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THESIS

Reframing the flow of indigenous artefacts in 17th century colonial America: Material analysis of metal inlays in ball-headed clubs from the Ashmolean Tradescant Collection

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Abstract

The ball-headed clubs from the Ashmolean museum's Tradescant collection offer a unique chance to study a creolized object from the context of early colonial contact between European colonizers and indigenous North Americans. Of particular interest were the unique metal inlay decorations used on two of the three clubs, and how their compositional knowledge could contribute to our current understanding of their internal relationship, their ties to the broader tradition of weaponry design within indigenous production history, and their representation of the complex power-dynamics governing the trade and relationships of early contact.

The two decorated clubs were analyzed using a suit of imaging and compositional techniques, including X-ray, portable X-ray Fluorescence (XRF), and Scanning Electron Microscopy. The X-ray allowed for the visualization of the depth and shape of the metal inlays which were confirmed to be European sheet metal. The compositional XRF data was analyzed and compared to a database of historical copper for the period using PCA to establish narrower possible origins for the individual metal inlays. High-arsenic copper material was positively assigned to English material, while high nickel and tin content brass was linked to German sources. Both French and Swedish material were also possible matches for some of the material, but would require more in depth analysis to confirm this attribution. A possible overlap between the material used for the individual clubs were established, possibly confirming an internal relationship between these items. Additionally, a significant decorating practice was found to have been used on the hilt of one of the objects, raising questions about the significance of the metal and metal origin in their use in a

distinct decoration pattern. Possible equivalent decoration traditions including the historical use of wampum, were used to contextualize this finding.

These objects and the findings in this study offer new and intriguing views into the making of cultural goods in the midst of the early contact period, indicative of the mixing pots of resources, cultures, and aesthetics of the 16th and 17th century. This study makes an attempt at complexifying the narrative of colonial conquest that often strips indigenous communities of their historical agency, and tries to diversify our current understanding of material culture exchange during the period. More than anything, this study lays some groundwork for a body of research into these objects and their siblings in collections around Europe.

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1. Introduction

Objects created and acquired during the early period of European colonisation of North America offer a unique opportunity for us to understand the nature of this early interaction, the cultures and power-dynamics that existed before it, and how indigenous groups responded to this change. Through the analysis of three ball-headed clubs, two with metal inlays, belonging to the Tradescant collection of the Ashmolean museum, it is hoped that we can elucidate the complex trade routes and relationships that dictated the exchange of material culture throughout the 16th and 17th century between colonial forces and indigenous communities in the American northeast. Particularly, this project hopes to complexify homogenized narratives about early contact, and offer a perspective obtained through the analysis of material culture to expand upon the European-biased historical accounts.

1.1 Colonial contact, trade of material culture, and archeology

Colonial contact throughout the early 16th and 17th century marked for indigenous communities the start of a slow and constant erosion of their cultural identity and agency within their own lands. Most tangible was the trade, looting, and theft of material culture from their lands for export to European courts and markets. A bourgeoning tradition of collecting the "exotic", a European fascination with indigenous objects, hit a crescendo in the late 16th and early 17th century, with the import of substantial material culture from America (Feest, 1993). The long term consequences of this include the presence of extensive indigenous material in European museums, private collections, and research institutions today. Conversely, European material did find its way into

the hands of indigenous groups in the northeast, but the effects of colonialism have dwarfed this side of the exchange considerably. The first, more exploitative interaction is often at the center of trade studies for the period, underscoring the complex and varied trade and interactions that defined the early contact period. Indeed, the transfer of both material goods and cultural knowledge, fed a growing thirst for collecting on both sides of the colonial divide (Immonen, 2013). European courts could learn from the New World through objects brought back from exploratory, missionary, and trade expedition to Northern America. Meanwhile, indigenous groups suddenly had available to them a richness of exotic international material that could be used and traded through internal commercial routes (Bleichmar and Mancall, 2011). Trading items and resources back and forth between indigenous and colonial groups, or through indigenous or colonial middlemen as was common, and led to effects on the economic and cultural landscape of eastern Northern America and Europe that are still visible now (Naum and Ekengren, 2018). That is not to say that colonial period trade was no without problematic power-dynamics: the competing value systems of the indigenous and colonizers eventually lead to severe trade imbalances that would rob indigenous groups of their land. Yet, this singular narrative of an overpowering colonising force robs indigenous groups of the agency they held as custodians of the land, a complexity that analyses of these creolised artefacts may help to define.

Archeological study of this early contact period seeks to uncover the intricacies of colonial relationships between these groups which have been homogenized and often sanitized, for the sake of colonial descendants who continue to reap the benefits of this centuries-long occupation. The material culture which did cross the Atlantic at the time and now sits in collections throughout Europe offers a type of time-capsule for the state of trade and exchange during early contact, and

acts as a linchpin to our understanding of this cultural exchange, if one severely biased by years view through an ethnographical lens (Feest, 1993). Loss of information from malignance, ignorance, and poor handling of these objects will hinder any and all attempts at painting a complete picture of these items' history. Despite this, material culture acts as the key to understanding the subjectivities of colonial identities in the context of early contact (Lucas, 2006). The global network of exchange which existed throughout the early contact period can be glimpsed through the lens of material artefacts from the period, and the macroscale politics can be untangled to clearly display forces of desire at play between interacting parties. Moreover, it allows us to step outside the paradigm of Western Universalizing history by considering the trade of individual items, at singular moments in history (Immonen, 2013). While this does not allow us to make sweeping claims about trade in early colonial North America, it instead lets us diversify the narrow narrative of colonialist conquest.

Archeological science here plays a pivotal role because it allows access to a set of tools necessary for the exploration of these indigenous items in European collections from further outside the colonial lens, if still constrained by a western ontological framework. Most written first-hand accounts from the early contact period survive as letters and testimonies from European explorers and colonisers. Reconstructing material and cultural exchanges based on these one-sided attestations is what has led to the standardization and subjugation of groups who were diverse and active participants in the trade networks of the northeast (Feest, 1993). Archeological science, specifically material analysis in this case study, allows the determination of material sources, production processes, and pattern determination otherwise invisible to the historical and typological analysis. While these methods will continue to be plagued by the effects of centuries

of racist collecting practices, understanding the *chaine opératoire* of indigenous items in European collections to the best of our current abilities allows us to glimpse the complex histories of these items, and better understand critical moments in the early contact period, and better criticize our understanding of the cultural biography of these objects (Gosden and Marshall, 1999).

1.2 Tradescant ball-headed clubs

Three ball-headed clubs from the Ashmolean Museum's Tradescant collection are exemplary artefacts for the exploration of trade in early contact North eastern America. They have an early confirmed date, a unique typology and are the only example of metal inlay use for the decoration of indigenous weaponry in the world. These items, described as of indigenous make, are assumed to originate from New England, most likely its southern region, sometime in the early 17th century. The origin of the clubs is obscured, and they first appear concretely in a 1656 catalogue for the Tradescant Collection (Tradescant et al., 1660). Celebrated naturalists, and gardeners, both John Tradescant Senior and Junior travelled widely throughout their lives, collecting first hand and through the gifts of artefacts from well-travelled friends and connections, built a trove of international artefacts and relics which they made available to the public under the guise of Britain's first museum: the 'Ark' at Lambeth. The clubs in question are listed in section *6 – Warlike Instruments* of the Ark's catalogue as "Tamahacks, 6 sorts" (Tradescant et al., 1660).

The earliest written account of the contents of the Ark do not mention the clubs directly: Peter Mundy's description of the collection during his 1634 visit only mentions "Armes […] shells […] of sundrey Nations, countries, forme, Coullours" which do not refer directly to any North America material (Temple, 2010). The origin and journey of the clubs until their incorporation into the

Tradescant's collection is heavily conjectured. The younger Tradescant was the only one of the pair to travel to eastern North America, undertaking an expedition to Virginia in 1637, where he purchased two plots of land along Chesapeake bay (Potter, 2006). He returned to Europe in June 1638, and a description of the Ark from July of the same year from a visiting German student, Georg Stirn, mentions amongst other sights: "a cup of an East Indian alcedo which is a kind of unicorn, […] Indian arrows, […] the robe of the king of Virginia, […], pipes from the East and West Indies, […] (Leith-Ross, 1984). North American material appears to have been introduced between both descriptions, including items such as the Powhatan's mantle, which still features in the Tradescant collection today. Further trips to Virginia are mentioned across accounts of Tradescant's life, but are heavily disputed, marking the 1637 trip as the sole verifiable jaunt of the collector to the New World (Potter, 2006). While a collection date as early as 1638 does seem probable for the clubs, many benefactors to the Tradescant collection listed in the 1656 catalogue include various captains and sailors who could also have sources the items during their journeys between the 1630s and 1656.

The clubs were part of the collection bequeathed upon the death of the younger Tradescant in 1662 to Elias Ashmole. The Ark, and subsequently the clubs, composed the core of what became the Ashmolean museum in its many iterations, and now residing as part of the Ashmolean's Tradescant Collection in *The Ashmolean Story* gallery (Ashmolean Museum, 2017a). This also makes these items the earliest dated eastern-North American ball-headed clubs in the world, and, here, a key group of artefacts to analyze the flow of artefacts between North American and Britain in the 17th century. The three clubs are here known under their accession numbers and shall be referred as clubs B.133, B.134, and B.135.

1.3 Tomahawk typology

Club B.133 (Figure 1) is dark wood decorated with a zigzag pattern of brass and copper inlays along the shaft, four rows of inlays along the hilt, and irregular placements along the head of the club. It should be noted that the repeated application of wax to the item as conservation treatment may have altered the color of the wood and inlays. X-rays images taken by the Ashmolean department of antiquities in the 1980s are mentioned as assertively identifying sheet metal for the inlays, driven into the wood and bent at a right angle to obtain the flat edge along the surface of the item (MacGregor, 1983). It is also noted in the work that remains of pitch but no inlays can be found along the triangle cut-outs on the ridge of the club, which are similar to the pitch used for shell inlays elsewhere on the item. The dark wood is described as showing no tool marks, contrarily to the other two clubs in the collection. A Miss Dorothy Catling is noted as having identified the wood of B.133 as possibly from the *Cornaceae* family, which is corroborated in conservation notes in the Ashmolean archives (A1).



Figure 1. Club B.133

Club B.134 (Figure 2) is dark wood undecorated apart from incising: shallow chevron-hatched areas near the head. The hatching is similar in design to that seen in the inlays on B.133. The wood was also identified by D. Catling as being of the *Cornaceae* family. The club was, at some point, broken and is now approximately 100 mm shorter than the original and other clubs. A hole, most likely for a suspension string, punctures the shaft.



Figure 2. Club B.134

B.135 (Figure 3), similarly, also boasts incised designs along the shaft in triangular, diamond, and zigzag patterns. The hachure and cross hachures on this club are embellished with irregular brass inlays along the ridge and head of the item. Of particular interest, is the zoomorphic representation of a snake into which the club was carved. Eye sockets which might have at one point contained inlays dot the sides of the head, near where the snake holds the ball of the club in its open maw. Particularly, the inlays on the hilt are placed as if to act as a crest to the snake, doting its back at regular interval (no image was available, but these details will be visible on illustrations and X-rays further in the text). Conversely, the inlays on the head are varied in placement, size, and

clustering, as is the case for B.133. The wood of B.135 was not sampled along with the others, but is described as dissimilar to that of B.133 and B.134.



Figure 3. Club B.135

Historical examples of the clubs show variation in curvature, cross-section, shape, size of the ball, shape of the proximal end, use of points, carvings, incisions, and inlays, across historical examples, geographic distribution, and historical periods. As such, the typology of the artefact is indicative of its place of origin, purpose, and period. This does raise some questions about the internal relationship between the Tradescant clubs. Club B.135 differs from the other clubs with its peculiar zoomorphic carving. The use of animal heads to hold the ball of clubs is only seen in late 18th and 19th century weapons from the Great Lakes region of Canada (Hodge, 1973). Moreover, the club differs from the other two in its straighter shaft, shift in cross-section width and shape, shape of the ball head, and possibly the type of wood (MacGregor, 1983). However, it is similarly decorated to B.133 through the use of copper and brass inlays, and has similar incised designs to B.134. Still, their relative uniqueness, even between themselves, sets them apart from other examples from the period.

Only a handful of contemporaneous examples exist in collections around the world (list in A2). Copenhagen, Stockholm, and Skokloster museums each hold 17th century ball headed clubs from the northeast's Delaware (or New Sweden) region. The clubs in these collections are each characterized by particular decorations. The club in the Copenhagen Museum sports intricate carving of a face on its ball which was painted half red and half black in the way of traditional indigenous tattoos (Birket-Smith, 1920). The clubs in the Swedish Ethnographical Museum of Stockholm and the Skokloster collection are heavily decorated with inlayed shells (Rydén, 1963). Additional clubs reside in Leiden, Paris, London, and the United States (Boisard et al., 1989; Bushnell, 1908; Feest, 1980; Hodge, 1973; Sturtevant and Trigger, 1978). Later examples are identifiable by detailed carvings and the use of brass furniture tacks as decoration (Feest, 1980). Interestingly, the proximal carving observed on many contemporaneous clubs is not present on the Tradescant clubs. Moreover, the use of copper and brass inlays is rare to see on such clubs, mostly appearing on Norther Iroquoian pipe-bowls from the same period (Birket-Smith, 1920; Hodge, 1973).

The Skokloster clubs are of particular interest as the only 17th century example, apart from the Tradescant clubs, to show metal inlay decorations prior to the use of furniture tacks. The inlays on the Skokloster clubs are described as "copper wire inlays" in the shape of faces and animals (Becker 1990). This does differ from flat-topped metal used in on B.133 and B.135, and its anthropomorphic design, which is at most geometric in the Tradescant clubs. However, the similarities in materials and history have led to postulations that these and the Tradescant clubs were all made by the same master carver (MacGregor, 1983).

1.4 Possible provenance

The Skokloster clubs also have a body of literature which expand upon their probable provenance in greater depth that what is currently available about the Tradescant clubs, but offers scaffolding for their object biographies. As the leading producer of copper throughout the 17th century, it has been hypothesised that the copper used to decorate the Skokloster clubs was of Swedish origin (Becker, 1990). This could be confirmed with material analysis of the inlays, but substantial historical evidence supports that that Swedish copper, mined in Falun, was sent to North America in the form of kettles, chains, and other commodities in substantial amounts. This was then traded to the Lenape and Susquehannock peoples inhabiting the regions today known as Pennsylvania, Delaware, and New Jersey, which was occupied between 1638 and 1656 by Swedish colonizers (Johnson, 1911). The ball-headed clubs, then decorated with Swedish copper, were traded back to the colonizers, and sent back to Europe where they reside to this day (Nordin, 2013).

This hypothesis for the provenance of the Skokloster clubs aligns well with what is already known and assumed about the Tradescant clubs. The clubs, most likely of indigenous make and of eastern North American provenance, are decorated with copper and brass inlays that are unlikely to come from eastern North America, yet are contemporaneous to the object, and typologically align with few other examples of tomahawks from the period. A complex networks of trade between both indigenous parties and various colonizing empires is well known for the region, so the metal inlays could have come from any possible European force importing metal goods: Swedish, English, Dutch, and less likely, French or Spanish. What's more, the indigenous community of origin is not known, and the historical records available outlining the relationships between indigenous folk

and European colonizers varies both regionally and nationalistically, further obscuring the potential provenance of these items.

Still, some hypotheses have been put forth for the provenance of the clubs. A New England or Mohica, origin has been proposed for B.133 and B.134, with B.135 likely being of a different origin (Feest, 1992; MacGregor, 1983). Evidence supporting this includes historical typologies, and art-historical evidence. The ball-headed weapon type were found in a mostly northern distribution of eastern North America, from the northern Chesapeake Bay area to the Canadian Maritimes. Cree and Ojibwa communities carried the typology into the northern plains, where it spread from the Atlantic to the Midwest (MacGregor, 1983). The wood type of B.133 and B.134 are consistent with this provenance. Additionally, a historical depiction (Figure 4) of a ball-headed club pairs the item with the Mohican tribes, an Algonquin tribe whose territory overlapped with the New England (Verelst, 1710). The painting in question is one of the portraits of the Four Kings, a delegation of four indigenous leaders who visited England in 1710. The regent at the time, Queen Anne, had the portraits commissioned by Dutch artist John Verelst (Brandon, 2022). Of the four paintings, that of Etow Oh Koam, "King of the River Nation", depicts the Mohican leader holding an undecorated ball-headed club. A figure in the background clubs a prostrate victim with its own weapon (Muller, 2008). This is one of only three depictions of a ball-headed club contemporaneous with the items (A2). It is the only one which shows the weapon wielded.



Figure 4. Etow Oh Koam, King of the River Nation, by John Verelst (1710)

A Virginian, and much more southern, provenance has also been suggested, but not adopted by all (Feest, 1992; Peterson, 1965). This is supported by the known presence of Tradescant in the Chesapeake bay area between 1637 and 1638. Moreover, the additional material in the North American section of Tradescant collection is all Virginian, specifically of Powhatan origin, which occupied the Western and Southern parts of the Chesapeake bay during the 17th century (A3).

Linguistic specificities support both: the term *tomahawk*, as these three clubs are referred to in the Tradescant catalogue, is the Algonquin derived term. The Mohican, Lenape, and Powhatan peoples all fall under the Algonquin language group umbrella (Dresslar, 1988). Some assign the term specifically to the colonist translation from contact with the Lenape people, due in part to the concurrent settlement at Jamestown (Peterson, 1965). The term referred originally to indigenous war clubs, but throughout the contact period, changed to englobe the iron hatchets being traded by colonizers, even within indigenous dialects. By the 18th century, the term stopped referring to ball-headed clubs altogether, making its use in the 1656 catalogue particular (Holmes, 1908).

Occam's razor would suggest the Tradescant ventured to Virginia in 1637, returning in June of 1638 in the possession of various artefacts from the Algonquin tribes of the Chesapeake bay region, where he owned land. These would include, amongst others, the Powhatan's mantle, bows, and the ball-headed clubs that became part of the Ashmolean collection. However, it is also possible these clubs were manufactured in New England and traded south to Virginia where they were collected by Tradescant.

Due to the complex collections history of these items, the lack of direct historical evidence, and the various hypotheses as to the provenance of the clubs, alternative methods of investigation need to be employed, such as the analysis of the copper and copper-alloy inlays along B.133 and B.135. With few contemporary examples of the same typology, and due to the date associated with these items, the use of decorative or purposeful metalwork is curious and raises many questions about the provenance of the metal, the possibility of recycling, and what it can tell us about trade during the period. Particularly, the metal inlays are one of the few parts of these objects that has not been

previously analyzed. In fact, no analysis of any metal inlay on any 17th of 18th century indigenous object has ever been performed to our knowledge (Rafferty and Mann, 2004). Yet, the information that could be obtained from a material analysis could yield answers about the shrouded provenance of these items, and a wealth of knowledge about trade patterns and relationships between colonial and indigenous peoples of the northeast.

1.5 Copper in the 17th century

Prior to contact in eastern North America, indigenous groups had access to rich copper sources. The Lake Superior model proposes that most pre-contact copper is sourced from large deposits of native copper surrounding Lake Superior in present day Ontario and Michigan. These deposits ranged from igneous, to sedimentary in type, and have been mined for 6800 PB (Ehrhardt, 2009). More recent studies have broadened the reach of copper sources throughout eastern North America. Additional outcroppings in the Bay of Fundy area have also been identified, and yet more research continues to broaden our knowledge of copper sources pre-contact (Levine, 2007; Whattam, 2014). Native copper requires no smelting or refining, and as such, is a characteristic rich red color. Native copper was treated as a prestige metal, with significant spiritual significance, not unlike how Europeans viewed gold or silver. Due to the lack of natural alloys, copper is easily malleable but demonstrates poor handedness. According to Technological Determinism, a theory which explains the choices of cultures who make use of certain materials based on the qualities of the materials without considering alternative anthropological reasons, the decline of the Old Copper Culture was caused by the technological advantages of stone (Bebber et al., 2019). The existence of an Old Copper Culture is strongly disputed, but material evidence confirms the

knowledge of technologies necessary for metalwork well before trade with the Europeans (Sturtevant and Trigger, 1978). Copper, a valued commodity despite little technological purpose to the indigenous peoples, was instead used to make items of self-adornment, mostly beads, talismans, tinkling cones, as well as burial goods, arrow heads, and utensils. This use of extremely pure copper makes it simple to distinguish from imported copper during the contact period. Indeed, the amount of trace elements in a copper object is much higher for copper of European origin, which variations trace elements composition further narrowing the source of origin (Hancock et al., 1991).

Trade between indigenous communities and European colonizers began early in the 16th century. Worked copper sheets are reported in eastern North America as early of 1524. The written record of the voyages of Giovanni da Verrazzano mention "many sheets of worked copper which [the natives] prize more than gold" (Nowell and Wroth, 1971). Sheet copper was most likely traded between indigenous communities in Maine and Nova Scotia and European fishermen and fur traders during this early period. The copper then made its way south through established indigenous trade routes (Sturtevant and Trigger, 1978). Indeed, historical accounts from the period which are of closer geographic interest include records of Captain Gosnold's 1602 voyage to Virginia, where an encountered native along the coast of Cape Cod is described as wearing "certaine plates of Copper hanging at his Eares […]". Yet more are described as "apparelled […] with Tobacco and Pipes steeled with Copper, […] one had hanging about his necke a plate of rich Copper in length a foot, in breadth halfe a foot for a brest-plate, the Eares of all the rest had Pendants of Copper" (Purchas and Hakluyt, 2014). A different account of the same voyage described in greater detail the "great store of Copper, some very redde, and some of a paler colour;

none of them but have chaines, earrings or collars of this mettall: they head some of their arrows herewith […]. Besides these, […] other thinne plates of Copper […] all which they so little esteeme, as they offered their fairest collars or chaines, for a knife or such like trifle […]" (Burrage, 1906). A year later, another expedition recounts encounters with natives wearing "plates of Brasse a foot long, and halfe a foote bread before their breasts" (Burrage, 1906). With that said, it is not surprising or remarkable to have sheet metal inlays in these clubs, and not even in the variation of sources that we are seeing. By the mid-1600, indigenous groups throughout the northeast had adopted techniques of manufacture to deal with European sheet metal, and numerous examples of repaired and indigenous made kettles illustrate this within the archeological record for the period. Moreover, some research suggest the possibility of coastal metal specialists where trade with colonisers would have been most significant, trading along interior routes to groups further inland (Wray and Hayes, 1987).

The sudden influx of refined copper into eastern North America during the early contact period creating a complex network of exchange that directly influenced how copper was viewed and used in the northeast (Mallios and Emmett, 2004). Witthoft describes these snowballing events as phases, the first extending from contact to the 1590s and characterized by the deconstruction of traded metal objects to make ornaments and knives (Witthoft, 1966). Increased European contact after 1590 strengthened the ties between the colonisers and the Huron, Iroquois, Susquehannock, Powhatan, and Cherokee tribes, yet it isn't until the 1600s, or the third phase described by Witthoft, that trade goods beyond scrap metal and tiny glass beads start to appear in the archeological record. Brass kettles as whole objects start to appear as grave goods in indigenous burials, pottery and clay tableware finds its way into the Jamestown settlement, and steel tools and weapons begin to be

traded in earnest (Immonen, 2013). The fourth stage begins in 1630 with the appearance of firearms in northeastern sites. The fifth and sixth stage are characterized by the increased presence of European finery in colonial America, and a wealth of indigenous crafts, such as pewter pipes with extensive carvings. The economic bubble of the mercantile trade across the Atlantic eventually pops in 1700, by which point, it has reached beyond the area of interest for this study (Witthoft, 1966).

The shifting association and meaning of copper in indigenous social networks is directly correlated to its economic value and abundance. Prior to contact, copper objects were reserved for grave goods and status wear due to their relative rarity and religious association. When the Europeans arrived with their commodified copper, the metal became a currency used for trade (Galke, 2004). By the end of the 16th century, European metal was widely available throughout the colonial and indigenous trade networks of the northeast, and that is the environment in which the Tradescant clubs were made (Fitzgerald et al., 1993). As such, beyond native copper, all relevant European copper production centers must also be considered, which include English, German, and Swedish industries.

