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Reviewed Article:

Hoes or Adzes? Experimental Reproduction and Uses of Deer Antler Tools from the Bronze Age Terramara of Pragatto (Italy)

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This research aimed to evaluate the hypotheses related to the production and possible uses of a class of deer antler tools from the Bronze Age Terramara of Pragatto (Italy). These bevel-ended instruments are traditionally considered handled hoes, related to agricultural purposes such as tillage. The aim of this work was to provide an alternative interpretation of their function, possibly linked to the different morphology of their active areas. A first experimental protocol was developed to create a reference collection of the archaeological antler tools to provide information on the manufacturing technology adopted by the ancient craftsmen approximately 3500 years ago. The second stage of the experiment allowed us to assess the potential versatility of the replicated artefacts from a functional point of view, as some of them have also shown great effectiveness in woodworking activities. The final comparison between traces through a microscopic analysis of the surfaces was essential to support this latter functional hypothesis. This study allowed us to determine which tools and methods were required to produce these artefacts and, ultimately, to identify their possible multifunctions, offering perspectives in understanding their economic role within the Pragatto population.

> “ The analysis of functional traces on the surfaces of the archaeological and the experimental tools required both the use of the stereomicroscope, with which it was possible to

Introduction

The Terramare civilization occupied the Central-western Po Valley in Northern Italy in a chronological span from the beginning of the Middle Bronze Age (MBA) to the Recent Bronze Age (RBA) (circa 1650-1150 BC) (Bernabò Brea and Cardarelli, 1997; Cardarelli, 1997, 2009). Complex forms of social and economic organization can be recognized in the advanced settlement planning, characterized by a regular arrangement of dwellings[1] , and in the increasing evidence of analyse the macro-traces, and the high-magnification microscope (metallographic) for the analysis of the micro-traces.

handicrafts industry, specialized in the production of metal, ceramic, and animal hard material artefacts.

The analysed archaeological sample is represented by six antler bevel-ended instruments (See Figure 1) uncovered in the recent excavations of the Terramara of Pragatto (Bologna, Italy). The abundance of tools belonging to this typological category testifies to their widespread use in several Italian sites of the Bronze Age, from the pile-dwelling settlements in the northern area (Cilli, Malerba and Giacobini, 2013) to later sites (Pasquini, 2005a, 2005b; Maini and Curci, 2009)[2] . They are widely attested within the Terramare culture (Forni, 1997; Provenzano, 1997, 2001), perhaps suggesting the existence of semi-specialized craft activities aimed at their rather standardized production. These specific instruments are traditionally classified in the literature as agricultural hoes (Forni, 1997; Provenzano, 1997, p. 529; 2001, p. 94; Pasquini, 2005a, 2005b; Cilli, Malerba and Giacobini, 2013, p. 144), despite the lack of experimental studies confirming this single functional interpretation. We decided, therefore, to assess their potential versatility to understand better the activities for which they could have been used in ancient times, as we were strongly convinced that different functions should not have been completely excluded. Relevant elements supporting our claim derive from recent studies conducted on antler instruments from various European prehistoric contexts which bear evident similarities with our archaeological sample, due to the morphology and orientation of the active edges, together with the presence of large perforations for hafting. The hypothesis of their possible use in woodworking has been corroborated by the results of trace analyses carried out on the active surfaces of Late Neolithic tools of the Vinča culture in the Balkans (Vitezović, 2017), and by the experimental research of Orłowska and Osipowicz (2017) as well. In the latter work, the authors have evaluated multiple functions of the so-called ‘heavy duty bevel-ended tools’ (axes and mattocks/adzes[3]) from Poland. An integrated trace analysis allowed them to characterize the developed use-wear traces, demonstrating that these instruments have been used for several purposes, including wood processing. Other antler tools from a peat bog site in western Poland dated to the Early Mesolithic (8700-7300 cal BC) strongly resemble our Bronze Age items (Winiarska-Kabacińska and Kabaciński, 2017, p. 133, figure 6). The site chronology confirms they were not used as hoes.

Our hypothesis of an alternative use of the Pragatto antler implements, not exclusively linked to agriculture, has been verified through the application of an experimental programme which had assessed their effectiveness not only in tillage, but also in further daily activities (for example cutting and debarking) on different types of wood. The difference in uses could be directly related to the morphologies of the instruments themselves, as they belong to a very heterogeneous group.

As required by the experimental method, the research was focused on the constant comparison between the archaeological and the replicated antler tools. For their reproduction we decided to apply a technology compatible with the ancient ones, using a specifically created experimental bronze toolkit and a set of sandstone abraders. These tools have been selected according to the archaeological evidence documented in the Terramare. All data was recorded and discussed to provide a reliable experimental reference collection, on which the traceological analyses were finally carried out. This made it possible to establish the nature of the technological and functional traces, and to characterize them, validating our hypotheses.

The archaeological context

The site of Pragatto, located in the upper Bolognese plain, has been known since the 19th century for the discovery of a portion of the Bronze Age necropolis with cremation burials. The settlement had been exclusively investigated through field surveys until 2016-2017[4] , when it was then excavated with a total area of about 7000 sqm (Miari *et al.*, 2019; 2020). The settlement was probably organized with a first inhabited core dated to the early stages of the MBA 2, which extended to the South-East in the MBA 3, occupying part of an external area that previously had a non-residential function (Vitali, 2005; Consolini, 2007).

