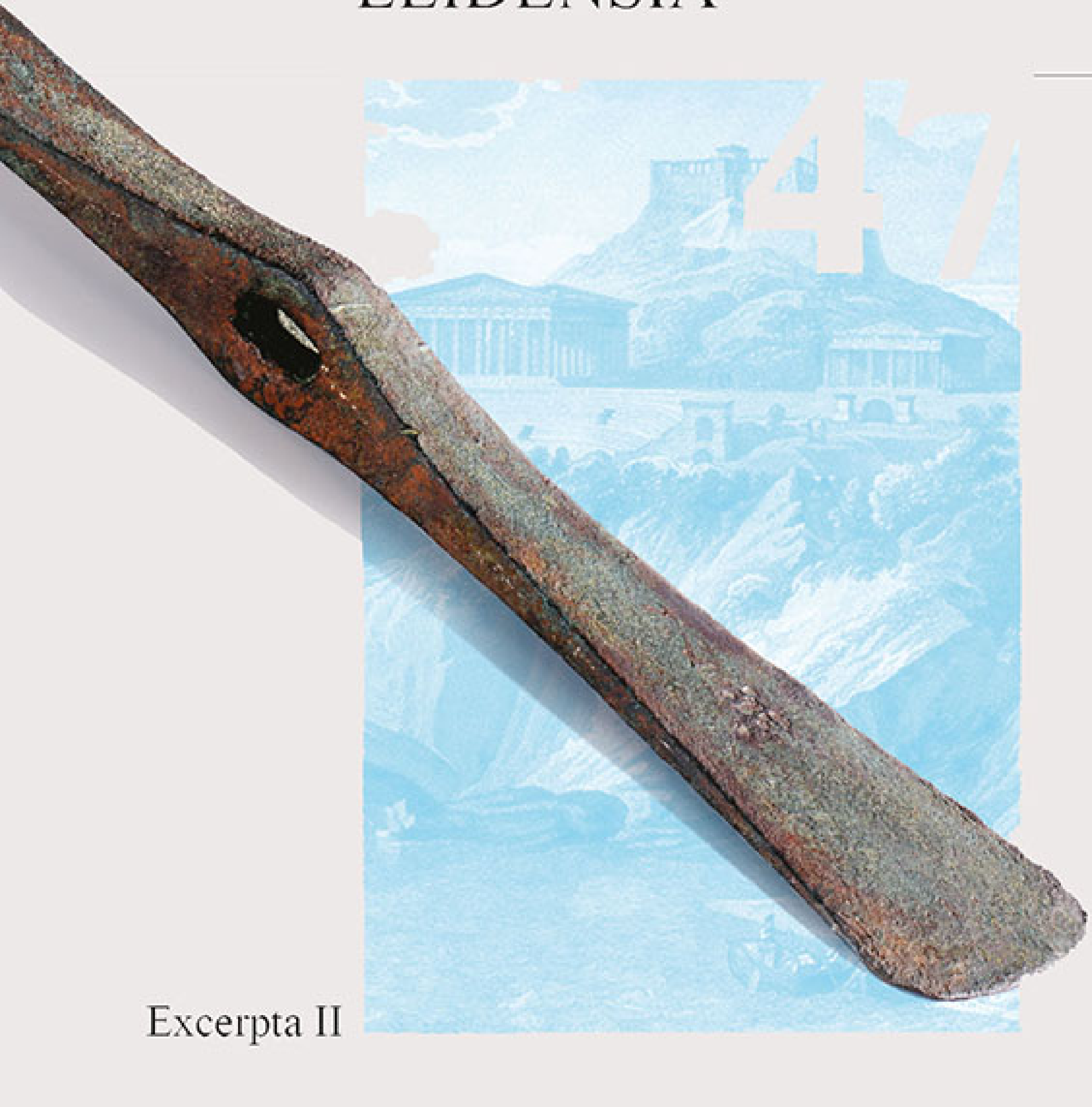
ANALECTA PRAEHISTORICA LEIDENSIA



Excerpta II

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Contents

Enigmatic plant-working tools and the transition to farming in the Rhine/ Meuse Delta

Aimée Little and Annelou van Gijn

This paper represents an attempt to address the transition to farming through a long-term study of plant microwear traces on flint tools. We report on a series of archaeological research projects which show the presence of a specific type of siliceous plant-working flint tool in the Mesolithic and Early Neolithic of the Rhine/Meuse Delta region that disappears when the first evidence for crop growing appears in the archaeological record. A long-running programme of experimentation has shown that these plant traces are related to plant craftwork. The disappearance of tools displaying traces of this particular type of plant-working at the time agriculture starts to take hold in this region has led us to argue that this craft was related in some way to subsistence, probably a change in subsistence technology. We show that microwear studies of plant polish on tools offer a complimentary and often overlooked form of evidence to more traditional methods of studying the Neolithisation process.

1 Introduction

Microwear analysis of a series of Dutch flint assemblages dating to the Mesolithic and Neolithic appears to show the disappearance of a specific type of wild plant polish found on unretouched blade and flake tools as agriculture takes hold in the Rhine/Meuse delta region. The disappearance of these wild plant working tools at a time that crop growing takes hold leads us to believe that this microscale evidence for plant-working may add to a much larger debate regarding the timing and speed of transition from hunter-gathering to fully agricultural subsistence economies in Northwest Europe (*e.g.* Huisman and Raemaekers 2014; Armit and Finlayson 1992; Whittle and Cummings 2007 and references therein; Smits *et al.* 2010). While rarely considered as a means of investigating the transition, microwear analysis of flint tools has revealed evidence for a change in the way people were interacting with their environment, in turn affecting tool selection and use. As a technique, we show that microwear studies of plant polish on tools offers a complimentary and often overlooked form of evidence to more traditional methods of studying the Neolithisation process, for example zooarchaeology, archaeobotany, settlement and the adoption of pottery.

The specific type of microwear polish that is the focus of this research has been frequently observed on Mesolithic and Early Neolithic assemblages in the Lower Rhine Basin, at sites such as Hardinxveld-Giessendam Polderweg and De Bruin (Van Gijn, Beugnier *et al.* 2001; Van Gijn, Lammers *et al.* 2001), Leeuwarden Hempens/N31 (Noens 2011), Swifterbant (Bienenfeld 1986; Van Gijn 2010; Devriendt 2014), Hoge Vaart (Peeters *et al.* 2001) and Brandwijk (Van Gijn 2010) (fig. 1). Most commonly, it has been identified on unretouched blades with a regular, straight to often slightly concave edge of approximately 30 degrees on average (fig. 2). The polish discussed here is oriented in a transverse to slightly oblique direction, indicating that the tools were used to scrape or plane. The polish is semi-invasive, meaning

Figure 1 Dutch Mesolithic and Early Neolithic sites containing flint tools with transverse siliceous plant polish

the worked material is soft, with either the ventral (mostly) or dorsal surface displaying a more invasive polish than the other, denoting the leading face. Appearing in a continuous band along the edge, this polish has a high degree of linkage. The polish is usually distributed, if well developed, along a length of 1-1.5 cm of the edge. It is the smoothness and brightness of the polish that suggests that the tool has been used to work a siliceous plant material. However, it should be stressed that there is some variation in the polish, especially regarding its topography (fig. 3). One variation is flat with a higher density of striations, the other is smoother and has a more undulating topography with lesser and finer striations. Occasionally we encounter this variability on the same edge of a tool.

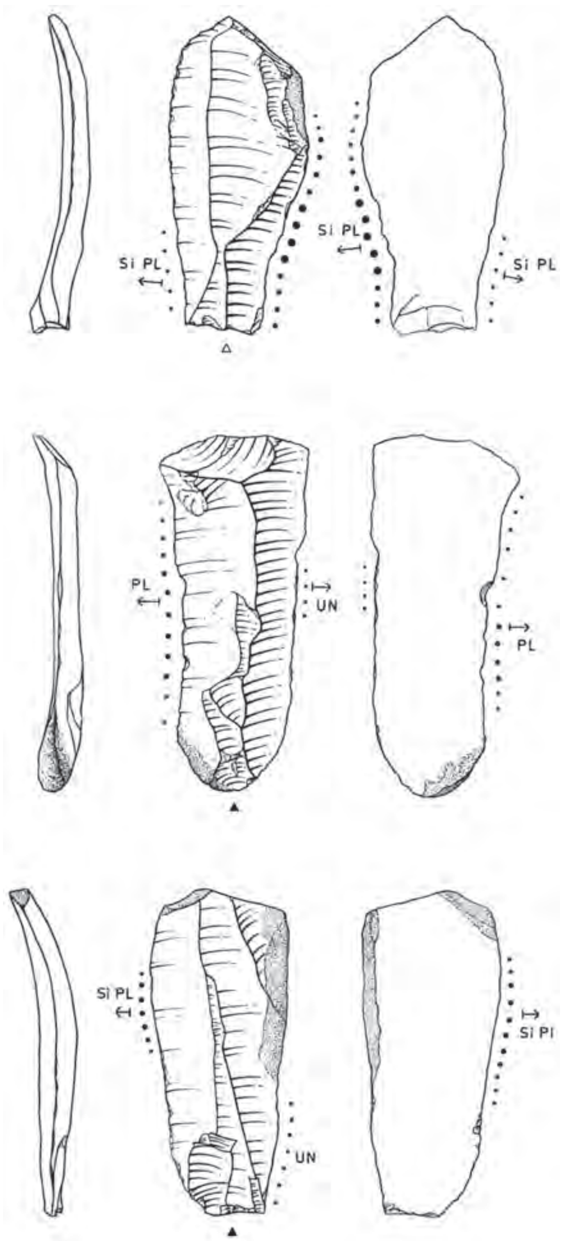

Figure 2 Illustration of unretouched blades from Hardinxveld Polderweg showing the distribution of transverse siliceous plant (si PL) polish (Van Gijn *et al*. 2001a)

Figure 3 Variation in transverse siliceous plant polish on unretouched blades from Hardinxveld-Polderweg (200x) (Van Gijn *et al*. 2001a)

A combination of experimental research with processing various types of siliceous plants and an extensive microwear study of a range of sites from different chronological periods, encompassing the 8th - 4th millennium, has shown that this polish is likely to be linked to a plant based craft; a craft that may have been vital to the Mesolithic and Early Neolithic occupants of the Lower Rhine basin, but appears to have lost its relevance somewhere between 4000-3750 cal BC. In this paper we present the results of a long running programme of experimental research on plant-working tools, evaluate the existing evidence from the Netherlands, place our data into its European context, and finally, discuss the implications of our findings.

2 Recognising limitations in our methodologies

It is important to be clear that while microwear analysis may enable us to interpret the general contact material and motion in which a tool was involved, it rarely provides conclusive evidence for the exact task carried out or the specific end product made (Van Gijn 1990). Microwear analysts rely on experimental reference collections to compare traces with those seen on archaeological tools. Experiments thus form a critical element of microwear studies. It should be stressed that this reliance on experiments also constitutes an important methodological weakness: when experimentally produced wear traces and archaeologically developed ones match sufficiently we infer a similar function. This is an inferential leap which assumes that such traces are exclusively linked with specific activities (Van Gijn 2010, 31–33) For example, traces from working wood can show extensive similarities to those formed from working antler or other non-siliceous plants (Van den Dries and Van Gijn 1997). Also, repetitive use and repair of a tool is not always easy to recognise. It is with these limitations in mind that we present our research.