Higher average trace element compositions can be expected for all European copper due to the required smelting process introducing - or the refining process poorly extracting - minor and trace lead, silver, zinc, tin, iron, and arsenic (American Chemical Society National Historic Chemical Landmarks, 2007). Major generalized differentiators between European sources are nickel and arsenic. eastern and central European copper ores are associated with high nickel contents (between 0.11 and 0.72%) (Mitchiner et al., 1987a). Meanwhile, British and Swedish sources have

been shown to be non-nickeliferous (<0.04%) (Forshell, 1992). English copper is derived from arsenic-rich ores so despite changes in concentration due to methods of production, it is associated with higher trace arsenic composition (>0.18%) (Mitchiner et al., 1987a). This burgeoning English metal smelting industry that was finding its footing throughout the 16th and 17th century was run by the copper monopolies known as the Society of Mines Royal, and the Society of Mineral and Battery Works (Martinon-Torres et al., 2009). These efforts were not met with satisfactory results as the production of brass using English material was met with many pitfalls, which in part pushed for the prospecting of land in the New World (Veronesi et al., 2019). Instead, metal from the Swedish Falun mine satisfied most European copper needs. Mines in the Harz Mountains and Mansfeld city in Germany also supplied substantial copper throughout these centuries (Forshell, 1992).

1.6 Current study and significance

This thesis project aims to undertake material analysis on unique items from the Ashmolean collection using a suite of imaging and compositional techniques to determine the origin and object biography of the metal inlays of the Tradescant ball-headed clubs. This is done in an effort to elucidate the complex trade routes and relationships that dictated the exchange of material culture throughout the 16th and 17th century between colonial forces and indigenous communities in the American northeast.

To achieve this, this section has so far discussed documented knowledge about the items, typology, and suspected provenance as context to the Tradescant ball-headed clubs. These items were

demonstrated to be incredibly rare examples of early 17th century clubs out of the American northeast, and key artefacts for the study of trade of material culture for the period. The metal inlays, which are of particular interest for this study, were elaborated upon to give a comprehensive background of the copper industry during the 17th century, and establish profile compositions for regional export from Europe.

This project is both an iterative interrogation of the origin, make, and trade history of these ball-headed clubs, but also a pilot study for the analysis of metal elements in multi-material indigenous objects from the period. Studies on the cross-Atlantic copper industry of the 17th century have relied on the analysis of metal scraps found at significant sites in North America, copper sources and mines throughout both continents, or the contents of shipwrecks holding ingots meant for international trade (Fitzgerald et al., 1993; Martinon-Torres et al., 2009; Skowronek et al., 2021). This study would mark a first attempt at discerning the object biography of metal used in the production of an indigenous trade item from the period. It is hoped that this project illustrates how non-destructive methods can achieve significant results for the provenance of such items, and that further work be attempted on relevant collections.

2. Materials and Methods

2.1 Materials

The two Tradescant ball-headed clubs decorated with metal inlays, B.133 and B.135, were analyzed for this study. B.133 is a 54cm long object with a width at its largest section, that of the ball, of 11.2cm (Ashmolean Museum, 2017b). The shaft is visibly decorated with a zig-zag pattern of 70 small square metal inlays, and additional inlays on the butt of the hilt. Larger square inlays are also present on the ball of the artefact. B.135 is 58cm long, and 10.8cm wide at the level of the ball and has seven inlays along its hilt, and multiple larger ones on its head (Ashmolean Museum, 2017c). The items have an early date within the collection, which gives a short range of time for their creation and obtention. Additionally, having spent the last 400 years in a museum, no heavy corrosion covers the inlays, and all conservation procedures have been recorded and evaluated for possible effect in this study (A1).

Comparative material was gathered from the literature. Particularly, a study by Mitchiner, Mortimer, and Pollard analysing the chemical composition of English seventeenth-century base metal coins and tokens, and their sibling studies on European metal from that period, serve as the comparative data set both for this study and others on the subject of period-specific copper provenance (Martinon-Torres et al., 2009; Mitchiner et al., 1987a, 1987b). As such, the use of this comparative material allows for both contextualization of the Tradescant material within the large trends for the period, and for comparison with studies such as the Jamestown historic metals which also use this data set for comparative study.

Additional images of the clubs were supplied by the Ashmolean data bank. Conservation notes were supplied from the museum archives, as were the 1980s X-rays of the items for consultation (A1).

2.2 Methods

The analysis of these items included the use of X-ray imaging and non-destructive portable X-Ray Fluorescence (pXRF) of the item inlays. X-ray was used to visualize the wood grain and depth and morphology of metal inlays in the items. pXRF allowed for the non-invasive determination of metal composition. Trends in minor and trace elements will distinguish inlay profiles that will be compared to known historical sources both from the literature and statistically using Principle Component Analysis (PCA). The original analysis plan also included destructive sampling but due to time constraints and the unique nature of these objects, this was delayed to allow further consultation.

The new radiographic X-rays of each club was done at the Ashmolean museum using in-house equipment under the direction of the Conservation Department. New X-rays were taken to allow control over experimental conditions, looking to achieve greater contrast between the woodgrain and inlays. No sampling or preparation was required, only the positioning of the clubs at various angles on the plate. A ScanSilc digital imaging plate and Golden pulsed generators were used, and images of the head and hilt were taken for each club at lateral and anterior position. Pulse number between 5 and 40 were used to obtain clear images of both woodgrain and metal inlays.

The XRF analysis was also completed in-house at the Ashmolean museum using their equipment. Analysis of the metals inlays was done as spot open-air XRF on a Bruker CRONO XRF instrument. 157 analyses were run, of which 2 were wood blanks, 18 were standards, 13 were new comparative material, and 124 were metal inlays on the two decorated clubs. Of those 124, 109 were inlays on B.133, including all inlays on the head of the item, and the zigzag pattern on one side of the hilt. The other 14 inlays were analyzed on B.135, and this made up the entirety of the metal decoration on that item. This selection of metal studs for analysis was done to obtain the widest scope of metal composition used in the objects within the experimental time constraints. Ideally, all metal studs on both clubs would have been analyzed.

No sampling or preparation was conducted, and all analyses were performed without machine contact with the object, as non-destructive and semi-quantitative. No cleaning was done prior to the analyses but prior interventions by the conservation department were kept in mind. As such, blanks of the club wood were also analyzed to account for conservation treatments and their possible effect on the inlays results. A silver-copper reference sample proprietary to Brucker was used to calibrate the machine prior to running standards and samples. Standards used were from the CHARM set of certified reference material for historical copper alloys. Standards 32XSN6A (bronze), 31XTB5A (brass – trace elements), 32XSN7A (bronze) and 33XGM4AC6 (gun metal) were employed to cover the expected variance in alloying in the analyzed objects (Heginbotham et al., 2015).

The CRONO XRF instrument comes with both a tripod stand and a frame fixture which allows for horizontal and vertical analysis. Horizontal analysis was used for the hilt of B.133, and the tripod was used for the other inlays, the additional movement allowing for the necessary flexibility in positioning the XRF to analyze around the curvature of the object ball-head. A variety of tissue-paper bumpfs and plastazote blocks were used to stabilize the object during analysis. The following instrumental settings were used:

Duration: 400 seconds (60 sec for AgCu reference sample)

XRF Voltage: 50kV

XRD Current: 20 μA

Filter: 2 (Brucker proprietary "metal" filter, thin sheet aluminum and titanium)

Collimator: 0.5 mm (increased to 1mm if pulse density registered below 2000)

The nomenclature used for the inlays follows the following codification:

Club number (1 or 2) – side (A/B/C/D) – section (C/B/H) – sample number

Club B.133, which was the first to be analyzed, was numbered 1, and B.135 was 2. The side on which the ball faces the right was side A, and the first part to be analyzed was the chevron of inlays. As such, the first sample was named 1AC1, and subsequently (Figure 5). C was specifically used for the zig-zag pattern, while B (for body) was used to distinguish the general hilt sections from the head (H) throughout the assemblage. Comparative material which were analyzed in conjunction with the items were are named according to their reference number, and then measurement repeat (i.e. XX-1, XX-2, etc.)

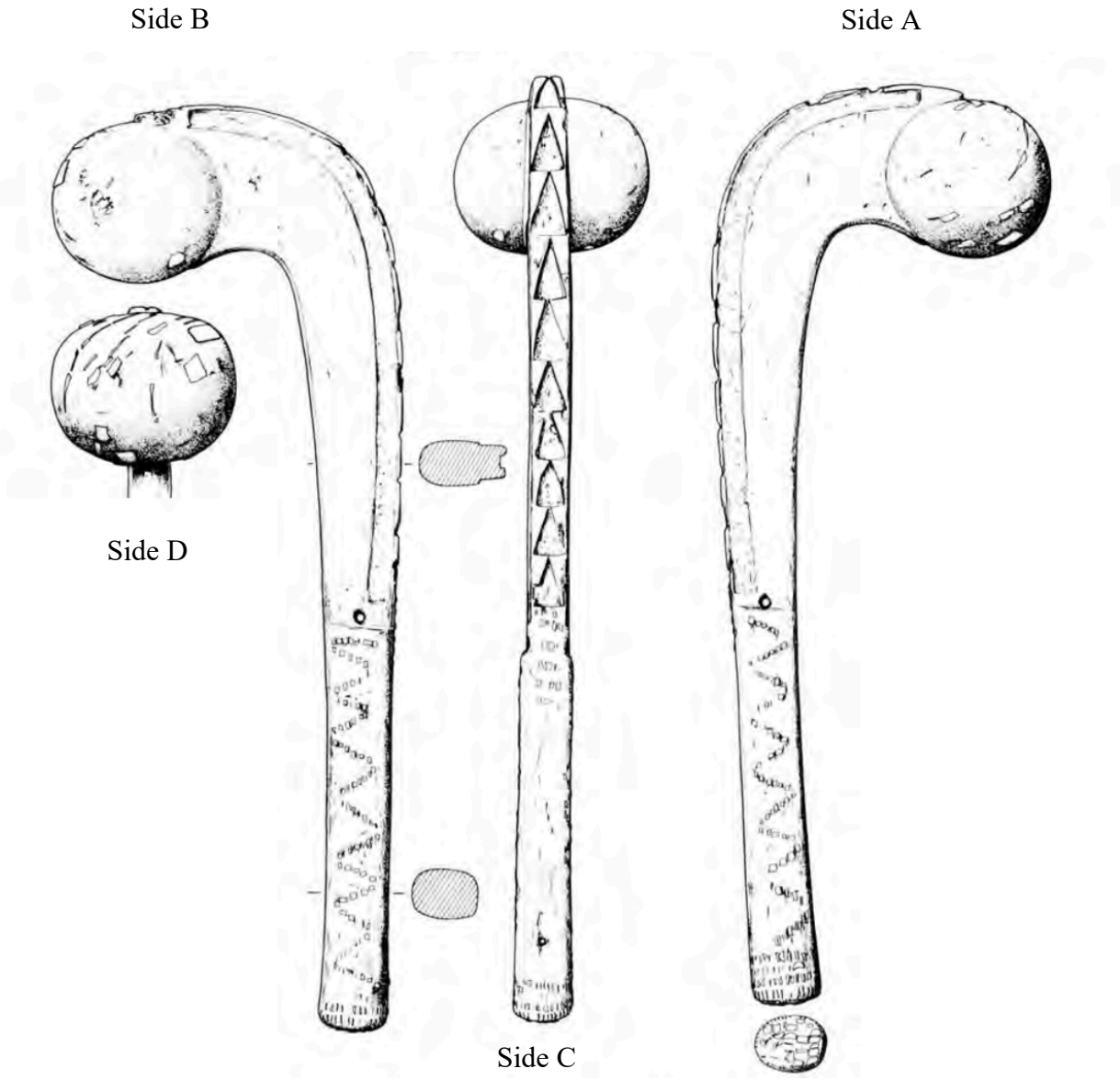


Figure 5. B.133 drawing showing side numbering (illustration originally from MacGregor, 1983)

Of note, certain inlays were broken off leaving only a sliver of metal remained visible out from the wood. The narrowness of these samples made it extremely difficult to achieve the desired precision at the above settings, so the collimator was increased to 1.0mm as required. Despite this, some results still fell below desired pulse density (<3000) and were excluded from the analysis.

The data was first analyzed using PyMCA, an open source software for XRF spectra analysis (Solé et al., 2007). All data was calibrated according to the Bruker AgCu samples, and configured to estimate the concentration of compositional markers: elements Cu, Zn, Sb, Pb, As, Ag, and Ni. The cut-off categories for alloying were placed at 4% presence in individual samples in an attempt to keep data uniform with the current body of literature on early colonial metal analysis (Martinon-Torres et al., 2009). All further graphing were conducted in R version 4.2.2 and Microsoft Excel version 16.76.

Additional accuracy and precision study to compare the effectiveness of XRF in this study was performed using a scanning electron microscope (SEM). The CHARM standards were analyzed on a TM4000 Plus tabletop microscope fitted an Oxford Instruments Aztec One EDS detector, and output was analysed on Aztec One software. Carbon tact was used to affix the samples to the analysis platform, and back scatter was used to visualize the surface of the samples. EDS settings include Conductor H vacuum, count-based acquisition mode set to 500 000, and pulse pile-up correction. The analysis was of an approximately 10μm by 5μm rectangle selected on the sample surface. Flat and uniform sections of the sample were preferentially selected. Each sample was analyzed at 3 different spots and data was averaged.

Lastly, due to the variation in Europe's complex geology, multiple elements are required to be considered when hoping to assign provenance of copper to specific regions. As such, PCA was used to statistically account for variance in multiple-element compositions and graphical representations against the chosen comparative material.

2.3 Analytical Limitations

The use of pXRF in this study was due to both conservation concerns requiring non-destructive techniques, and feasibility of the work within a restricted time frame requiring rapid analysis of well over 100 metal inlays. While XRF does prove to be less precise than other techniques such as Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry and Electron Microprobe Analyzer, its larger sampling area and inherent averaging does allow us to avoid issues with heterogeneity and corrosion which do plague some the more precise methods (Dussubieux et al., 2008). Still, issues of imperfect conditions that come with open-air and non-contact analysis do lower the sensitivity of the analysis. A preliminary 0.1 wt% lower detection limit was entertained prior to the analysis, when it was shifted according to the precision and accuracy of the standards. As such, major and minor elements in composition do show with reasonable precision, but some trace elements were lost due to lack of sensitivity. This means that provenance can only be general at this stage, as more precise (and generally destructive) methods would be necessary to ascertain copper sources beyond general areas of production.

Additional issues that arise with this method include the mislabelling of peaks due to the analysis of high purity copper. Previous studies have encountered that certain elements such as Fe, Cr, and S, were over reported for copper metal (Whattam, 2014). It is also known that high concentrations of single elements can cause escape peaks. This can cause the excitation of the detector eliciting silica to be detected in a sample. For the analysis of copper, a large escape peak often arises where Fe would usually be detected. Heterogeneity was also a concern due to the overlap of the copper and zinc peaks (Potts and West, 2008). Lastly, irregularities in tin and silver data were a concern in preliminary results analyses. As with copper and zinc, the peaks for silver and tin overlap for

both the K and L peaks. The K peaks show generally less overlap, so were used for the analysis, but are also privy to overestimation due to the presence of Rayleigh and Compton peaks in the same region (Figure 6). Indeed, the overlap of the rhodium excitation peaks and Bremsstrahlung radiation curve over the area cause a hike in the background that the software interprets as peaks. This background radiation is related to the angle of detection, which in the case of this study fluctuated depending on the point of analysis (Mitra et al., 2000). The hilts were analyzed with relative similarity between analysis set up, but the use of the tripod to analyze the various inlays along the spherical heads of the clubs did cause greater changes in experimental conditions. Consequentially, higher Bremsstrahlung radiation curves can be observed for these data points, and as such, the tin and silver data for these was not considered for the analysis.

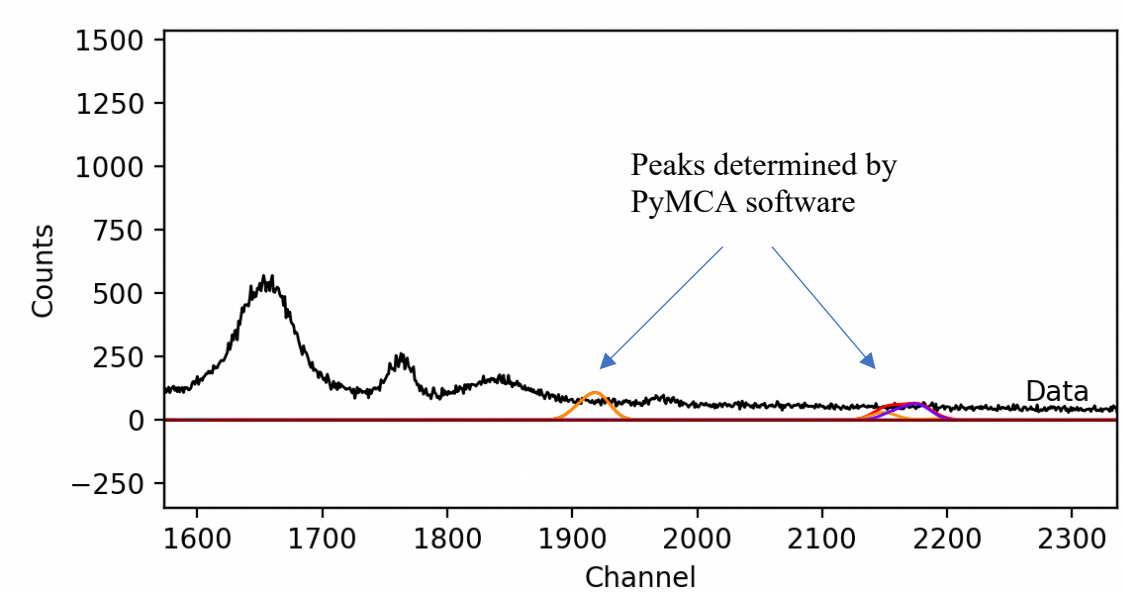


Figure 6. Spectra from analysis of 1CH2 with Bremsstrahlung radiation curve overlapping area of tin (purple) and silver (orange) peaks

Additionally, some samples returned back with lead quantities far above what would be expected for copper and copper-alloy samples. Due to the characteristics of lead, it tends to form pools within the copper matrix, creating pockets of metal that can skew average compositional data for a spot analysis. Consequentially, samples that recorded lead w% higher than 5% were excluded from the data set. This upper limit was set based on the comparative material which did not include metal of lead compositions higher than 5%.

To curb some of these issues, some measures were put into place. As mentioned, a higher detection limit was determined based on the data obtained from the standards. Additionally, results with pulse densities below 3000 were excluded from the analysis as their results offered erroneous quantification of peaks, generally recording higher amounts of heavier elements. This included 25 analysis points on the two clubs of interest, bringing the total number of analytical points to 99. Wood blanks were taken to determine whether conservation treatments had an effect on the XRF results. These returned with negligeable amounts which could be attributed to the Compton peak (A4). Standards were also used to establish corrections to the experimental spectra according to a fundamental parameters with standards methodology (Heginbotham et al., 2010).

3. Results

3.1 X-Ray

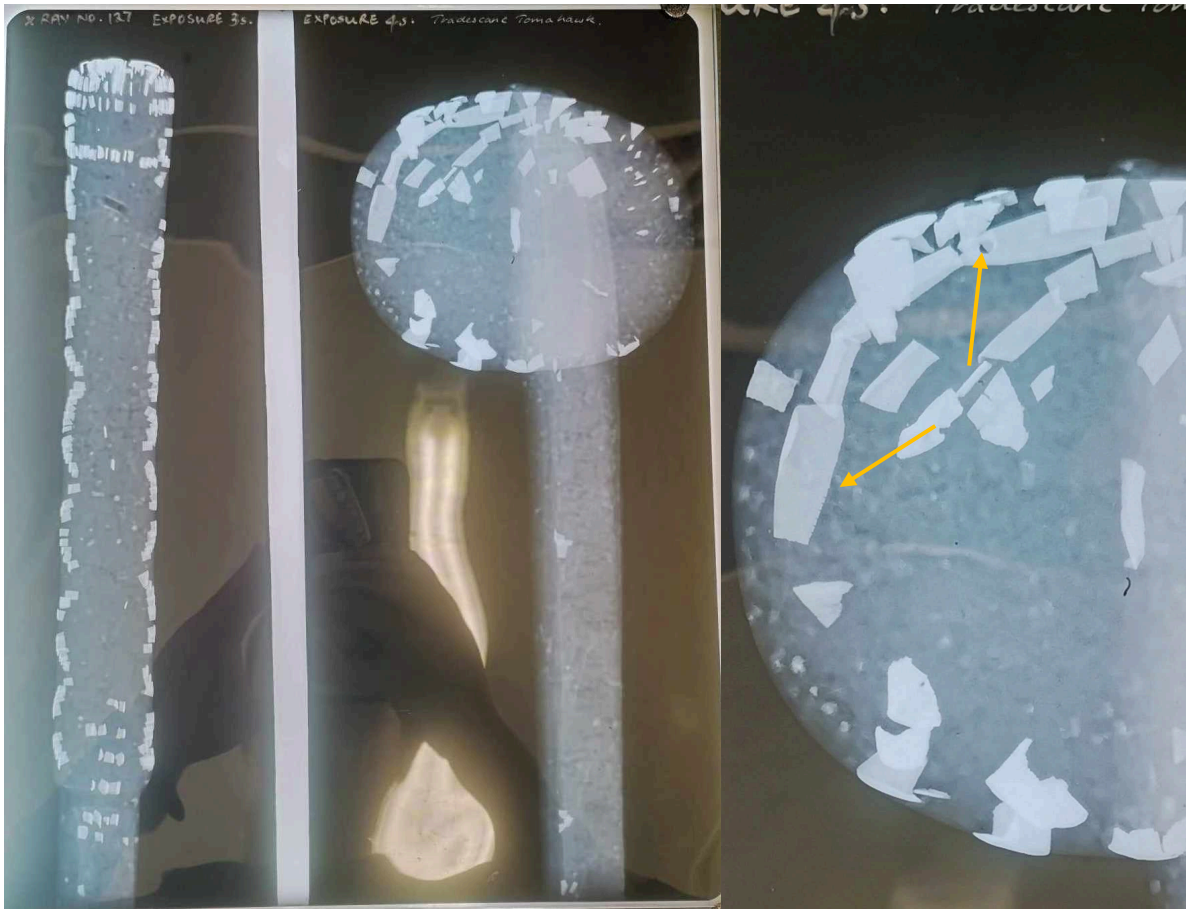


Figure 7. 1983 X-rays of B.133 and B.135 with close-up of serrated edge and perforation details

X-rays taken in 1980 by the Ashmolean department of antiquities were recovered from the conservation archives of the objects (A1). Instrumental details pertaining to the x-ray images were not available. However, they clearly showed the depths and morphology of the metal inlays. Based on these images, the inlays could be characterized as sheet metal folded along the surface of the object at a right angle. Additionally, details such as perforations and serrated edges were visible in the sections of the inlays inserted in the club (Figure 7). Considering the lack of structural integrity

these marking offer, and the decorative purpose of the inlays on the clubs, these are indicative of alternative metal use prior to their use as inlays in these items. Perforations in particular point to the use of rivets, while the serrated edge is typical of early indigenous metal sheet-cutting (Wray and Hayes, 1987).