The investigated area, which transversely cut the meridional side of the original core's southern extension, was divided into three sectors: the western portion (A), the central portion (B) and the eastern portion (C) (See Figure 2a). The latter was occupied by the perimetral defensive system of the village that had a large ditch characterized by at least two reconstruction phases, a partially preserved embankment, and a wooden structure with self-supporting gabions, which perhaps contained the earthwork embankment[5] .

Sectors A and B have supplied the residential evidence. After an initial occupation featured by the presence of long palisades, possibly linked to farming activities, the distribution of the structures had spread over the entire surface of the excavation due to the expansion of the inhabited area. The piles of ash documented how these dwellings were raised on wooden platforms, according to the traditional Terramare model known since the 19th century. The presence of smaller sized structures without these drains placed within the residential fabric of the village has led to a different hypothesis of function for them, perhaps related to food storage or other activities (Cazzella and Recchia, 2009).

A large portion of the excavated area returned evidence of an extensive fire, which had involved numerous buildings. This event has well preserved the perimetral and supporting structures of the dwellings. In fact, several remains of charred walls, made with an intertwining of flexible wooden elements, and wooden planks have been uncovered (See Figure 2b). These organic structural remains have always been found associated with selected and pressed yellow silt layers, probably residues of the plaster applied to the walls. Many elements related to craft activities (spindle whorls, macro-lithic tools, bronze and deer antler instruments) suggest that these were carried out within the excavated part of the inhabited area.

This first identified phase of the settlement can be dated to the MBA 3. It has been followed by a second certain phase of occupation dated to the RBA, the stratigraphical evidence for which, associated with the settlement until its abandonment, has been compromised by modern agricultural working.

The archaeological sample: different morphologies for different uses?

The exploitation of deer antler, thanks to its physical and mechanical properties (high resistance and elasticity) and the great availability in nature due to its cyclical annual fall (Billamboz, 1979, pp. 101-103; Orłowska and Osipowicz, 2017, p. 103; Vitezović, 2017, p. 210), has progressively played an important role in various prehistoric communities, influencing several aspects of their social lives. It would appear that the gathering activity in the cervids shedding season (February – March for adult individuals) has been preferred to hunting in the Bronze Age, as suggested by a large number of artefacts without bone pedicles attached to the proximal basal part (burr) (Provenzano, 1997; De Marinis *et al.*, 2005; Pasquini, 2005a). This required good knowledge of the surrounding environment (as stags tend to lose their antlers annually in the same area), but mainly the acquisition of forms of social organization related to seasonal collection and antler storage (Provenzano, 1997, p. 535; 2001, p. 98; Vitezović, 2017, pp. 210-212), which needed particular conditions.

Our archaeological sample is made up of six large artefacts of red deer (*Cervus elaphus*) antler. Taking into consideration a series of parameters (sizes, colour, tines conformation), it would seem that the entire sample came from adult male individuals (5-15 years)[6] , except for tool no. 636, which possibly came from a sub-adult male individual (3-4 years). Based on the direct observation of the antler's structural characteristics[7] , it was assumed that the instruments were obtained by detaching the following sections (See Figure 3):

- No. 169: beam segment between trez tine and crown;
- No. 296: distal wider segment embedding the crown (without final branches);
- No. 186: beam segment between brow tine and trez tine;
- No. 636, 1482 and 1810: proximal segment between burr and trez tine.

All our samples have quadrangular holes with a longitudinal direction along the antler axis, for the mounting of wooden handles at an angle of approximately 90°.

The selected finds from Pragatto differ from each other not only for the presence or absence of the burr, but also for the morphology of their bevelled ends. Five different morpho-types could be characterized:

- Wide and flat bevelled end: tool no. 296;
- Flat bevelled end with diverging sides: tool no. 169;
- Bevelled end with converging sides: tools no. 186 and 636, which has a completely intact burr;
- Concave and rounded bevelled end: tool no. 1810, with a completely intact burr. This item can be considered a *unicum* for the presence of an additional element with reduced size and rounded shape, probably caused by wear;
- Forked bevelled end: tool no. 1482. Even though its active part is only partially preserved, the rounded edges and the step near the central fracture suggest to us that it originally had a forked end. Its burr has also been extremely worked and shows a homogeneous and quite rounded surface.

As already asserted, these specific large bevel-ended artefacts have always been categorized as hoes. Commonly the term 'hoe' refers to an agricultural implement characterised by a handle and one or more sharp active parts. It is used in launched percussion to move and level the clods, and to create furrows in the soil. These instruments, however, could have been created for various purposes, as they display all the morphological differences listed above. Some may even have had more than one function; therefore, it was essential to proceed with an experimental protocol that confirmed or refuted our hypotheses.

Methods

The experimental programme

The study on deer antler artefacts from the Terramara of Pragatto has been developed in two main stages. The first experimental protocol aimed at the production of five tools resembling the archaeological finds. The technological chain has been further divided into three sub-phases (Provenzano, 1997, 2001; Pasquini, 2005a):

1. *Débitage*: extraction of the coarse support by detaching it from the beam;
2. *Façonnage*: removal of transverse tines, shaping of the support, active edge finishing, and perforation.
3. Hafting.