3 Plant working traditions in Holocene Northwest Europe

For close to twenty-five years, there has been ongoing debate amongst microwear analysts concerning enigmatic types of microwear polishes that are most commonly recognised on flint blades and flakes dating to the Mesolithic and Early Neolithic of Northwest Europe. The geographical distribution of blades and flakes with plant polish is broad: encompassing most of Northwest Europe, including Denmark, Britain and France (*e.g.* Juel Jensen 1994; Crombé and Beugnier 2013; Hurcombe 2007; Gassin *et al.* 2013; Guéret 2013). Most analysts who have encountered these smooth and bright polishes agree that they are the result of siliceous plant-working activities (Juel Jensen 1994; Van Gijn, Lammers *et al.* 2001; Van Gijn, Beugnier *et al.* 2001; Hurcombe 2007; Gassin *et al.* 2013; Guéret 2013), however, exactly what plant and what activity it relates to is uncertain as the variation in polishes has not yet been experimentally replicated. Typically these traces are interpreted as being related to craftwork, but the use of tools with this polish in plant food procurement has also been suggested (Van Gijn 2010). During the early Holocene we see the emergence of different polishes most likely associated with working plants, often found in association with denticulated blades and flakes, often referred to as microdenticulates. The polish associated with these tools is described by Juel Jensen (1994, 61) as an asymmetrical polish: the non-contact surface has a highly reflective, vitreous, metallic polish with few striations. The contact surface has more variation and shows a bright smooth polish with perpendicular striations. Sometimes this side displays an almost hide-like polish, with heavy rounding, pitting abrasion and striations. The combination of the two polish types then closely resembles what has been called "polish 23" in an LBK context (Van Gijn 1990). In Britain, microdenticulates with slightly concave curved edges are known from a range of early and middle Neolithic site-types, but their presence declines in the late Neolithic (Hurcombe 2007, 45). In Denmark, they are known to occur in Late Mesolithic Kongemose, Early Ertebølle and TRB contexts (Juel Jensen 1994).

Another type of tool, notched blade forms, occurring in the 7th and 6th millennium BC, were used on wood but also to scrape siliceous plants (Gassin *et al.* 2013). In Northern France, at the Mesolithic site of Beg-an-Dorchenn, microwear analysts conducted experimental work, drawing on earlier studies of Caspar *et al.* (2005) to make a case for notched 'Montbani blades' or 'bladelets' as siliceous plant and plant fibre scraping tools (Guéret 2013; Guéret *et al.* 2014). Two main variants – the scraping of rigid plant material, i.e. arrow shafts (resulting in marginal polish) and the scraping of pliable vegetal fibres (producing a more invasive polish) were further identified. Their results reaffirm those from a comparable study of 42 used Montbani bladelets from nine Late Mesolithic sites over a broad region from North Belgium to South France (Gassin *et al.* 2013), which was extended to include North Africa (Gassin *et al.* 2014), suggesting these types of tools were part of a broad geographical tradition of plant-working.

In the delta areas of the Rhine and Meuse the morphology of the flakes and blades involved in plant-working substantially differ from the microdenticulates and notched tools in that they are typically un-retouched. Guéret (2013) has documented the same unretouched flakes and blades in the Scheldt basin of Belgium (a.o. the sites of Doel and Verrebroek) and northern France (Noyen-sur-Seine). These blades and flakes displaying siliceous plant polish are slightly concave, sometimes straight. It is the shape of the worked edge that shows similarities to the Scandinavian microdenticulates (Juel Jensen 1994) as well as the British Early/Middle Neolithic serrated forms (Hurcombe 2007, 45), but the fine denticulation is lacking.

Not only do we see morphological variation across North-western Europe in the types of tools selected for siliceous plant-working, the wear traces themselves also vary. Firstly, there are significant differences in the motion that was executed: the French notched pieces display slightly diagonal directionality and the microdenticulate blades from Ageröd V, Scania, often display traces of siliceous plant working that are longitudinal, therefore indicating a different motion and task (Juel Jensen 1994). In contrast, as mentioned, unretouched blades and flakes from the Mesolithic and Early Neolithic sites in the basins of the Rhine/Meuse/Scheldt are nearly always used in a transverse or slightly oblique motion associated with scraping or planning. Secondly, the polish on these unretouched flakes and blades never displays the undulating, highly smooth polish typical for many microdenticulates. They also never have a two sided polish. Yet, there are variations in the polish topography and distribution and some of these variations are also visible in other regions: a good example is the comparable wear traces on a blade from Hardinxveld Polderweg with a blade from the Belgian Early Mesolithic site of Verrebroek (see Beugnier 2007, figure 7).

It is apparent that a high degree of complexity arises when trying to grapple with comparisons and differences in plant-working evidence at this very broad inter-regional scale. Variations are subtle. It also remains to be seen how useful this geographical scale of analytical comparison is when microwear analysis as a method will always retain a degree of subjectivity (van Gijn 2014) and when comparisons are frequently made on the basis of photographs. Perhaps more critically, in attempting to identify such broad spatial and chronological patterns in plant-working traces we should consider whether in by doing so we are potentially obscuring vital differences – differences that may reveal intimate insights into regionally-specific or even site-specific practices. For this reason we want to focus the remainder of this paper on the transverse siliceous plant polish on unmodified blade and flake forms that shows continuity over a long period of time in the Dutch Rhine/ Meuse Delta region, but which curiously comes to an end as the Middle Neolithic commences.

4 Flint plant-working tools in the Dutch Mesolithic and Neolithic

Comparative microwear evidence indicates that the same type of wild plant-working activities was practiced at Mesolithic and early Neolithic wetland sites in the Netherlands. Although often associated with the Late Mesolithic, these plant-working tools occur in earlier periods as testified by the recently excavated Early Mesolithic sites of Yangtze Harbour (Sier *et al.* 2014) and Ede Kernhem (Crombé and Beugnier 2013), as well as at sites dated as late as *c.* 4200 cal BC (Swifterbant S2-4) (Bienenfeld 1986; Van Gijn 2010) (fig. 4a-c).

During the Early Neolithic Swifterbant culture, dated in the 5th millennium BC, people were still mainly hunter-fisher-gatherers, although towards the end of this millennium they had access to agricultural resources and even practised crop growing in the later phases (Cappers and Raemaekers 2008; Huisman and Raemaekers 2014). A small number of artefacts from the type sites of Swifterbant, were studied for microwear. These sites contained numerous unmodified blades that displayed transversely or obliquely oriented plant polishes (Devriendt 2014; Van Gijn 2010). The characteristic unretouched blades and flakes with transverse or slightly obliquely oriented plant polish are also encountered at various Early Neolithic B (4900-4200 cal BC) wetland sites like Hoge Vaart (Peeters *et al.* 2001), and Brandwijk (Van Gijn 2010). Their presence in these early Neolithic sites shows a strong continuity with the Middle and Late Mesolithic, and the more recent evidence from Yangtze Harbour (Sier *et al.* 2014), Ede-Kernhem (Crombé and Beugnier 2013) and Swifterbant N23 (Siebelink *et al.* 2012), dating to the Early and Middle Mesolithic. Remarkably, these traces are completely absent in the Middle Neolithic sites of the Hazendonk culture (3750-3400 cal BC) like Schipluiden (Van Gijn *et al.* 2006), Wateringen 4 (Raemaekers *et al.* 1997), and Ypenburg (van Gijn and Verbaas 2008): a period for which we have the first conclusive evidence for local cropping in the Rhine/ Meuse basin (Louwe Kooijmans and Jongste 2006). This absence cannot be attributed to differences in taphonomy or different selection procedures, as the plant working traces in question can be seen with the naked eye and are still visible even if the piece shows signs of heating or moderate patination.

The apparent disappearance of this very typical tool with equally prominent traces is interesting as these latter sites provide undoubted evidence for local production of cereal crops, albeit on a small scale, in this delta region (Out 2009). The recent evidence for tilled fields at the site of Swifterbant, dating to the later phases of occupation, c. 4000 BC (Huisman and Raemaekers 2014), suggests that somewhere between 4000 BC (when we still have these plant working tools at Brandwijk and Swifterbant S2-4) and 3750 BC, when they have vanished at Schipluiden (van Gijn *et al.* 2006), Ypenburg (van Gijn and Verbaas 2008) and Wateringen 4 (Raemaekers *et al.* 1997), the shift to agricultural practices gradually made these blades with straight or slightly concave profiles used for plant processing

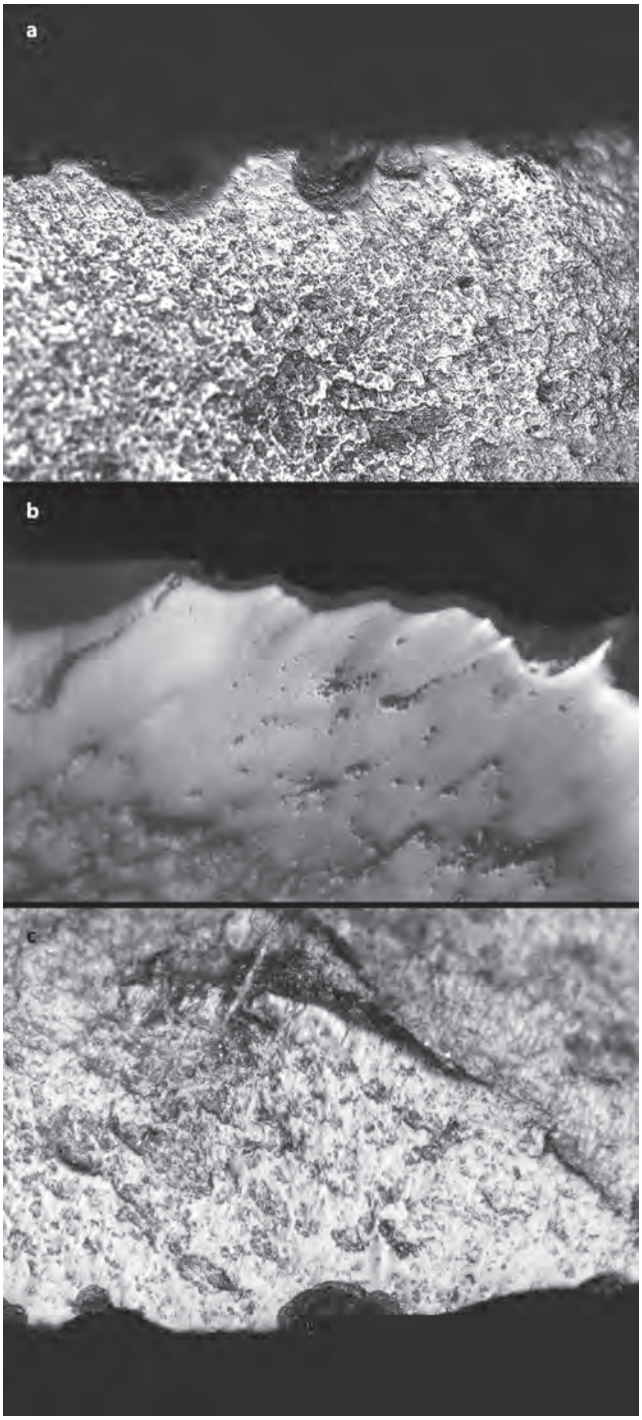

Figure 4 Plant working traces on unmodified flakes or blades from: a Yangtze Harbour (200x); b Swifterbant (S-2) (100x); c Brandwijk (200x) (photo's © Laboratory for Artefact Studies)

obsolete. It is, however, important to point out that no sites have been identified for the period 4000-3800 cal BC, making it difficult to assess the rate at which these tools go out of use. The fact that they disappear as agriculture begins to take hold in the delta area may provide a clue as to which activity lies behind the development of these characteristic plant processing traces. Most likely we have to search for a change in subsistence, with the transverse plant polishes associated with a technology connected to an important Mesolithic (and Early Neolithic) food source that was gradually becoming less important as a reliance on domesticated cereals increased.

It should be stressed that the disappearance of these typical plant processing traces in the Middle and Late Neolithic, so ubiquitous in the Late Mesolithic and the early Neolithic Swifterbant period, does not mean that plants were no longer being worked. On the contrary – in several sites of the Vlaardingen culture (3400-2600 cal BC) pointed flakes, having a very different working edge from the unretouched blades and flakes, were used to split semi-hard plant materials like thin branches of willows or other types of softer wood (Van Gijn 1990). It may well be possible that these tools were used to make the fish traps that we find at the site of Vlaardingen for example during the Middle and Late Neolithic, showing that wild plants continued to be important as a source of food and raw materials for craft activities in these wetlands (Van Gijn 2010).

5 Experimental research on subsistence and craft plant-working tools

On the basis of the palaeobotanical evidence (Out 2009) we conducted a number of experiments using replica unretouched blades and flakes on consumable and craftwork plants. Tubers of common reed (*Phragmites australis*), *Typha angustifolia*/*latifolia* (bulrush), *Equisetum* (horsetail), *Nymphaea alba* (white water lily) and *Nuphar lutea* (yellow water lily) were peeled (peeling can also create a transverse polish) with replicas of these blades. These tubers contain a lot of starch (Wood 1997, 381) and may have constituted an important food resource in some regions during the Mesolithic (Zvelebil 1994). However, the resulting experimental polish does not match the archaeological traces. Cooking experiments with tubers of horsetail indicate that it is actually far easier and tastier to roast the tubers directly in the fire than peeling them in advance of cooking, with well charred outer skin peeling off easily before consumption. Hazelnuts (*Corylus avellana*) which have become synonymous with the Mesolithic were split using blades. We also experimented with raking the seeds of wild grasses (fig. 5). On the basis of their charred state at the Hardinxveld sites tubers of *Ranunculus ficaria* (*Lesser celandin*e) and water chestnuts (*Trapa natans)* were probably consumed (Bakels *et al*. 2001).

It is, however, difficult to conceive of a way that flint tools would be useful in the collection or processing of any of the aforementioned plant foods. In fact, few wild plants gathered for consumption would actually require the use of a flint tool. We have therefore concluded that direct use of these blades and flakes for procurement of plants is not sensible. For this reason we turned our attention to plants used in craftwork, which we believe is the likely source of the archaeological polish.

The experimental craft activities carried out with unretouched blanks included the scraping of various siliceous plants including reeds (fig. 6), *Juncus* (rushes), bulrush, horsetail and *Urtica* (nettles). In addition we scraped the bark of *Salix* (willow stems), *Tilia* (lime), hazel, and *Cornus Sanguinea L.* (dogwood). De-barking different types of soft wood like brambles, lime, willow, hazel and dogwood resulted in a wood polish with the correct directionality but with a very different texture, distribution and coalescence (fig. 7). By scraping the fresh stems of the reeds/grasses a series of breaks are created, making the stems more pliable after drying so that they could be included in matting, basketry and twining. If the stems are not made pliable when fresh, they easily break when bent or twisted in a dry state. Although the archaeological and experimental traces still do not entirely match, this activity has produced the closest parallel (see fig. 6). It is still unclear what the variation in polish between our reference collections and the artefacts reflects. Possibilities include different plant taxa, modes of working, the addition of minerals/dyes, or even differences in the state of the plants, in particular their water content at the season of harvest.

6 Conclusion

The fact that this type of plant-working tool disappears in a period during which agriculture becomes established as part of the subsistence system suggests that these tools were in some way or another involved in subsistence related activities. Whether this was the actual procurement or processing of plant materials for consumption, or whether we need to think of the production of a craft item or facility to procure a particular type of food, is not possible to ascertain at the moment. The fact that they are absent in contemporaneous Mesolithic sites like Hattemerbroek (Verbaas *et al*. 2011), a site located on the Pleistocene uplands, suggests that these tools were involved in a task that was closely connected to inhabiting a wetland environment. It is on this basis that we propose that these tools were involved in a craft activity requiring wetland plant(s), most likely fresh reeds. We further suggest that this craft may relate to fishing activities; however, this theory remains largely hypothetical, and given the evidence for fish remaining a major component of the Middle Neolithic diet in this region (see Smits *et al.* 2010) what we may in fact be seeing is a change in fishing technologies. What is clear is that at this microscopic level it has been possible to see how plants played an essential component of hunter-gatherer daily activities in the wetland environment of the Rhine/Meuse/Scheldt Delta region, with a common tradition of plant-working, using the same tool forms, continuing over several millennia. It is such long term traditions in tool use, and the subtle changes that take place through time that microwear analysis can reveal, thereby contributing towards a better understanding of the Neolithisation process (see also Van Gijn 2015). These studies provide crucial information on the development of agriculture, the impact this had on the composition of toolkits, and the activities people carried out as part of their daily routines.

Acknowledgments

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Figure 5 De-husking grass seeds with a flint blade and the resulting polish (100x) (photo's © Laboratory for Artefact Studies)

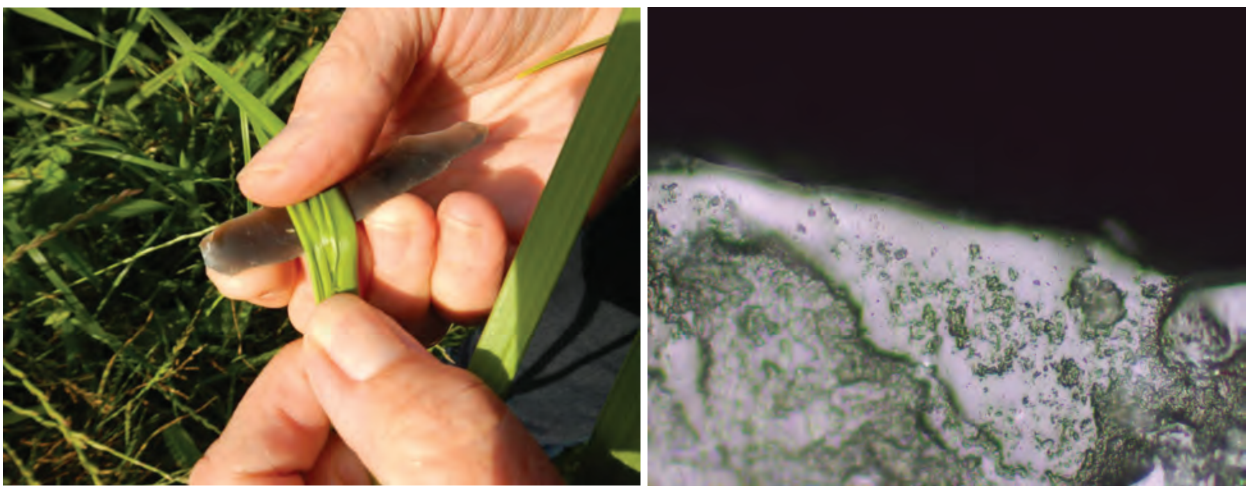

Figure 6 Planing fresh Phragmites with a flint blade and the resulting polish (200x) (photo's © Laboratory for Artefact Studies)

Figure 7 Scraping fresh willow and resulting polish (100x) (photo's © Laboratory for Artefact Studies)

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Aimée Little
BioArCH
Department of Archaeology
University of York
Environment Building
York, YO10 5DD
United Kingdom
aimee.little@york.ac.uk

Annelou van Gijn
Laboratory for Artefact Studies
Faculty of Archaeology
Leiden University
PO Box 9514
2300 RA Leiden
The Netherlands
a.l.van.gijn@arch.leidenuniv.nl

A visual spatial analysis of Stone Age sites

Milco Wansleeben

Intra site spatial analyses in the Netherlands has applied both visual techniques and statistical methods for some time. The actual characteristics of spatial data in general, and of Stone Age sites in particular, force us to rethink our analytical approaches. New developments in spatial statistics, easily available in modern GIS software, might not solve all the encountered problems. However, GIS also includes powerful methods to visualize the trends on our intra site distribution maps. This study proposes a visual approach, to better support archaeological interpretations, which often require substantial background knowledge to form viable conclusions.

1 Archaeological spatial data

A recent analysis of the site at Dronten-N23 (Wansleeben and Laan 2012) highlighted how archaeological spatial data contains a number of very specific characteristics which may hamper a spatial analysis. In order to discover regularities and irregularities in the spatial distribution of the archaeological remains, archaeologists produce distribution maps for visual inspection and calculate spatial statistics. Trends, concentrations, voids and outliers offer a way to get insight into the behavior of people in the past, insofar as these patterns did not become too blurred over time by subsequent habitation, geological and soil processes, or by the archaeological discovery process itself. While the distribution patterns of archaeological remains are inevitably faint and faded, a meaningful reconstruction of past behavior is still possible.

Characterizing the spatial distribution on an archaeological map is not self-evident. Spatial patterning has the ability to show different patterns in different spatial scales at the same time. The Dronten-N23 site, discovered in a shielded Pleistocene coversand landscape and dated to the late Mesolithic/early Neolithic period, serves as an example here (fig. 1). This site was excavated in squares of 50 by 50 cm for which the soil was sieved over a relatively fine sieve (2mm mesh size). The distribution of the thus excavated flint artifacts clearly displays a circular patterns of high density squares, which is strongly correlated to the elevation of the natural topography of the coversand ridge. The slightly higher parts of this ridge are much richer in flint than the central depression and surrounding edges. Within the generally wet areas of the Netherlands this is a typical reccurring locational preference.

The presence of a large number of hearths on the ridge confirms the primary context of these finds. Within the circular concentration nine individual concentrations can be recognized, each with a specific size and density. A detailed map of the concentrations VI and VII shows that these concentration are effectively composed of two to three small concentrations of flint artifacts. Zooming in further reveals that even these smaller concentrations are a fusion of little (1 to 1.5m) spots of high density. These tiny rich spots seem to represent individual flint knapping events. It is clear that these activities did not take place at the same time or close to the same hearth. It is simply a large palimpsest of many individual activities over a long period of time, resulting in an almost random collection of concentrations in different sizes, shapes, and densities. Reconstructing the behavior of the Stone Age inhabitants from these patterns is difficult but not entirely impossible. This multi scale characteristic of archaeological distributions has obviously been identified for some time and documented in archaeological literature, with *Confronting Scale in Archaeology* (Lock and Molyneaux 2006) as an excellent example.

Multi scale patterning has not only been discovered in spatial data but also in time series. A well-known example is provided by weather stations in their temperature measurements. The daily cycle of rise and fall of the temperature per hour is bound to the day-night rhythm, effectively the presence/absence of the sun due to the earth's rotation. This rhythm is crosscut by the influence of weather systems by which very irregular fluctuation of high and low pressure seem to result in a randomizing effect on day and night temperatures. This in contrast to much better predictable effects of the seasons (rotation around the sun) on the average daily temperature on a slightly longer timescale. An even longer timescale is considered when studying global warming, in which yearly or even 30-years (running) temperature averages are applied to visualize and discover climate trends. The longer the time span of the unit of measurement (hour, day/night, day, season, year, 30 years) the more general the pattern which can be discovered. At the

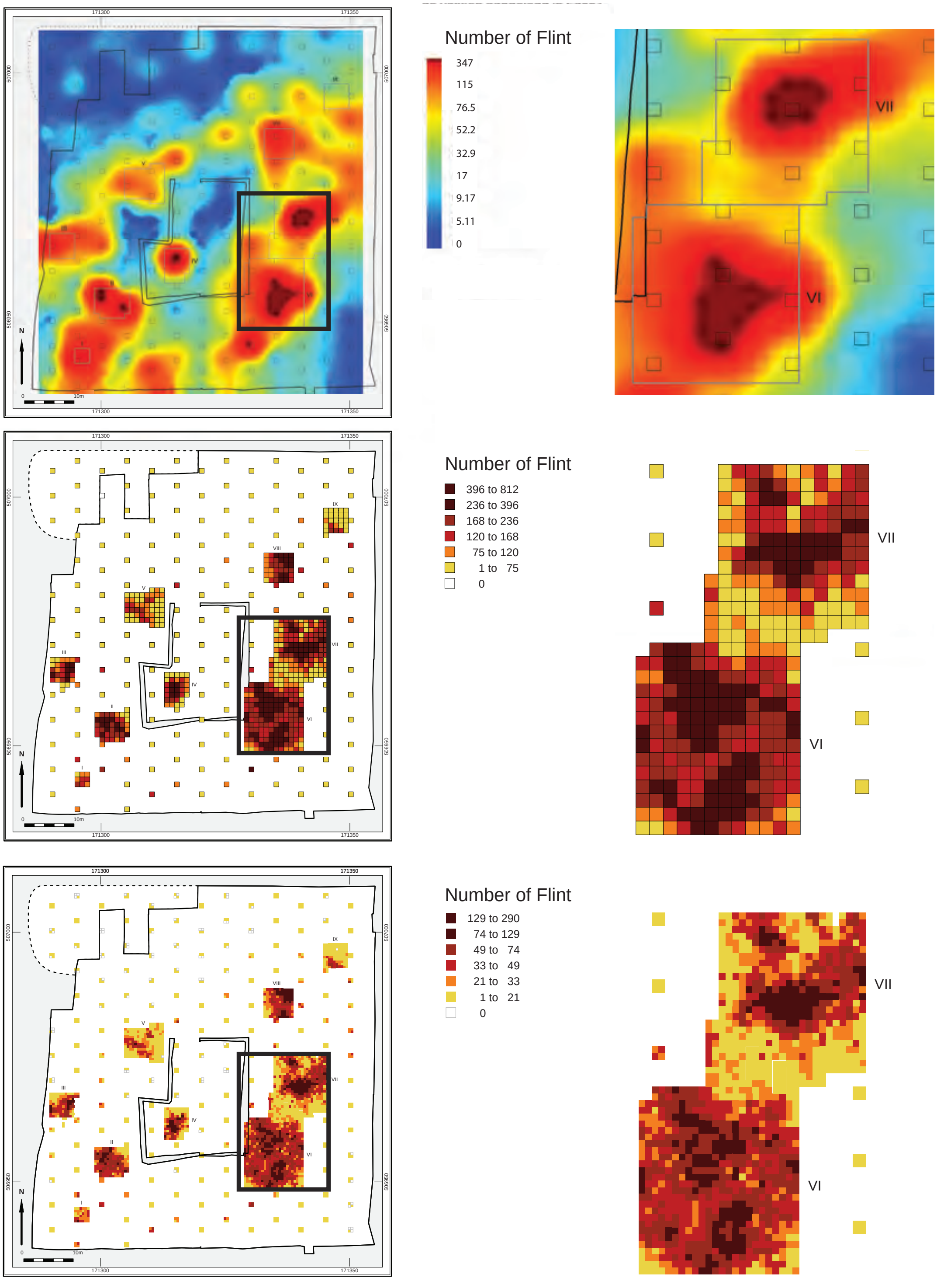

Figure 1 Spatial distribution of Dronten-N23: at different spatial resolutions, the entire site consists of a number of concentrations upon a ring shaped ridge of the coversands (top). The distribution patterns within these concentrations become more and more clear, richer in details and individual deposition events when stepwise zooming in to the 1 by 1 meter (middle) and 50 by 50 cm. grid size level (bottom). Multiple concentrations within a concentrate characterize the multi scale characteristic of (archaeological) spatial data. Details of the concentrations VI and VII are presented on the right

same time this example shows how different time scales have different explanations. The same conclusion applies to archaeology, which is confronted with both a spatial and a temporal component. The way an archaeological site was formed over time also includes temporal *multi scale* effects. A series of daily activities by the Prehistoric inhabitants of the campsite will melt together over the days and weeks into a diffuse pattern over a season. Even a yearly migration with multiple returns to the location, without the certainty that exactly the same activities were performed, will contribute to the seemingly unstructured clustering of flint artifacts across this coversand ridge.

The notion that spatial patterns on archaeological sites have multi scale properties, makes them a bit more difficult to discover. There is however another issues to consider: even at one spatial level the pattern might not be homogeneous across the entire site. At one corner of the excavation the patterns might indicate a clear clustering, while at another corner a much more random or regular pattern might be visible. At the same level of analysis concentrations might be large, round and rich, while interspersed with a lot of small irregular concentrations.

Both these observations, archaeology is confronted with *multi scale* and *non-homogeneous* spatial patterns, should have methodological consequences. This requires rethinking the way we perform a spatial analysis on an archaeological site.

2 Intra site visualization

Spatial data available for archaeological sites is often available as one of two types: point data where we know the exact coordinates of individual objects, or grid data (squares). In the latter only the amount or total weight of the finds is registered in square excavation units of a specific size (for instance at Schipluiden 1 by 1m (Wansleeben and Louwe Kooijmans 2006), at Dronten 50 by 50cm (Wansleeben and Laan 2012) and at Merselo 25 by 25cm (Verhart 2000)). Coordinate data can be reduced to grid data, yet grid data cannot be converted into coordinate data. Based on the exact position of the artifacts recorded in the field, the amount of finds within a square can be calculated afterwards. This approach is often applied to Stone Age sites in order to discover the general trend in the distribution. Many Dutch publications include a distribution map with the count of artifacts per square meter (fig. 2a). This is a broadly accepted visualization that offers some generalization. Methodologically, counting the number of artifacts in squares of 25 by 25cm, 50 by 50cm or even 2 by 2 m is equally valid. A larger square size will result in a more generalized visualization of the distribution pattern. Even the position, shape and orientation of the units used for counting the artifacts is not fixed. Why not use triangular or hexagonal units? The ring and sector method proposed by Stapert (*e.g.* Boekschoten and Stapert 1996) uses slices and segments to count the number of artifacts, expecting the distribution

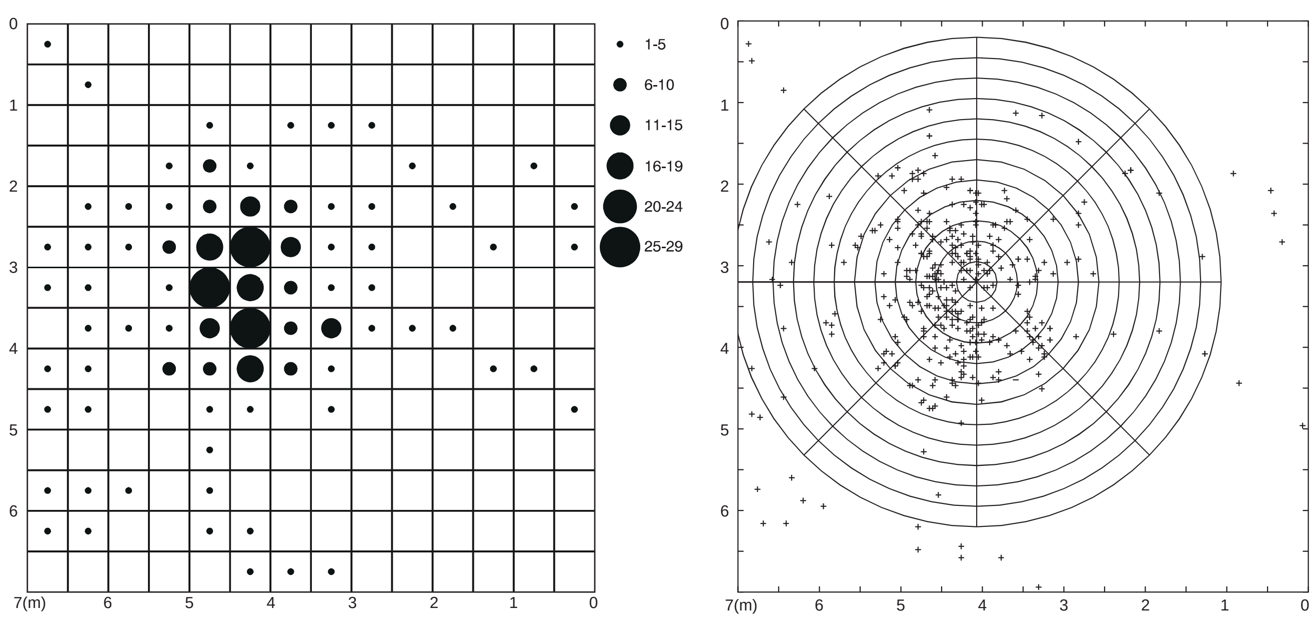

Figure 2 A traditional distribution map of the occurrences of flint artifacts across a Stone Age site, generalized into counts by square unit (2a, on the left). Stapert's ring and sector approach (Boekschoten and Stapert 1996) uses alternative spatial units to count and visualize the spatial pattern (2b, on the right)

pattern to focus on a central hearth (fig. 2b). As long as the area of all the units used for counting is of equal size, the frequency of artifacts can be displayed, if not, the density (corrected for the surface area) will be presented.

Any changes to the shape or size of the units will however lead to another visual image of the distribution pattern, and potentially to another archaeological interpretation. This problem is known as MAUP (=modifiable areal unit problem) (*e.g*. Cressie 1996; Kvamme 1990:269; Lock and Harris 2000:xx-xxi). The results of a generalization of the spatial distribution largely depend on the choice of spatial collection units. In the case of point data this problem can be easily bypassed by calculating counts for squares of 25 by 25cm, as well as 50 by 50cm, 75 by 75cm, 1 by 1m, 2 by 2m, etcetera. The smaller units show a more detailed (*local*) pattern, whereas with larger units a more generalized (*global*) pattern is displayed. Nowadays this can easily be applied in the spatial analysis of Stone Age sites, since GIS software facilitates quick and easy counts for several unit sizes and shapes.

Be aware that counts using units of unequal sizes or shapes across the distribution map, like the ring and sector approach, might create an unwanted side effect, namely that the amount of generalization is unequal as well. Therefore, it seems better to use the same size and shape of the collection units across the entire site, making the interpretation more robust. If a circular concentration exists, with or without different densities in certain sectors, this will certainly show up clearly in a spatial analysis which uses small squares.

If the archaeological excavation collected the artifacts in squares during fieldwork (grid data), the only option left is merging grids into larger units, creating an increasingly more generalized overview. There are no ways to experiment with very small or irregular shaped units.

3 Spatial statistics

Which spatial statistics can be applied depends completely on the type of spatial data available. Point data require other techniques and parameters than grid data, although the aim of the technique might be the same. A statistical technique can be applied in order to characterize the spatial distribution into a single numerical parameter that would indicate whether the distribution is random, clustered or regular. In case grid data is available a technique called the Variance/Mean-ratio (V/M) is sometimes applied, whereas for grid data the Nearest Neighbor statistic (R) is available. An introduction to many of the spatial analysis techniques mentioned here, can be found in GIS handbooks, like Conolly and Lake (2006).

Many traditional statistical parameters, however, are not intended for spatial data. Kvamme (1993:92-93) clearly demonstrated that these a-spatial statistics often lead to meaningless results. The statistical assumption that each square is an independent observation is simply incorrect, since spatial data is known to be spatially correlated. If the density of artifacts in one square is high, then very often the squares neighboring it will contain many artifacts as well. This spatial autocorrelation, nearby observation have similar values, is completely ignored by the V/M-ratio, therefor the value of the ratio might be arithmetically correct but archaeologically meaningless. It simply does not give a valuable representation of the spatial distribution.

In addition, these single parameters describe the total distribution pattern across the entire site. This is exactly the same way Census Bureaus used to predicted the behavior of the entire population using a single ‘ideal’ representative, known as Jan Modaal (NL), Joe Sixpack (US) or Otto Normalverbraucher (D). A single representative is simply too crude a simplification of reality. These simple statistical parameters are apparently not very well suited for spatial data after all.

In geography and biology many spatial analysis techniques have been developed that harness the spatial autocorrelation perfectly and are able to recognize trends at different spatial levels. Despite this special characteristic of spatial information, these techniques seem to be able to provide a formal description of a distribution pattern. The development of the *nearest neighbor statistic* might be used as an excellent example here. At first this parameter was calculated with the distance between one artifact and its closest neighbor only. The average “nearest neighbor” distance for all artifacts was compared to a theoretical expectation and expressed into one parameter called R. A value for R of less than 1 would indicate a clustered distribution pattern, whereas a high value pointed to a regular pattern. But this parameter would effectively only take the lowest spatial scale into account. To get around this problem the calculation was extended, not only did it include the first nearest neighbor, but also the average to all second closest neighbors, and third, fourth, fifth, etcetera. With this approach a graph emerges that characterizes the spatial distribution in an increasingly larger area. For instance, clustering at a local scale and random at a higher level. This has been improved further into the Ripley’s L approach (Ripley’s K function). Within an increasing search radius the number of artifacts close by is calculated and matched to a theoretical expectation.

The generic concept behind these techniques is clear: spatial units of an increasing size are used to calculate the same parameter over and over again. Where Ripley’s K is available for point data, a technique called Getis-Ord Gi* (hot spot analysis) is available for grid data. The strength of the spatial autocorrelation is calculated at different spatial distances. Although these alternatives seem to have solved the multi scale problem, the aforementioned non-homogeneity seems to be persistent. Even these techniques ignore the problem that in one corner the pattern might be clustered while elsewhere it is regular.

Additionally one might question what the benefit for archaeologists is with these formal descriptions. Given the nature of archaeological spatial data, what do we gain from a statistical parameter or graph in terms of understanding the human behavior in the past? Archaeologists take so many other things into account then just the bare artifact distribution when interpreting an archaeological sitemap. Take for instance the site at Schipluiden (Wansleeben and Louwe Kooijmans 2006): a small permanent settlement of a Neolithic community on a low dune in the tidal area of the Dutch coast. The central, higher part of the small dune shows very low numbers of artifacts, which is in this case due to a well-known and very simple cause: erosion (fig. 3). The flanks of the dune have probably been enriched due to the

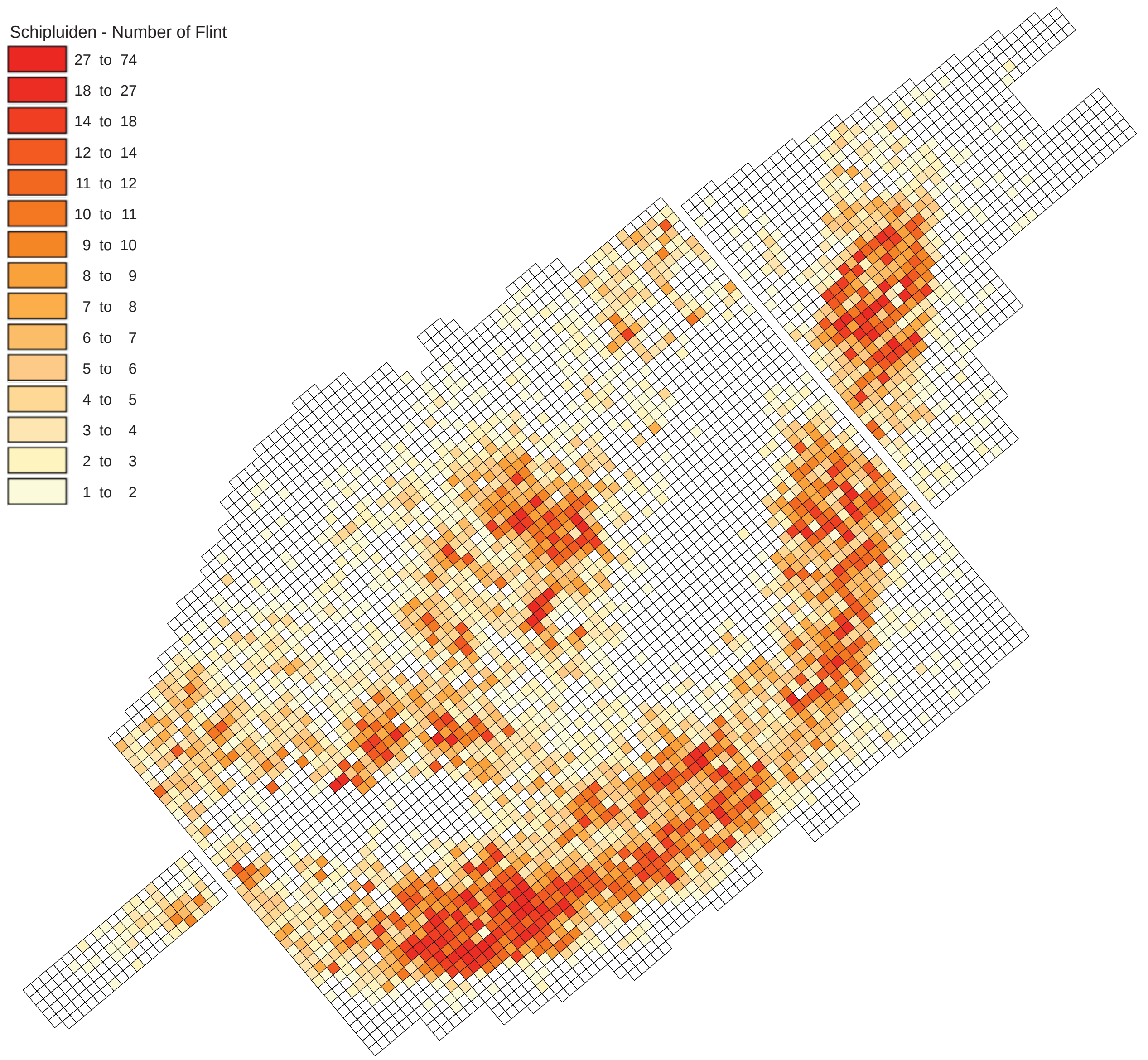

Figure 3 Spatial patterns of the density of flint artifacts as discovered at the Neolithic site of Schipluiden (1 by 1m squares). The center of this site has eroded after the habitation and caused a void in the distribution maps which does not represent human behavior but will be taken into account by spatial statistics (after: Wansleeben and Louwe Kooijmans 2006, fig. 4.10)

same process that took place after the site was abandoned. In the low lying deposits around the dune four concentrations of rubbish dumps could still just be identified, supporting the idea that four small houses were present at the site. A statistical technique would simply take the void in the center as a given fact and the resulting oval shaped ring of high densities would never be properly represented in a numerical value.

4 Visual inspection

It seems, to us, that archaeology might be better off with a number of well-chosen spatial visualizations after all. The current GIS software makes it possible to generate many different distribution maps for the archaeological site in a very quick and easy way. As mentioned before, counting the number of artifacts within multiple sized square units is very easy. The visualization can be improved by using geographical approaches like local density and kernel density. The original distribution map of points will be transformed into a map showing the general trends based on (weighted) densities within search radii. The spatial scale, i.e. the degree of the generalization, depends again on the size of the search radius. By calculating multiple kernel density maps, with increasing search radii, the distribution of the artifacts can be effectively analyzed and interpreted, both in terms of multi scale and subareas. With these techniques it is possible to identify clusters within clusters as well as subzones with clusters next to subzones with a regular pattern (fig. 4). For grid data the available counter part of

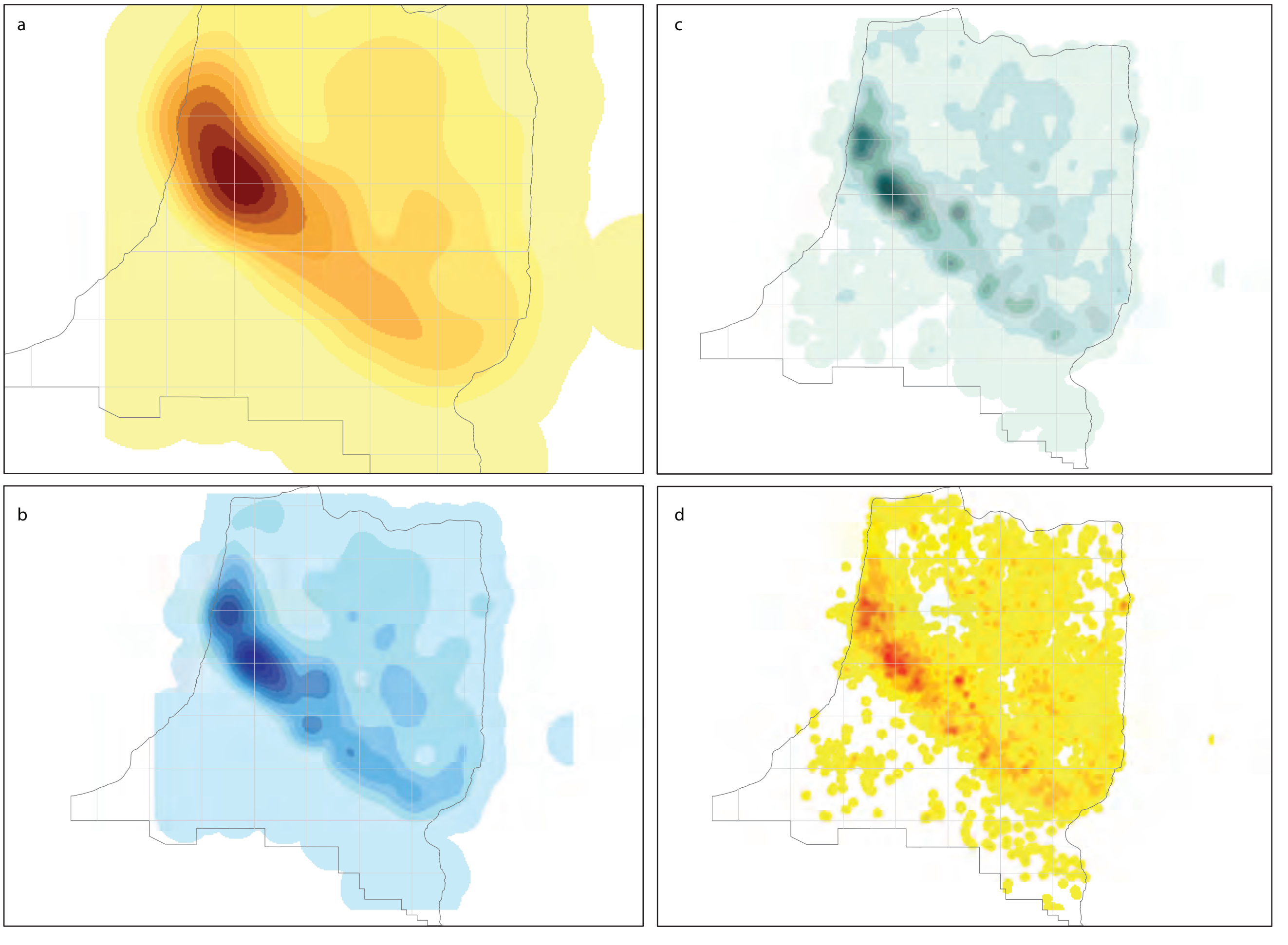

Figure 4 Kernel density-maps of the bone artifacts at Schöningen (Germany) as it was analyzed for different spatial scales and levels of generalization (based on data provided by Böhner, Böhner *et al*. 2015). This visual analysis shows that the artifacts are spread across a relatively narrow band along the former shoreline of a lake (top left). The ideal conservation conditions in the narrow band have played an important role in the perfect survival of the Palaeolithic finds. Within this band a number of large concentrations can be distinguished (bottom left), which clearly consist of smaller concentrations each (top right). At the lowest spatial scale (bottom right) individual butchering events seems to be present. The squares within the excavation represent areas of 10 by 10 meters

kernel density is called moving average. In this technique too, a larger *template* will result in a more general visualization of the find scatter. The Meteorological Office does not use the 30 years moving average for no reason in climate change analyses.

GIS software is very helpful in this approach, as it allows us to generate these trend maps on the fly. This interaction allows us to play with search radii, different ways to calculate the averages, different weights, different color ranges and class divisions, in order to optimize the visual effect. Adjusting these settings makes it possible to emphasize those key characteristics of distribution patterns we consider important for our interpretation of the archaeological site. This may seem less formal ("statistically solid"), but it allows us to incorporate our archaeological knowledge about the site (formation) and the human behavior in the past in a much more coherent manner. A number of well-chosen trend maps, in a well readable map presentation form, will do fine for archaeology.

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Milco Wansleeben
Faculty of Archaeology
Leiden University
PO Box 9514
2300 RA Leiden
The Netherlands
m.wansleeben@arch.leidenuniv.nl

A world ends: the demise of the northwestern Bandkeramik

Pieter van de Velde and Luc Amkreutz

One of the most enigmatic aspects of the Early Neolithic in the Euregion is its rather sudden end. After the initial settling of the area around 5300 cal BC the following two centuries saw a growing and even booming settlement landscape with expanding and newly founded bandkeramik villages. This in stark contrast with its ensuing rapid decline and disappearance in just three generations. In contrast to neighbouring regions there is no evidence for continuity of habitation through later Early Neolithic groups. Instead evidence points to a gap in occupation of this region for almost two centuries. While the possibility remains that contrary evidence can still be found, it is clear that there came a sudden stop to the LBK and that the Graetheide, Maastricht and adjacent Siedlungskammer have been abandoned. Clearly some sort of crisis must have underlain these developments. This paper seeks to address this issue and understand what happened. The authors adopt two different but related perspectives. The first one addresses the problem by focusing on the hereditary rules and kinship system characteristic to the LBK and how the unwillingness to change tradition may have resulted in increasing internal social stress and external social isolation. The second perspective adopts a wider regional view and outlines how changes elsewhere in the LBK world caused the important networks that held together LBK social fabric to disintegrate. The knowledge, or lack thereof, and the attitude towards these changes that were developing both to the southeast and southwest of our study region, in combination with its geographical position appear to have played an important role in its increasing isolation. Communities became as it were lost in translation. A combination of causes outlined in both approaches may be likely and while this paper does not provide a conclusive answer to the sudden disappearance, the authors believe it does draw into perspective its most important factors and ingredients.

1 Introduction

"No ethnologist has ever witnessed a major internal crisis in an aboriginal culture, which was not provoked by Western disruptive intrusion. An archaeologist may meet with traces of such a complex happening, yet the facts will often be ambiguous and difficultly put into the right order." (Jeunesse 2011b)

In the brilliant text from which these lines are taken, Jeunesse describes the archaeological transformation of the Early Neolithic Bandkeramik culture of the Upper Rhine and Moselle valleys through Hinkelstein into its successor cultures, mainly the widespread Grossgartach Culture. His overt implication of a crisis in Bandkeramik society, though, is not followed up by an investigation into the causes of that crisis. It is our intention to go where Jeunesse did not enter: the social origins of the crisis in Bandkeramik/LBK society that resulted in especially the demise of the northwestern branch of the LBK in the Euregion (the loessic area between Cologne and Brussels), while probably as a result of that very crisis more to the South and East LBK culture was transformed into Hinkelstein, Grossgartach and other successor cultures. The first part of this paper by Van de Velde highlights these social origins of the crisis that took place. The second part by Amkreutz returns to the work of Jeunesse and draws out the geographical position of the Euregion LBK and the collapse of the LBK network. Both place different accents, but the elements of both approaches may complement each other in a broader perspective.

2 Part one: the NW-LBK –bloom, decline and fading away

2.1 *LBK social structure*

In ethnology a society like the Bandkeramik goes by general labels such as familistic, tribal, ranking, primitive, etc. (Service 1971) comprising fairly egalitarian societies made up of families connected through habitual or customary exchange of marriage partners and goods, 'segmentary societies', without any other encompassing political structure whatsoever. These societies are mainly held together by relations of exchange – (non-monetary, non-commercial) exchange of marriage partners, of goods, and of services. The mechanism behind these relations is that the receipt of a good results in the givers' expectation of a return and a receivers' moral debt which is to be evened by a return; immediately in a commercial purchase as in our society, or rather, when not commercial, after some time as in those societies. The expectation of a return implies mutual dependence of the partners, familiarity, be they individuals or groups –reciprocity is what keeps societies together (Mauss 1925; Lévi-Strauss 1967, 52-68; Godelier 2004, 447, 456). Hardly conceivable to us, beyond these exchanges there is no political organization binding the villages internally or externally; families ("lineages") are the largest independent political units (cp. Pechtl 2016).

In small-scale societies relations of exchange are patterned, an automatic and unavoidable consequence of the repeated selection of customary and trusted partners, even of marriage partners. Thus, "... a man must obtain a woman from another man who gives him a daughter or a sister" (Lévi-Strauss 1958, 44). This selection of brides from the same group/family as one's mother came from results in a so-called ´elementary structure', as it is based on a simple i.e., elementary marriage rule (Lévi-Strauss 1967; Allen 1985; Parkin 1997; also cf. Godelier 2004). When specifying such marriage relations, this works out in a system in which at least two male and at least two female lines of descent ("kin groups") are required (Allen 1986, 4.3; Godelier 2004, 525). For, a woman in group P will have sons P and daughters P, a man in group A will have daughters A and sons A. To avoid incest –a universal arrangement (Godelier 2004, 476ff.) – these children have to look for partners and marry non-P, and non-A respectively. Say 'non-P' is Q, and 'non-A' is B, then children from these successor families (Q, B) should marry into groups non-Q and non-B. Certainly, non-Q and non-B might as well be (descendants from) the P- and the A-groups in an earlier generation – or still other groups, but at least 2 × 2 groups are required (Allen 1986; 2008).

P/non-P, Q/non-Q, A/non-A, and B/non-B are suggestive of twinned groupings of descent lines, technically 'moieties', and more often than not kin-based societies recognise such pairing of descent groups. If both descent reckoning (heredity) and marriage choice are conditioned by the same preferences (either female or male succession) then such a structure is labelled 'harmonic', if by opposite customs it is called a 'disharmonic regime' (inheritance along the male line, partner choice according to female groupings, or *vice versa).* It is generally acknowledged that disharmonic regimes are less stable and in the long run will tend towards harmonic arrangements (Murdock 1949, 211; Lévi-Strauss 1967, 317; Fox 1967, 109-110; Godelier 2004, 533).

The exchange of marriage partners is probably the most important exchange in one's lifetime; in small-scale societies it is not only this choice which is at stake: marriage relations are part and parcel of long-standing, customary relations between groups/families. Partner-families tend to visit each other, probably frequently; they will bring and/or receive small things thus strengthening the bonds. Also and beyond these marital exchanges, some other groups may be involved as well: flint sources may be 'owned' by a specific lineage, another group may be specializing in links with the supernatural, etc, necessitating dealings by the non-privileged groups. All of these exchanges are governed by traditional and familiar partner group (not individual) relations. Every deal requires/brings forth a counter-prestation, this reciprocity consolidating the weave of society: *"... it is groups, and not individuals, which carry on exchange ... (A) lthough the prestations and counter-prestations take place under a voluntary guise they are in essence strictly obligatory, and their sanction is private or open warfare"* (Mauss 1925, 3).

The logic of such partner group arrangements is quite compelling, at least in print. Real societies, however, never fully conform to their own exchange/kinship maxims or preferences: deviations do occur, sometimes frequently; and this not only because the right partners are not always available for demographic probability reasons (cf. Schiesberg 2010; Strien 2010), hard-headed individuals may sometimes skip over as well. Ethnologists acknowledge this state of affairs by distinguishing between "mechanical models" (as theory/custom/tradition would have it) on the one hand, and "statistical models" (as lived by real people in real society) on the other (*e.g.*, Lévi-Strauss 1967, xxxix, 445-446). Generally (not always!), deviant behaviour is denied and veiled under conformist terms; the weight of familiarity and tradition is heavy, especially so in small-scale societies.

As shown by several studies, LBK society was organized in kin groupings, too, united by a societal (mechanical/ theoretical) model that was lived in a statistical way; i.e., with more or less frequent deviations from its own traditional norms (Hofmann 2010), though at least in some social fields conformity seems to have been sought consciously for (Sommer 2001). Thus, from the distribution of the finds in the settlement of Vaihingen on Enz (Land Württemberg, Germany), Strien, the excavator concluded that a substantial number of the women there had come from outside the village, while the males were of local origins mainly (Strien 2000; 2005; 2010). The distribution over space and time of so-called secondary motifs on the decorated pottery and of flint knappers' signatures suggested to him even a patrilocal moiety (or "dual") system; the per generation shifting position within this and other LBK settlements of the very special type 1a houses (interpreted as an assembly hall, a chieftain's or chieftess' lodge, or something similar) pointing in the same direction (Strien 2005; Van de Velde 2008, 237; Van de Velde and Van Wijk 2014, 53-54). Other, earlier and later LBK investigations have shown that the female part of the equation was organised along matrilineal principles (*e.g.*, Claßen 2006 and 2009; Hoyer 2010; Krahn 2003). Together these studies confirmed earlier findings of a disharmonic social structure of LBK society based on an analysis of the Elsloo LBK-graveyard (Limburg Province, Netherlands; Van de Velde 1979a; 1979b, 79-119), specifically, a combination of patrilocality and matrilinearity. Of late, 'hard scientific' tests (esp. isotope analyses) have also found patrilocal practices in the LBK (*e.g*., Price *et al*. 2001; Price and Bentley 2005; Bentley *et al*. 2012; Bentley 2013) as well as the import of females into these communities (*e.g*., Bentley *et al*. 2003; Bickle and Whittle 2013a).

Statistical analysis of the grave inventories at Elsloo (where the skeletons had been dissolved in the decalcified soil) showed three sets of gifts, the first two excluding one another per grave, and a third one going with all burials without preference regarding the first two sets. Distance analysis showed a clear pairing of graves: those with gifts from the first two sets were nearer one to another than graves with gifts from the same set. An interpretation of the gift set which included arrow heads as male, and the opposite set as female was quite straightforward, paired graves being indicators of marriage partners. Analyses by the same procedures, now on the gift sets at the Niedermerz (near Cologne) and Flomborn (in the Palatinate) cemeteries yielded similar patterns (Van de Velde 1979b; 2011). Going by the amount of gifts per grave, on the average male graves held some more than did female burials, yet in particular pairs this might be reversed. With time (going[1] from LBK-II to -V), the amount of gifts accompanying the burials increased, even doubled, and the differences between male and female interments became more outspoken, men gradually commanding more grave goods (especially adzes) than their partners (Nordholz 2015).

In the present context it is of special interest that whenever decorated pottery was in a grave, with female burials its decoration was homogeneously decorated, and with males heterogeneously; with curvilinear ("C") *or* rectilinear ("R") motifs in female graves, C *and* R motifs in male interments, in all LBK cemeteries examined (fig. 1) On the assumption that the clear distinction of R *vs*. C-decorated pottery was important to them, these patterns should have had a *meaning* in non-literate LBK society[2], apparently related to the distribution of the women. An explanation can be derived from the previous paragraph: an R-male (who is a son of an R-family mother) *has to* marry a non-R, i.e., C-female to 'avoid incest', and so becomes associated with the latter group; when he dies there will be both R- and C-vessels present[3], whereas in the case of a defunct woman she will be accompanied by her own family-"label" (either R or C). In more general, sociological terms this means that there was a social organization consisting of matri-moieties (one moiety associated with curvilinearily decorated pots, and the other with rectilinearily adorned vessels). Within these moieties,

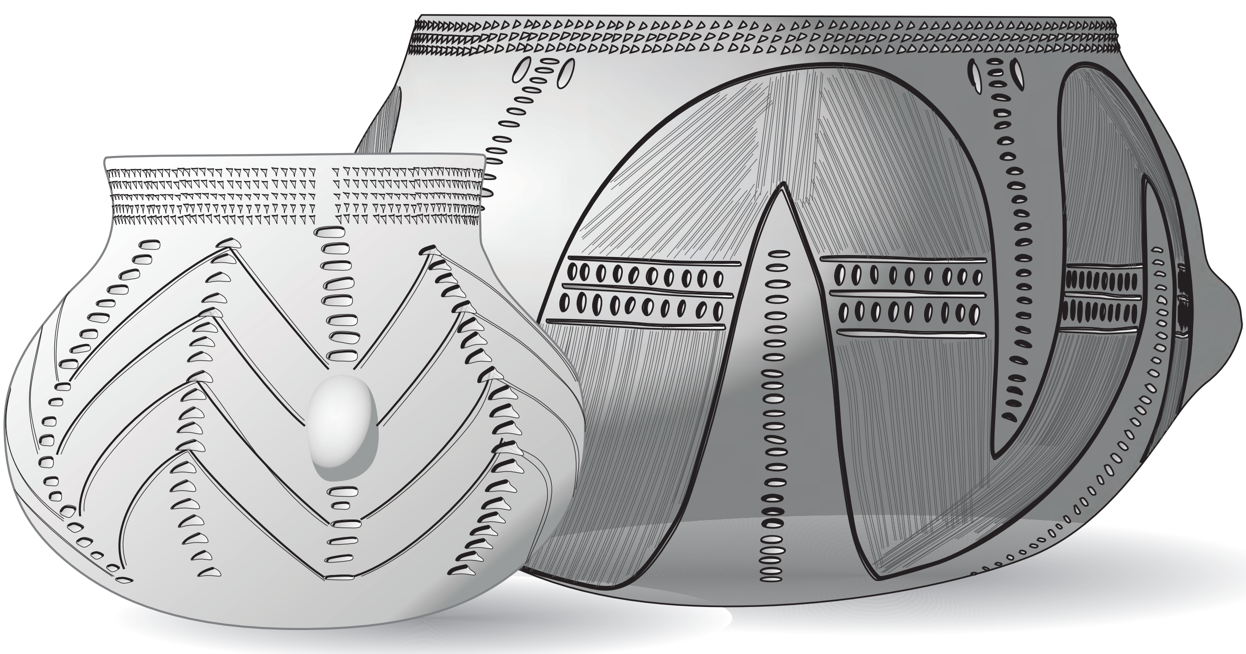

Figure 1 Curvilinear and rectilinear decoration on two LBK pots from grave 112, Elsloo cemetery (drawing van de Velde)

smaller entities (matrilineages) have been identified, also from the pottery decoration, specifically from the secondary motifs, apparently a kind of family name-plates (*e.g.*, Claßen 2006; Krahn 2003; Strien 2005). The importance of this sign system is perhaps the reason that complete (decorated) pots are hardly ever found on LBK settlement sites, not even in sherds; they occur almost exclusively in the graves. Also, neither R- nor C-decorated sherds ever occur alone but always are accompanied by their counterparts, even in small assemblages (again, excepting graves); if no meaning had been attached one-sided sets should more frequently be found.

One important and suggestive confirmation of their disharmonic social structure is found in the fate of the type 1a houses (with their distinctive ex- and interiors, generally being the largest of the houses in the village), already by LBK-II and -III. Probably restricted to the larger settlements these constructions shifted every generation to another *Hofplatz*, suggestive of a special function tied to one of its inhabitants, something like the village chief(ess), or medicine (wo)man, or village priest(ess). On the occasion of such a shift the old house was set to fire; ritually, apparently, for where it has been noted, it has ever been the same Southeastern front part of the house that had been ignited (Modderman 1959, Abb. 25; Waterbolk 1959, 129; Kuper *et al*. 1973, 44; Van Wijk 2001, 81; Van de Velde 2008, 238; generally Van de Velde and Van Wijk 2014, 53-54). One would see here an expression of (1) the importance of the matri-principle in a virilocal environment, and once per generation (2) a ritual alleviation of the tensions implied by the disharmonic social structures.

To sum up: LBK society was composed of patri- (or viri-) local groups crossed with a dual, matrilinear moiety-organization, each moiety uniting a number of matrilineages; ethnologists would label this organization a disharmonic regime. It may be expected that exchanges between the groups, not only of women but also of social support, of flint, amphibolite, of field and forest products, and of supernatural connections were generally along traditional (in this case, matrilinear) relations between these groups, some of which resources were probably controlled or even monopolized by specific lineages.

For its disharmonic social organization, with time LBK society was in for problems, as below.

2.2 LBK dynamics

Given such a basic social structure of virilocal groups tied socially by a matrilinear organization, the effects on LBK society may be investigated. As a start, in Frirdich 2005 a social explanation is sought for the Landnahm, the expansion of the Oldest and Older LBK (LBK-I and -II) in Central Europe. Earlier writings had proposed reasons preferably in the economic sphere such as agricultural exhaustion of the soil pushing people to move elsewhere (a.o., Childe 1950; Ammerman and Cavalli-Sforza 1979), or the acculturation of native mesolithicians because of the economic superiority of the neolithic way of life (e.g., Zvelebil 1986). Frirdich found evidence for competitive behaviour of local LBK groups, which resulted in a drive to extend their domain through the migration of group members. She did not specify the composition of these local groups, but given a social system as described above, (local) patrilineages would be best candidates for this role (Strien 2000; 2005).

Then, only indirectly connected with the foregoing, several authors observed that within especially the larger Bandkeramik settlements the size and constructional complexity of the houses are quite different (Modderman 1968; Van de Velde 1990; 2008; Coudart 1998; Jeunesse 2011a; Van de Velde and Van Wijk 2014; Gomart *et al*. 2015). One of the most suggestive differences being that the larger/most complex houses have granaries either within their walls or in silo-pits nearby, while smaller houses are lacking such features –indirectly pointing to social differences when not dependency relations. Of course, subsistence specialization may at least partially account for this notable diversity (*e.g*., Hachem 1997; 2000; Gomart *et al*. 2015), but the size differences are systematic and recurrent, quite obvious and too substantial to be ignored.

Additionally, LBK burial practices are indicative of considerable social status differences, too: the grave gifts testify to differential treatment, some graves going with complex inventories, others with few or no goods. Even more tellingly, at least about 90% of the Bandkeramians have not been buried in regular cemeteries; some few of the latter have found graves within the settlements, but the large majority has left no archaeological trace at all, possibly having been lain in the field or the forest (Van de Velde 1990; Jeunesse 1997; 2011a).

To put sociological flesh on this archaeological skeleton, to the outline of LBK social structure above it can be added that in a virilocal group the heir/successor would set up his house[4] close to his father's. Also, the more important the linear principle in social life, the stronger the emphasis on succession –leaving the successor's brothers with a choice between marginality on his premises, or moving out and setting up a new estate elsewhere, together providing the background of the *Hofplatz Modell* (Boelicke 1982; Strien 2010; Zimmermann 2012). The quite rapid expansion of the LBK (*e.g*., Jakucs *et al*. 2016; Timpson *et al*. 2014) testifies to the choices that have been made: new estates were set up nearby (together constituting a *Hofplatz*), or even new villages founded when some more similarly affected men from other lineages with their partners were involved. The results were the filling-in of landscapes, a pattern seen in many regions settled by the LBK (*e.g.*, Jeunesse 1994). That way, the patrilineages/-families (or 'houses' in the sense of Carsten and Hugh-Jones 1995, also Gillespie 2000) extended their sway, projecting their interrelations to the surrounding younger villages: once exchange partners, "always" exchange partners, wherever the houses of lineage members would be constructed.

Social structure never being static, in due time (maybe a few centuries) *"... the concentration of property in the hands of men specifically facilitates a transition to patrilineal inheritance among peoples who have previously followed the rule of matrilineal inheritance, for men now have the power and the means to make effective their natural preference for transmitting their property to their own sons rather than to their sororal nephews [living under another roof, probably in another village]"* (Murdock 1949, 207; also cf. Fox 1967, 109-110). More recent texts acknowledge these harmonising tendencies but deny exclusive patri-solutions (Godelier 2004, 533).

Thus, ethnology tells of tendencies to straighten out the 'opposition', the discongruity of patri- and matri-tendencies –patrilocal succession in the house/estate being at odds with matrilinear heredity of names and titles working towards a harmonic regime of either virilocal and patrilinear groups, or matrilocal and matrilinear groups. Given the duration of LBK societies of some fifteen generations we may expect such a simplificatory tendency, too.

As already deduced by Lüning and Stehli regarding the expansion of the LBK, social 'problems' (especially succession) have clearly been more important than economic factors such as exhaustion of the environment (Lüning and Stehli 1989; more recently, Zimmermann *et al*. 2009). The establishment of younger villages was not too complicated, since most of these were situated in the vicinity of the parent settlements where knowledge of soil, forest and environment was readily available. There, the decision to found a new place could be effected almost overnight; and in the case of failure, retreat to the parent village was easy.

Bandkeramians did not restrict migration to their home environments, much less frequently (though archaeologically more spectacularly) they invaded and occupied districts farther away, too. Obviously, when moving to distant lands more challenges have to be faced. For, to found a colony in a less common or even unknown area thorough reconnaisance is necessary, followed by a gauging and evaluation of the possibilities of the new land for several years through field trials etc., before even attempting settlement there. Generally, long distance colonisation is by small groups that establish themselves in a territory considered void of habitancy by them. Initially they tend to keep strong ties with their groups of origin (regular visits); later, when the new colony flourishes, it will tend to steer its own course, gradually deviating from the parental one –the mechanism by which the several regional LBK groups came to differ in material and social culture, Modderman's *diversity in uniformity* (Modderman 1988; Hofmann *et al*. 2016). Reasons to deflect will probably have been similar to those in shorter distance moves. Here too, a major *push* factor will initially have been virilocal inheritance which tends to alienate those in secondary positions; but perhaps the drive to extend the influence of the patrilineage was rather more important on these occasions: for, if successful, such an undertaking will have brought considerable prestige to the originators.

Once a new colony had been established and proven its viability, it will have attracted some of the people who initially had chosen to stay behind. Especially the weaker parental/lineage control in locations farther away, as compared with the home settlement, will have been a luring, additional motif.

2.3 Crisis, migration, and the end of the NW-LBK

Migration was a perennial aspect of LBK society, it was one one of its (defining) social structures; with origins primarily in patrilocal succession, as well as in the competition between the patrilineages; factors which continued and intensified by the growing differences within and between the lineages and the sexes against a background of disharmonic kin-reckoning. Where the latter was resolved into a simpler harmonic structure migration became less important[5], apparently.

Migration is movement of people; for those staying behind it is also a latent opportunity available in less than optimal social circumstances, a way out if needs be (Albrecht 1972; Hanlon and Vicino 2014; Massey *et al*. 1993; Del Mármol and Vaccaro 2015). As noted above, migration may start as a response to social stress, then become a regular possibility, and end up as a social structure, driving people out because every group that leaves is changing the social climate of those staying. Driven to its utmost, there will come a time when customary exchange partners have departed and substitutes are not immediately available, when less hands remain to help in the field or with defense, etc., all to the effect of a readily perceptible debasement of the local social environment. Consequently, migration tends to continue (sometimes long) after the original causes have abated, often ending in complete abandonment of the land of origin, especially when relatively small populations are involved in the process (Albrecht 1972, 17; Massey *et al*. 1993; Black *et* *al*. 2011). Recent examples are provided by the depopulation within a few generations of rural Northern Spain and Southern France (a.o., Del Mármol and Vaccaro 2015).

Back to LBK-archaeology. There is a curious divergent development of pottery decoration in the LBK at large: in contrast to the NW-LBK, in the Paris Basin in France, in Germany East of the Rhine and in Central Europe as well, in the LBK-IV period an ever stronger presence and elaboration of exclusively rectilinear motifs is found on the pottery, soon to be so different as to go by new labels: Stichband/Stroke Ware, Hinkelstein, Blicquy, etc.. Simultaneously, changes (esp. in house construction) are observed within the settlements there, yet accompanied by widespread habitation continuity (Stäuble 2014; Jeunesse 2011a).

That the R-C opposition is no longer being signified is probably indicative of the collapse of the matri-moiety system there, as theoretically predictable (Murdock1949, 213-215; Lévi-Strauss 1967, 69; also Eisenhauer 2003). Tensions arising from the disharmonic kinship relations have apparently been alleviated by the transition to a rather more harmonic organization of the patri-groups while suppressing differently structured matri-interests. The absorption of matrimoieties into a homogeneously patri-oriented social system will certainly not have gone without conflicts – possibly many times, yet ever on a local scale only (cf. discussion in Fausto 2001, 4-7), as there has never been a political organization uniting the LBK villages of a region capable of sustained repression or war; some ethnological texts emphasize permanent terrorizing between villages or kin groups in this kind of society (Service 1971, 104). The lineages were the largest independent political units, of necessity limited to simple raids[6]. Of course, the Herxheim complex and the Talheim massacre come to mind here (resp. Zeeb-Lanz *et al*. 2009 and Zeeb-Lanz and Haack 2016; Wahl and König 1987 and Wahl and Strien 2009), but while their discovery is associated with conditions of preservation, their occurrence perhaps argues for an interpretion as effects of these periods of stress and change. One with a raid-like character (vengeance? –irreverent burial of the corpses), the other perhaps a strongly ritualized massive ceremony at a place of central importance. In any case, there, in those more southerly regions the social transition to a more harmonic social system was by and large successfully accomplished – as demonstrated by the general cultural and social settlement continuity (Strien hints at this transition at Vaihingen: Strien 2005, 197).

In the NW-LBK however, the traditional kinship system and its associated exchange patterns persisted, with tensions between and within the lineages deriving from the disharmonic regime; finally resulting in regional extinction. There, the matrilinear organization was evidently stronger than in the other LBK-regions, if the signs of pottery decoration and the continuity in material culture may be trusted –the Elsloo cemetery, where the matri-moieties have first been recognised, dates mainly to LBK-IV; here, the matrilinear system clearly resisted assimilation to its virilocal environment.

The persistence of the disharmonic tradition in the Euregion, the resistance to structural change will not have gone uncontested, but rather accompanied by conflicts, probably more virulent than in the South of Bandkeramia where the structural opposition was duly solved. However, with the exception of the wilful destruction by fire of the type 1a houses, hardly any direct evidence can be presented from the archaeological record, only (indirect) pointers to conflicts are known: fortifications (Belgian Hesbaye, but these may have been constructed against local Mesolithicians, according to the excavators; Cahen *et al*. 1987; 1990; Bosquet 1993; also Golitko and Keeley 2007; but cf. Crombé 2016), ritual earthworks (German Rhineland, Dutch Limburg; Boelicke 1988; Van de Velde *et al*. 2009) and two or three graves with arrowheads in awkward positions (Elsloo cemetery; Van de Velde 1979b, 89) –unless the rather wide scatter and the rather small size of the villages of the two latest LBK-phases in this area are significant in this respect, too.

Also, in Maastricht-Klinkers an event as yet not explained may possibly be associated with the present problematic: in the 1980's two similar pits next to another have been found which showed massive destruction of decorated pottery, dated to LBK-IV. Into the one pit that has properly been excavated, on one single occasion nearly 300 vessels had been destroyed and thrown in –again, none of them complete. The pot decorations refer to several non-local styles (Van Wijk *et al*. 2014a, 244-249) as if the long-distance exchanges of women (and/or the matri-system) signified by them have consciously been rejected, we would suggest now, in line with the foregoing. We are quite sure that more traces of such an unexplained kind have been (and are still to be) found; they have not been reported explicitly, and certainly not in the light of the present problematic.

It is not only the disharmonic kinship system that was contested, most of the other archeologically visible exchanges suffered similar crises (imagine the non-visible realms!), illustrative of the general deterioration of exchange relations of which kinship is but one aspect. Claßen (*e.g*. 2009), De Grooth (*e.g*. 2016), Bosquet (*e.g*. 2011) and others have described the shrinking of the traditional geographically extensive exchange networks and the emergence of new, shorter ones together with the exploitation of new sources of flint and stone, possibly even of ceramic ware (Gomart 2014) in Belgian Hesbaye, Dutch Limburg, and the German Rhineland in the later and final phases of the NW-LBK. It is in such a social climate of insecurity that people tend to escape from their old places, and move to possibly less insecure environments outside the traditional and increasingly conflictuous settlement areas (Wahl 2013; Amkreutz 2016). For the Belgian Hesbaye, Golitko has proposed outright war between the LBK settlements, caused by *economic* factors such as disputed control of *economic* resources (flint, potter's clay, amphibolite, etc.) (Golitko 2010; also Golitko and Keeley 2007), basically a traditional Marxist argument. In our opinion however, economic causes of war pertain to our own type of society; in tribal societies such as the NW-LBK, with their independent kin groups without any wider political superstructure, only raids are performed, primarily for *social* (incl. ritual) reasons (in Marxist terminology, emanating from the *relations* of production). Following Mauss again, if exchange implies mutual dependence of the partners, then less exchange simply means less interdependence and more conflict – reciprocity is what keeps societies together, the decrease of reciprocity unties the bonds and even leads to "open warfare" (Mauss, as quoted above). In the Rhineland and Limburg unmistakably Bandkeramik 'earthworks' (ditched, often circular enclosures, with ritual functions assumed) were constructed outside the settlements, sometimes even after local LBK-habitation had come to an end (Boelicke 1988; Van de Velde *et al*. 2009), suggestive of remnant nomadic refugee groups. To no avail, though; as it turned out there, the Bandkeramik world had come to an end (Lüning and Stehli 1989; Modderman 1985; Hauzeur and Van Berg 2005).

Culture is a social phenomenon lived by a group; if the group dissolves, its culture disappears. Thus, the occupation in LBK-IV of the uplands beyond the older settlement areas, in the Rhineland (Dohrn-Ihmig 1979; Claßen 2009), in Limburg (Amkreutz 2006a; 2016; Van Wijk 2016), and in the Hesbaye (Cahen *et al*. 1990; Jadin 2003), even of fluvial terraces (Amkreutz 2006b), mostly with a few or even single farmsteads, should be interpreted not as a floruit of the NW-LBK, but rather as a preliminary stage of its full downfall and demise –which would take merely three generations (the end of LBK-IV, plus LBK-V). Survivors will have gone elsewhere, refugees to be absorbed by other groups, acquiring those other cultures' and losing the long-hallowed LBK habits –that is, becoming archaeologically invisible (cf. Albrecht 1972).

3. Part two: the pan-European LBK – transformation or decline

3.1 Introduction

In the second part of this contribution a broader regional perspective is adopted largely based on a recent paper by Amkreutz (2016). Bearing in mind the social factors described above that may have caused the demise of the NW-LBK in the Euregion, the perspective is now drawn to the wider developments that characterized the LBK world at the end of the 6th millennium. It is argued that the archaeological patterns that are found on this regional scale both underline the importance of networks for the survival of these early farmers and may at the same time be brought in line with the argument formulated above.

3.2 The importance of a familiar horizon: a broader regional view

What the foregoing demonstrated is that the larger, pan-European LBK is composed of communities that adhere to rather distinct societal rules and traditions (Sommer 2001). The mere fact that the LBK expanded over such an enormous area in such a short time span (*e.g*. Cladders and Stäuble 2003; Gkiasta *et al*. 2003; Gronenborn 1999) also argues that movement was an important trademark of this culture. More than just emblematic, both aspects should be understood as crucial to the very existence of the LBK, and, moreover, they cannot be understood in isolation. The strict traditions that we as archaeologists pick upon materially are grounded in distinct societal relations and systems of inheritance and ancestral ground. These rules are the backbone of the individual communities and explain the homogeneity that characterizes the LBK over its vast area. At the same time they constitute the single most important aspect of the expansion itself: the LBK could neither have existed nor have expanded without these rules. The mere fact that in the Flomborn and post-Flomborn LBK the material culture from the Paris Basin to the Dniester is, given of course a degree of regional variation, so comparable, is the very proof of the success of these rules and the LBK's coherent and conservative system (later than its initial phases, see Lukes 2004). That is, rather than focusing on place, people and community, we should place the relationships that connected them and that were introduced above from an anthropological perspective to the foreground. Instead of sites and material culture, we should understand that it was social structure and social networks that really are the reason that we currently encounter LBK in a similar form in so many different countries. Yet from a distinct causal perspective, a number of scholars have argued that the similarities in material culture, site location choice, economic package, raw materials etc. were necessary conditions for maintaining such a vast and expanding network over such great distances (*e.g*. Bickle and Whittle 2013b; Bogucki 1988; Frirdich 2005; Gronenborn 1999, 187; Sommer 2001, 257; Whittle 2003). Either way the expansive LBK was strongly dependent on its network, which in turn depended on mutually exchangeable signals and symbols, both material and social. It could be argued that for a good part of the last quarter of the 6th millennium LBK villagers shared a familiar world.

3.3 Missing the link

What happens afterwards (already discussed in some detail above) is the breaking down of these networks in three ways probably related to tensions arising from the initial disharmonic system of patrilocality and matrilinearity. In the NW-LBK we see that there is a gradual increase in the number of settlements climaxing around phase LBK-IV (Van Wijk et al. 2014b, 496–497). At the same time less traditional site locations are chosen, changes in the lithic networks appear and even evidence for fortifications (phenomena that also, including more distinct changes in pottery decoration, occur in other areas: Hofmann 2016; Lefranc 2007; Pavúk 2005; Pechtl 2015). Thus in the Rhineland around 5000 cal BC there is a peak in the number of households with about 1250–1350 household units (Claßen 2009, 98; Zimmermann et al. 2005, 34; also see Lüning 1982, 23) after which occupation density drastically plummets within a century, leaving the area empty (cp. Zimmermann et al. 2005). This also is the case in the Limburg and adjacent Belgian areas. This network breakdown therefore can be characterized as a peak in occupation followed by a situation of stress. Normally the means to mediate this would have been through the network, but due to the increasing emphasis on the local as for instance expressed in raw material procurement, and the evidence of violence as witnessed in the earthworks and defences, the tensions in the underlying system of exchange no longer made it a feasible option. One would expect that this regional crisis could have been assuaged by reaching further along the lines of the network. Outside the Aldenhoven-Limburg-Hesbaye area other, extensive Bandkeramik communities existed, both to the southeast and southwest and the problems arising from what may in fact have been related to a change in hereditary system could have been appeased by interaction of people, or goods moving along those lines. Except this is where the second and third network breakdown occurred.

Following perhaps similar problems as described above the situation further to the SE in the Rhine-Main area took a different turn. As argued by Gronenborn (2007, 85) the new Hinkelstein (HH) tradition (which included importantly a harmonic social structure) develops in the Rhine-Hessen area and spreads into the Neckar valley. Distinct imports at for instance Köln-Lindenthal (Zimmermann *et al.* 2005, 34) indicate that contacts existed between the two areas and that some material correlates of the changes further south reached the Euregion. However, here we see different developments. In its Rhine-Main core area erstwhile conservative elements were won over (although this was probably not without conflict and stress) and without a break in occupation there is continuity from the Late LBK, over HST and Grossgartach (GG) into Rössen. In the NW-LBK of the Euregion the new-fangled ideas that lay behind Hinkelstein and what would come after it would not get a foothold until there was renewed occupation during the middle phase of GG at sites such as Hasselsweiler 1 and 2 and Hambach 260 (Zimmermann *et al.* 2005, 34, 37). Instead of seeing here a clash of both worlds, reality may have been more complex. As for example proposed by Zimmermann *et al.* (2005, 36) and also argued above, the problems in the Euregion may have formed an important push-factor for people to move elsewhere, while the post-crisis developments of new ideas, relationships and alluring material culture from abroad, may to us in view of recent European history be an all too familiar pull-factor as well, albeit that the extent to which familiarity with these elements could be gained is questionable. A further distinct characteristic is that once the Aldenhovener Platte was resettled the old LBK settlement locations were deliberately avoided and settlement took place at a distance from these. While Zimmermann *et al.* (2005, 38) argue that this points to absence of kin relations or continuity it may also point to an awareness of previous occupation and conscious avoidance because of a very deliberate break with the past. In any case, one route of escape for the NW-LBK of the Euregion seems to have been barred since the world there had already changed irreconcilably, compared to old familiar LBK oecumene.

At the same time developments in the most western extent of the NW-LBK yield a comparable image. Settlements around Maastricht and the Geer-Hezerwater valley were probably part of the same settlement group (*e.g.* Van Wijk *et al.* 2014b, 495–496), while those further afield may have subsequently been established from these sites (Golitko and Bosquet 2011, 89). Strikingly in this area as well the later LBK sees the development of cemeteries (Toussaint and Jadin 2011) and the already mentioned enclosed sites (Darion–Colia, Oleye–Al Zèpe, and Waremme–Longchamps) (Golitko and Keeley 2007; Jadin and Cahen 2003a; Jeunesse 2011b). While there is as yet no distinct evidence for the plummeting of site numbers before the final phases of the LBK in this area there is indeed evidence of change. We here refer to several sites of the Groupe de Blicquy (BCQ), in the Upper Dendre area in Hainaut as well as 100 km further east. Remarkably some sites are located in the direct vicinity of LBK settlements (*e.g.*, *"le secteur blicquien"* at Darion (Jadin 2003, 477–478)), which contrasts with site location choice in the Paris Basin (Ilett 2012, 76). This new group is in fact not an isolated development, but part of the Villeneuve-Saint-Germain (VSG) complex which stretches into Brittany and to the Loire (Hauzeur 2011, 180–181; Ilett 2010; Jadin 2003). Compared to the LBK some striking differences already occur. These include the different forms, temper and decoration preferences and patterns on pottery, different, trapezoidal house shapes, expedient lithic technology, no adzes and schist or serpentine bracelets. Furthermore, a wider array of crop plants and different settlement locations (Constantin 1985; Hauzeur 2011; Ilett 2010; 2012; Jadin 2003) are part of this new constellation. It is, however, difficult to completely establish the chronological composition of BCQ (*e.g*. Blouet *et al*. 2013; Constantin and Burnez-Lanotte 2008; