Mesolithic woodworking, experimental archaeology & underwater heritage in Hampshire and the Isle of Wight (UK)

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Introduction

Presenting underwater archaeology to the public can be a challenge due to the isolated and somewhat exclusive nature of this work, despite popular interest in it. When the underwater heritage in question is a submerged Mesolithic landscape, it suddenly becomes even more inaccessible. Without contemporaneous textual references, human remains, monumental architecture, or many of the other qualities that can glamorize archaeology, one way to engage the public is through experimental archaeology. In the case of the current project on Mesolithic woodworking and the site of Bouldnor Cliff, incorporating the public into the experiments also served a scientific purpose in addition to addressing the knowledge gap.

This pilot woodworking project was formulated as a result of questions remaining after excavations and monitoring at the submerged landscape at Bouldnor Cliff (Figure 1), which produced an array of worked wood (Momber et al. 2011, 84-97). The site is situated at ~12m below the surface of the Solent, the strait separating the south coast of Britain from the Isle of Wight. Beneath the layer of peat, exceptionally well-preserved plant matter, including hazelnuts, tree stumps, leaves, sticks, and worked wood, in addition to worked flints, can be found readily. For site II on the eastern side of the cliff, radiocarbon dates have provided a *terminus ante quem* of 6020-5980 cal BC (95%), with inundation occurring shortly after 5990-5890 cal BC. Radiocarbon and wiggle-matching of woody material from site V, on the western side, have provided a *terminus post quem* of 6150-6110 cal BC (Momber et al. 2011, 59-61, 74-75, 93, 102-104). Taken together, Bouldnor Cliff can be estimated to have been occupied ca. 8100-8200 yBP.

The conversion methods of the wood and flint assemblages indicate technologies roughly 2000 in advance of those attested elsewhere in the UK (Momber et al. 2011, 85-89, 140). These observations were corroborated by recent DNA analyses of sealed sediment samples from the site which indicate the presence of wheat 2000 years before it is known elsewhere on the British Isles and 400 years before known in the neighboring continental regions (Smith et al. 2015). One of the most impressive pieces of worked wood was a tangentially split timber, estimated to have been removed from an oak tree >750 mm in diameter (Momber et al. 2011, 86). One reason for doing this would have been to construct a logboat (Momber et al. 2011, 89), and other aspects of the site could be interpreted to support a hypothesis of logboat construction (Momber et al. 2011, 175; cf. Andersen 2013, 200, fig. 3.109). At this time, Britain was in the process of becoming an island as melting polar icecaps raised sea levels worldwide. In the areas of Hampshire and Wight in southern Britain, pine-dominated boreal forests were replaced with deciduous oak-dominated marshlands better suited to the warming trend and inundation of low-lying areas. Over a relatively short period of time, the region changed from riverine to estuarine to marine (Momber & Rich 2015). During this period of climatic and geological transition, the wetter environment would have made waterborne transit an essential part of human existence. Logboats would not only have been widely constructed, but given the amount of work required for their construction (see below), they would have been continually adapted to suit the needs of navigating the rapidly changing waters. Furthermore, the precocious dates for industrial development at Bouldnor Cliff, and the lack of similar evidence in the proximity, imply a strong connection with the Mediterranean, where seafaring has been underway since the Paleolithic (e.g., Strasser et al. 2010; Ferentinos et al. 2012; Simmons 2014).

