J.M. Howell, Early Farming in Northwestern Europe. Scientific American 257, 1987, 118–126.

Joussaume 1981: R. Joussaume, Le Néolithique de l'Aunis et du Poitou occidental dans son cadre atlantique. (Rennes 1981).

Kytlicová 1960: O. Kytlicová, Eneolitické pohřebiště v Brandýsku. Památky archeologické 51, 1960, 442–474.

Larven 2007: J. Larven, Shooting Technique Biomechanics. (Panania 2007).

Lemercier 2011: O. Lemercier, Le geurrier dans l'Europe du 3e millénaire avant notre ère. L'arc et le poignard dans les sépultures individuelles campaniformes. In: L. Baray/ M. Honegger/ M.-H. Dias-Meirinho (eds.) Actes de la Table ronde internationale et interdisciplinaire Sens, CEREP (Dijon 2011), 121–224.

Mann/Hunt 2005: R.W. Mann/ D.R. Hunt, Photographic Regional Atlas of Bone Disease: A Guide to Pathologic and Normal Variation in the Human Skeleton. (Springfield 2005).

Mariotti et al. 2004: V. Mariotti/ F. Facchini/ M. Giovanna Belcastro, Enthesopathies-Proposal of a Standardized Scoring Method and Applications. Collegium antropologicum 28, 2004, 145–159.

Mariotti et al. 2007: V. Mariotti/ F. Facchini/ M. Giovanna Belcastro, The Study of Entheses: Proposal of a Standardised Scoring Method for Twenty-Three Entheses of the Postcranial Skeleton. Collegium antropologicum 31, 2007, 291–313.

Martin/Saller 1957: R. Martin/ K. Saller, Lehrbuch der Anthropologie: In Systematischer Darstellung mit Besonderer Berücksichtigung der Anthropologischen Methoden. (Stuttgart 1957).

Milella et al. 2012: M. Milella/ M. Giovanna Belcastro/ C.P.E. Zollikofer/ V. Mariotti, The Effect of Age, Sex, and Physical Activity on Entheseal Morphology in a Contemporary Italian Skeletal Collection. American Journal of Physical Anthropology 148, 2012, 379–388.

Moucha 1972: V. Moucha, Mochov: okr. Praha-východ střední Čechy. Československá Akademie Věd Archeologický Ústav 1972.

Nash 2005: G. Nash, Assessing rank and warfare-strategy in prehistoric hunter-gatherer society: a study of representational warrior figures in rock-art from the Spanish Levant, southeastern Spain. Warfare, Violence and Slavery in Prehistory 2005, 75–86.

Neustupný/Smrž 1989: E. Neustupný/ Z. Smrž, Čachovice – pohřebiště kultury

se šňůrovou keramikou a zvoncovitých pohárů. Památky archeologické 80, 1989, 282–383.

Nicolas 2013: C. Nicolas, Symboles de pouvoir au temps de Stonehenge: Les productions d'armatures de prestige de la Bretagne au Danemark (2500–1700 av. J.-C.). Université Paris I–Panthéon Sorbonne 2013).

Nicolas 2016: C. Nicolas, Flèches de pouvoir à l'aube de la métallurgie de la Bretagne au Danemark (2500–1700 av. n. è.). (Leiden 2016).

Olivik 2012: J. Olivik, Archery Equipment in Burial Rites of the Bell Beaker culture in Bohemia and Moravia. Presentation at the European Associations of Archaeologists, 18th annual meeting (Helsinki 2012).

Pavúk 1991: J. Pavúk, Lengyel-culture fortified settlements in Slovakia. Antiquity 65, 1991, 348–357.

Pažinová 2007: N. Pažinová, The Lengyel culture settlement in Bučany (preliminary report on pottery processing). Documenta Praehistorica 34, 2007, 299–310.

Pétrequin/Pétrequin: A.-M. Pétrequin/ P. Pétrequin, Flèches de chasse, flèches de guerre, le cas des Danis d'Irian Jaya (Indonésie). Bulletin de la Société préhistorique française 87, 484–511.

Piel-Desruisseaux 2013: J.-L. Piel-Desruisseaux, Outils préhistoriques: Du galet taillé au bistouri d'obsidienne. (Paris 2013).

Putz/Pabst 2009: R. Putz/ R. Pabst (eds.) Head, Neck, Upper Limb, Thorax, Abdomen, Pelvis, Lower Limb. Sobotta Atlas of Human Anatomy 1 (München 2009).

Růžičková 2009: P. Růžičková, Bow-Shaped Pendants of the Bell Beaker Culture. Acta Archaeologica Carpathica 44, 2009, 37–72.

Saintot 1998: S. Saintot, Les armatures de flèches en silex de Chalain et de Clairvaux. Gallia préhistoire 40, 1998, 204–241.