The second experimental protocol was subsequently carried out with the aim of testing the replicas on three different materials (clay-sandy soil, fresh wood, dry wood), for long enough to allow traces to develop on the active surfaces.

The trace analyses

The final phase of this research focused on the analyses of technological and functional traces, a fundamental aid with which we had a better understanding of how these tools were produced and used by comparing their traces with those on the experimental tools[8] .

Active surfaces have been reproduced by silicon moulds (Provil® Novo Light Fast). The analysis was undertaken on the surfaces of the experimental and archaeological instruments through observation with a stereomicroscope (Nikon SMZ-2T JAPAN and SMZ-U) and a metallographic microscope (Nikon Y-IDP). The photographs were taken with digital cameras, Amscope, Olympus SC 100 and Nikon DMX1200. The Helicon Focus programme was used for digital image processing.

All the experimental protocols and the traceological studies were processed and performed within the Laboratory of Technological and Functional Analyses of Prehistoric Artefacts (LTFAPA) of Sapienza University of Rome.

The bronze toolkit

In order to create historically accurate reproductions of the artefacts found in Pragatto, we have decided to use the tools available during the Bronze Age in the Terramara culture. We believe that this approach is essential to create significant manufacturing traces comparable to those on the archaeological items.

Previous experimental work was carried out in 2018 by one of the authors[9] , initially aimed at the replication of the same archaeological antler tools by using a different technology. In fact, a bronze bladed frame saw and hand saw were used for antler cutting. This approach, however, showed no cut marks comparable with the archaeological ones[10] . Based on this observation, we decided in the new experiment to use a bronze axe as an alternative instrument for cutting the antlers and shaping them, while chisels were used to create the holes for handles.

Only one chisel has been recovered in the site, but no axes. We, therefore, based our replica on the flanged axe from the nearby coeval site of Casinalbo (Modena). The axe has been dated to MBA 2 and features a composition of 90,75 % of copper and 8,69 % of tin (Scacchetti, 2013).

The experimental axe has been made in 9 % tin bronze (See Figure 4). Two sandstone blocks were carved with bronze chisels and stone abraders to make the mould. The melting was performed in a pit fuelled with charcoal. The copper was melted in about 20 minutes and then tin was added to the molten metal. Once the bronze reached the right temperature and viscosity, it was poured in the pre-heated moulds. The cast was successful, but the mould cracked and it could not be reused. The flashings were then removed, and the sides forged to refine the shape for about 30 minutes, using a bronze hammer and anvil. The cutting edge was cold forged for 10 minutes, alternating the hammering with annealing cycles to avoid any cracking. Once the edge was hammered into shape and work-hardened, the axe blade was ground and polished on wet sandstones for 20 minutes. Then it was mounted on the handle with beeswax, resin glue and leather strings.

The chisels were made featuring a bronze composition of 92 % copper and 8 % tin[11] .

The technological experiment

Pre-treatment: yes or no?

As already mentioned, this research partly recalls some passages of a preliminary experimental study (Durante, 2019). The selected antlers had been soaked in water for 12 hours before their processing, to facilitate the subsequent manipulation by softening them temporarily. This treatment is usually reserved for demineralized and totally calcified shed antlers (Vitezović, 2017, p. 213). They were then soaked again for a further 12 hours before the finishing phase. The internal cancellous tissue, however, had over-absorbed the water, causing a considerable expulsion of organic liquids (marrow), which made it difficult to cut the raw material. From the experience gained, we had decided this time not to pre-treat the available antlers at all, as we did not know their calcification state.

The technological sequences

The raw material came from different red deer (*Cervus elaphus*) specimens: one antler had the pedicle attached to a cranial remain; the second was a shed antler; the third was a burr-less antler.

a. *Débitage*. We used the bronze axe perpendicularly on the entire main beam antler's circumference to cut the distal and proximal ends for direct percussion (the latter was untouched for the reproduction of tools with the burr). The extraction of each support took 30 minutes.

b. *Façonnage*. The axe had also been used to reproduce the active edges by hewing the distal area for direct percussion blows in an oblique direction. The axe blade was held at an angle of approximately 45° with respect to the antler axis, and small portions were gradually removed (See Figure 5a). This technique allowed us to have more control over the action. The bevelled edge of tool no. 1810 was produced using a semi-circular section bronze chisel and a wooden hammer for indirect percussion, with which we partially removed the internal tissue. This tool also has a second active area extremely worn on the brow tine. This was replicated through precise and controlled axe blows, reducing the tine length, and splitting it longitudinally. The tines were cut using the axe, while the final detachment was made by manual flexing.

The finishing of the active surfaces was carried out by abrasion (See Figure 5b). These were first wetted, then dipped in sand. They were abraded for one hour with fast and repetitive multidirectional movements (to-and-fro longitudinal and transverse) performed on sandstone abraders. This technique made it possible to smooth and sharpen the cutting edges and to increase their compactness and regularity. The sandstone abraders had been selected considering the main features of those found in Pragatto that show use-wear traces compatible with this purpose, such as raw material and morphology of the active surface[12] (Hamon, 2006). The two abraders were used both holding them in one hand and resting on the ground. When needed, water and sand have been re-used to improve performance.