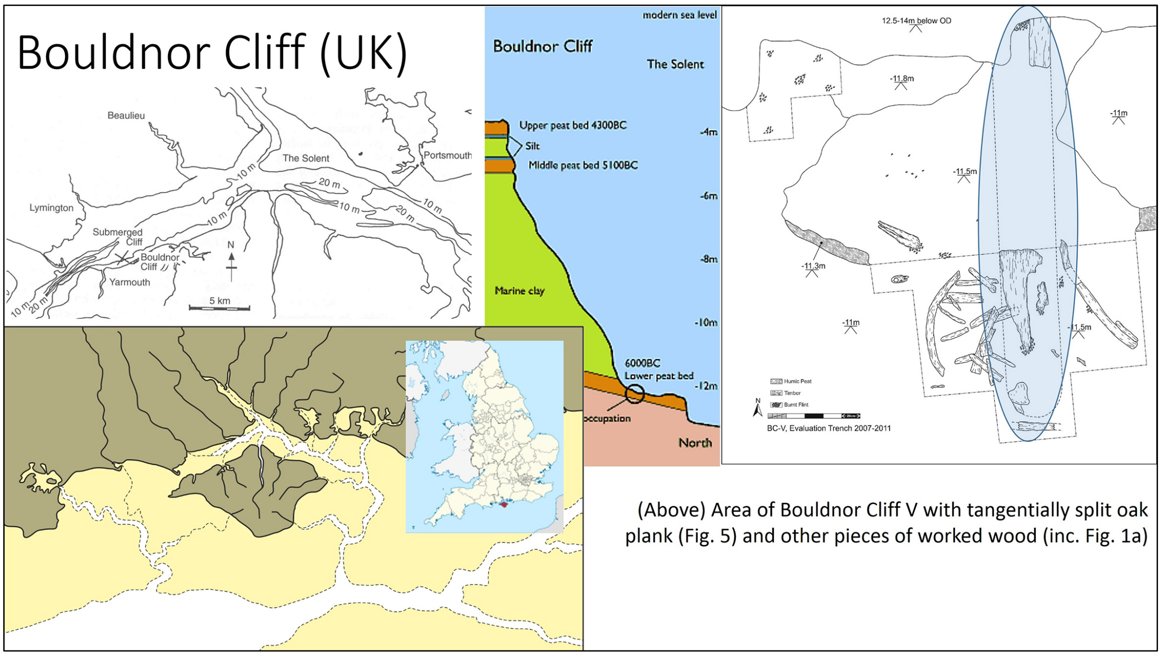

Figure 1. Locational details of Bouldner Cliff site, and plan showing worked wood.

Much of the wood collected from Bouldnor Cliff bears tool marks that do not appear to have been made by stone tools. Much of the other wood was collected in the form of chips or debitage. Given the samples' ambiguity and the lack of comparative datasets on either tool marks or Mesolithic worked wood, an experimental project assessing tool marks on tangentially split wood using non-stone tools was developed to address the feasibility of instruments, techniques, and the logboat hypothesis. The project aims included the following:

1) to help determine conversion processes and production techniques, especially in relation to the assessment of worked timbers and xylic debitage found at Bouldnor Cliff;
2) to raise public awareness of past phases of global warming, and of Britain's prehistoric heritage found underwater and the risks to its integrity;
3) to determine how wood chips produced would change depending on the nature of the woodworker (gender, age, size, etc.) and tools used.
4) to develop knowledge of the effects of woodworking on the tools themselves: tensile breaks vs. and butcher's marks that would alter the interpretation of a bone's original function;
5) to situate the results within the wider corpus of existing Mesolithic archaeological wood artefacts and associated tool marks (aided by recording tool marks with RTI (Reflectance Transformation Imaging)), and;
6) to analyse processes used in woodworking to help facilitate 'reverse engineering' of parent trees;

The present paper will address the first three aims, while the latter three will be discussed in a forthcoming paper.

Assessment of the waterlogged wood

At the time of publication of the Bouldnor Cliff monograph, seven pieces of modified wood had been lifted and recorded in detail, and a wood expert had examined and characterized dozens more (Momber et al. 2011, 177-178). Since then however, others have been lifted from the site, which is currently experiencing rapid erosion from tidal currents that threatens the survival of the archaeological material. In the most recent phase of timber assessment, the primary research question was one of 'ecofact or artefact', which was a somewhat subjective procedure as, despite the superior quality of preservation, having been waterlogged for 8000 years and subjected to occasions of erosion and compression can complicate visual assessment. Since removal from the site, timbers and fragments have been stored at 4°C at the British Ocean Sediment Core Research Facility (BOSCORF) repository of the National Oceanography Centre (Southampton). They were individually measured and photographed and inspected for the following features:

1. biological or stress damage, including erosion, compression, fractures, fragility, post-excavation fungal attacks or breakage, and *in situ* boring from piddock (*Pholas dactylus*) and gribble (*Limnoria lignorum*);
2. evidence of tool marks (as opposed to breakage resulting from biogenic degradation), shaping, reuse;
3. from which tree part the wood originated and how it was converted;
4. growth rings (when possible) to estimate size and growth pattern of the original tree and the extent of conversion;
5. prioritization for further study based on level of contemporaneous human manipulation.