Sangmeister 1974: E. Sangmeister, Zwei Neufunde der Glockenbecherkultur in Baden-Württemberg. Ein Beitrag zur Klassifizierung der Armschutzplatten in Mitteleuropa. Fundberichte aus Baden-Württemberg 1, 1974, 103–156.

Schaefer et al. 2009: M. Schaefer/ S. Black/ L. Scheuer, Juvenile Osteology: A Laboratory Field Manual. (Amsterdam 2009).

Schmitt 2005: A. Schmitt, Une nouvelle méthode pour estimer l'âge au décès des adultes à partir de la surface sacro-pelvienne iliaque. Bulletins et Mémoires de la Société d'Anthropologie de Paris 17, 2005, 89–101.

Strahm 1998: C. Strahm, Il bicchiere campaniforme: fenomeno e cultura. In: F. Nicolis/ E. Mottes (eds.) Simbolo ed enigma. Il bicchiere campaniforme e l'Italia nella preistoria europea del III millennio a.C. [Catalogo della mostra tenuta a Riva del Garda nel 1998] (Trento 1998), 20–44.

Strahm 2002: C. Strahm, Tradition und Wandel der sozialen Strukturen vom 3. zum 2. vorchristlichen Jahrtausend. In: J. Müller (ed.) Vom Endneolithikum zur Frühbronzezeit: Muster sozialen Wandels? (Tagung Bamberg 14.–16. Juni 2001) (Bonn 2002), 175–194.

Tihanyi et al. 2015: B. Tihanyi/ Z. Bereczki/ E. Molnár/ W. Berthon/ L. Révész/ O. Dutour/ G. Pálfi, Investigation of Hungarian Conquest Period (10th c. AD) archery on the basis of activity-induced stress markers on the skeleton--preliminary results. Acta Biologica Szegediensis 59, 2015, 65–77.

Turek 2000: J. Turek, Being a Beaker child. The position of children in Late Eneolithic society. In: In Memoriam Jan Rulf (Prague 2000), 424–438.

Turek 2002: J. Turek, „Cherche la femme!" Archeologie ženského světa a chybějící doklady ženských pohřbů z období zvoncovitých pohárů v Čechách. Archeologie nenalézaného, Plzeň-Praha 2002, 217–240.

Turek 2003: J. Turek, Řemeslná symbolika v pohřebním ritu období zvoncovitých pohárů : suroviny, výroba a struktura společnosti v závěru eneolitu. In: L. Šmejda/ P. Vařeka (eds.) Sedmdesát neustupných let (Plzeň 2003), 201–220.

Turek 2004: J. Turek, Nátepní destičky z období zvoncovitých poháhů, jejich suroviny, technologie a společenský význam. K poctě Vladimíru Podborskému, Přátelé a žáci k sedmdesátým narozeninám, Ústav archeologie a muzeologie, Filozofická fakulta Masarykovy univerzity v Brně 2004, 207–226.

Turek 2008: J. Turek, Pohřebiště z období zvoncovitých pohárů v Praze ii. Katalog a diskuse o vzniku a původu nejstarších zvoncovitých pohárů. Archaeologica Pragensia 19, 2008, 31–104.

Turek 2015: J. Turek, Bell Beaker Stone Wrist-Guards as Symbolic Male Orna-

ment. The Significance of Ceremonial Warfare in 3rd Millenium BC Central Europe. In: M.P. Prieto Martinez/L. Salanova (eds.) The Bell Beaker Transition in Europe. Mobility and local evolution during rhe 3rd millennium BC (Oxford 2015), 28–40.

Turek/Peška 2001: J. Turek/ J. Peška, Bell Beaker settlement pattern in Bohemia and Moravia. In: F. Nicolis (ed.) Bell beakers today. Pottery, people, culture, symbols in prehistoric Europe. Proceedings of the International Colloquium Riva del Garda (Trento, Italy), May 11–16 1998 (Trento 2001), 411–428.

Vaquer/Maille 2011: J. Vaquer/ M. Maille, Images de guerriers du Néolithique final – Chalcolithique dans le Midi de la France: les poignards-figurations sur les statues-menhirs rouergates et objets réels. In: L. Baray/ M. Honegger/ M.-H. Dias-Meirinho (eds.) L'armement et l'image du guerrier dans les sociétés anciennes. De l'objet à la tombe (Dijon 2011), 103–119.

Villotte 2006: S. Villotte, Connaissances Médicales Actuelles, Cotation des Enthésopathies: Nouvelle Méthode. Bulletins et Mémoires de la Société d'Anthropologie de Paris 18, 2006, 65–85.

Villotte 2013: S. Villotte, Practical protocol for scoring the appearance of some fibrocartilaginous entheses on the human skeleton. (Bordeaux 2013).