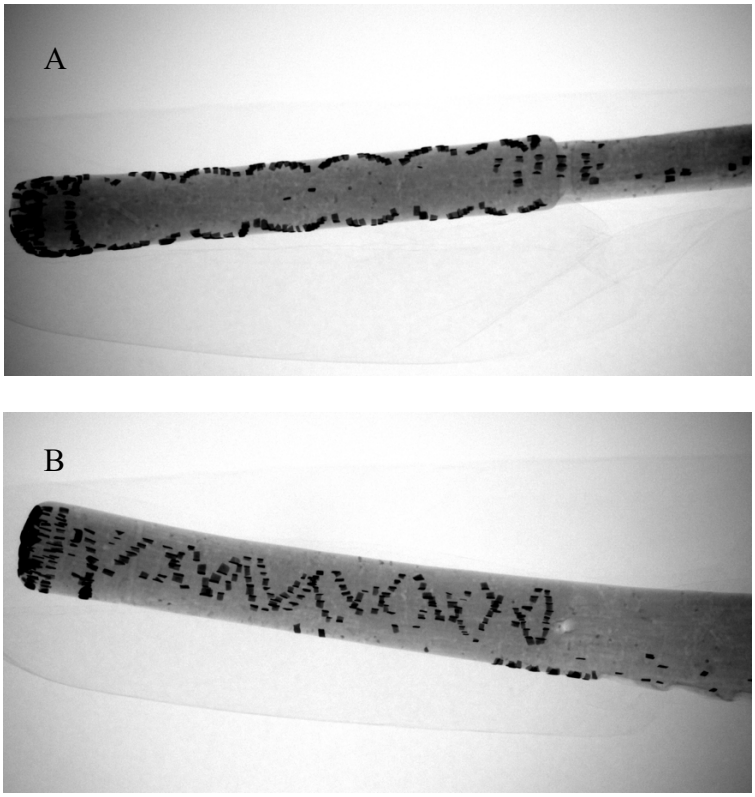


Figure 8. X-rays of B.133 hilt from two angles: a) top down view, showing mirrored pattern along both sides of the item and short rows of inlays along the top of the handle, b) side view showing zigzag pattern and rows of inlays along the bottom of the hilt.

The new X-rays better display the homogenous size of all inlays along hilt. This is indicative of a single event or premeditation in terms of material use. The inlays, as in the archived X-rays, can be seen to be sheet metal folded over to make “flat top”. To achieve this, the pieces of metal would

have to have been hammered or wedged into the wood before being folded over to make a square surface. All of the inlays on the hilt are evenly spread apart, and folded in the same direction, again pointing to some initial design being implemented on the hilt of B.133. Additionally, the inlay zigzag pattern is mirrored on each side of the hilt despite the uneven number of inlays on each side. Adding to this the additional inlay work on the top and bottom of the item beyond the observed pattern. It would seem the overall design rather than the number of inlays was prioritized in terms of the hilt pattern, and leftover metal was used to fill in the gaps along the top and bottom of the hilt.

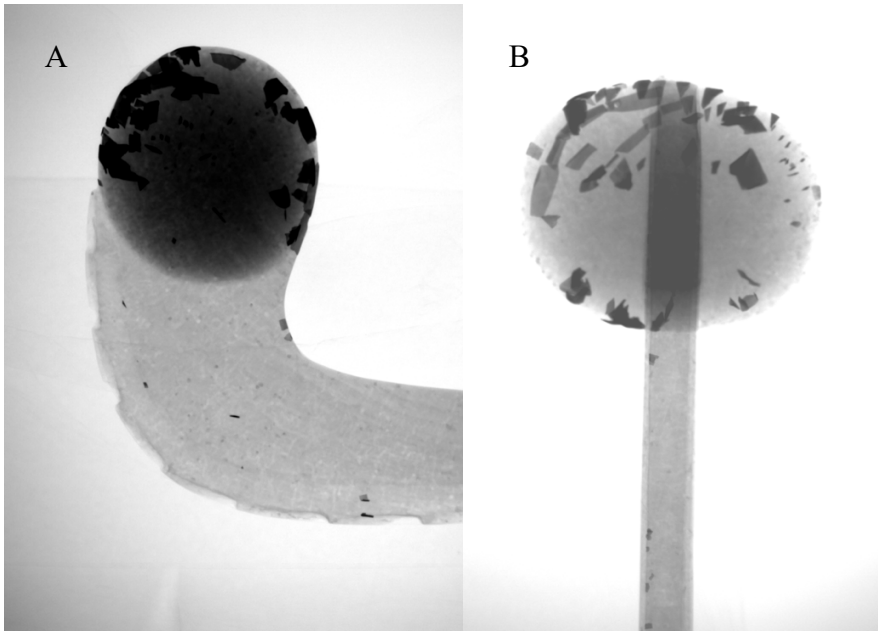


Figure 9. X-rays of B.133's head from two angles: a) side view, b) top-down view.

Contrary to the hilt, the inlays in the head of B.133 form an aggregate and non-uniform distribution of irregular inlays, indicative of less planned production. Additionally, the depth set in of the inlays is here much more varied. This could be due to a lack of uniform or easily transformed material

available to producer, a lesser importance attributed to the head, or a range of more possible reasons. Mostly irregular in placement, certain inclusion of inlays filling splits in the wood caused by age or usage with metal. Most likely, these inlays were a separate event from hilt decoration, and possibly the result of multiple events of decoration throughout the item's lifetime.

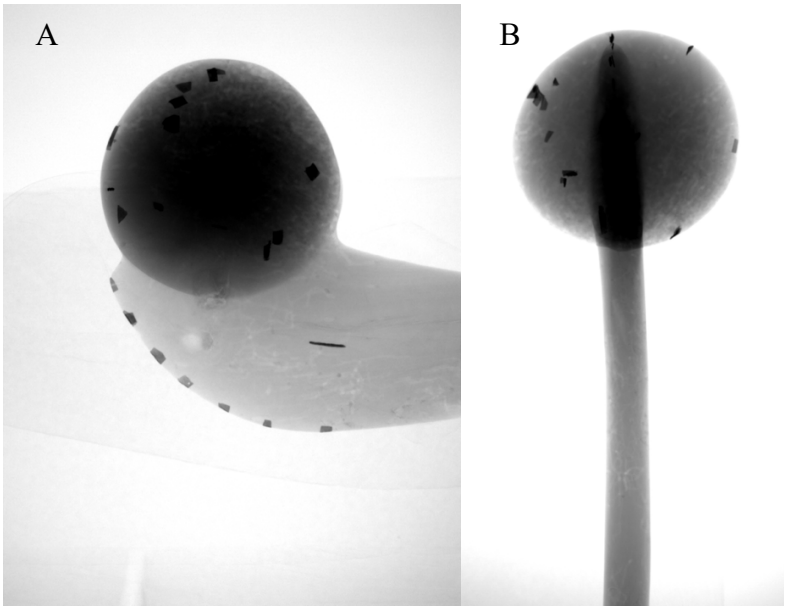


Figure 10. X-rays of B.135's head from two angles: a) side view, b) top-down view.

B.135 boasts much smaller and fewer inlays than B.133, though similar in style (sheet metal folded over, evidence of recycling from perforations visible, inclusions along cracks in wood). The inlays on this club follow the zoomorphic depiction of a snake. We are also seeing similarities in regularity of inlay use: ordered inlays along the hilt, and disordered decorations on the head.

3.2 CHARM Standards

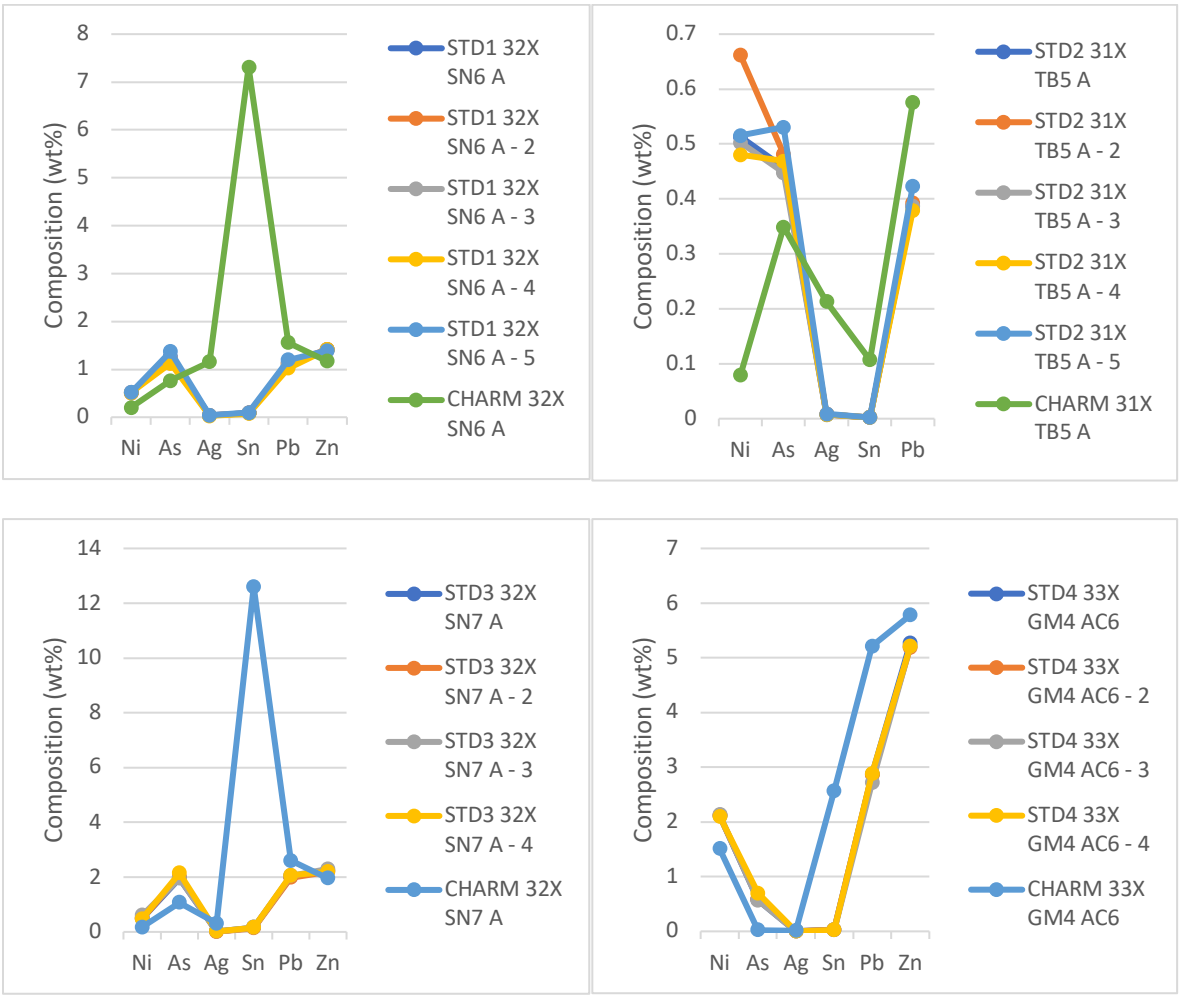


Figure 11. Uncorrected XRF data for the composition of standards both experimental and CHARM literature values

Table 1. Precision and accuracy (wt%) for CHARM standards by XRF

			Ni	As	Ag	Sn	Pb	Zn	Cu
32X SN6 A	Literature	wt%	0.21	0.78	1.18	7.42	1.58	1.19	87.66
	Experimental values	Mean (n=5)	0.51	1.24	0.04	0.09	1.11	1.41	95.60
		Sdev	0.00	0.09	0.00	0.01	0.07	0.01	0.16
		Precision	0.01	0.07	0.12	0.07	0.06	0.01	0.00
		Accuracy	148.60	60.00	96.87	98.83	29.92	18.88	9.07
31X TB5 A	Literature	wt%	0.08	0.36	0.22	0.11	0.59	41.55	57.10
	Experimental values	Mean (n=5)	0.53	0.48	0.01	0.00	0.39	37.57	61.01
		Sdev	0.07	0.03	0.00	0.00	0.02	0.11	0.09
		Precision	0.14	0.07	0.04	0.04	0.04	0.00	0.00
		Accuracy	561.94	33.72	96.41	98.03	33.10	9.56	6.85
32X SN7 A	Literature	wt%	0.18	1.08	0.31	12.73	2.63	1.98	81.10
	Experimental values	Mean (n=4)	0.51	2.02	0.01	0.16	2.03	2.23	93.03
		Sdev	0.06	0.09	0.00	0.01	0.04	0.05	0.12
		Precision	0.11	0.04	0.31	0.07	0.02	0.02	0.00
		Accuracy	190.42	86.88	95.70	98.77	22.72	12.89	14.71
33X GM4 AC6	Literature	wt%	1.51	0.02	0.01	2.57	5.22	5.79	84.88
	Experimental values	Mean (n=4)	2.12	0.61	0.00	0.03	2.83	5.22	89.20
		Sdev	0.01	0.06	0.00	0.00	0.08	0.04	0.11
		Precision	0.01	0.10	0.41	0.07	0.03	0.01	0.00
		Accuracy	39.92	2855.5	79.48	99.00	45.77	9.79	5.09

The CHARM standards were run to determine the accuracy and precision of the XRF measurements made displayed significant shifts from the known values expected for the samples. Of note is the significant underestimation of tin and silver in all samples, as well at the underestimation of the other major alloying and trace elements. The similarity of experimental repeats does demonstrate that the obtained data is reproduceable at the level of the XRF machine,

but that the software analysis of the hardware output does require correction to reflect more accurately the real composition of the tested samples. In other words, the precision is at acceptable levels, but the accuracy results are indicating distinctively incorrect values. This does mean that corrections can be applied to the obtained values to fix the gap between experimental and literature values.

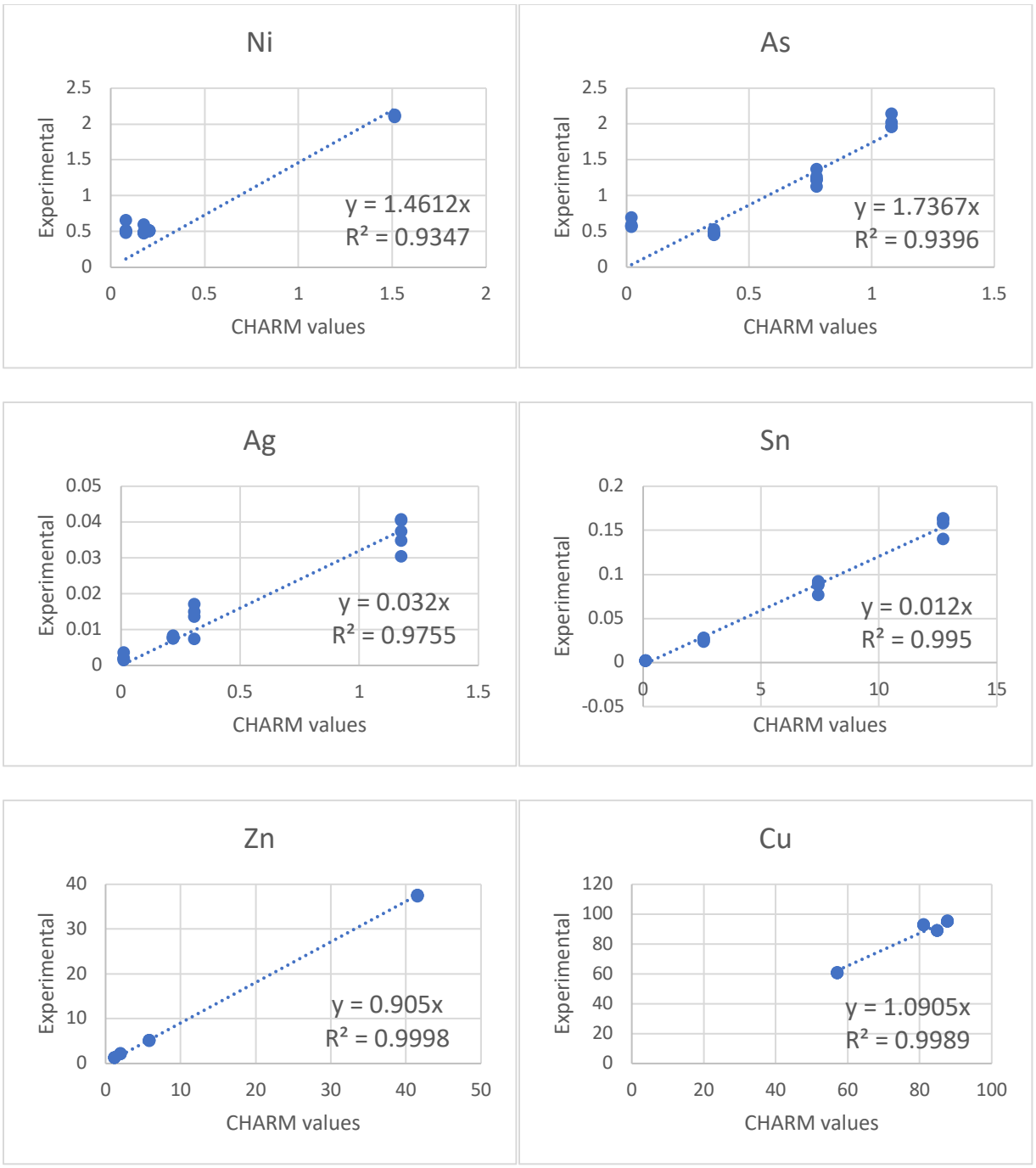


Figure 12. Graphical representation of experimental and expected literature values for the CHARM standards compositional elements with linear trendlines, equations and R values

To determine the coefficient of correction to apply to each element, they must be graphed against their respective theoretical values to determine whether a statistical relationship exists between the expected and obtained values. In the case of this data set, all values trend linearly with their expected values with the lowest R score coming in at 0.934. Having set the intercept, a coefficient of correction can then be applied uniformly to the corresponding elemental data to obtain the corrected value.

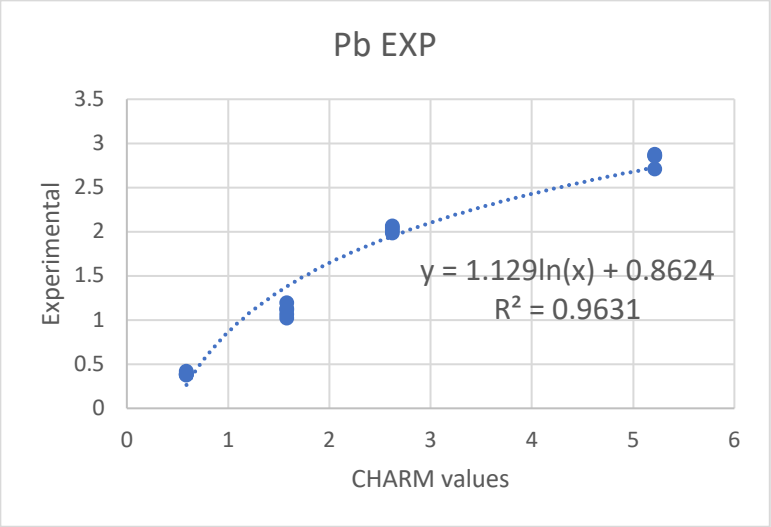


Figure 13. Graphical representation of experimental and expected literature values for lead with logarithmic trendline, equation and R value

In the case of lead, while a linear fit did produce an acceptable R value, the knowledge that the ability of XRF to determine the presence of lead accurately within a sample is already hampered by the extensive shielding of the Pb atom. Due to its sensitivity to matrix effect, the use of a logarithmic fit is more appropriate knowing how lead acts within this type of analysis (Narmanlı Han and Boydaş, 2021). As such, the correction for lead, to curb the appearance of spuriously high compositional amounts, is logarithmic.

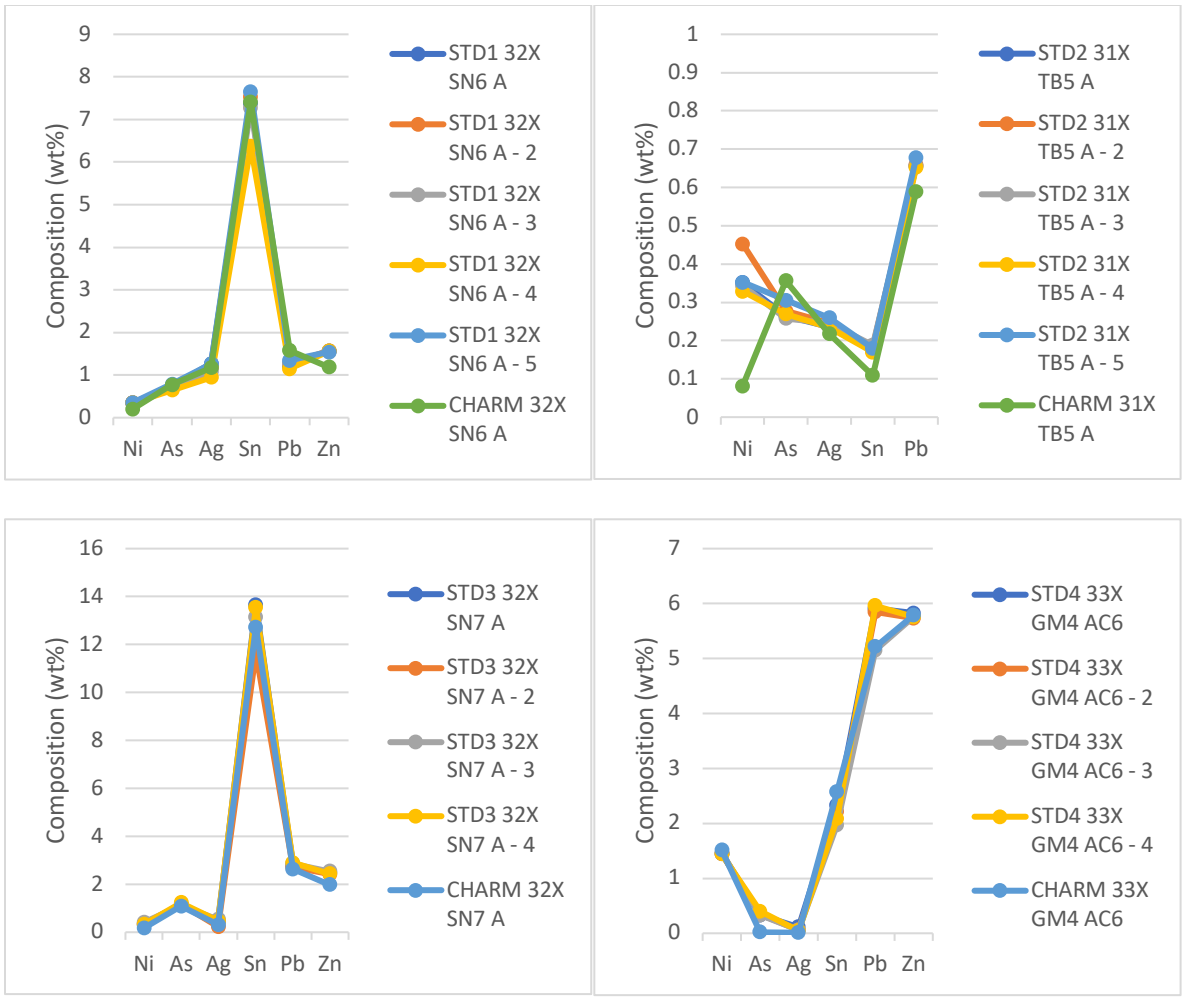


Figure 14. Corrected XRF data for the composition of standards both experimental and CHARM literature values

Table 2. Precision and accuracy (wt%) for corrected CHARM standards by XRF

			Ni	As	Ag	Sn	Pb	Zn	Cu
32X SN6 A	Literature	%	0.21	0.78	1.18	7.42	1.58	1.19	87.66
	Experimental values	Mean (n=5)	0.35	0.71	1.15	7.25	1.25	1.56	87.67
		Sdev	0.00	0.05	0.13	0.51	0.07	0.01	0.14
		Precision	0.01	0.07	0.12	0.07	0.06	0.01	0.00
		Accuracy	70.14	7.87	2.31	2.28	21.24	31.35	0.02
31X TB5 A	Literature	%	0.08	0.36	0.22	0.11	0.59	41.55	57.10
	Experimental values	Mean (n=5)	0.37	0.27	0.24	0.18	0.66	41.52	55.95
		Sdev	0.05	0.02	0.01	0.01	0.01	0.12	0.08
		Precision	0.14	0.07	0.04	0.04	0.02	0.00	0.00
		Accuracy	353.01	23.00	12.07	63.83	12.18	0.07	2.02
32X SN7 A	Literature	%	0.18	1.08	0.31	12.73	2.63	1.98	81.10
	Experimental values	Mean (n=4)	0.35	1.16	0.41	13.00	2.81	2.47	85.31
		Sdev	0.04	0.05	0.13	0.92	0.09	0.06	0.11
		Precision	0.11	0.04	0.31	0.07	0.03	0.02	0.00
		Accuracy	98.75	7.60	34.24	2.14	7.14	24.74	5.19
33X GM4 AC6	Literature	%	1.51	0.02	0.01	2.57	5.22	5.79	84.88
	Experimental values	Mean (n=4)	1.45	0.35	0.07	2.15	5.72	5.77	81.80
		Sdev	0.01	0.03	0.03	0.15	0.38	0.04	0.10
		Precision	0.01	0.10	0.41	0.07	0.07	0.01	0.00
		Accuracy	4.24	1601.83	541.20	16.58	9.59	0.32	3.63
Established lower detection limit			0.20	0.50	0.50	0.50	0.50	1.00	57.01*
Upper detection limit			1.50	1.08	1.18	12.74	5.22	41.55	-*

Post correction, significant improvement to the experimental data are visible. The low tin and silver peaks are now closer to expected values, and other elements have shifted compositional values to lessen the gap between known and obtained data. That being said, values for trace

composition of certain elements does diverge from expected values. As such, lower detection limits were raised from the establish 0.1%. These new lower detection limits were determined according to the lowest point where literature and compositional values agreed. Upper detection limits were established at the highest composition values of each element according to CHARM standard data. If the data fell above the upper limit, it was capped there. *For copper, any sample registering less than the lower limit was excluded from the data set, and no upper detection limit was established as no pure copper standard was analyzed, but could be present in this dataset. All correction were made to both standards and samples according to the above details. Data points which fell below the established detection limits were replaced by “BD”. Data was not standardized following the correction so some compositional total exceed 100% (A6).