These inspections, and consideration of the pieces' *in situ* placement, led to the conclusion that within the most recent additions to the assemblage, consisting of 43 samples or groups of samples, 23.3% demonstrated clear signs of being artefacts (Figure 2a-d), while 37.2% have no visible evidence of having been manipulated by humans and are therefore identified as ecofacts (Figure 3), leaving 39.5% as ambiguous (Figure 4). Figure 2a has tell-tale signs of having been a large hollowed section of roundwood, which could suggest boatbuilding and compares favorably with the stern section of the linden (*Tilia* sp.) logboat found at the Late Mesolithic site of Møllegabet (Skaarup & Grøn 2004, 35, fig. Iva.a.2) but which postdates the Bouldnor Cliff timber by around 1000 years. The forked poles (Figure 2b) are also reminiscent of those found in conjunction with the Tybrind Vig logboat, dating 2000 years later than Bouldnor Cliff, that were suggested as having been used as punts for navigating over soft sediments (Andersen 2013, 122-123).

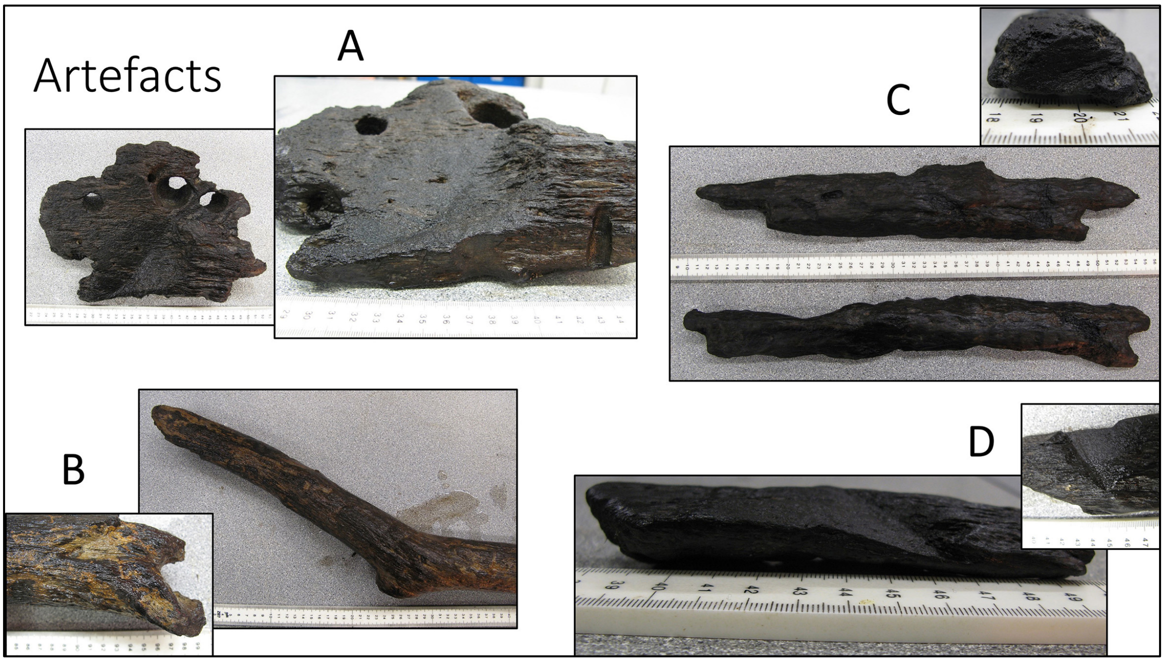

Figure 2. Wooded wood from Bouldner Cliff.

While the Danish sites offer comparisons that post-date Bouldnor Cliff, in the UK Star Carr pre-dates our site by roughly 3000 years, placing it in the Early Mesolithic. Star Carr is known for Britain's first house, as well as the area's earliest carpentry, but it also provides a possible function for the timbers shown in Figure 2c, which feature planks rounded on one side. Star Carr was located on a lakefront, and a 30m long wooden platform had been constructed around the lake edge. After being split, most of the boards were lain into the peat with the round sides facing down and the flat sides facing up to form a walkable platform, which has been interpreted as a dock for boats navigating the lake (Conneller et al. 2012, 1007-1012). The Bouldnor Cliff examples could conceivably have had a similar function; even though they are narrower than those at

Star Carr, they are wide enough to have served as a footpath. Another plank has clear tool marks and is flat on both sides (Figure 2d).