The bronze axe has also been used in controlled direct percussion to decorticate and reduce the thickness of the area that would have been carved for the quadrangular hole (See Figure 5c). The perforation was performed in one hour using indirect percussion with a chisel and wooden or antler hammer on both sides (See Figure 5d). The internal cancellous tissue was removed by tilting the chisel towards the inside of the quadrangular area, which was already shaped by grooving actions.

A separate mention should be made for tool no. 1482, which originally may have had a forked end. In order to verify and characterize a further operational sequence, we decided to modify the replica already made of instrument no. 186 (Durante, 2019). Its cutting edge had been split lengthwise by axe on both ventral and dorsal sides (See Figure 5e). As the replica did not have the burr unlike its archaeological model, all the edges of the proximal end were rounded by axe to make them as similar as possible.

c. Hafting. Each tool has been hafted with handles of two different lengths (50 cm; more than 100 cm) and woods (*Arbutus unedo*; *Pinus* sp.; *Celtis australis*). This action was completed by the insertion of wooden wedges and applying natural fibre (jute or hemp) rope if needed (See Figure 5f).

The experimental replicas have been labelled with an identification number (See Figure 6).

The functional experiments

Premise

Some experimental tools had already been produced and used in 2018 (Durante, 2019). To proceed with a new functional experimentation process, all the working surfaces were subjected to *reaffûtage* [re-sharpening] by abrasion on sandstone abraders. Each instrument had been used on two different materials, testing other variables that could demonstrate their possible multifunctionality. Another intention was to verify if some morpho-types of bevelled ends could have represented an indicator of a specific use. We had then decided to exempt two items from the multifunctional test: replica no. 2, with the widest and flat bevelled edge, and replica no. 4, with a bevelled end with converging sides. The first one had exclusively been used as a hoe in tillage, while the second had only been used as an adze in woodworking.

Trials as agricultural hoes

The replicated tools were used as hoes in direct launched percussion in clayey-sandy soil for one hour each (only no. 2 was used for longer, 2 hours), with a medium intensity (See Figure 7). Generally, all of them showed great performance in tillage, creating furrows and holes. We had used shorter handled tools while we were in a bent position, mainly for the removal of weeds and small pebbles in specific and limited areas (gardening activity). The greater width and weight (453 g) of tool no. 5 facilitated ground penetration, producing very deep furrows; furthermore, its large lateral surface, which has the second active surface on the brow tine, seemed to be functional for compacting and levelling the soil. The forked tool was not very suitable for this task, due to the creation of furrows excessively close together (not functional to a subsequent sowing of crops), and to the continuous obstruction of the empty part between the bifurcation.

Trials as woodworking adzes

The second hypothesis aimed at testing the experimental tools as woodworking adzes. They were used for one hour each by means of direct launched percussion with a medium-strong intensity on fresh wood from a hackberry tree (*Celtis australis*) and dry wood from a laurel tree (*Laurus nobilis*)[13] .

Only two instruments, no. 1 and no. 4, had shown impressive efficiency in every activity (See Figure 8). These tools had been used on hackberry branches by perpendicular direct blows. Wood sections of 5 cm in diameter were chopped in less than 3 minutes. They had also been effective in debarking, for which smaller and more controlled blows had been given in direct percussion at an angle of 45° by shortening the handle grip distance. The excavation and removal of the stump of an almost dead laurel, with rather friable wood, had easily been achieved by all the replicas. Experiments had also been performed in carving the dry laurel wood, for which few instruments have succeeded. The forked tool did not prove to be functional in either one of the activities described above.

Results and discussion

The technological analysis

The analysis of technological traces had been carried out with a low-magnification microscope (stereomicroscope) thanks to which it was possible to characterize the specific processing phases of the tools. The data obtained from the experimental activity have highlighted some aspects of the *chaîne opératoire* for these tools' production: the comparison between the experimental and the archaeological traces has confirmed the proposed hypotheses.

On the proximal extremities of some archaeological artefacts, short and deep grooves were found deriving from the extraction activity of the supports. As mentioned above, the experimental detachment of the antler segments took place using a bronze axe, and the resulting traces on the experimental instruments coincide exactly with those found on the archaeological ones. In addition, the use of the bronze axe is also conceivable in *façonnage*, specifically for the 'roughing' of the tool to shape its active part. This action carried out with a bronze axe left conchoidal detachments on the surfaces, making them wavy. The trace on the tools from Pragatto matched with that experimentally created using this working technique (See Figure 9a-b), thus corroborating the hypothesis according to which the use of metal axes should have multiple purposes within the operational chain (Pasquini, 2005a).

Another technique attested in the North-central Italian sites of the Bronze Age is the launched percussion on antler aiming at the creation of the holes, for which the use of bronze chisels on antler instruments had already been ascertained in other sites (De Marinis *et al.*, 2005, p. 692). Numerous wide and deep furrows are visible on the quadrangular holes, both perimeter and in the section, arranged in a perpendicular way to the tools' axis. These traces are very similar to those found on experimental tools, on which the realization of the holes took place with the use of a bronze chisel for indirect percussion (See Figure 9c-d).