3.3 SEM

Table 3. Precision and accuracy (wt%) for CHARM standards by SEM

			Cu	Zn	As	Ag	Sn	Pb	Ni
32X SN6 A	Literature	%	87.00	1.18	0.77	1.17	7.36	1.57	0.20
	Experimental values	Mean (n=2)	89.34	1.17	0.32	0.96	5.99	1.44	0.00
		Sdev	6.56	0.34	0.37	1.40	1.48	4.23	0.00
		Precision	0.07	0.29	1.15	1.46	0.25	2.95	ND
		Accuracy	2.69	0.89	58.59	17.61	18.58	8.53	ND
31X TB5 A	Literature	%	56.54	41.14	0.35	0.22	0.11	0.58	0.08
	Experimental values	Mean (n=3)	55.42	43.83	0.00	0.00	0.03	0.15	0.00
		Sdev	0.68	0.68	0.00	0.00	0.05	0.27	0.00
		Precision	0.01	0.02	ND	ND	1.73	1.73	ND
		Accuracy	1.99	6.54	ND	ND	73.12	73.62	ND
32X SN7 A	Literature	%	80.71	1.97	1.08	0.31	12.66	2.61	0.18
	Experimental values	Mean (n=3)	86.58	2.34	0.00	0.00	9.98	1.09	0.00
		Sdev	1.06	0.10	0.00	0.00	0.74	0.40	0.00
		Precision	0.01	0.04	ND	ND	0.07	0.37	ND
		Accuracy	7.28	19.02	ND	ND	21.20	58.18	ND
33X GM4 AC6	Literature	%	84.87	5.79	0.02	0.01	2.57	5.21	1.51
	Experimental values	Mean (n=3)	84.63	7.07	0.43	0.00	2.57	3.38	1.92
		Sdev	0.05	0.13	0.12	0.00	0.53	0.28	0.29
		Precision	0.00	0.02	0.29	ND	0.21	0.08	0.15
		Accuracy	0.27	22.25	1986	ND	0.00	35.22	26.74

*ND: not detected

To determine the accuracy and precision of the XRF data as compared to a method with better controlled environment, we also ran the CHARM standards on an SEM machine. Each sample was

run three times and averaged. One run for the 32X SN6 A sample was excluded as an outlier, and the average was instead taken from the remaining two spectra. Contrary to the XRF data, these did not require statistical correction. SEM is generally not experimentally run with standards, but the machine is instead calibrated with standardised material. The obtained results show very good accuracy and precision for major alloying elements Cu and Zn. The minor and trace elements show much more variable results. Arsenic and silver were rarely picked up by the SEM, and tin shows too great variability, particularly at low quantities, to be useful. Nickel also failed to be observed consistently. Lead shows greater variability than would be expected considering the higher quantities in the standards, than the trace elements. An attempt to statistically correct lead was made, but the fit of both linear and logarithmic trendlines was below the necessary precision to be acceptable.

3.4 XRF

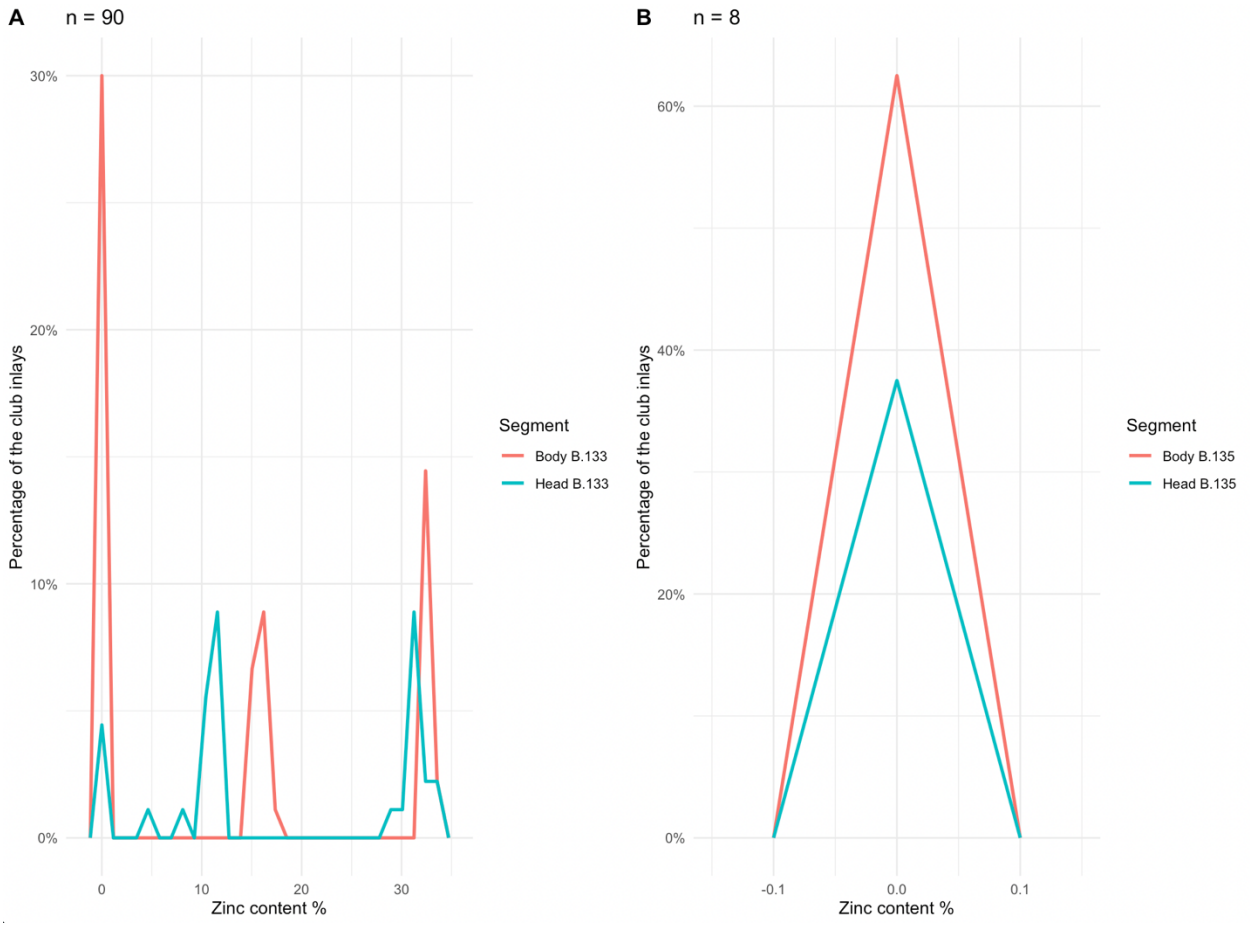


Figure 15. Zinc content of metal inlays across the assemblage, according to club

The above chart shows the result of 99 XRF analyses, each of a separate copper inlay. Values are presented as percentages of the total assemblage, and separated by club, and on the basis of head and shaft of each. This was done due to the clear stylistic difference in inlaying that can be observed both visually and by X-ray. A first distinctive difference between clubs B.133 and B.135 is the major absence of brass and other major alloys in the second club. While the number of inlays on B.135 is much smaller than on B.133, some variation, especially on the head, was expected based

on the variability in size and shape of inlays seen on the x-rays, yet the XRF data shows only pure copper inlays on the item. Further examination of trace elements will establish trends in this subset. As for B.133, the main peak sits at 0% zinc content, but subsequent peaks shows variation through to high-zinc brasses. Interestingly, while a large subset of inlays on the hilt are copper, the composition of the head is more equally spread out amongst alloys. The head of B.133 demonstrates expected versatility in composition, but both the hilt and head show two peaks identifying distinct brass metals, one with a ~15% zinc, and one above 30% zinc. All samples come in below 35% zinc content, so are likely to exist in a predominantly alpha brass structure (malleable, can be worked cold, have a gold color). The peak above 30% zinc is typical for cementation process, which would have been the production method of choice for brass at the time.

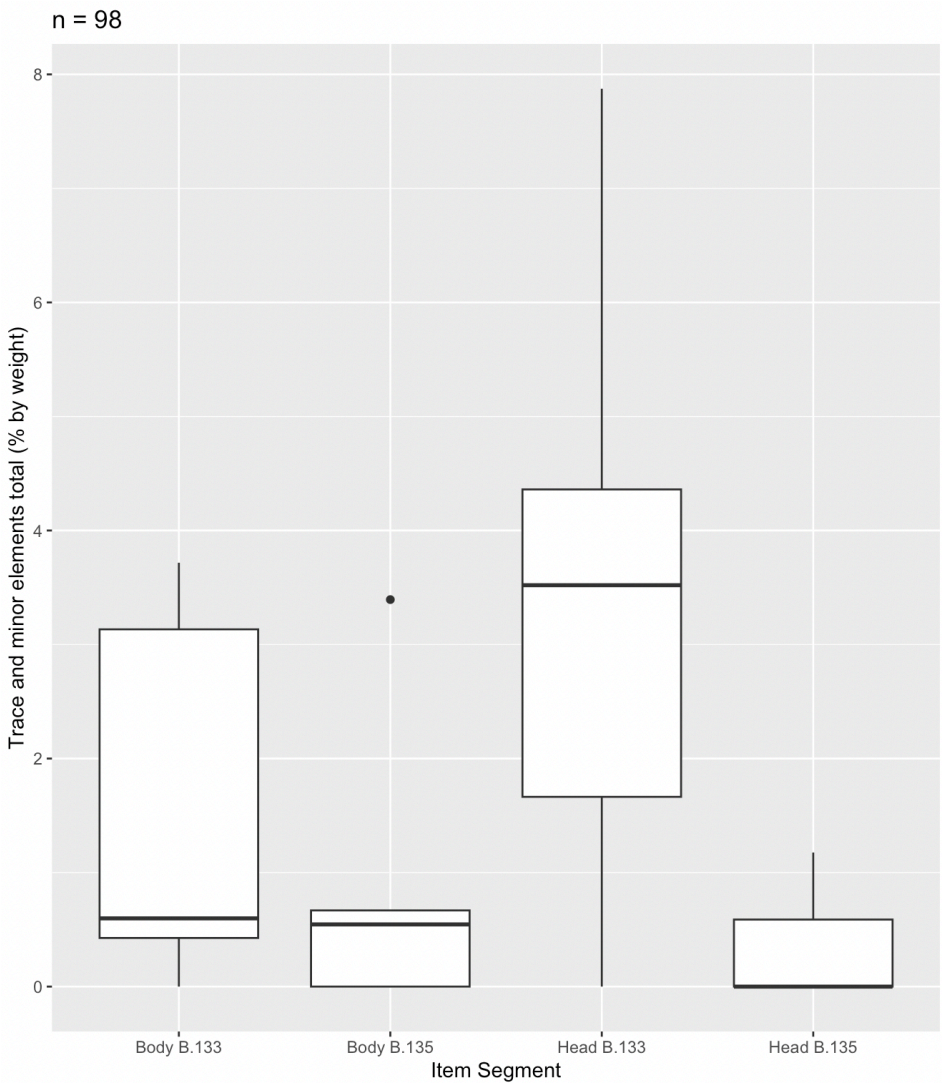


Figure 16. Trace and minor element totals for the whole assemblage

In terms of how the variation in trace element composition across both clubs sums up, all trace totals are above what would be expected for native copper in eastern North America, agreeing with the visual analysis of the X-rays. Moreover, the greater variability in the head of the objects is also visible on this graph compared to the respective hilts of the objects. What's more, is the difference between B.133 and B.135, also illustrated here. Now knowing that B.135 is only decorated with copper inlays, the relatively narrower spread in trace and minor element totals is expected.

However, the median for these is still higher than that of the hilt of B.133 which is decorated mostly with copper. This points to a different type of copper than what was used in B.133, but further trace analysis will tell.

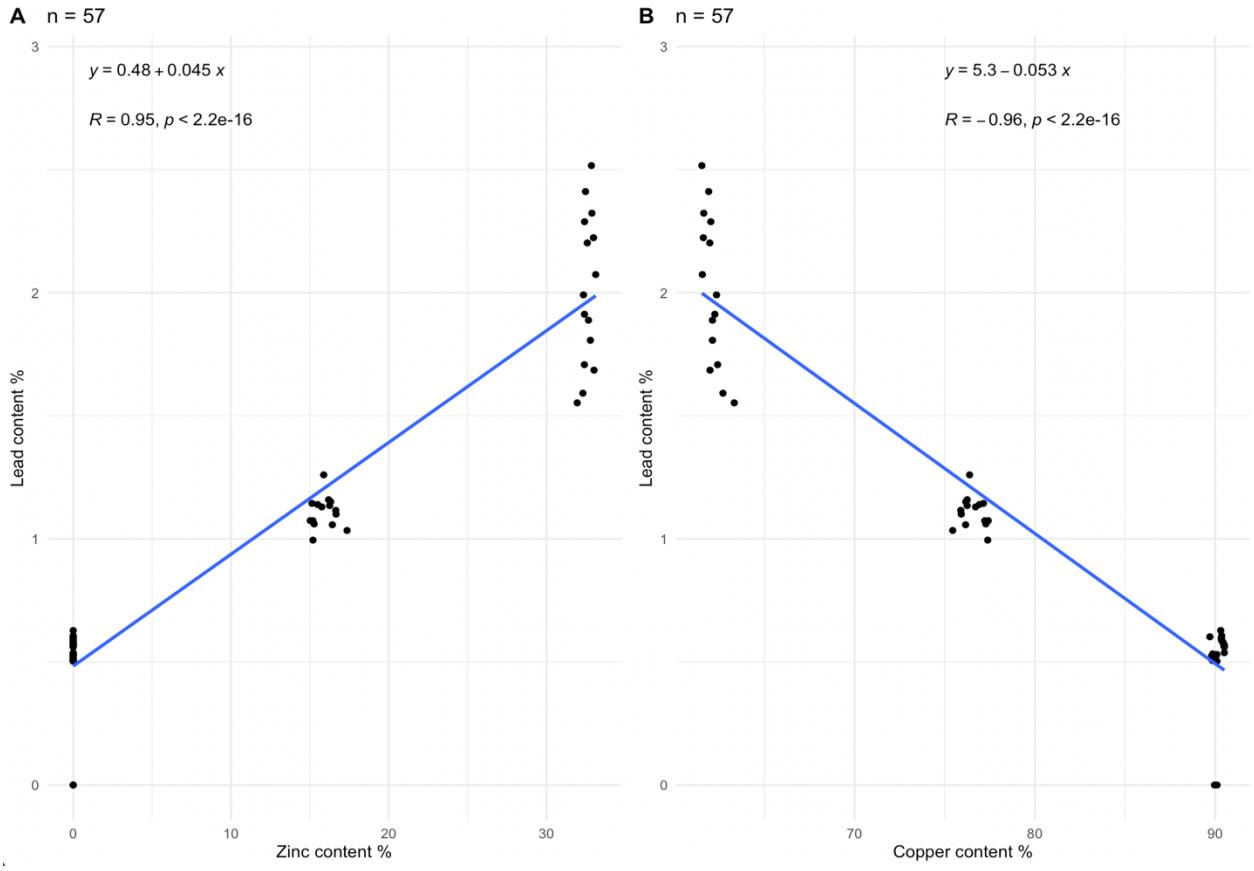


Figure 17. Inlays on the hilt of B.133 parsed according to a) lead and zinc % content, and b) lead and copper% content

Looking more closely now to the hilt of B.133, it is clear that the relation between the zinc and copper, and the lead in the brass inlays on the hilt are linear. It is safe to assume that the brass of middling zinc quantity were most likely achieved through the addition of lead to copper. Lead was added in large quantities to copper to improve casting and machineability throughout history.

Additionally, the three groupings along the hilt of B.133 show separation here, clustering as a relatively pure copper, a ~15% zinc brass, and a >30% zinc brass, each with distinctive lead quantities.

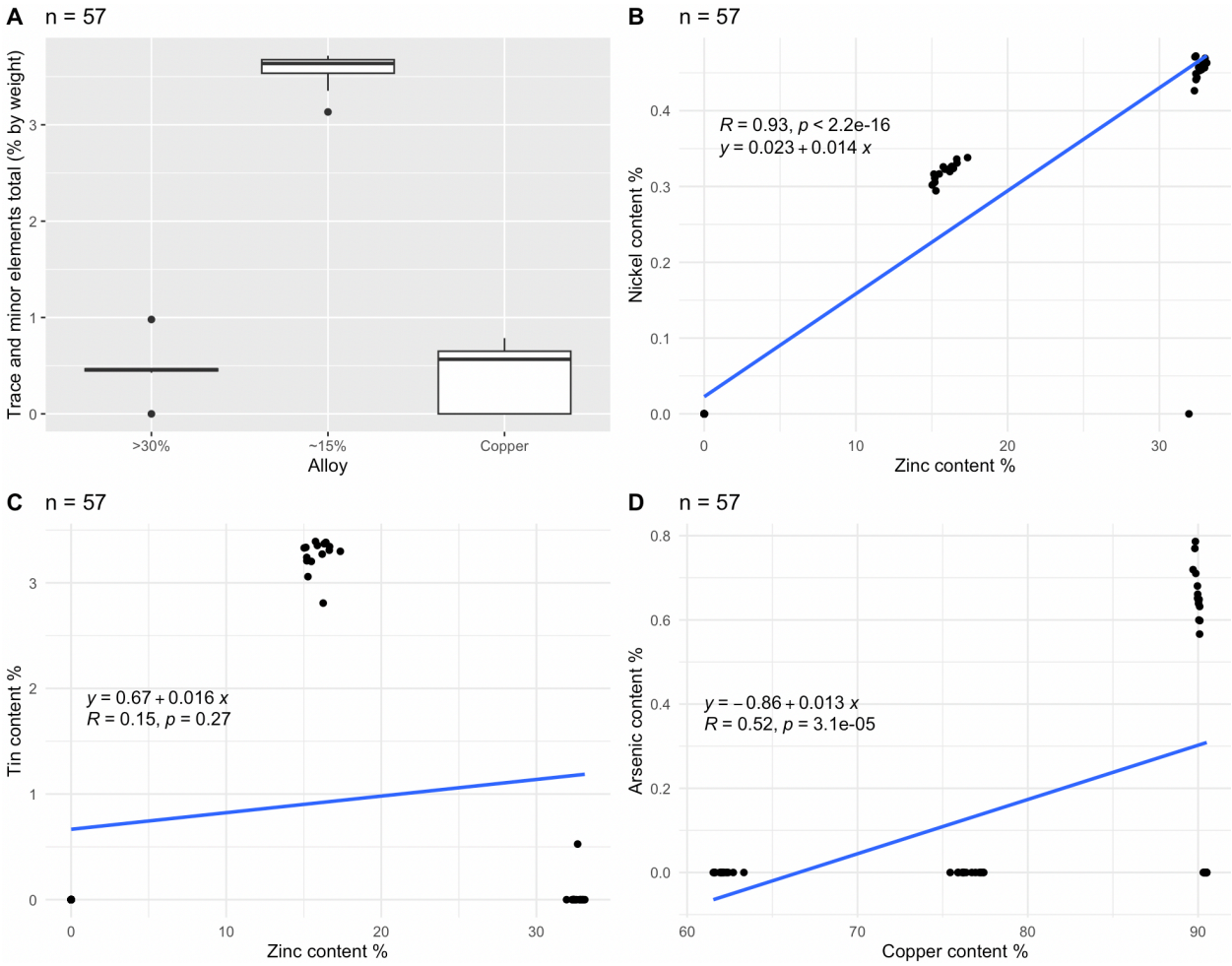


Figure 18. A) Trace and minor element composition for B.133's hilt, according to zinc % composition, and trends in b) nickel, c) tin, and d) arsenic

Looking further into the composition of the trace elements on the various hilt inlays, the distinction between the three metals – the copper and two brasses – becomes more stark. Both nickel and tin further distinguish the three compositional profiles. The nickel follows the same proportional trend

as lead in zinc, proposing that the lead is being extracted from a nickeliferous source. Additionally, the tin content of the ~15% zinc brass is significantly higher than for the other two metal groups that generally fall below the limit of detection, explaining in part the higher trace element content. Additionally, while the ~15% and >30% groups show limited variability in trace and minor element content, the copper displays greater variability, suggesting there exists further subgrouping within the larger alloy class. The lower limit of detection for arsenic was set to 0.5. As such, when looking at the split in the copper inlays that is visible in the arsenic graphs we can distinguish two different arsenic compositions: one below the detection cut off, and the other at about 0.7% content. This proposes two copper types, one with higher arsenic amounts, and one with lower, as well as two different brasses, one at ~15% zinc with high tin and a >30% zinc with high nickel, but otherwise low trace elements. No samples recorded silver quantities above the detection limit.

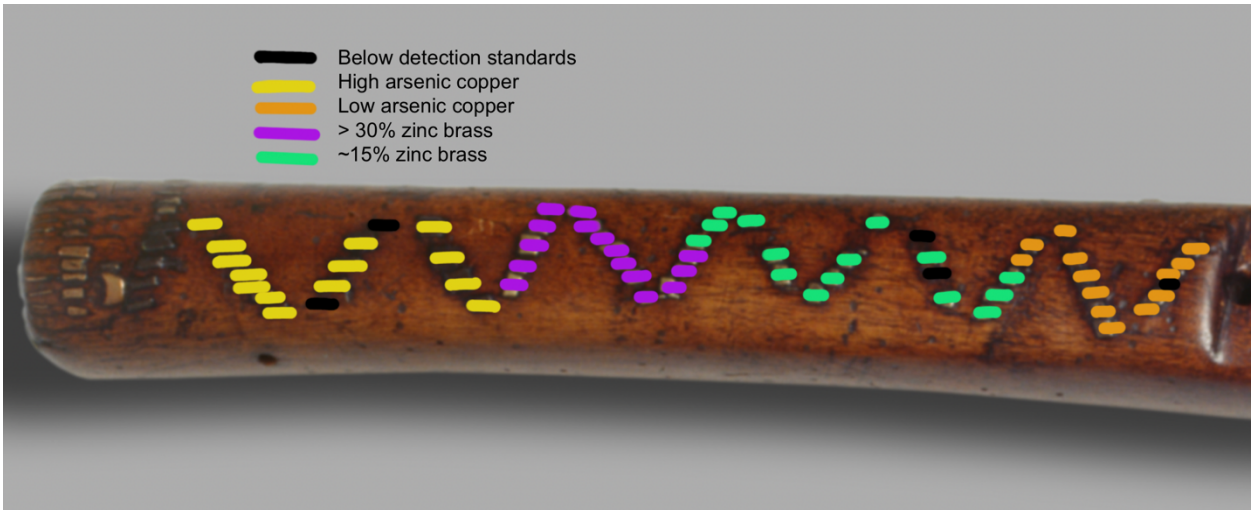


Figure 19. Image of B.133 hilt with colored inlays according to zinc composition

Visually the variation in inlay composition, it becomes vividly clear that intent and knowledge of the metal types was at play in the decoration of this item. The inlay types are used sequentially along the item, without overlap or switching inlays accidentally, suggesting intentionality in their placement and perhaps order.

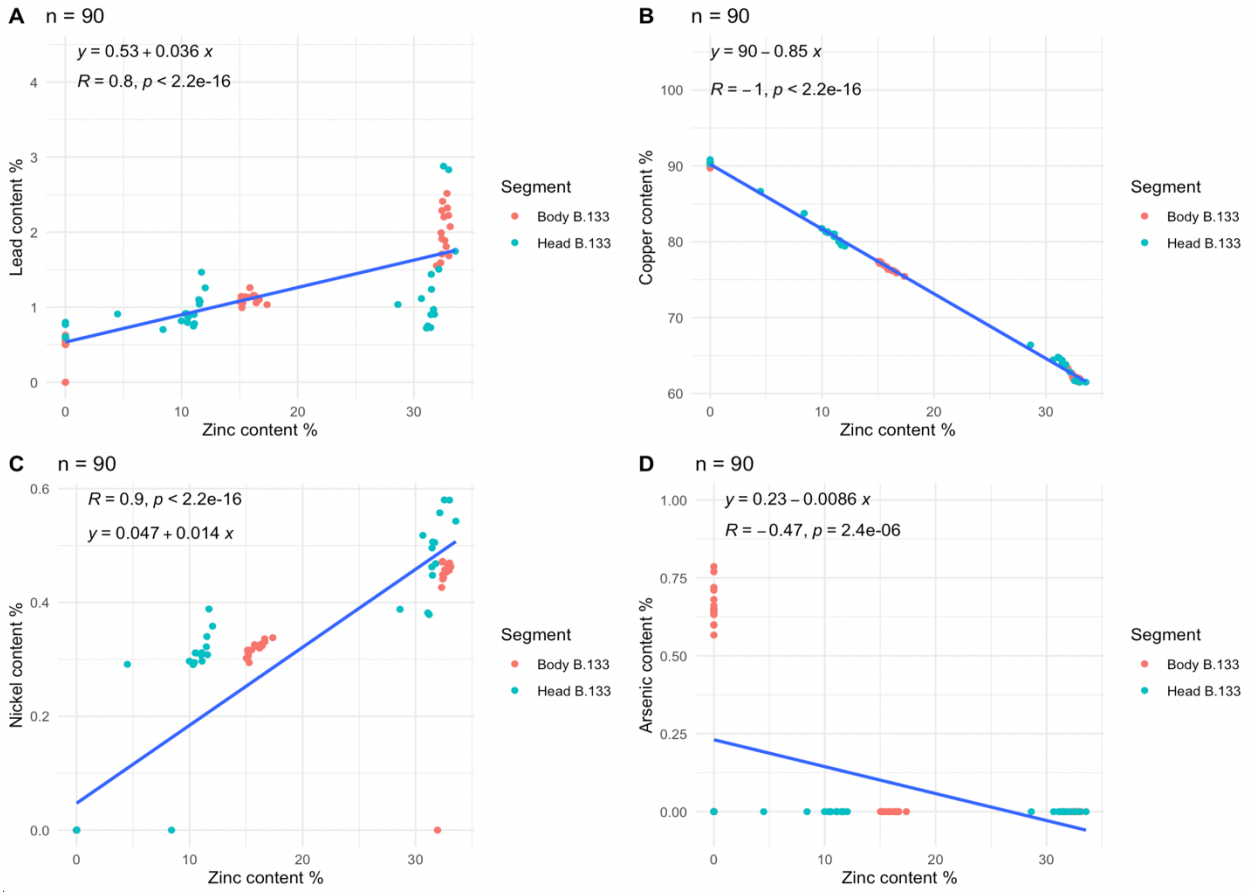


Figure 20. Major and minor alloying, and trace elements for B.133 by item segment

Adding in the inlays along the head, greater variation in the established metal profiles can be seen. As seen in the assemblage graphs, the zinc content of B.133's head shows variation across the compositional map, but clusters similarly to the hilt of B.133, at two particular weight percentages. The first is a peak just about 10% zinc, and the other grouping is >30%, but not as narrow a cluster

as the hilt inlays. We are seeing similar trends in major alloying elements, with zinc and lead progressing proportionally. The characteristics of these groupings also follow minor and trace element trends that were visible on the hilt: nickel proportional to zinc and lead and below detection arsenic.

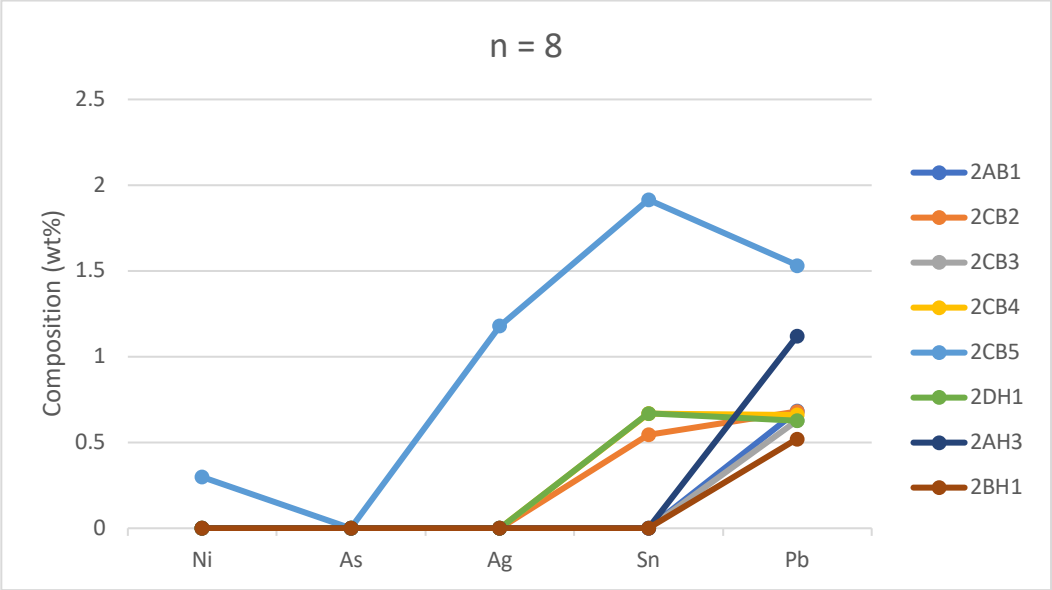


Figure 21. Comparative element composition for B.135

As for B.135, the fewer number of inlays do allow for easier graphical representation. All samples previously registered as copper inlays with <2% trace and minor element totals. No clear trend in composition can here be established, besides from 2CB5 standing significantly apart from the others if only in terms of registering data above the detection limit. Aside from lead, most elements record a few compositional elements below the limit of detection. In the case of arsenic, none was detected at all, setting this type of copper apart from that recorded on B.133. Additionally, it is unlikely this copper came from a nickeliferous or argentiferous source. Some samples did contain measurable tin, and most samples demonstrate lead within the range expected for un-alloyed

copper. Both 2AH3 and 2CB5 show lead amounts within the range of the ~15% zinc brass on B.133. This might indicate a separate copper source than the other B.135 samples, or, most likely, an artefact of the analysis, and as such, no clear conclusion will be drawn.

3.5 Comparative material

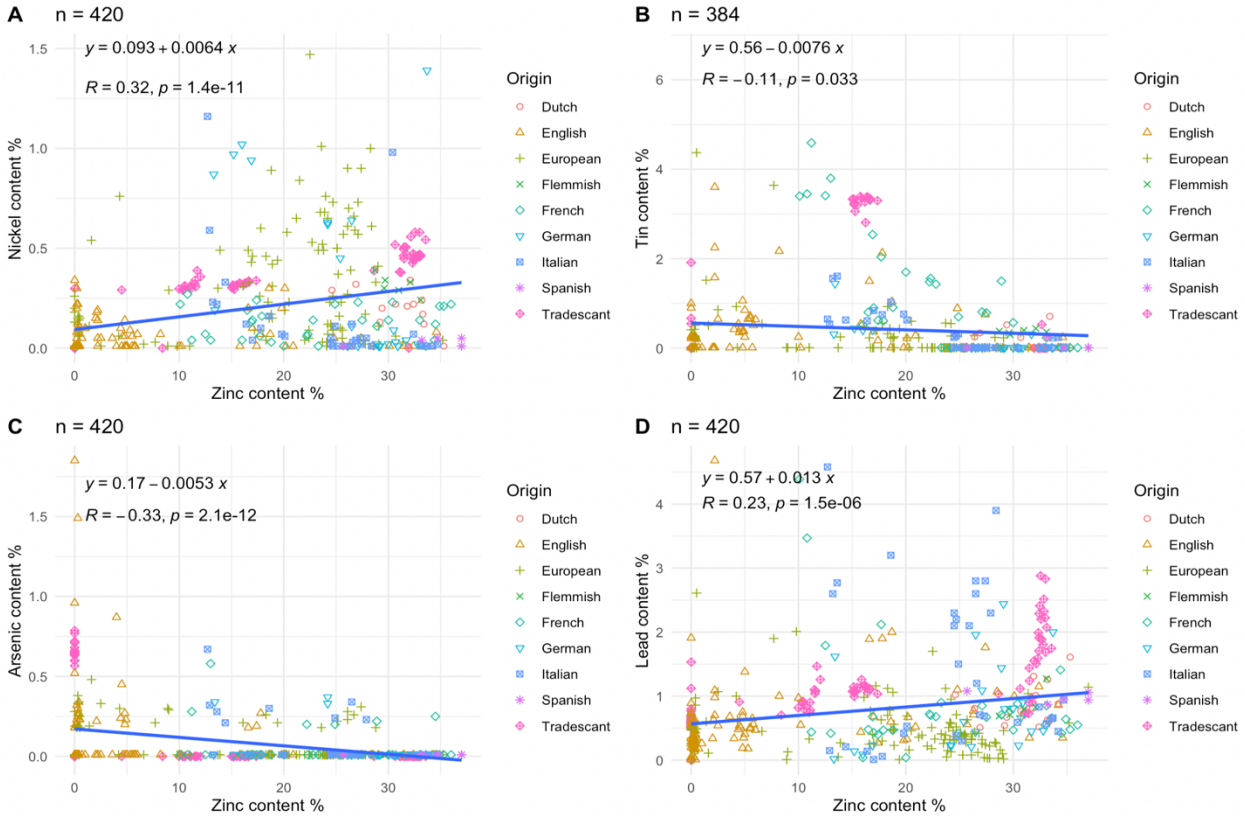


Figure 22. Major, minor, and trace elements according to zinc content for Tradescant clubs and comparative material (Mitchiner et al., 1987a)

Plotting the comparative data according to minor elements allows us to start to parse the origin of the Tradescant inlays. We can start to see some earlier hypotheses confirmed here. Particularly, the arsenic graph shows the English material overlapping the high-arsenic copper group from the

hilt of B.133. Interestingly, the cluster ~10% zinc composition that comes from the head of B.133 overlaps with French material in the nickel and tin graphs. The hilt grouping at ~15% zinc is near general European comparative points in both lead and nickel, and the >30% inlays, which include both the hilt and head of B.133, stand apart from any direct comparative material apart from the off German sample.

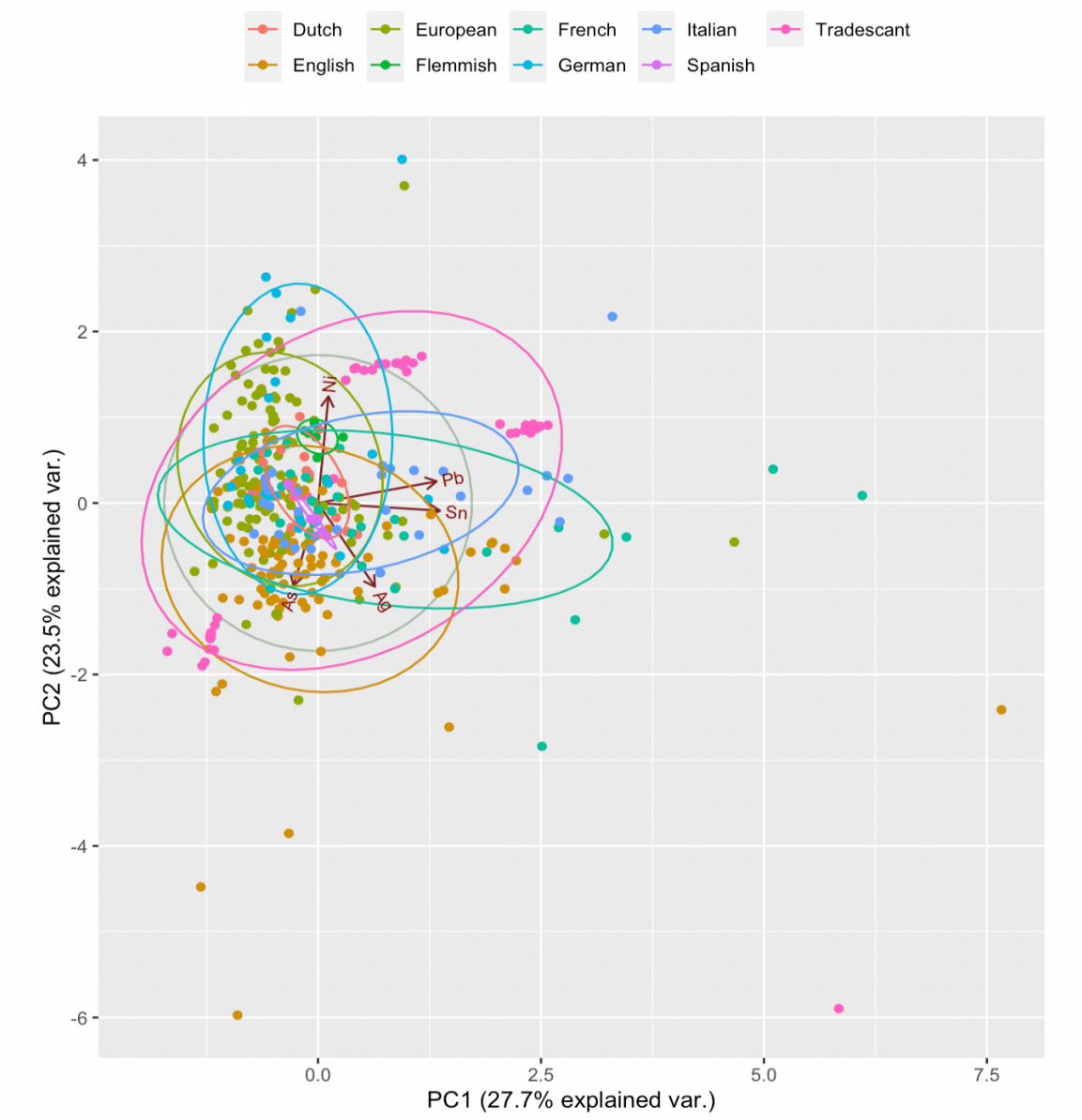


Figure 23. PCA of minor and trace elements for the hilts of clubs B.133 and B.135

The comparative material was also graphed against the Tradescant material using PCA to determine how the multiple trace element composition affect the provenance attribution of the material. Here the hilts of both B.133 and B.135 were graphed against the comparative material. Nickel, lead, and arsenic concentration are the main separators for the material but despite this, poor resolution is achieved in isolating comparative grouping. The Tradescant material, on the other hand, clearly groups into four distinct clusters. Considering the proportional distribution of copper and arsenic, and or lead and zinc, these clusters separate along major-alloying lines. Still, they do confirm some hypotheses established earlier in the text. The high-arsenic group overlaps securely with English material. The >30% zinc cluster, which also contains significant nickel, does display greater lead quantities than the German material, but otherwise fits nicely within that group. The ~15% zinc group follows the trends of French and Italian material in terms of tin and lead content, but stands outside the main groupings for those types. As for the low arsenic copper, it is majorly obscured by the main cluster of material that covers all of the potential sources. While no significant contribution in terms of provenance determination can be made, the overlap of the low-arsenic material form the hilt of B.133 and the hilt material from B.135 presents the interesting possibility of these metals being from a same source.

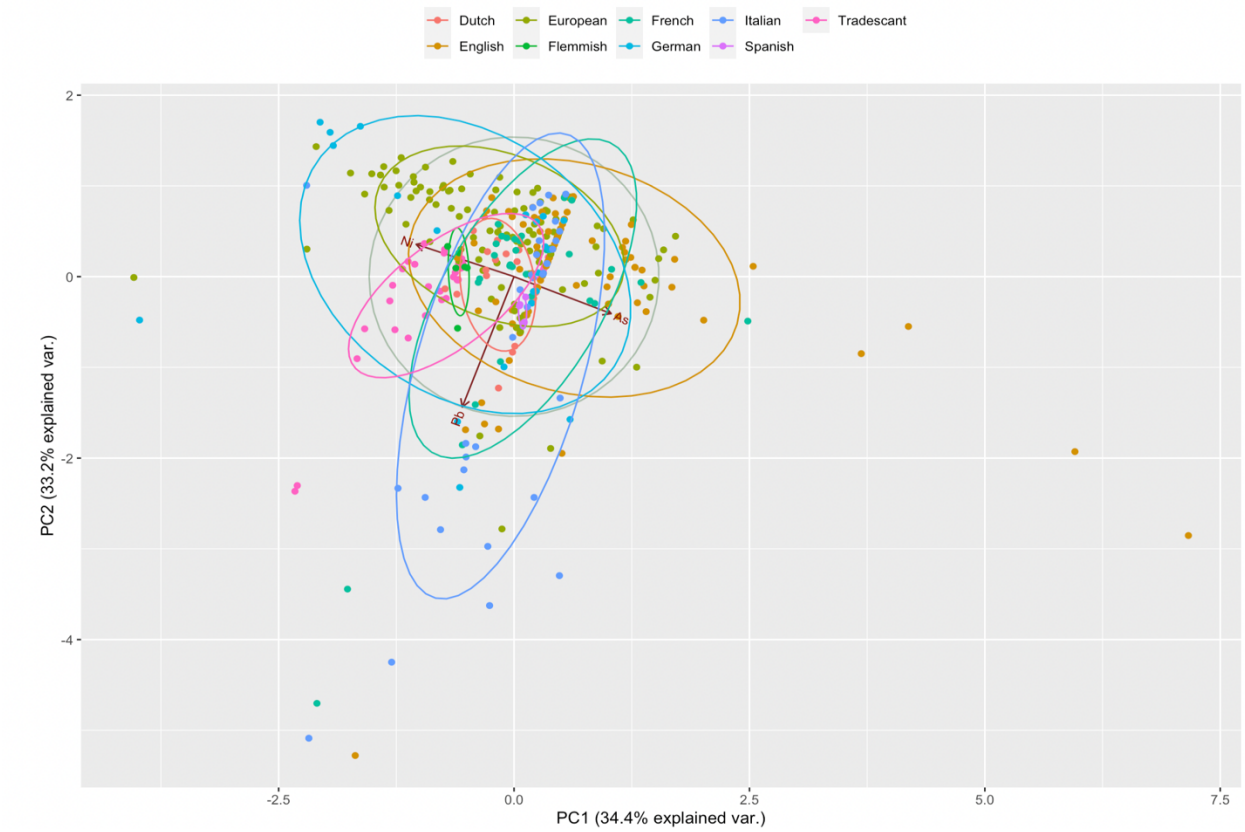


Figure 24. PCA of minor and trace elements for the inlays on the head of club B.133 and B.135

As for the heads of the item, the silver and tin quantities could not be used, but the nickel, arsenic and lead do separate out the material pretty well nonetheless. Particularly, the arsenic and nickel here also create a spread of the data, with most of the English points sitting far on the arsenic side of the divide. Considering the lack of arsenic detectable in the inlays on the head of both items, the dispersal of data points is along the lead and nickel lines. While the European, French/Italian, and German comparative data form a distinct spread in terms of composition, the Tradescant material sits between these trends, showing a distribution that overlaps, but does not sit within these extant groups. Both Dutch and Flemish material overlap with some of the Tradescant's, but overall, the distribution is almost along a mixing line between the German and French. Considering the variability in inlay morphology on the head, and in compositional data so far, it is not surprising

that the data does not form singular clusters, as with that of the hilt, but even the attribution of singular points to a potential origin seems tenuous based on the graph here. These are potential origins, but it is clear from this data that metal from multiple sources are present in these items.

4. Discussion

The main purpose of this work was to reintegrate the Tradescant ball-headed clubs into the narrative of early colonial contact and trade of material goods in 17th century eastern North America. To achieve this, the analysis of the typologically unique metal inlays was attempted to retrace the object biography down to the provenance of its multiple parts. While many theories dispute the origin of these objects, there was hope that the archeological scientific analysis might elucidate some aspect of the past of these clubs. Indeed, while some questions have been answered, this analysis has also raised many more. Firstly, the compositional profiles of the clubs demonstrate variation that both play in favour, and against, the theory of a singular maker for all three clubs. Second, the variation in metal composition posits multiple sources for the metal inlays, including English, German, and French copper; this would serve as proof of extensive trade routes between French occupied territory in current-day Canada, down the coast to Virginia. Lastly, the distinctively intentional use of specific metal types in sequential manner on the hilt of B.133 may point to traditions in decoration of weapon-type objects that did not survive the colonial contact, making these items perhaps some of the only examples of this type of adornment. Overall, these items are incredibly unique and offer a view into indigenous weapon making in the 17th century, as well as trade with indigenous and colonial partners throughout the century, and this study lays necessary groundwork for potential further research into these objects.

4.1 Discussion of results

First looking to the results of the instrumental analysis in terms of the accuracy and precision data, as well as the comparative analysis on SEM, we can establish the groundwork necessary for the discussion of the obtained results. The analytical limitations section did go in-depths about mitigating techniques that were employed to limit the effects of known issues such as escape, Rayleigh, and Compton peaks, as well as sample heterogeneity and low return counts for the analysis. To frame the data obtained despite these limitations, the CHARM set of standards was also analyzed by SEM. The controlled environmental factors such as analysis distance and vacuum would hypothetically allow for greater sensitivity and selectivity due to reduced background and variability in beam length. Despite this, what was obtained was significantly less robust results than those obtained by open-air point XRF. Indeed, while the results did not require the same correction based on linear regression that the XRF results needed, the SEM data failed to efficiently recognize minor and trace elements key to the identification of copper provenance in this study. Particularly, arsenic and silver were not picked up by the software against the background radiation despite known quantities above the limit of detection for the instrument. What's more, low-tin concentration demonstrated greater variability in the SEM data than in the XRF. Reproducibility across the sample was reduced. Both lead and zinc demonstrated possible statistical errors in quantification. Nonetheless, correction to zinc would have been minimal, and lead did not graph close enough to either a linear or logarithmic trendline to be corrected without introducing significant error into the model. It seems that the key strengths of SEM (smaller analysis spot size, greater sensitivity, better detection of light elements) here hinders the methods actual ability to return useful data. Due to the necessary bulk analysis of heterogenous metal inlays, the averaging

of larger analysis spots permits for more consistent compositional data across the sample. Moreover, due to the greater penetrative depth of X-rays versus electron beam techniques and the XRF's lower detection limit allows for minor and trace elements to be picked up more consistently by the instrument – if to a higher limit experimentally than that known for the instrument (Pendleton et al., 2014). It should be noted that the CHARM standards were developed for use with XRF, and that SEM studies usually calibrate the instrument using certified standards, but otherwise do not use standards in the experimental set up (Heginbotham et al., 2015). Knowing this, issues encountered due to the heterogeneity of the CHARM standards can be understood, but in terms of the analysis of historical metal, cannot be set aside. While XRF may not be the most precise method in terms of obtaining compositional data compared to techniques such as Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry (LA-ICP-MS), it here was the best method for the non-destructive and non-invasive analysis of this item's historical copper inlays.

That said, we can then take a look at the obtained results for the XRF analysis of the Tradescant clubs. There are many ways to parse the discussion of these objects and how the results shift our understanding of their making and history, and this discussion will focus first on the generalizable trends in the data, then on specifics points of interest. To begin, similarities in composition between the two clubs are of interest to establish common ancestry, in either production, decoration, or trade group of origin. A first key point is the lack of brass inlays on B.135 as opposed to the significant presence of alloyed metal on B.133. Indeed, all inlays that passed the standards of analysis set forth by the methodological requirements returned high copper purity, with low trace element composition. Trace elements of interest such as arsenic and silver were either not observed, or fell below established detection limits, respectively. This quickly sets aside English

and likely argentiferous sources. Tin concentrations near the limit of detection for the element makes trends difficult to ascertain, but moderately high lead quantities for otherwise low-zinc samples was somewhat indicative. Particularly, when graphing the PCA, clear grouping of these copper inlays with the low-arsenic copper group from the hilt of B.133 might indicate a same source for these metal inlays. Similarities in the morphology of the inlays in B.135 with those on the hilt of B.133 as visible on the X-rays supports this hypothesis. This material can at best be linked to a European, and likely non-English source. Low nickel quantities would also warn against assigning a German source. By process of elimination, a Swedish origin is possible, but the lack of such material in the comparative database makes this assignation precocious. Nonetheless, the possible unification of these two clubs by a singular material source does promote the idea of a same maker for these objects (MacGregor, 1983). This also raises questions about B.134, and whether that club had been intended to be decorated as well. Considering the similarities in wood type between B.133 and B.134, as well as typology, it seems probable. Additionally, considering that the trade of these items to the British colonisers did not seem particularly constrained by the level of decoration of these items, one can assume the practice was not a way to increase the relative value of these items, especially not if their own materials were being repurposed for their adornment. As such, one can start to paint a picture of a decoration practice specific to an individual within an indigenous community with possible direct or indirect trade ties to European, and maybe Swedish, colonizers. Considering the variety in item typology, it is possible the decorator and carver were not the same person, contrary to the hypothesis put forth in the 1983 catalogue (MacGregor, 1983). Additional wood speciation of B.135 would further this line of inquiry.

Moving onto the much more varied inlays on the heads of the Tradescant clubs, this burgeoning understanding of a decoration practice complexifies. Firstly, the variety of inlay morphologies visible on the X-rays is immediately visibly different from the ordered and somewhat regular inlays on the hilt of the object, and on B.135. These inlays are of various size, depths, and thickness. Significant elements such as perforations and saw marks are distinct of material reuse. If the use of sheet metal was not enough of a clue, the evidence of previous use of these metal scraps would point to a European origin all the more. Knowing that copper items such as kettles were being sent over in droves and traded to the indigenous groups, most of whom took decades to make use of the objects as intended, make the recycling of the metal a very likely story. The serrated edge and perforation are also typologically consistent with early metal work for indigenous groups of the period (Wray and Hayes, 1987). An inlay on the head of B.135 also have a visible perforation mark, once again pointing to a similar history between these objects. Particularly, it is indicative of a decorative practice that distinguishes the uniformity of the hilt inlays from those of the head. While care was taken to make small, consistent, rectangular inlays to fit along the hilts of the clubs, the inlays on the heads of the objects are larger, varied in size and shape, and show evident signs of recycling. The compositional data also supports this difference, as significant variation in composition was found on the heads of the objects, even in major alloying element sub-groups. Between the clear reuse of scrap metal and the variation in compositional data, it can be assumed that the decoration of the heads of these items was not completed with the same preparation and care as those on the hilt. Significantly, the use of inlays along wear lines in the wood make these inlays more likely to be structural repairs than aesthetic additions. It is difficult to ascertain whether the variation in inlay morphology simply reflects the size and depths of the cracks in the wood of the items' heads, both due to the nature of the x-ray,

and because of the conservation treatments over the years which have filled in the caps in the wood with colored wax, but it is a possibility that should not be discounted.

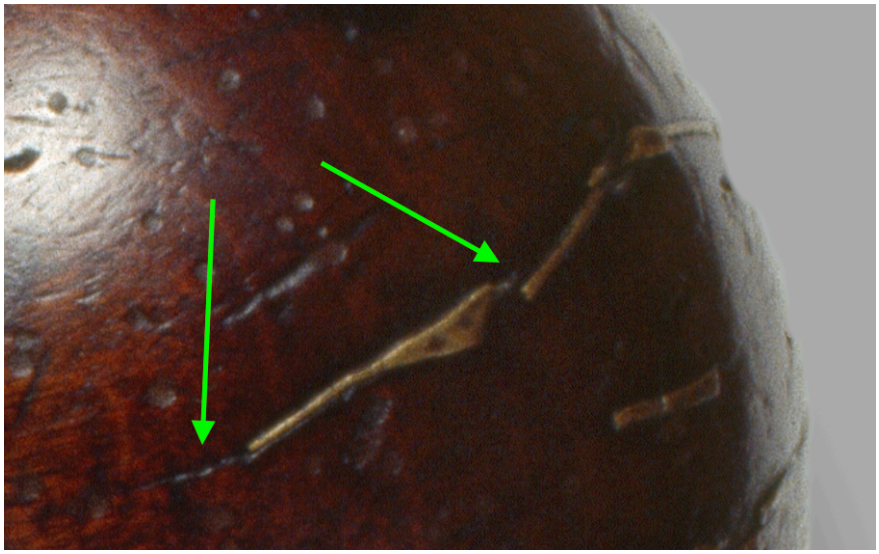


Figure 25. Close-up image of the head of B.133 with arrows pointing to areas of damage on the object that seem to have been filled in with metal inlay as a repair

Overall, we are seeing compositional profiles that establish low-arsenic copper, again similar to the possible Swedish material on B.135, and two brasses. The brass inlays have significant nickel content that points to European sources. Literature values would be quick to assign a German origin, but the PCA and comparative data also raise the possibility of a French origin to the metal, particularly for the ~10% zinc brass. This would have particularly interesting implications in terms of trade routes along the eastern coast of America, since French colonies occupied territory much further north than what was originally considered for this item in terms of metal origin. Tin compositional data would be key to confirming this hypothesis, but here is unavailable for the head

of B.133 due to issue with overestimation as a consequence of heightened background radiation. Further analysis of these points is encouraged to elucidate the potential implications of French material in the object. As for the >30% zinc brass inlays, we are seeing the greatest distribution of compositional data within a grouping to date. These all fall within expected values for German material, and this corroborates as well with the PCA. Despite a singular general origin, the variation in composition points to multiple different points of supply in terms of items recycled for decoration of B.133. Germany had various active mines throughout the 16th and 17th century that supplied most of eastern Europe in copper metal. The precision of the methods used here are insufficient to detangle the individual copper mines from the greater variations in geology throughout Europe (Coker, 2001). One can only assume that the variability that we are seeing, particularly in lead and nickel composition, is due to the intra-variability within the greater monopoly of nickeliferous copper courses in Europe.

Lastly, focusing on the hilt of B.133, we encounter one of the most delightfully surprising finds of this study: clear decorative decision making based on metal origin rather than visible difference in the metal phenotype. At first glance, and on the x-ray, the metal types are difficult to discern. What is distinct is the shift in color between the copper and brass inlays due the color difference the addition of zinc causes in the copper, giving it a more golden hue. Close inspection of the object also reveals very faint color difference between the high and low arsenic coppers, but it is difficult to observe without the ability to place images of both sections of the hilt side by side (Mecking, 2020; Radivojević et al., 2018). Additionally, the lower zinc% brass on the hilt shows increased tarnishing compared to the >30% zinc inlays, likely due to the role of zinc in delaying the oxidation

of copper, but this difference would not have been an aspect of the inlays during the inception of the weapon.



Figure 26. Close-up images of the hilt of B.133 showing a) the high arsenic copper, b) the low arsenic copper, c) the >30% zinc brass, and d) the ~15% zinc brass inlays

Indeed, it was not until we returned to these pictures after analysing the results did most of these minute differences become apparent. Indeed, the variety of brass and copper that the XRF reveals was anticipated, but the groupings of the metal profiles by origin along the hilt was not. The two

different copper types are delimited by a defining difference in arsenic content. The high arsenic copper is most likely of English origin, while the low-arsenic copper is the one that overlaps with the copper material on B.135, and has been suggested to be European, and tentatively Swedish (Martinon-Torres et al., 2009). As for the brass inlays, the >30% zinc is also the grouping with the highest nickel content, making its overlap with German material in the PCA well warranted. The ~15% zinc brass has a much lower nickel, but significant tin content, making it a good contender for an Italian or French origin. Considering the occupation of territory in America for the period, French material is more likely. What this concretely determines is that the inlays along the hilt are from at least four distinctive origins, and were used for decoration on the object with some aspect of that knowledge available to the decorator, as is clear by the use of these metal inlays sequentially instead of randomly.

4.2 Decoration practices

Whether that origin was demarcated by difference in scrap metal type (ie. type of object or sheet metal being traded by Europeans to indigenous groups), or the actual group of origin, is up for debate. But, with a minimal ability to differentiate the inlays based on visible differences, this author would like to make the argument that the differentiator of these metal types would most likely have been their origin through trade linking them to various European colonizing groups. This is due to the uniformity of the inlays as seen on the x-rays and the difference between the two copper groups in the hilt. Specifically, if thinking through the production of these inlays, the established grouping would have had to been treated separately from the recycling of the original objects and scraps into the rectangular inlay shape, through to their insertion into the club to keep

these small and similar metal pieces from mixing together an achieving a more homogenous distribution on the hilt. Considering the making of between 14 and 17 inlays of each type, it is possible the inlays for each section were sourced from more than one piece of metal, especially if these were similar in size to the scraps found at historical sites for the region (Martinon-Torres et al., 2009). As such, the unifying factor is most likely not a singular object of origin, especially since it is very unlikely that little if any of the copper transported to North America was in the form of raw sheet metal (Carter C. Hudgins, 2004). Also taking into account the similarity in inlay production, no visible difference in morphology affected the placement of these pieces along the hilt apart from the color difference between the copper and brass. The difference between the arsenic and low-arsenic copper is not distinct enough to have warranted segregation throughout the production process. Interestingly, no visible recycling elements such as perforations are visible on the hilt inlays. Considering the difference in composition, especially stark for the ~10-15% zinc brass groups, this means the head and hilt were not decorated with the same material. As such, it cannot be said that the uniform sections of a larger trade object was used for the hilt, and then the scraps leftover from the hilt inlays then used for the head. This further supports the hypothesis of 2+ decorating events for B.133 where different material was available to the decorator.

If following through with this hypothesis that trade origin guided the decoration of this object, one begins to question why the metal origin would impact the production of these clubs. Our current knowledge of decoration practices in terms of ball-headed clubs is skewed to later typologies, particularly zoomorphic and anthropomorphic depictions. Indeed, the only early record we have of particular decorative choices when it comes to this type of weaponry is the addition of wampum and the significance of wampum color to such items. Instances of copper replacing wampum in

decorative objects include the sudden prevalence of creature necklaces made of sheet copper in the 1620-30s throughout the inland area West of the Chesapeake bay (Bradley, 2011). Similar to the inlays in the clubs, the use of copper and brass sheet metal is sudden, then disappears completely within 10 years of high prevalence. In terms of why wampum was used, one historical account of the King Phillip ball-headed club alleges that the number and color of wampum inlays on the weapon was meant to represent the number and skin color of those killed by the object, distinguishing the white colonizers from the dark-skinned indigenous peoples (Sturtevant and Trigger, 1978). In terms of the Tradescant clubs, the prioritization of the number of inlays is difficult to ascertain, but the much smaller high-arsenic copper inlays as compared to the >30% zinc ones could indicate as much. The use of specifically distinct metals to decorate the weapon could have been a decision based in representing the history of these objects as weapons of war. Considering the varying number of inlays on each club, this could support such a hypothesis, arguing that B.133 was used the most, as is also visible from the wear on the head of the object, and that B.134 was the "youngest" club, yet to be used or consequentially decorated. On the other hand, the sheer number of inlays on B.133 make it unlikely that that singular item had warranted such decoration within a tradition of tallying the dead according to origin. Moreover, as mentioned earlier in the text, the weight and handling of the object casts doubt as to its actual use as a weapon. If it was instead of ritualistic purpose, the above hypothesis could still hold true, if a singular record of the wars waged by an entire tribe, rather than the individual killings of a singular weapon. And if that is the case, it raises questions as to the differences in decoration of the hilt versus the head, and what distinction are made there.

The argument of martial weapon versus ritual instrument is one at the heart of the interpretation of these objects, yet is the hardest to answer in terms of the material studied for this thesis. Wood speciation and anthropological study would be more adept at differentiating the roles of these weapons in their given context. What can be said is that typologically ball-headed clubs were usually made of maple or iron wood, heavy hardwoods native to north America. Maple does not have a native region that extends south to Chesapeake bay, but as is demonstrated by B.135, the trade of wooden goods throughout the region is not limited in scope (Burns and Honkala, 1990). Dogwood, as determined by the 1980s analysis to have been used for B.133 and B.134, is a softwood that grows along the entire eastern coast of North America, and as such would have been readily available to the tribes of Virginia, but not of the length or heft expected for a weapon of the ball-headed type (Atkinson et al., 2016). The Skokloster clubs do make the distinction, as one is listed as ritualistic while the other is defined as martial, but the discussion as to why is sadly in Swedish. Nonetheless, further research into this distinction and what it would mean for the contextualization of these objects would be interesting to pursue.

4.3 Further Research

Having established the breadth of this current project and discussed the avenues of investigation this study only begins to broach, certain subjects of interest have been highlighted. Internal relations between these clubs is a key question mark, and further research into their relationships would mark a step forward in our understanding of the assemblage as a whole, and how the individual objects biographies intermingle within the shared history in the Tradescant collection. Particularly, the wood speciation of B.135 would be key to determining the closeness in typology

of the zoomorphic club to the other two. Additionally, and in a two-pronged fashion, the analysis of the inlays on both B.133 and B.135 using techniques allowing for the determination of provenance trace elements beyond the current limitations of the XRF set up would be key to both determining whether the copper inlays on both items come from a singular origin, and detail the source of the major metal-profiles determined in this study. The use of LA-ICP-MS would be in line with other studies on similar metal material from both the region and time period, but would require taking out inlays form the clubs for analysis, and microscopic destructive sampling.

In terms of further work within the restrictions of this study, the XRF analysis of all additional samples on the hilt of B.133 would complete this first portrait of the metal inlays on that club. Moreover, establishing a better format for the point analysis of curved surfaces such as the ball-head without the introduction of impeding background radiation would allow for more specific analysis of these inlays and important trace elements. The making of a 3D model of the club would also facilitate the understanding of how trends in composition are visualized as decorative elements on it. Particularly since some elements are aesthetically additive, such as the inlays along the "crest" of the zoomorphic B.135, the visualization of patterns in the metal are key to understanding how the decision-making process was understood at the time of the item's inception.

Looking now to more anthropological and comparative work, the analysis of the Skokloster clubs' metal inlays would allow for a fuller image of the use of metal as decoration on clubs for the period. Specifically, confirming whether these objects are decorated with Swedish material only, or if the use of metal wire rather than sheet metal interacts with the current patterns in decorative tradition being established here would be particularly interesting. Similarly determining what

distinguishes the ritual and martial weapons there could help categorize the Tradescant clubs within a larger typological grouping, and may explain certain points of contention in this current work.

Lastly, connecting with source communities in and around Virginia should be made a priority. While this work was requested and completed by European institutions, the material is originally from North America, and specifically from groups that have direct lineage still occupying the ancestral land where these items were first traded. These groups may hold onto knowledge about decorative practices, historical trade routes, and the meaning of this material culture that would be key to contextualizing these objects. Even if the knowledge of these clubs' production and decoration did not survive the colonial contact, this is information about these people's and these groups' history that should to be available to them. This project has allowed for the understanding of unique practices otherwise not yet documented in the historical record for the period and holds educational worth in terms of diversifying the colonial narrative of the region.

Overall, these items make for a small but endlessly interesting collection of early indigenous weaponry out of eastern North America. This study has attempted to determine the composition of the copper and copper-alloy inlays on both B.133 and B.135 and in doing so has assigned potential countries of origin to the traded and recycled goods that became said inlays. It also has started to shape the outline of a decorating tradition that may have been in answer to the colonial contact, yet did not perpetuate through later examples of similar objects. The Tradescant clubs truly are a unique set of indigenous artefacts. They offer a new and intriguing view into the making of cultural goods at the onset of international trade in North America. Moreover, they act as a time

capsule for a period when the turnover of artistic tradition was at a peak, the mixing of cultural styles and materials causing the exploration of new styles and opportunities of expression. This study, more than anything, lays the groundwork for a body of research into these objects and their siblings in collections around Europe.

5. Conclusion

The aim of this work was to offer a novel interpretation of items of North American indigenous make in the care of a European cultural institution in an attempt to complexify the colonial narrative of the 16th and 17th centuries. Within the pastiche of 400 years under the care of an English museum, and here interrogated using techniques pulled from a tradition of European archeology, the conclusions that can be drawn from this work will, despite all efforts, be heavily dependent on biases of heritage, of tradition, and of legacy. Within this framework, this study attempts to elucidate the intricate forces governing the exchange of material culture between colonial forces and indigenous communities in the American northeast during the early contact period.

Against a background of European copper monopolies, extensive import of sheet metal were brought into eastern North America as early as the 1500s. This directly impacted the value of native copper and significantly shifted the role of the metal within the values and lives of indigenous people throughout the northeast. Out of this trade, items such as the three Tradescant clubs serve as important objects to the study of creolized material culture for the period. The poor internal relationship between these items promoted the study of the unique metal inlays along the bodies of clubs B.133 and B.134. X-rays of the items revealed the inlays were European sheet metal, some inlays with significant indication of secondary recycling. Compositionally, probable provenance was able to be determined for a significant portion of the inlays. Compared to regional compositional profiles for major European copper centers, the presence of English and German material could be confidently identified. Subsections of the inlays could also be cautiously assigned to French and Swedish origins. Significantly, there seems to exist overlap between the

inlays used on B.133 and B.135, concretizing hypotheses about the singular maker of both items (MacGregor, 1983). Evidence of distinct origin-dependent decision making as to the decoration of the hilt of B.133 is potentially proof a production practice that did not survive the colonizing of America, and might be singularly caused by the context of early contact and the rapid change in copper value to indigenous groups. Some thoughts as to how this decoration practice fits into the current understanding of indigenous weaponry stylistic evolution are given. These items further confirm the presence of vast internal trading routes from Canada to Virginia, and particularly, of selective trading of groups with European countries. Multiple avenues of future research are outlined, focused on how indigenous items in European collections can help in recovering a history otherwise obscured by the colonial narrative.

This work was completed by an author of white descent at a university that stood as it does today during the colonization of the Americas. By no means can this use of efforts and resources to a cause to which the legacy of these peoples and institutions has caused significant harm, be called reparations. This work is necessary, not because we may consider it to be just in the grand scheme of colonial karma, but because access to one's history is necessary. This study was completed in the hopes of generating knowledge and making available its findings to those who wish to seek it out. Nevertheless, if it has inadvertently caused harm, this author apologises and kindly invites you to contact them to discuss ways to mitigate further damage to you, your community, and your history.

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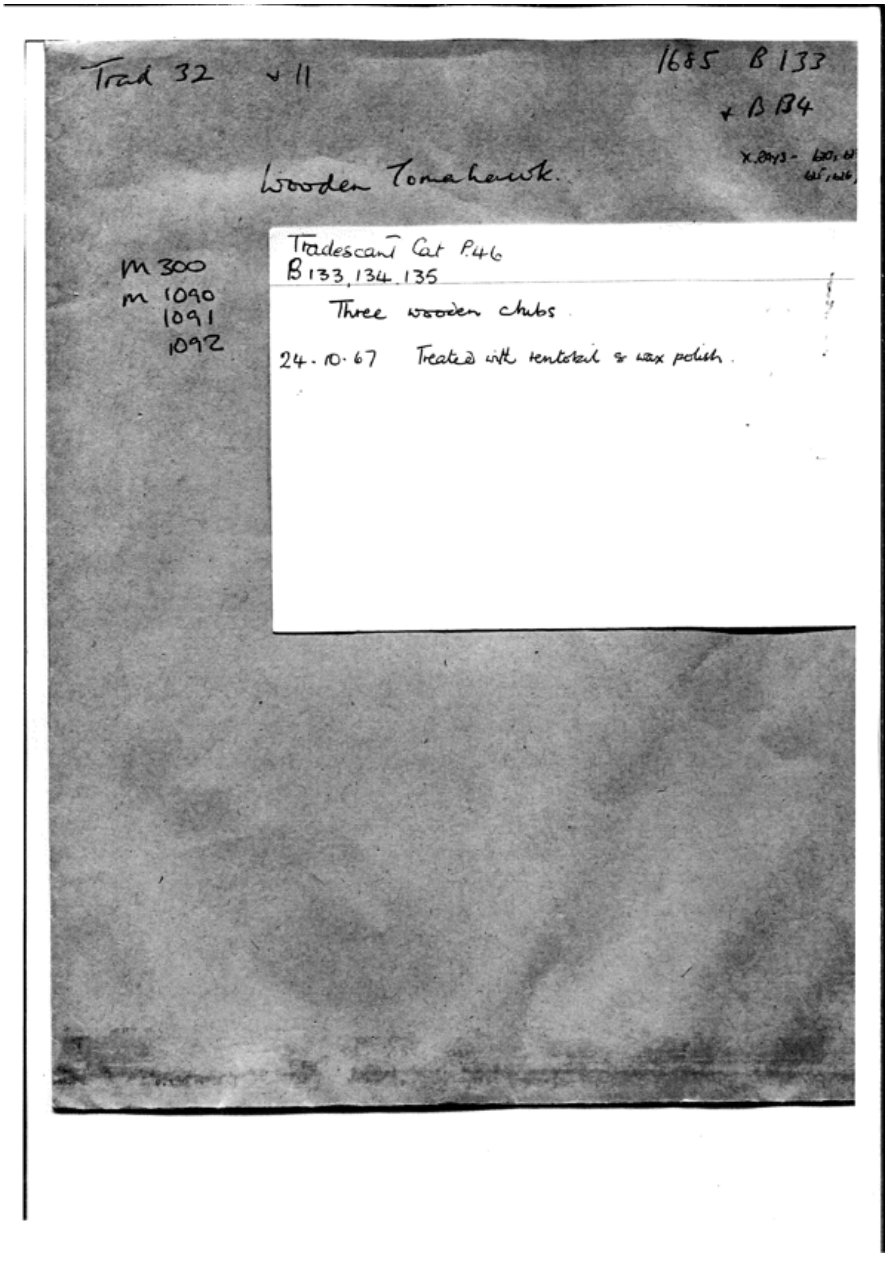
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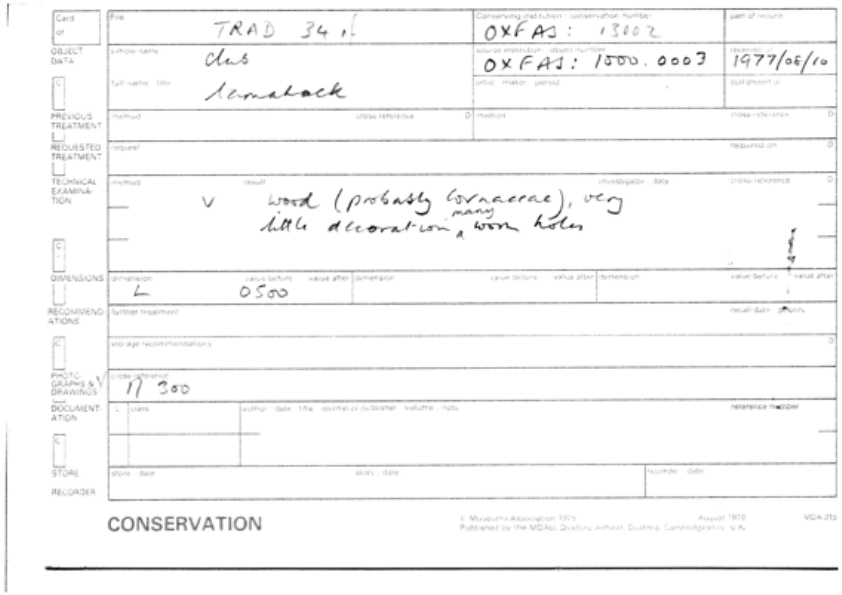
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Appendices

A1 – Conservation notes for the care of the Tradescant ball-headed clubs





Card of

File: TRAD 34.1

Concerning institution · conservation number: OXFAS: 1380.2

part of record

OBJECT DATA

simple name: clog

source institution · object number: OXFAS: 1000.0007

received: 1977/06/10

full name · title: Tamarack

artist · maker · period

completed on

PREVIOUS TREATMENT

method · cross reference

method · cross-reference

REQUESTED TREATMENT

request

required on

TECHNICAL EXAMINATION

method · result · investigator · date · cross-reference

V wood (probably Cornaceae), veg many little decoration & worm holes

DIMENSIONS

dimension · value before · value after

L 0500

RECOMMENDATIONS

further treatment · recall date

storage recommendations

PHOTOGRAPHS & DRAWINGS

V

slide reference: 11 300

DOCUMENTATION

L · loans · author · date · title · journal or publisher · volume · nos · reference number

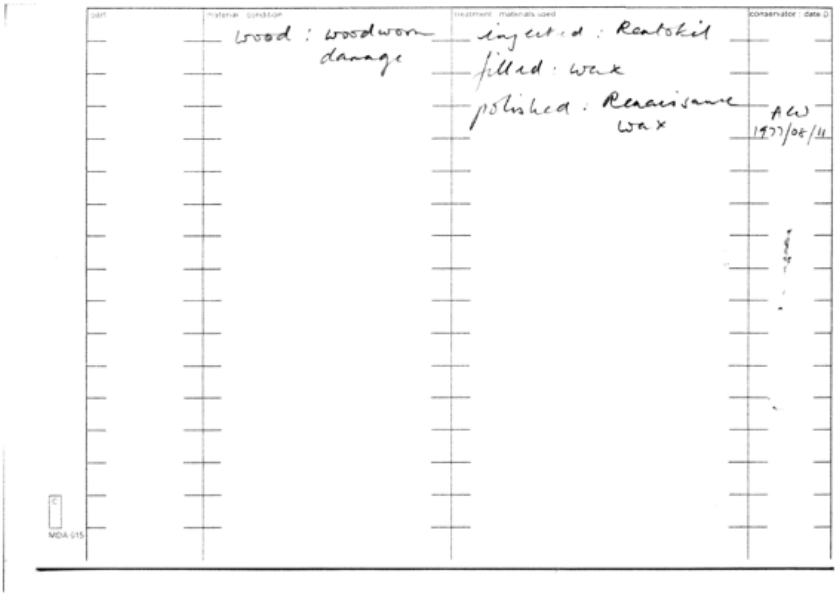
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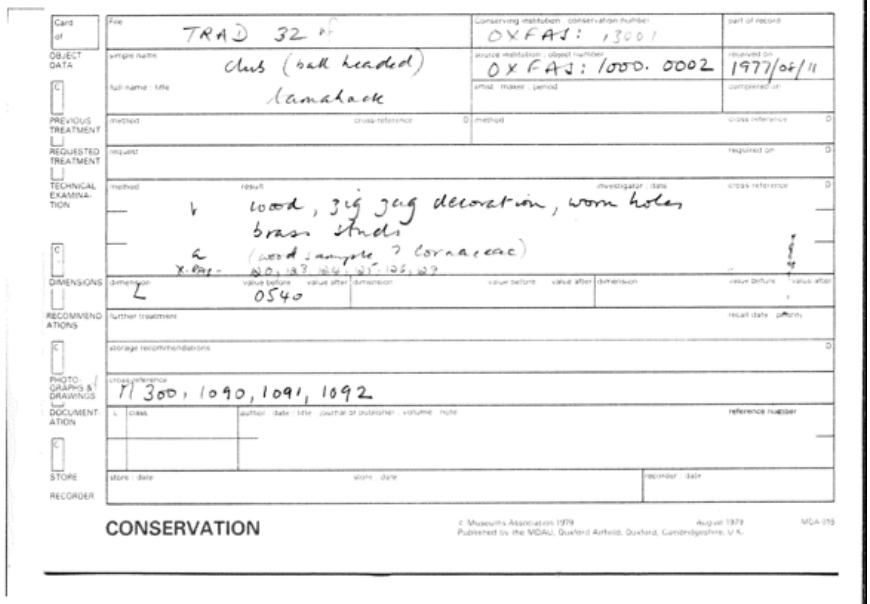
store · date · store · date · recorder · date

RECORDER

CONSERVATION

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part
material : condition
treatment : materials used
conservator : date ()
wood : woodworm damage
injected : Rentokil
filled : wax
polished : Renaissance wax
ACW 1977/04/11
MDA 015



Card of

File: TRAD 32 PF

Conserving institution : conservation number: OXFAJ: 1300.1

part of record

OBJECT DATA

simple name: club (ball headed)

full name : title: lamalaock

source institution : object number: OXFAJ: 1000.0002

artist : maker : period:

received on: 1977/02/11

completed on:

PREVIOUS TREATMENT

method: cross-reference:

method: cross-reference:

REQUESTED TREATMENT

request: required on:

TECHNICAL EXAMINATION

method: result: investigator : date: cross-reference:

V wood, zig zag decoration, worm holes brass studs

R (wood : sample ? Connaceae)

X-Ray - NO. 187 188 - 191 195, 197

DIMENSIONS

dimension	value before	value after	dimension	value before	value after	dimension	value before	value after
L	0540							

RECOMMENDATIONS

further treatment: recall date : person

storage recommendations:

PHOTOGRAPHS & DRAWINGS

cross-reference: PI 300, 1090, 1091, 1092

DOCUMENTATION

L | class: author : date : title : journal or publisher : volume : note: reference number:

STORE

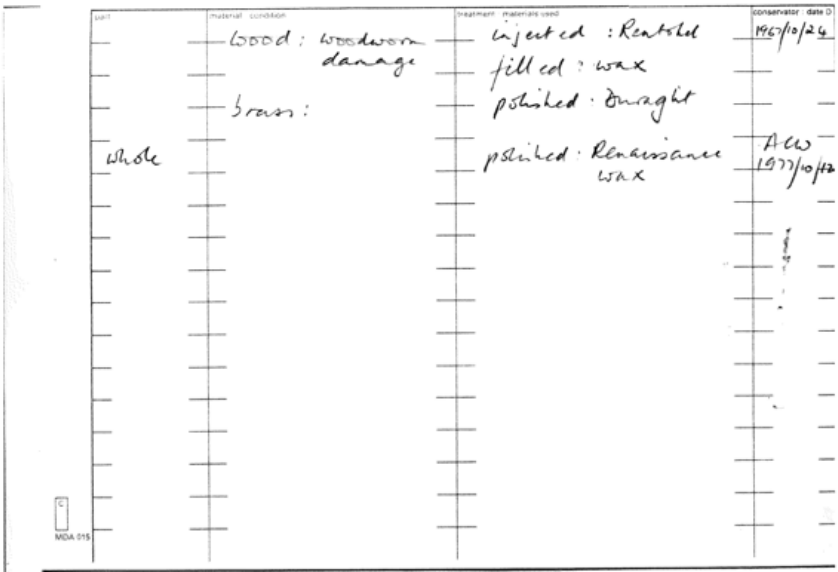
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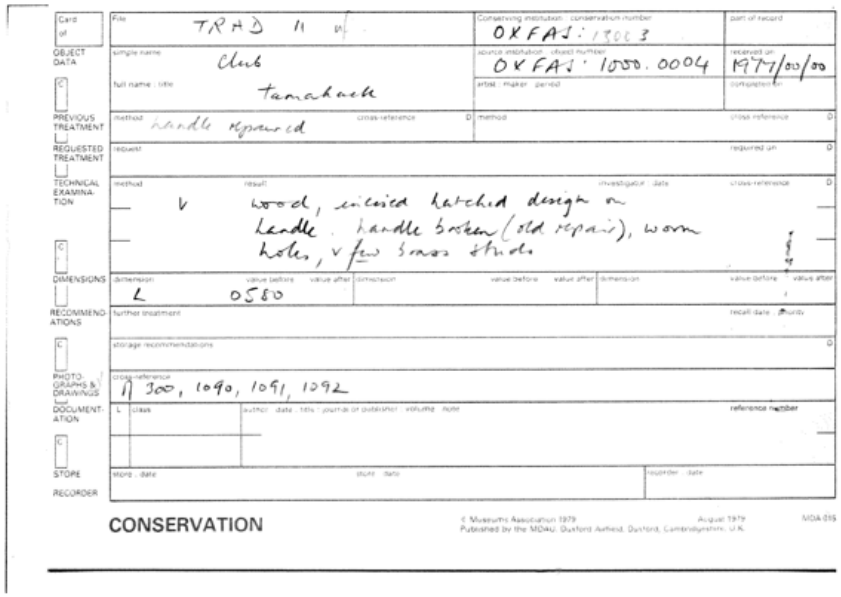
RECORDER

CONSERVATION

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Published by the MDAU, Quarford Airfield, Duxford, Cambridgeshire, U.K.


unit
material : condition
treatment : materials used
conservator : date ◇
wood : woodworm damage
brass :
whole
injected : Rentokil
filled : wax
polished : Duraglit
polished : Renaissance wax
1967/10/24
ACW 1977/10/12
MDA 015



Card of

File: TRAD II

Conserving institution : conservation number: OXFAS: 1803

part of record

OBJECT DATA

simple name: Club

source institution : object number: OXFAS: 1050.0004

received on: 1971/00/00

full name : title: Tomahawk

artist : maker : period

completed on

PREVIOUS TREATMENT

method: handle repaired — cross-reference

method — cross-reference

REQUESTED TREATMENT

request — required on

TECHNICAL EXAMINATION

method — result — investigator : date — cross-reference

V — wood, incised hatched design on handle. handle broken (old repair), worm holes, v few brass studs.

DIMENSIONS

dimension — value before : value after — conversion — value before : value after — dimension — value before : value after

L — 0580

RECOMMENDATIONS

further treatment — recall date : priority

storage recommendations

PHOTOGRAPHS & DRAWINGS

cross-reference: N 300, 1090, 1091, 1092

DOCUMENTATION

L — class — author : date : title : journal or publisher : volume : note — reference number

STORE

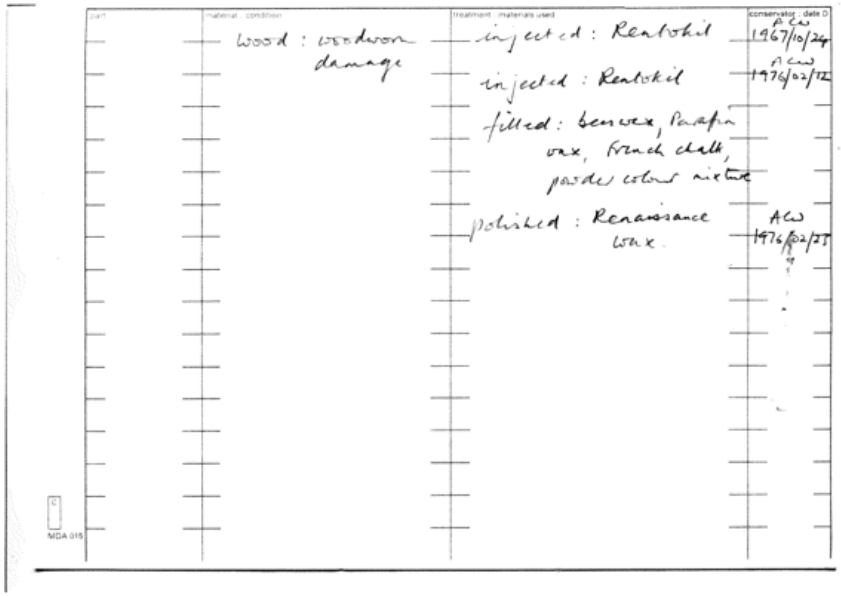
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RECORDER

CONSERVATION

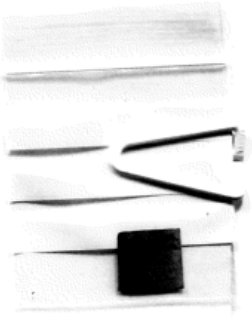
© Museums Association 1979 August 1979 MDA 015

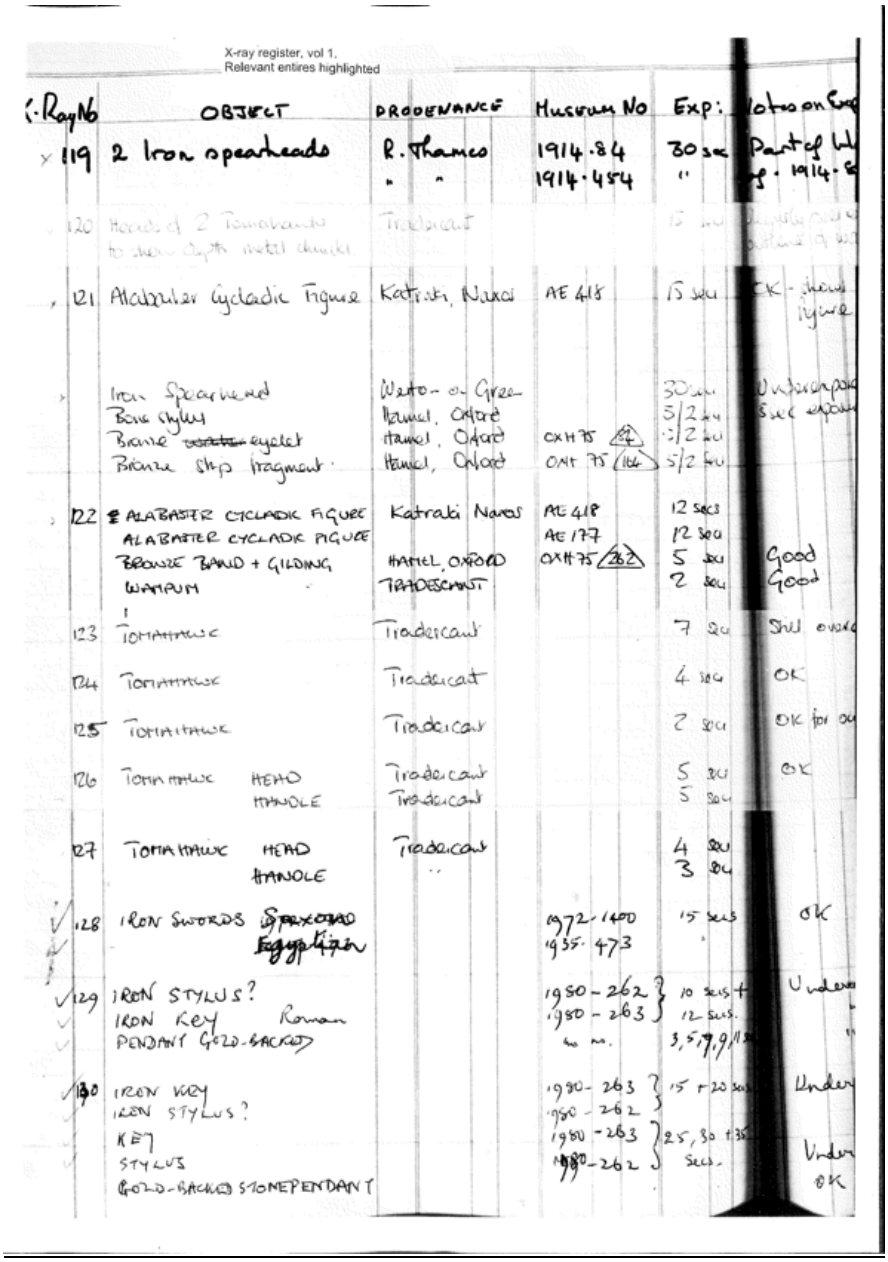
Published by the MDAU, Duxford Airfield, Duxford, Cambridgeshire, U.K.


part
material : condition
treatment : materials used
conservator : date D
wood : woodworm damage
injected : Rentokil
A C W 1967/10/24
injected : Rentokil
A C W 1976/02/12
filled : beeswax, Paraffin wax, French chalk, powder colour mixture
polished : Renaissance wax
A C W 1976/02/27
MDA 015

1685 B133 Trad 32

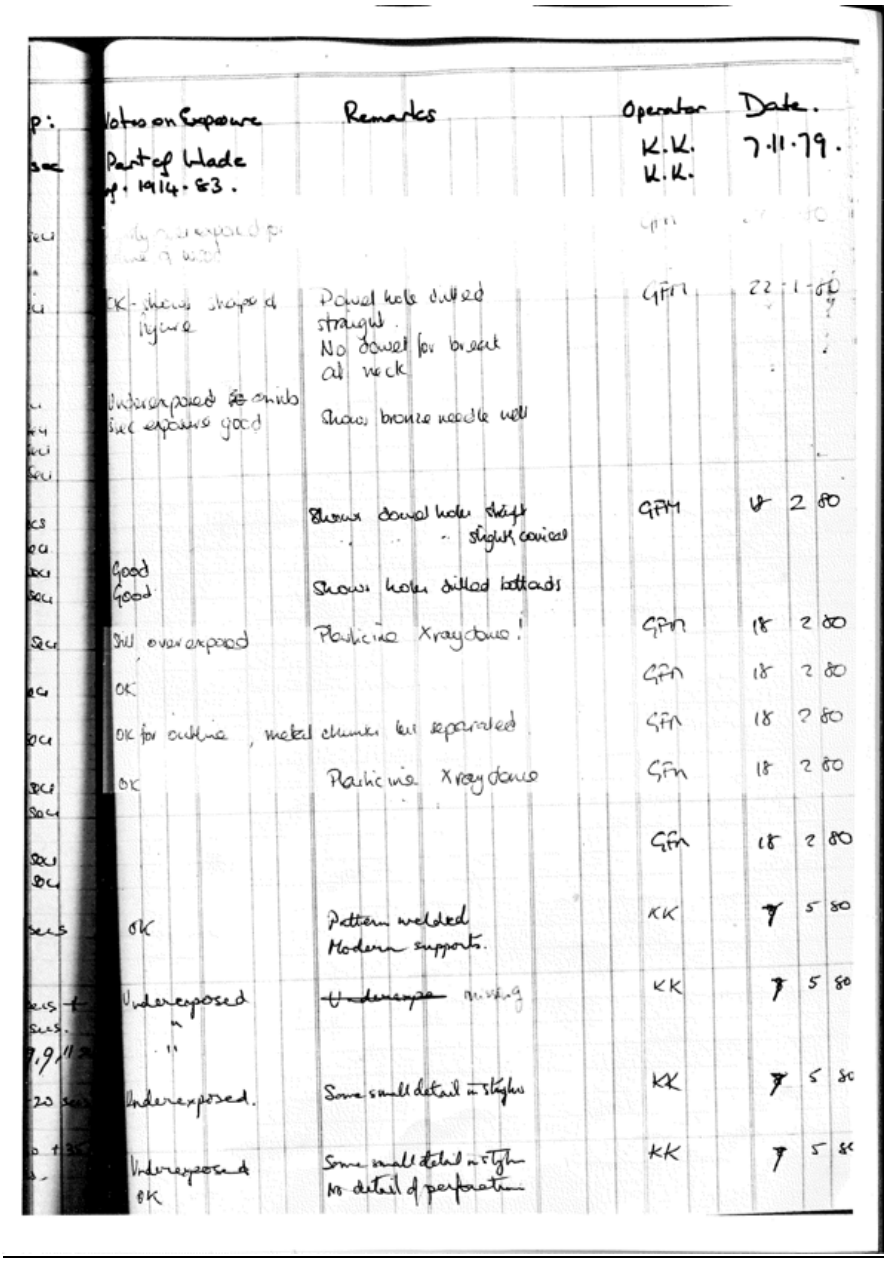
Wooden tomahawk with zig zag decoration





X-ray register, vol 1.
Relevant entires highlighted

X-Ray No	OBJECT	PROVENANCE	Museum No	Exp:	Notes on Exp
119	2 Iron spearheads	R. Thames	1914.84	30 sec	Part of lot
		" "	1914.454	"	of 1914.8
120	Heads of 2 Tomahawks to show depth metal chunks	Tradecraft		15 sec	Slightly over exposed
121	Archaic Cycladic Figure	Katraki, Naxos	AE 418	15 secs	OK - shows figure
	Iron Spearhead	Water-colour Green		30 sec	Underexposed
	Bone stylus	Hamel, Oxford		5/2 sec	Slight exposure
	Bronze ~~bracelet~~ eyelet	Hamel, Oxford	OXH 75 (4)	5/2 sec	
	Bronze strip fragment	Hamel, Oxford	OXH 75 (164)	5/2 sec	
122	ALABASTER CYCLADIC FIGURE	Katraki Naxos	AE 418	12 secs	
	ALABASTER CYCLADIC FIGURE		AE 177	12 secs	
	BRONZE BAND + GILDING	HAMEL, OXFORD	OXH 75 (262)	5 secs	Good
	WAMPUM	TRADESCANT		2 secs	Good
123	TOMAHAWK	Tradecraft		7 secs	Shell overexposed
124	TOMAHAWK	Tradecraft		4 secs	OK
125	TOMAHAWK	Tradecraft		2 secs	OK for outline
126	TOMAHAWK HEAD	Tradecraft		5 secs	OK
	HANDLE	Tradecraft		5 secs	
127	TOMAHAWK HEAD	Tradecraft		4 secs	
	HANDLE	"		3 secs	
128	IRON SWORDS ~~SPANISH~~ Egyptian		1972-1400	15 secs	OK
			1955.473		
129	IRON STYLUS?		1980-262	10 secs +	Underexposed
	IRON KEY Roman		1980-263	12 secs.	
	PENDANT GOLD-BACKED		4 no.	3,5,7,9,11 sec	
130	IRON KEY		1980-263	15 + 20 secs	Underexposed
	IRON STYLUS?		1980-262		
	KEY		1980-263	25, 30 + 35	Underexposed
	STYLUS		1980-262	secs.	OK
	GOLD-BACKED STONE PENDANT				



p:	Notes on Exposure	Remarks	Operator	Date.
sec	Part of blade p. 1914-53.		K.K. K.K.	7.11.79.
sec	~~Only one exposed for~~		GFM	
sec	OK - sheath shaped like	Dowel hole drilled straight. No dowel for break at neck	GFM	22 1 80
sec	Underexposed 30 mins but explains good	Shows bronze needle well		
sec		Shows dowel hole slight slight conical	GFM	4 2 80
sec	Good Good	Shows holes drilled latitude		
sec	Still overexposed	Plasticine X-ray done!	GFM	18 2 80
sec	OK		GFM	18 2 80
sec	OK for outline, metal chunks but separated		GFM	18 2 80
sec	OK	Plasticine X-ray done	GFM	18 2 80
sec			GFM	18 2 80
sec	OK	Pattern welded Modern supports.	KK	7 5 80
sec	Underexposed "	~~Underexpose~~ moving	KK	7 5 80
sec	Underexposed.	Some small detail in blade	KK	7 5 80
sec	Underexposed OK	Some small detail in blade No detail of perforation	KK	7 5 80

A2 - List of eastern North American 17-18th century ball-headed clubs and representations in collections

1. *Ball-headed club* [Southern New England] (< 1656): Ashmolean Museum, Oxford (Tradescant Collection / cat.no. AN1685.B.133).
    1. Copper/brass inlays on body/head
        1. (Bushnell, 1907) p.97-98, pl.G Fig.1 photograph (club B)
        2. (MacGregor, 1983) p.110-115, Fig.2 black/white illustration
        3. (Peterson, 1965) p.85-6, photograph (club 1)

2. *Ball-headed club* [Southern New England] (< 1656): Ashmolean Museum, Oxford (Tradescant Collection / cat.no. AN1685.B.134).
    1. Incised triangles on hilt
        1. (Bushnell, 1907) p.97-98, pl.G Fig.1 photograph (club A)
        2. (MacGregor, 1983) p.110-115, Fig.3 black/white illustration

3. *Ball-headed club* [northeast] (< 1656): Ashmolean Museum, Oxford (Tradescant Collection / cat.no. AN1685.B.135).
    1. Carving of snake head holding ball
        1. (Bushnell, 1907) p.97-98, pl.G Fig.1 photograph (club C)
        2. (MacGregor, 1983) p.110-115, Fig.4 black/white illustration

4. *Ball-headed club* [Delaware] (~1676 < 1710), Skoklosters Castle, Balsta (cat.no. 6904)