Figure 2. Wood from Bouldner Cliff with no evidence of working.

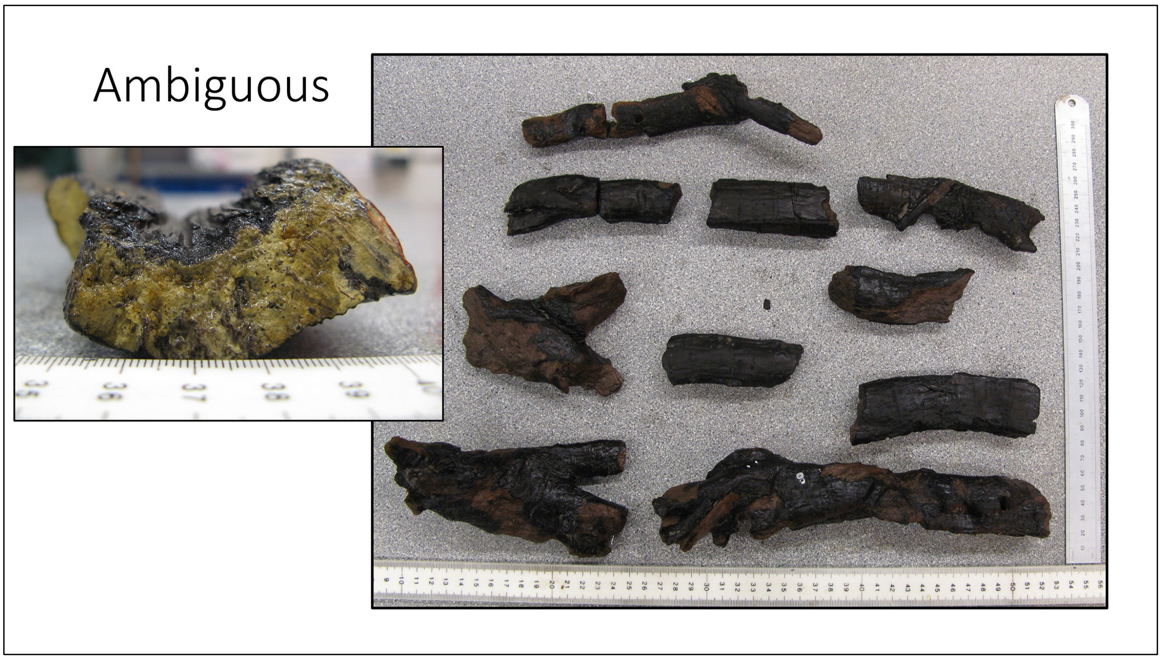

Figure 3. Ambiguous examples of wood from Bouldner Cliff.

Ecofact/Artefact

Even with these contextual comparisons and evidence, what makes any precise interpretation of the Bouldnor Cliff timbers so difficult is that any site interpretation is dependent upon object interpretation and objects are rarely precise as to their histories or intended use, or their inter-relationships. Water only further obfuscates these by washing away fine detail, camouflaging nuances, and continuing to be a conduit for tissue damage long after timbers have been removed from their primary underwater deposit.

Another issue in distinguishing artefact from ecofact is reuse; i.e., it is possible for a timber to be both? Especially in the cases of storms, parasites, or beavers, wood could be worked by any of these forces as well as by humans, resulting in a kind of multiple authorship. Trees blown over by the wind, split by lightning, weakened by fungal attacks, and undermined by *Castor fiber*, all would have been especially appealing to scavenging humans seeking the perfect timber for a logboat or other construction projects. These kinds of reuse have direct bearing on studies of the origins of human technology as well as object classification. Cases like these, documented in the prehistoric archaeological record (e.g. Schild et al. 2003, 152, fig. 21.5; Coles 2006), make such categories as ecofact and artefact seem somewhat arbitrary or oversimplified. It would be of great interest to see how, instead of winnowing all possible shaping forces for the single anthropogenic one, to instead see how the myriad and dynamic shaping forces interact with each other to form the archaeological object. In the meantime, in terms of assessing waterlogged timbers from sites of known archaeological, ecological, and geological interest such as at Bouldnor Cliff, we can be confident that the difference between rodent teeth and Mesolithic axes can be detected (Coles & Orme 1983, pl. XVIII). However, other questions, such as those of tool marks, who made them and how, can be addressed through experimental archaeology.