The production of antler bevelled artefacts can be characterized and summarized as follows:

1. detachment from the beam by direct percussion with an axe;
2. removal of the residual tines by direct percussion with an axe;
3. shaping of the support to bevel it by direct percussion with an axe;
4. finishing of the active edge by abrasion with sandstone abraders and abrasive agents;
5. decortication to prepare the area for perforation by direct percussion with an axe;
6. perforation by indirect percussion with chisel and percussor.

In conclusion, the recognized technological sequence of the artefacts from Pragatto fits perfectly with the known manufacturing techniques of animal hard material documented within the Terramare culture, of which we have a wide-held knowledge, especially thanks to the pioneering research of Provenzano (1992, 1997, 2001).

The functional analysis

The analysis of functional traces on the surfaces of the archaeological and the experimental tools required both the use of the stereomicroscope, with which it was possible to analyse the macro-traces, and the high-magnification microscope (metallographic) for the analysis of the micro-traces.

In addition to those caused by post-depositional events, macro-traces related to uses (compressions, deformation of the functional edges and detachments of small and medium portions of material) are visible on the surfaces of the archaeological instruments (van Gijn, 2005, pp. 56-63; Legrand and Sidéra, 2007, pp. 69-72). Strong analogies were noted when comparing these traces with those of the experimental reference collection, for which in some cases it would seem possible to connect a tool with a specific morphology to the processing of a specific material.

Tool no. 296 has the largest, but less sharp, active area of the entire sample. This has led us to assume that it could have been used in ancient times exclusively as an agricultural hoe. The macro-trace analysis of its active surface showed compressions and rounding very similar to those visible on the working edge of its replica no. 2, which was exclusively used in tillage (See Figure 10). Our hypothesis was supported by the results of the functional experiment, which showed that its morphology together with the longer length of the wooden handle were elements that facilitated the work more than other replicated tools.

Analogies between macro-traces, due to compression and detachments, are furthermore highly evident on both the active ends of tool no. 636 and its replica no. 4, which concerns particular conchoidal detachments with rounded edges (See Figure 11). This specific evidence was identified only on this experimental tool, corroborating the hypothesis that the archaeological tool no. 636 could have been used in woodworking. A noteworthy result was recorded by its experimental use as an adze, thanks to its bevelled end with converging sides, which proved to be effective especially in nicking and chopping the wood.

As for the micro-traces, the analysis of the archaeological tools had not always led to reliable results. In fact, as already mentioned, post-depositional phenomena have altered their surfaces, and consequently their traces. Just one kind of trace was found on the active surface of some instruments. Its reliefs are angular with much more rounded points tending to flat, and a very rough polishing with only a few smoother points, with medium-low brilliance. Scattered striations, which do not follow a single direction and with mixed morphology, could derive from the presence in the ground of irregular bodies (pebbles, gravel, et cetera...) that would have generated irregular striations for shape and direction, as the physical properties of the soil, in which an activity is carried out, can determine the typological development of the traces (Orłowska and Osipowicz, 2017, p. 108). The characteristics described above have been re-written on the active end of the archaeological instrument no. 169. A similar micro-trace was detected on its experimental replica no. 1, which had been used with a double function: as a hoe in tillage, and as an adze for debarking and chopping wood. Despite some differences attributable to taphonomy, the surfaces of the active areas of both instruments, which are flat with diverging sides, are rough to smooth, showing multidirectional numerous micro striations, together with holes and micro holes (See Figure 12).

The resemblances of the functional traces would, therefore, lend support to the hypothesis that some of these tools may have assumed a polyvalent role within the craft activities of the Pragatto population, as suggested by the results of the experiments. The contribution of the observation and characterization of the traces proved to be a complementary aid to the morpho-typological analysis of the working edges, and to the experimental programme to which our sample was subjected. The application of these three approaches could be a valid tool for determining the original function of these artefacts, although it is not always possible to obtain decisive interpretations[14] .

Conclusion

This work made it possible to investigate and elaborate on some aspects of the Terramare antler industry, whose achieved levels are not comparable to any production of other contemporary cultures in Italy (Mutti and Rossi, 1992; Provenzano, 1997; Pasquini, 2005a). It has been possible to formulate reliable interpretations both on the manufacturing technology, and on the multiple functions that can be attributed to this class of antler bevel-ended tools. Our results confirm that these instruments cannot be directly and exclusively linked to agricultural purposes, as it always has been done without assessing their potential versatility. It is reasonably likely that implements such as these, whose coarse manufacturing is far from the high degree of refining of other types of artefacts, must have been used by the members of Pragatto with a high frequency in several daily activities, as well as in woodworking. The different use-wear traces detected through the integrated support of the traceological analyses validate this hypothesis, opening new perspectives on the functional interpretation of these specific deer antler artefacts.

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1 Although it is not the only one known (Balista et al., 2008; Cardarelli, 2009), the traditional dwelling model refers to structures on raised wooden platforms built on the ground.

2 For an indicative list with the geographical distribution of other Bronze Age Italian sites see Pasquini 2005b.

3 The tools have been divided into two main categories based on the orientation of their cutting edges (Pratsch, 2006, cited in Orłowska and Osipowicz, 2017, p. 103). Our archaeological materials perfectly fall into the ‘mattocks/adzes’ category, as their working edges are perpendicular to the tools’ handles.

4 Direction of Monica Miari and Paolo Boccuccia of the Soprintendenza Archeologia, Belle Arti e Paesaggio per la Città metropolitana di Bologna e le Province di Modena, Reggio Emilia e Ferrara (SABAP-BO). Excavation entrusted to Ar/S Archeosistemi S.C. society of Reggio Emilia.

5 A rather similar situation has been observed in other contemporary Terramare villages, such as Castione Marchesi (Cupitò, 2012; Mutti, 1997) and Gaggio of Castelfranco Emilia (Balista et al., 2008; Scacchetti, 2018).

6 Antlers are a male prerogative due to the accentuated sexual dimorphism that characterized this species. The structure of the antler varies according to the individual's stage of growth, although factors such as natural predisposition and diet can have a significant influence on its development (Billamboz, 1979, pp. 103-106).

7 According to the anatomical nomenclature provided by Billamboz (1979) and Nikolaidou and Elster (2020).

8 The traces analyses were carried out by Sara Maria Stellacci.

9 Technological and functional experiments for the bachelor’s thesis of Arianna Durante (Durante, 2019).

10 The sawing technique would seem to be attested in Italy only from the RBA (Provenzano, 1992, p. 234; Provenzano, 1997, p. 527; Pasquini, 2005a, p. 981; Bedini and Petiti, 2011, p. 44), except for one indirect evidence from the Terramara of Baggiovara dated to the MBA (Epifani, 2013, p. 237).

11 The experimental reproduction of the bronze tool-kit was carried out by Alessio Pellegrini.

12 The selection of the lithic materials has been made by Antonella de Angelis.

13 The woods were selected for their availability at the moment of the experiment. However, these two arborean species did not seem to appear in the plant landscape of the Emilia-Romagna plain during the Terramare’s lifespan (based on in the anthracological and xylological records from Montale and its pollen diagrams in Mercuri et al., 2006).

14 A separate discussion should be made for the failed results of replica no. 3. If tool no. 1482 originally had a forked end, it may have been used for other purposes yet to be verified (for example to facilitate fruit-picking on trees).

Keywords antler
tools
tool traces
use wear analysis

Country Italy

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Gallery Image

FIG 1. THE DEER ANTLER BEVEL-ENDED TOOLS FROM THE TERRAMARA OF PRAGATTO. COURTESY OF THE SOPRINTENDENZA ARCHEOLOGIA, BELLE ARTI E PAESAGGIO PER LA CITTÀ METROPOLITANA DI BOLOGNA E LE PROVINCE DI MODENA, REGGIO EMILIA E FERRARA (SABAP-BO). PHOTOS BY SARA MARIA STELLACCI; ELABORATION BY GIANCARLO LAGO.

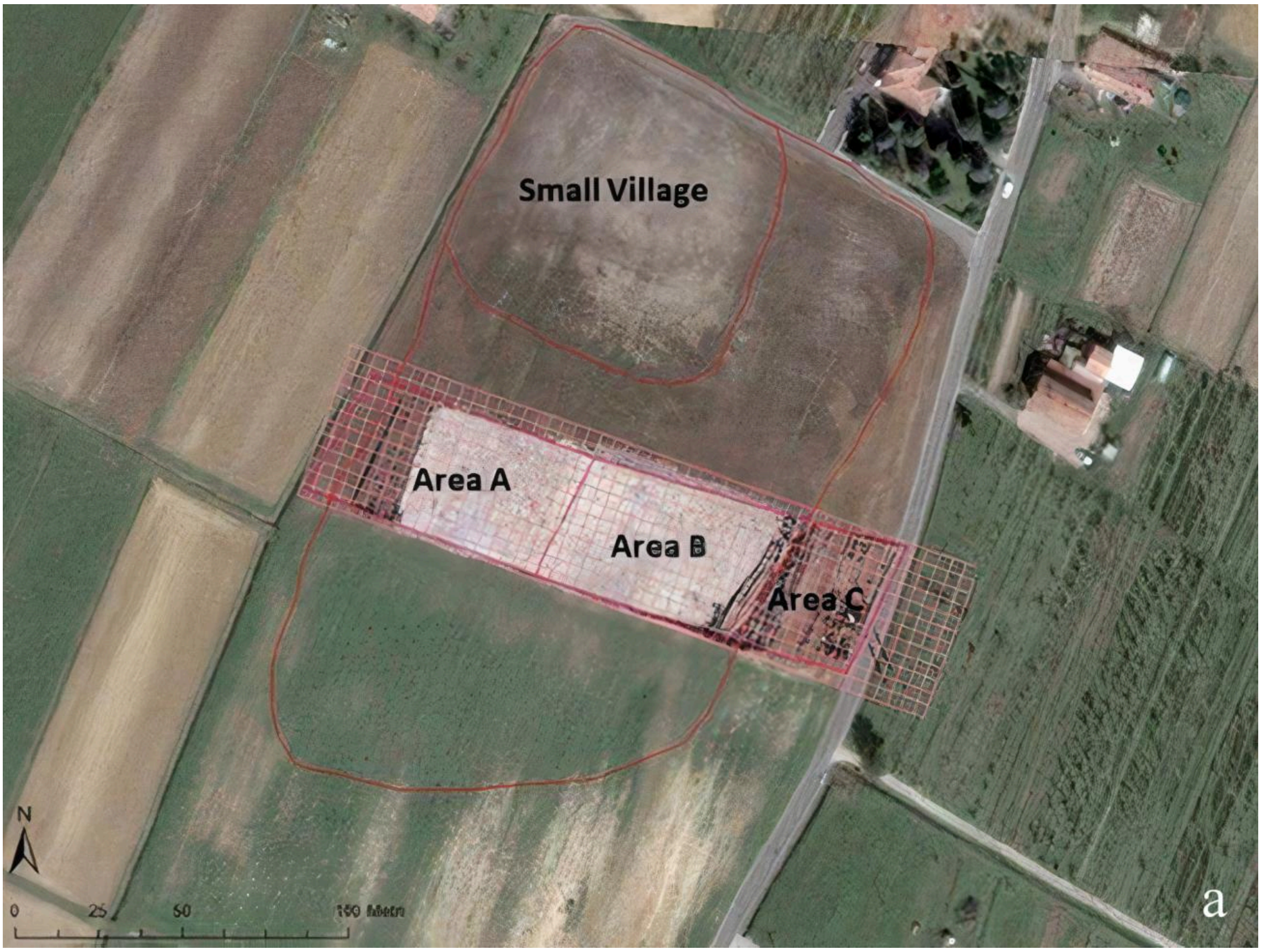

FIG 2A. THE TERRAMARA OF PRAGATTO EXCAVATED IN 2016-2017: RECONSTRUCTION OF THE SETTLEMENT WITH THE EXCAVATED AREAS. COURTESY OF THE SOPRINTENDENZA ARCHEOLOGIA, BELLE ARTI E PAESAGGIO PER LA CITTÀ METROPOLITANA DI BOLOGNA E LE PROVINCE DI MODENA, REGGIO EMILIA E FERRARA (SABAP-BO).

FIG 2B. THE TERRAMARA OF PRAGATTO EXCAVATED IN 2016-2017: REMAINS OF CHARRED WOODEN PLANKINGS. COURTESY OF THE SOPRINTENDENZA ARCHEOLOGIA, BELLE ARTI E PAESAGGIO PER LA CITTÀ METROPOLITANA DI BOLOGNA E LE PROVINCE DI MODENA, REGGIO EMILIA E FERRARA (SABAP-BO).