    1. Head carved as face, handle as foot, lizard/snake on ball, wampum inlays, organized copper “wire” inlays
        1. (Rydén, 1963) p.114-115, Fig.7a-b black/white illustration
        2. (Harrison, 1987) p.46 Fig.44, 2 photographs
        3. (Becker, 1990) p.24 Fig.1 black/white illustrations, whole object and details

5. *Ball-headed club* [Delaware] (~1676 < 1710), Skoklosters Castle, Balsta (cat.no. 6906)
    1. Undecorated apart for organized copper “wire” inlays
        1. (Rydén, 1963) mentioned
        2. (Williams and New Jersey State Museum, 1988) p.57 Fig.131 black/white illustration
        3. (Becker, 1990) p.24 Fig.2 black/white illustrations, whole object and details

6. *Ball-headed club* [Delaware] (~1676) Ethnographical Museum of Sweden, Stockholm (cat.no. 1889.04.3827)
    1. Head carved as face, handle as foot, lizard/snake on ball
        1. (Rydén, 1963) p.115-116, Fig.8a-b black/white illustration
        2. (Linné, 1955) p.85-86, Fig.c five photographs from various angles

7. *Ball-headed club* [northeasts, Iroquois] (< 1737), National Museum of Denmark, Copenhagen (cat.no. Gb8)

    1. Face carved ball, foot carved handle, lizard/snake on ball, black/red paint
        1. (Birket-Smith, 1920) p. 155-159, pl.2 Fig.2 black/white illustration
        2. (Sturtevant, 1974) p.120, photograph (left)

8. *War Club* [Chippewa / Northern Great Lakes] (c. 1775), Museum of American Indian, Washington (Heye Foundation / cat.no. 1/9638)
    1. Animal head and engraved decorations
        1. (Hodge, 1973) p.103 photograph

9. *Ball-headed war club* [Wampanoag / Massachusetts] (c. 1675), Fruitlands Museum, Harvard (cat.no. FM-1-OL)
    1. Maple wood with inlaid white and purple wampum
        1. (Sturtevant and Trigger, 1978) p.171, Fig.6 photograph

10. *Ball headed club* [New York] (< 1681), National Museum of Ethnology, Leiden, (cat.no. 360-1579)
    1. Undecorated wooden club
        1. (Bushnell, 1908) black/white illustration

11. *Ball headed club* [northeast] (< 1753), Horniman Museum, London (cat.no. 27.4.61/35)
    1. Inlaid with shell and furniture tacks (?), hilt carved as animal head
        1. (Feest, 1980) p. 55 2 photographs (whole object and hilt)

12. *Ball headed club* [Quebec, Iroquois] (~ 1606 < 1675), Bibliothèque Sainte-Geneviève, Paris, (cat.no. 1943.128)
    1. Wooden clubs with wampum inlays along ridge, traces of paint
        1. (Boisard et al., 1989) p.79, Fig. 67 photograph
        2. (Béguin and Béguin, 1984) p.104 Fig.37 photograph
        3. (Harrison, 1987) p.46 Fig.43 2 photographs

13. *Four Indian Kings painted by Jan Verelst - Etow Oh Koam* [northeast, Mahican] (c.1710), National Archives of Canada (cat. no. C-092421)
    1. Painting depicting undecorated wooden ball-headed club
        1. (Sturtevant, 1974) p. 127 photograph (right)

14. *Le cabinet de la bibliothèque de Sainte-Genève par Etinger* [Canada] (c. 1688), Bibliothèque Sainte-Geneviève, Paris
    1. Engraving depicting incised ball-headed club with wampum inlays (item 12)
        1. (Béguin and Béguin, 1984) p.104 Fig. 40 photograph

15. *Iroquois allant à la découverte by J. Grasset St. Sauveur* [Canada] (1787), New York Historical Society, New York
    1. Colored drawing of painted ball-headed club inlaid with furniture tacks, based on 1666 French documents from Archives Nationales, Paris
        1. (Sturtevant, 1974) p.120 (left)

A3 – Maps of 17th century northeast depicting indigenous lands and colonial occupations



Figure A3-1. Map of Virginia dated 1624, showing Powhatan land occupation. Orientation North to the right. (Smith and Hole, 1624)



Figure A3-2. Map of indigenous tribes in North America between 1600 and 1800 (Gallatin, 1836)

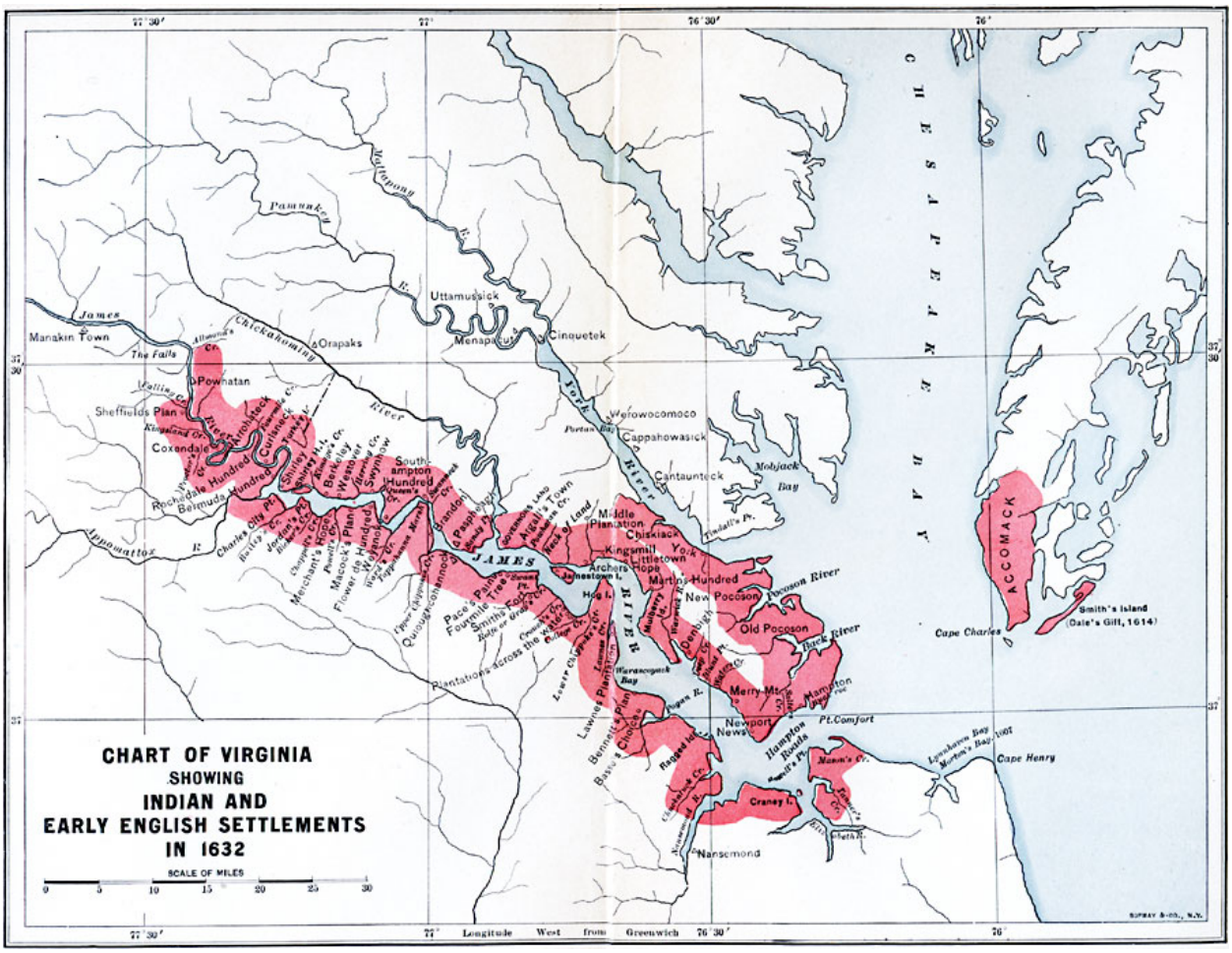


Figure A3-3. Chart of early Virginia (Hart, 1906)

A4 - Wood blanks spectra

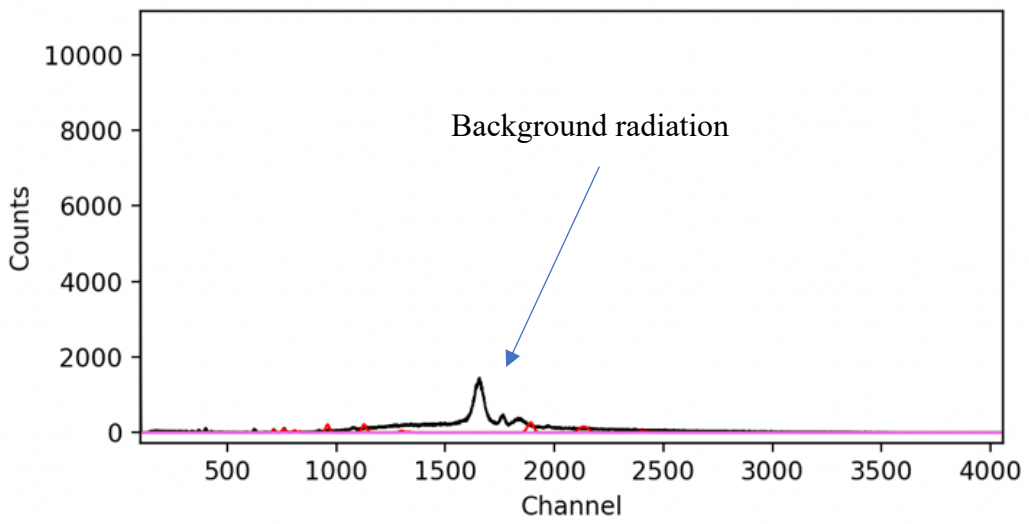


Figure A4-1. XRF of wood from the hilt of B.133

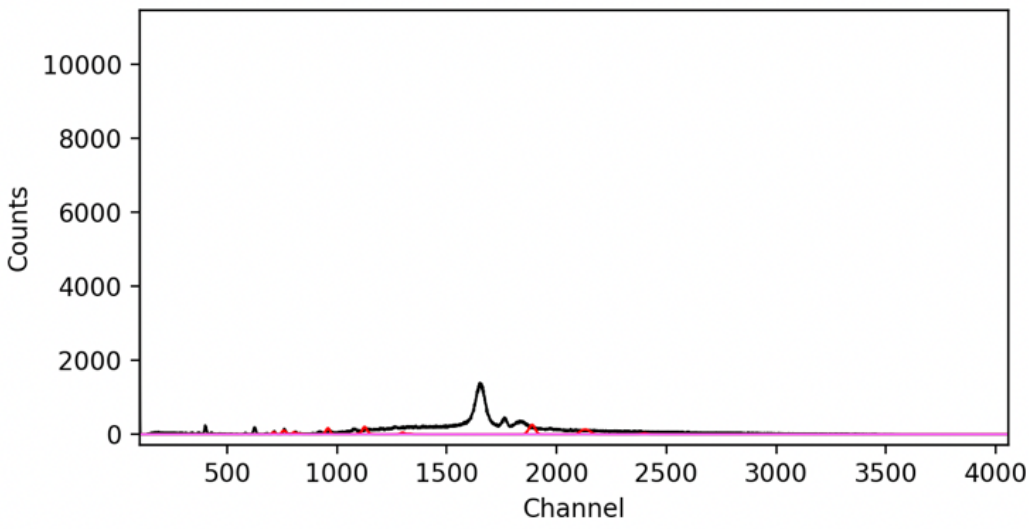


Figure A4-2. XRF of wood from the head of B.133

A5 – Tabulated experimental data

Sample	Ni	Cu	Zn	As	Ag	Sn	Pb	Item	Segment
1AC1	BD	89.81003	BD	0.769738	BD	BD	0.525943	Club B.133	Body B.133
1AC10	BD	89.86457	BD	0.710384	BD	BD	0.532839	Club B.133	Body B.133
1AC11	BD	89.96182	BD	0.680563	BD	BD	BD	Club B.133	Body B.133
1AC12	BD	90.14506	BD	BD	BD	BD	0.870045	Club B.133	Body B.133
1AC13	BD	89.84279	BD	0.786264	BD	BD	0.505853	Club B.133	Body B.133
1AC14	BD	90.09315	BD	0.631891	BD	BD	0.502748	Club B.133	Body B.133
1AC15	BD	90.10176	BD	0.598282	BD	BD	BD	Club B.133	Body B.133
1AC16	BD	89.97744	BD	0.661085	BD	BD	0.514465	Club B.133	Body B.133
1AC17	0.42636	62.70455	32.30708	BD	BD	BD	1.591923	Club B.133	Body B.133
1AC18	0.457208	61.97508	32.58648	BD	BD	BD	2.202238	Club B.133	Body B.133
1AC19	BD	63.32996	31.94501	BD	BD	BD	1.552636	Club B.133	Body B.133
1AC2	BD	89.97003	BD	0.65136	BD	BD	0.516846	Club B.133	Body B.133
1AC20	0.441071	62.03123	32.41087	BD	BD	BD	2.288396	Club B.133	Body B.133
1AC21	0.47102	62.34758	32.34212	BD	BD	BD	1.991152	Club B.133	Body B.133
1AC22	0.443704	61.91265	32.47075	BD	BD	BD	2.410977	Club B.133	Body B.133
1AC23	0.462173	61.63896	32.87695	BD	BD	BD	2.323035	Club B.133	Body B.133
1AC24	0.456702	61.61677	32.97792	BD	BD	BD	2.223488	Club B.133	Body B.133
1AC25	0.448808	62.25399	32.40619	BD	BD	BD	1.912421	Club B.133	Body B.133
1AC26	0.452988	62.12158	32.6593	BD	BD	0.526555	1.888276	Club B.133	Body B.133
1AC27	0.463088	61.5614	33.12003	BD	BD	BD	2.073855	Club B.133	Body B.133
1AC28	0.469206	61.9869	33.01074	BD	BD	BD	1.685319	Club B.133	Body B.133
1AC3	BD	90.05755	BD	0.648855	BD	BD	0.503645	Club B.133	Body B.133
1AC4	BD	90.08897	BD	0.566326	BD	BD	0.530362	Club B.133	Body B.133
1AC5	BD	90.02804	BD	0.638694	BD	BD	0.503766	Club B.133	Body B.133
1AC6	BD	89.70474	BD	0.719407	BD	BD	0.602271	Club B.133	Body B.133
1AC7	BD	90.04684	BD	0.599681	BD	BD	0.525702	Club B.133	Body B.133

1AC8	0.341036	88.49498	BD	0.579624	1.343038	1.677266	1.661638	Club B.133	Body B.133
1AC9	BD	90.03254	BD	0.645059	BD	BD	0.505828	Club B.133	Body B.133
1AC29	0.454259	62.12396	32.78127	BD	BD	BD	1.806692	Club B.133	Body B.133
1AC30	0.472142	62.40861	32.40171	BD	BD	BD	1.707694	Club B.133	Body B.133
1AC31	0.465306	61.53459	32.84794	BD	BD	BD	2.516443	Club B.133	Body B.133
1AC32	0.322783	76.37954	15.87747	BD	BD	3.353895	1.259934	Club B.133	Body B.133
1AC33	0.316574	76.92771	15.48818	BD	BD	3.20239	1.13969	Club B.133	Body B.133
1AC34	0.325929	76.7128	15.75753	BD	BD	3.391258	1.129733	Club B.133	Body B.133
1AC35	0.310995	77.22332	15.19309	BD	BD	3.240403	1.07387	Club B.133	Body B.133
1AC36	0.33814	75.44452	17.35715	BD	BD	3.298096	1.034084	Club B.133	Body B.133
1AC37	0.319686	76.24795	16.18869	BD	BD	3.27165	1.158932	Club B.133	Body B.133
1AC38	0.323886	76.16056	16.42422	BD	BD	3.383141	1.05739	Club B.133	Body B.133
1AC39	0.336173	75.89199	16.64433	BD	BD	3.308712	1.115919	Club B.133	Body B.133
1AC40	0.325023	76.24737	16.25148	BD	BD	2.808024	1.135147	Club B.133	Body B.133
1AC41	0.305637	77.3844	15.19731	BD	BD	3.208309	0.994841	Club B.133	Body B.133
1AC42	0.340118	76.31531	15.76938	BD	0.600788	3.90091	1.554992	Club B.133	Body B.133
1AC43	0.331035	75.91935	16.66199	BD	BD	3.343195	1.100454	Club B.133	Body B.133
1AC45	0.316325	77.14902	15.13738	BD	BD	3.335042	1.144264	Club B.133	Body B.133
1AC46	0.301999	77.41419	15.02707	BD	BD	3.330506	1.074132	Club B.133	Body B.133
1AC47	0.294339	77.28308	15.26906	BD	BD	3.05833	1.060657	Club B.133	Body B.133
1AC48	0.32656	76.17021	16.31591	BD	BD	3.37024	1.150991	Club B.133	Body B.133
1AC49	BD	90.4273	BD	BD	BD	BD	0.580109	Club B.133	Body B.133
1AC50	BD	90.48237	BD	BD	BD	BD	0.571256	Club B.133	Body B.133
1AC51	BD	90.30707	BD	BD	BD	BD	0.627751	Club B.133	Body B.133
1AC52	BD	90.34045	BD	BD	BD	BD	0.590427	Club B.133	Body B.133
1AC53	BD	90.5061	BD	BD	BD	BD	0.568027	Club B.133	Body B.133
1AC54	BD	90.50874	BD	BD	BD	BD	0.560777	Club B.133	Body B.133
1AC55	BD	90.3435	BD	BD	BD	BD	0.597486	Club B.133	Body B.133
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1AC58	BD	90.45204	BD	BD	BD	BD	0.575569	Club B.133	Body B.133
1AC59	BD	89.39829	BD	BD	BD	0.551059	1.135458	Club B.133	Body B.133
1AC60	BD	90.49711	BD	BD	BD	BD	0.566131	Club B.133	Body B.133
1AC61	BD	90.50542	BD	BD	BD	BD	0.537554	Club B.133	Body B.133
1AC62	BD	90.48728	BD	BD	BD	BD	0.563886	Club B.133	Body B.133
1AH10	0.462359	64.37851	31.44212	BD	BD	BD	0.72825	Club B.133	Head B.133
1AH11	0.506262	63.63394	31.51594	BD	0.643655	0.826066	1.237994	Club B.133	Head B.133
1AH12	0.290864	81.33123	10.31681	BD	BD	3.328169	0.914669	Club B.133	Head B.133
1AH13	0.323529	80.45463	11.37115	BD	BD	3.626985	0.895722	Club B.133	Head B.133
1AH2	BD	83.74513	8.401217	BD	BD	4.67917	0.702842	Club B.133	Head B.133
1AH3	0.308145	80.14806	11.58401	BD	BD	3.212009	1.078713	Club B.133	Head B.133
1AH4	0.311418	81.18764	10.55644	BD	BD	4.04872	0.866202	Club B.133	Head B.133
1AH5	BD	90.81655	BD	BD	BD	BD	0.607386	Club B.133	Head B.133
1AH6	0.340142	80.11409	11.5306	BD	BD	3.703629	1.041278	Club B.133	Head B.133
1AH7	BD	90.29278	BD	BD	BD	BD	0.59289	Club B.133	Head B.133
1AH8	0.505277	63.67113	31.68802	BD	BD	BD	0.969773	Club B.133	Head B.133
1AH9	0.468104	63.81329	31.77033	BD	BD	BD	0.90532	Club B.133	Head B.133
1BH1	BD	90.26103	BD	BD	BD	BD	0.768789	Club B.133	Head B.133
1BH10	0.383763	72.08388	22.13143	BD	BD	1.621269	0.695668	Club B.133	Head B.133
1BH11	0.296793	81.02434	11.10082	BD	BD	3.520346	0.781128	Club B.133	Head B.133
1BH12	0.310676	79.9034	11.45711	BD	0.796032	4.747601	1.440923	Club B.133	Head B.133
1BH2	0.580143	61.68753	32.54709	BD	0.649817	0.822068	2.879391	Club B.133	Head B.133
1BH3	BD	90.3701	BD	BD	BD	BD	0.799115	Club B.133	Head B.133
1BH4	0.311226	81.32124	10.50432	BD	BD	3.233718	0.79703	Club B.133	Head B.133
1BH5	0.358275	79.41835	12.03198	BD	0.561922	4.090963	1.2584	Club B.133	Head B.133
1BH6	0.393313	78.48652	12.03725	0.505572	1.351226	6.186103	2.613308	Club B.133	Head B.133
1BH7	0.388467	79.56058	11.71459	BD	0.92711	4.158412	1.466211	Club B.133	Head B.133
1BH8	0.360839	79.55421	11.76961	BD	0.588319	3.784589	1.27823	Club B.133	Head B.133
1BH9	0.296771	81.74959	9.983331	BD	BD	3.392026	0.818434	Club B.133	Head B.133
1CH1	0.42141	80.41979	10.86471	BD	1.964931	5.10004	1.57738	Club B.133	Head B.133

1CH2	0.447691	63.65581	31.49498	BD	1.100675	1.310928	1.438144	Club B.133	Head B.133
2AB1	BD	90.64852	BD	BD	BD	BD	0.683558	Club B.135	Body B.135
2AH1	0.323074	89.2957	BD	BD	2.08612	2.60606	2.047288	Club B.135	Head B.135
2AH2	BD	90.33355	BD	BD	BD	BD	0.795196	Club B.135	Head B.135
2AH3	BD	89.8709	BD	BD	BD	BD	1.121547	Club B.135	Head B.135
2AH4	BD	90.38872	BD	BD	0.812175	1.076304	0.788655	Club B.135	Head B.135
2BC6	0.319369	89.40905	BD	BD	2.000585	2.286491	1.893144	Club B.135	Body B.135
2BH1	BD	90.8473	BD	BD	BD	BD	0.521645	Club B.135	Head B.135
2CB1	0.277346	88.82809	BD	BD	1.376631	1.465682	3.227929	Club B.135	Body B.135
2CB2	BD	90.56818	BD	BD	BD	0.545295	0.681069	Club B.135	Body B.135
2CB3	BD	90.64955	BD	BD	BD	BD	0.62875	Club B.135	Body B.135
2CB4	BD	90.66145	BD	BD	BD	0.668257	0.661593	Club B.135	Body B.135
2CB5	0.298483	89.73443	BD	BD	1.568097	1.915395	1.532712	Club B.135	Body B.135
2DH1	BD	90.63568	BD	BD	0.505866	0.670153	0.627704	Club B.135	Head B.135
1AH15	0.381723	64.79297	31.08191	BD	BD	1.231261	0.721965	Club B.133	Head B.133
1BH14	0.350538	80.23068	11.22077	BD	0.823723	5.054411	1.201596	Club B.133	Head B.133
1CH10	0.311723	80.67679	11.07343	BD	BD	4.567024	0.902337	Club B.133	Head B.133
1CH11	0.517863	64.42731	30.64601	BD	0.838381	1.329788	1.115239	Club B.133	Head B.133
1CH3	0.557369	62.83869	32.14306	BD	1.489511	2.237362	1.506505	Club B.133	Head B.133
1CH4	0.579789	61.48511	32.99357	BD	2.371528	3.350567	2.831494	Club B.133	Head B.133
1CH5	0.542791	61.49482	33.56048	BD	1.443145	2.166408	1.745917	Club B.133	Head B.133
1CH8	0.32204	80.03044	11.48508	BD	0.636638	6.915622	1.100938	Club B.133	Head B.133
1CH9	0.291328	86.64962	4.491503	BD	0.928284	1.405338	0.90967	Club B.133	Head B.133
1DH1	0.294421	81.22891	10.42368	BD	BD	4.656916	0.915443	Club B.133	Head B.133
1DH3	0.307436	81.02972	11.02333	BD	BD	4.619879	0.747351	Club B.133	Head B.133
1DH4	0.378668	64.65491	31.19612	BD	BD	1.285443	0.750063	Club B.133	Head B.133
1DH6	0.495631	64.02703	31.4585	BD	0.54588	0.952692	0.900959	Club B.133	Head B.133
1DH7	0.387964	66.40131	28.62352	BD	0.685567	1.842228	1.036039	Club B.133	Head B.133