Experimental archaeology and underwater heritage

A persistent question in discussions surrounding logboat construction is over the use of fire as a hollowing tool. At Bouldnor Cliff, there are many burnt flints, pieces of charred wood and charcoal deposits, and the tangentially split oak plank was charred on the downward-facing side (Figure 5). Besides a hollowing tool, intentional charring could have been performed to protect wood from rot, parasites, and ironically, even fire (à la the Japanese wood treating method, *shou-sugi-ban* or *yakisugi*) (Akizuki et al. 2001). Fire was also used onboard, as in the case of the Tybrind Vig logboat, which featured a hearth in the stern that left the wood charred (Andersen 2013, 189). However, for attested logboat construction sites, charring does not appear in the archaeological record, or if so, only tenuously. Tybrind Vig excavators have concluded that if fire was used to hollow out the massive lime logs, it was used at an early stage and evidence was removed by the use of axes and adzes afterwards (Andersen 2013, 185).

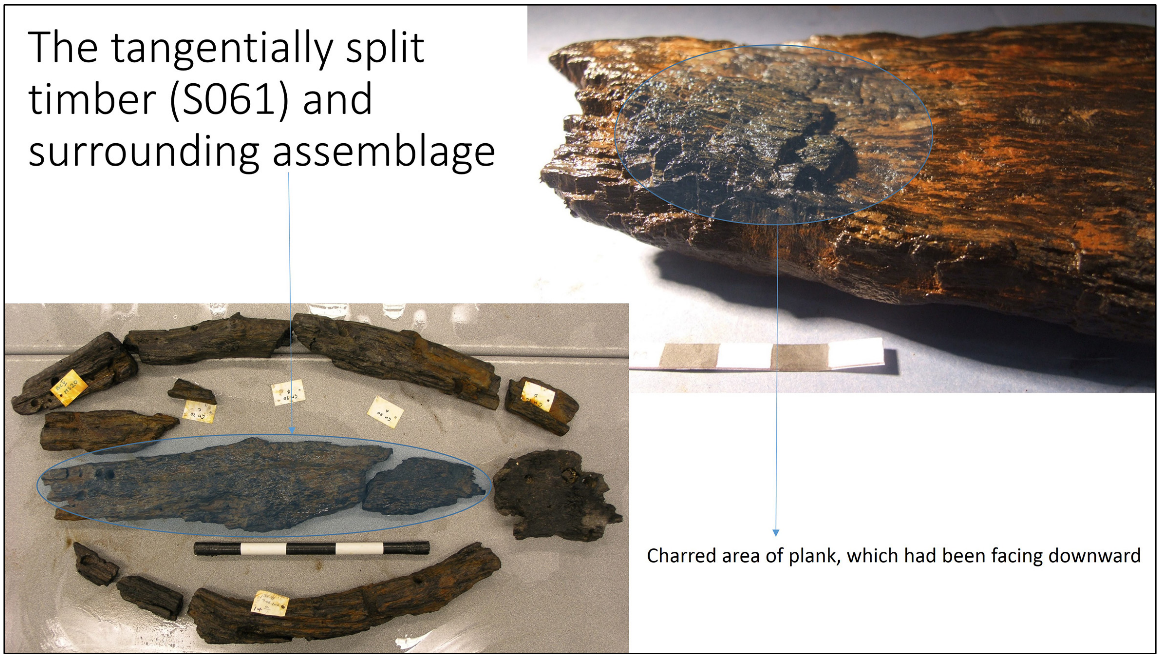

Figure 5. Tangentially split timber from Bouldner Cliff showing area of charring.

In 2013 and 2014, Butser Ancient Farm experimental hosted two logboat construction projects: *The Prometheus* and *The Eurybia* (Watts 2014a, b). *The Prometheus* determined, along with what was supposed at Tybrind Vig, that fire could be used to hollow a seasoned oak log without leaving archaeological evidence. *The Eurybia*, on the other hand, found that fire was ineffective in hollowing a green pine log, but that wooden wedges were effective in removing large amounts of wood with minimal effort. In combination with the lack of evidence for stone tool marks in the Bouldnor Cliff wood, these findings demonstrated the need for further investigation into the use of organic tools in woodworking. This is an area of human industry that has received little attention due to the common deficit of wood in the archaeological record, and the frequent assumption that when bone and antler are present, they represent food waste, not tools. As in modern carpentry, each tool type/material would have been advantageous for making specific kinds of cuts on certain kinds of wood, depending on physiology and condition both of the wood being worked and of the worker him- or herself.

Therefore, our experimental project also focused on an array of wood types that were available in the vicinity of the Solent during the Mesolithic (Smith 2015; Momber et al. 2015, 38-44, 71-74). The tree species which we had available and that matched those found in pollen records at Bouldnor were oak (*Quercus robur*), pine (*Pinus sylvestris*), ash (*Fraxinus excelsior*), birch (*Betula pendula*), and lime (*Tilia cordata*) in conditions ranging from green, to seasoned, to waterlogged. Other species were acquired for the purposes of comparison, including cypress (*Cupressus sempervirens*), beech (*Fagus sylvatica*), and aspen (*Populus tremula*). A wood species that was not tested but which should be included in further experiments is alder (*Alnus glutinosa*), which appears commonly in the Bouldnor Cliff assemblage, both worked and unworked.

To ascertain the potentials for organic tools in woodworking, a range of different tools was created for this project (Figure 6a-c). These included bone and antler chisels, an antler pick, wooden wedges, an antler adze and flint adzes. The bone and antler chisels and adzes were based on evidence from two Mesolithic sites in the Netherlands (Polderweg and De Bruin). These two sites are rare examples of bone and antler tools having been found in archaeological contexts (van Gijn 2007, 81). Examples of later bone tools were also used as a reference to supplement the limited evidence for Mesolithic organic woodworking tools (Legrand-Pineau and Sidera 2007, 67; Legrand-Pineau et al. 2010). Antlers from red deer (*Cervus elaphus*) and bones from both deer and cattle (*Bos taurus*) were used to create replica tools (Figure 6a-b). The antler adze was made using a large red deer antler and is based on the theoretical reconstructions proposed by Legrand-Pineau and Sidera (2007). Tools were constructed using modern instruments and methods as it was not the method of construction that was the focus of the project but the use of the tools and their marks on what was being worked (and vice versa).

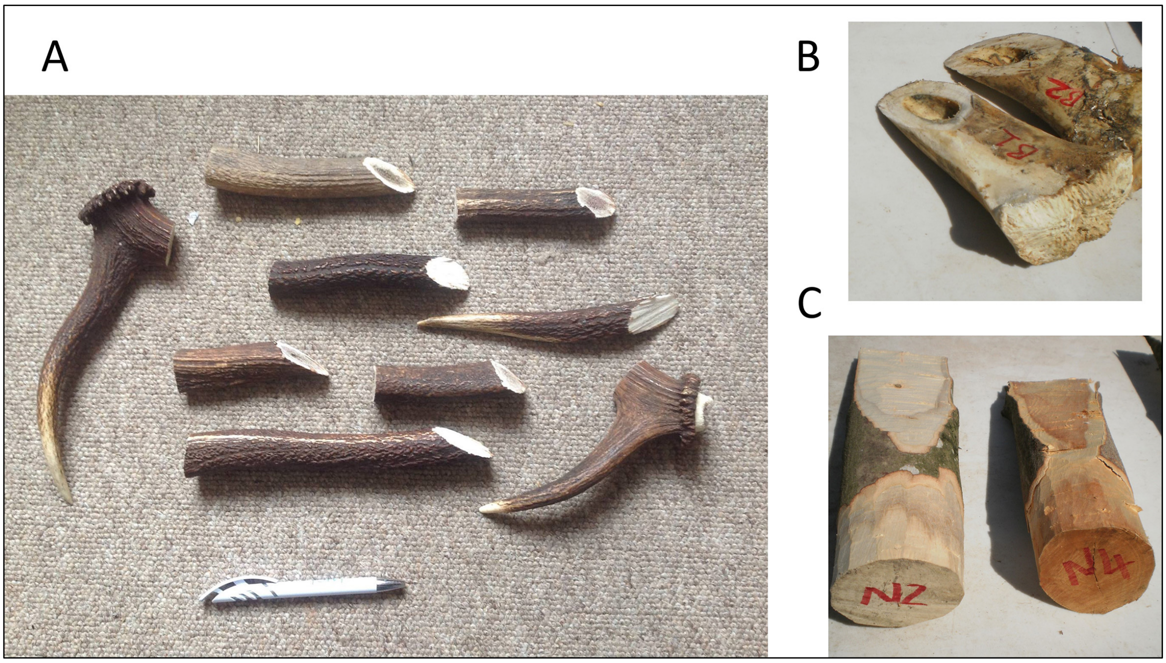

Figure 6. Antler tools used in the experimental research.

Physical evidence for prehistoric wooden wedges is, as yet, non-existent. This is hardly surprising given the unresistant nature of wood to rot and the difficulty in identifying a wedge if lucky enough to have a preserved wood assemblage. Despite the lack of evidence for the wedge itself, there is evidence for timber being split at Bouldnor Cliff and other prehistoric sites (Conneller et al. 2012; Tegel et al. 2012), and the easiest way to split timber without metal tools is with wooden wedges. Several different styles of wedge were created based on historical examples (Figure 6c), and it is hoped that through this project we will be better able to help identify the use of wedges in prehistory.

Finally, two flint tranchet adzes were made in order to create a comparative sample to the organic woodworking tools. These were manufactured using Norfolk flint and represent a generic style of Mesolithic tranchet adzes (cf. examples on finds.org.uk). They were hafted on ash handles with rawhide lashings.

After making this array of replica chisels and wedges from wood, antler, and bone, experiments began by selecting a tool and log (all of which were given a unique ID) and proceeding to split the log tangentially. A spreadsheet was maintained to organize data on the woodworker, tool, wood species, wood condition, hammer type, method/intent, time spent at work, and notes on effects and efficiency (Rich 2015). All wood chips produced were retained and labeled with the date and the wood and tool IDs. This debitage will serve as archives of comparison for the wood chips retrieved from Bouldnor Cliff and other sites. The worked wood itself was recorded photographically and with reflectance transformation imaging (RTI) to study tool marks in comparative assemblages (results forthcoming). The condition of the wood and how seasoned it was made a difference as to the size and shape of the wood chips produced. This is important for understanding early industry and how wood was procured. When we compare the chips produced to those found in the archaeological record, the original condition of the wood can be estimated, which then tells us to what extent people were opportunistic and took advantage of fallen logs versus cutting down living trees or branches from them.

The method of conversion deemed most efficient with these tools was by placing stop marks tangentially across the wood to be removed, and then splitting the wood out from the transverse face. With hard woods, such as oak, birch, and ash, antler chisels had to be used, as wood wedges curled at the ends, and bone chisels chipped. Besides being hard and resilient, antler tools have the additional advantage of being self-sharpening. Softer woods like pine were easily worked with bone chisels without damaging the tool, and wood could be removed more efficiently because the circumference of the cutting end is greater in bone than in antler. A combination of bone for stop cuts and antler for chiseling was also preferred, as the longer length of the antler means that wood of that same length could be removed at once. Wood wedges were highly effective once a deep enough groove had been made with the other tools that the wedges could be set firmly in place and then hammered.

Several different types of hammers or mallets were also tested. These included store-bought beechwood mallets (Figure 7a), self-made holly (*Ilex aquifolium*) wood mallets fashioned from a truncated stem or branch (head) and side branch (handle) (Figure 7b), and green and seasoned holly clubs or bats gathered from the forest floor (Figure 7c). Holly is a particularly tough wood, so the same qualities that make it difficult to work make it ideal as a hammering instrument. While seasoned holly clubs tended to fracture, green ones endured a great deal of stress without breaking, and their light weight made them ideal for prolonged periods of work. Given the lack of effort needed in fashioning a club, their combined disposability and efficacy made them a choice tool. Another type of hammer used was the base of the antler picks, which were retained after the larger, straighter prongs were fashioned into chisels (Figures 6a, 7d). These tended to take longer for workers to master, as the angle of handle to hammer was not the usual 90 or 180 degrees. However, after a few minutes of practice, antler hammers were comparable in efficiency to the other mallets, lighter in weight, and seemingly impossible to break.

Figure 7. Experimental tangential splitting of an oak log.

The human element

Including a variety of woodworkers was important to this project for three primary reasons: to increase public awareness of prehistoric maritime heritage and human adaptation to climate change; to add scientific value to the project's examination of wood chips produced; and to broaden the demographic of people who could have been involved in large-scale woodworking projects. To involve the greatest variety of people, public expos were scheduled and advertised at Butser Ancient Farm in South Downs, Exbury Gardens in the New Forest (Hampshire) and at Sunken Secrets at Fort Victoria (Isle of Wight). While it is commonly assumed that prehistoric woodworkers were adult men, this project demonstrated that males and females from early teens through retirement age and beyond produced roughly equivalent amounts of wood chips with similar tools and techniques. Pre-teen children were also included, but as expected, the efficacy decreased with age and levels of coordination and strength.

Another fascinating observation is that when two workers working opposite ends of the same log were asked to switch sides, there was a reluctance in surrendering the work done to someone else; in other words, a sense of ownership or pride in one's work could develop over the course of one hour. Participants also seemed to become attached to their tools, and even if at the beginning of the experiment, the worker may have complained about the tool(s) s/he chose, over a short period of time, a sense of affinity was often developed, even while recognizing the instruments' shortcomings. It would be of great interest to continue pursuing these observations and experiments within the frameworks of Marxist labour and Heideggerian *das Zeug.*

The logboat

After several weeks of experimenting with splitting smaller logs with Mesolithic techniques, the project had the opportunity to put this knowledge to work on a larger scale and continue the experiments using other techniques during a one-day public expo at Exbury Gardens. A 3-m long log of semi-seasoned oak was provided for the practice construction of a logboat. It was to be hollowed using a combination of the bone, antler, and wood tools used in preceding weeks, and stone adzes and fire-heated flints comparable in size to those uncovered at Bouldnor Cliff. The log had come from a large forked oak tree with some fungal rot in the heartwood near the base of the fork. As the log was lying on its side, the upper fork was removed with a chainsaw, leaving the lower fork and main stem for the logboat. The top-most end of the tree with the majority of rot was selected as the stern, which would eventually be removed completely and a transom board inserted. The base end of the stem would be the bow, as this end was free of any water-tight

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compromising decay. This formation also followed the construction plan of the Tybrind Vig boats (Andersen 2013, 194-195).

The fork in the log proved to be a greater challenge than anticipated, as the irregular grain created during the process of forking, and the tree's buildup of tension wood to hold the forked branches vertical, each contributed to a tougher material to work through. The morning of the expo was dedicated to removal of wood using the tools and techniques of the previous weeks, but rather little progress was made. By afternoon, the flints were sufficiently heated, and they were added to the area of the log where wood had been removed to speed up the process. A flue and pump were used to deliver oxygen to the burning flints, and every half hour, they were returned to the fire to reheat while the charred wood was scraped away. The layer of charred wood was thin and easily removed with the flint adze, but upon breaching that charred layer, the obstacle to wood removal remained the same. Because fire was used effectively in *The Prometheus*, a seasoned oak log, it is surmised that its ineffectiveness here was due to the log's condition as semi-seasoned, so the retained moisture proved inhibitive in the same way as with *The Eurybia*.

Conclusions

The project results so far have confirmed new possibilities for woodworking techniques that may have been used by a wide variety of people – male and female, young and old, and all those in between – in the Mesolithic and even before. These techniques make use of wood, bone, and antler tools that may not survive the archaeological record in such numbers as stone tools, but which would have effectively and efficiently hollowed and tangentially split roundwood for a variety of purposes, constructing a logboat being just one of them. Heated flints proved virtually ineffective in hollowing a semi-seasoned oak log, and the splitting techniques developed experimentally proved much less efficient on a forked log with a great deal of tension wood. The wood easiest to work, not surprisingly, was pine, with oak and birch being among the hardest. Shape and size of wood chips produced differed depending, not only on species, but also on the degree to which the wood was green or seasoned. Forthcoming analyses of these wood chips can be compared with the assemblage at Bouldnor Cliff to help estimate how settlers interacted with their forested environment: by taking advantage of fallen trees and limbs or by cutting them down. Additional analyses will also compare the tool marks made during these experiments and those observed while assessing the Bouldnor Cliff wood artefacts. The effects of working wood on the tools used will also be analysed in the forthcoming paper.

Acknowledgments

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