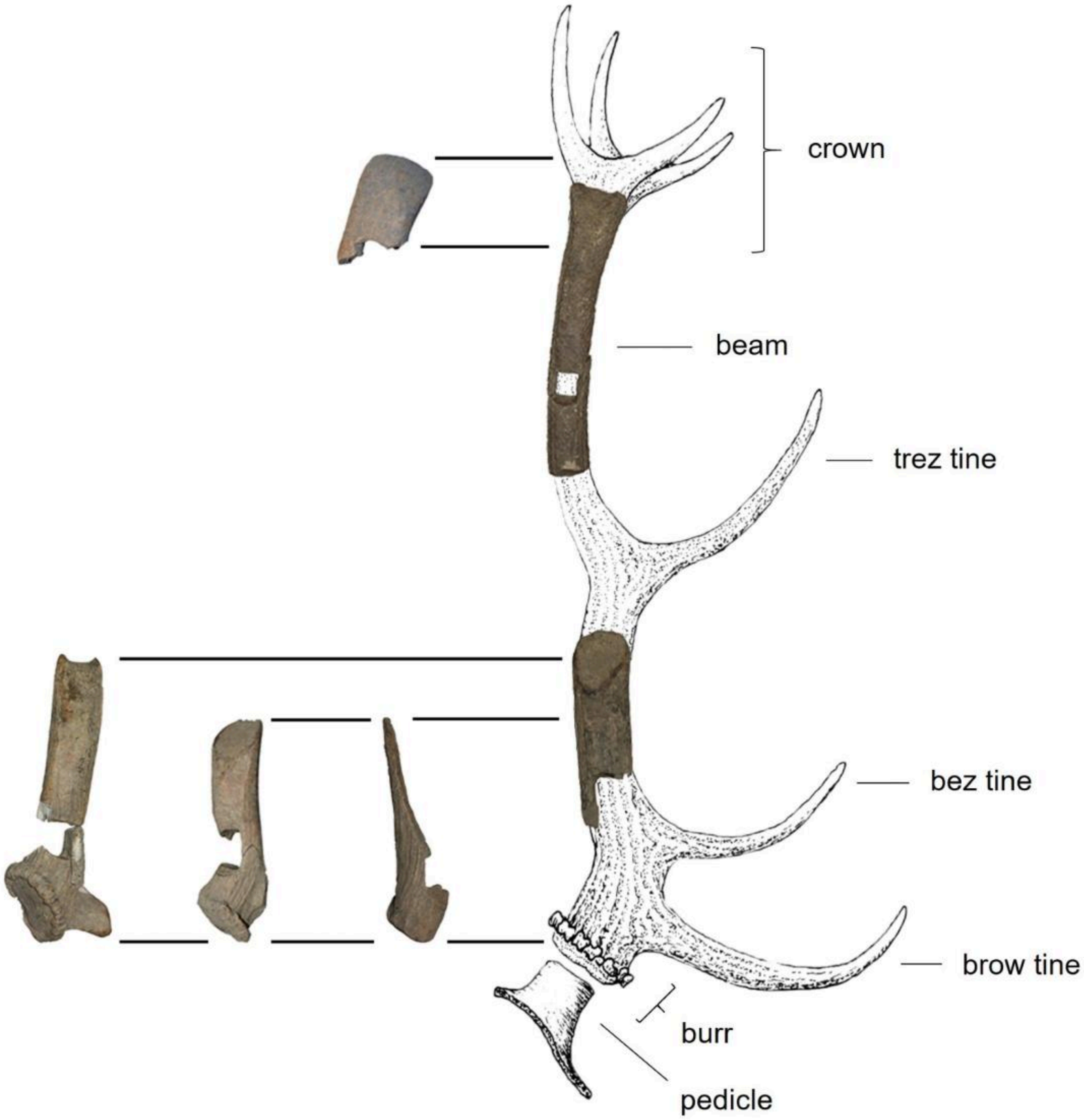

FIG 3. ANTLER'S STRUCTURE (FROM BILLAMBOZ 1979, P. 96) AND HYPOTHETICAL SEGMENTS USED FOR THE INSTRUMENTS. NOT IN SCALE. ELABORATION BY ARIANNA DURANTE AND GIANCARLO LAGO.

FIG 4A. EXPERIMENTAL REPRODUCTION OF THE BRONZE FLANGED AXE: SANDSTONE MOULD CARVING. PHOTO BY ALESSIO PELLEGRINI.

FIG 4B. EXPERIMENTAL REPRODUCTION OF THE BRONZE FLANGED AXE: BRONZE CASTING. PHOTO BY ALESSIO PELLEGRINI.

FIG 4C. EXPERIMENTAL REPRODUCTION OF THE BRONZE FLANGED AXE: POST CASTING. PHOTO BY ALESSIO PELLEGRINI.

FIG 4D. EXPERIMENTAL REPRODUCTION OF THE BRONZE FLANGED AXE: BEVEL HAMMERING. PHOTO BY ALESSIO PELLEGRINI.

FIG 4E. EXPERIMENTAL REPRODUCTION OF THE BRONZE FLANGED AXE: POLISHING AND SHARPENING ON SANDSTONE. PHOTO BY ALESSIO PELLEGRINI.

FIG 4F. EXPERIMENTAL REPRODUCTION OF THE BRONZE FLANGED AXE: FINISHED AXE. PHOTO BY ALESSIO PELLEGRINI.

FIG 5A. TECHNOLOGICAL SEQUENCE OF THE BEVELLED ARTEFACTS' PRODUCTION: SHAPING OF THE ACTIVE EDGE. PHOTO BY ARIANNA DURANTE.

FIG 5B. TECHNOLOGICAL SEQUENCE OF THE BEVELLED ARTEFACTS' PRODUCTION: FINISHING BY ABRASION ON SANDSTONE ABRADER. PHOTO BY ARIANNA DURANTE.

FIG 5C. TECHNOLOGICAL SEQUENCE OF THE BEVELLED ARTEFACTS' PRODUCTION: DECORTICATION. PHOTO BY ARIANNA DURANTE.

FIG 5D. TECHNOLOGICAL SEQUENCE OF THE BEVELLED ARTEFACTS' PRODUCTION: PERFORATION OF THE QUADRANGULAR HOLE. PHOTO BY ARIANNA DURANTE.

FIG 5E. TECHNOLOGICAL SEQUENCE OF THE BEVELLED ARTEFACTS' PRODUCTION: REALIZATION OF THE FORKED END OF TOOL NO. 3. PHOTO BY ARIANNA DURANTE.

FIG 5F. TECHNOLOGICAL SEQUENCE OF THE BEVELLED ARTEFACTS' PRODUCTION: HAFTING WITH WOODEN WEDGES. PHOTO BY ARIANNA DURANTE.

FIG 6. THE EXPERIMENTAL BEVEL-ENDED TOOLS. PHOTOS BY SARA MARIA STELLACCI; ELABORATION BY ARIANNA DURANTE.

FIG 7A. FIRST FUNCTIONAL EXPERIMENT: TILLAGE. PHOTO BY ARIANNA DURANTE.

FIG 7B. FIRST FUNCTIONAL EXPERIMENT: LEVELLING AND COMPACTING THE SOIL WITH LATERAL SURFACE AND SECOND ACTIVE EDGE OF TOOL NO. 5. PHOTO BY ARIANNA DURANTE.

FIG 8A. SECOND FUNCTIONAL EXPERIMENT: CHOPPING OF FRESH WOOD SECTION WITH TOOL NO. 4. PHOTO BY ARIANNA DURANTE.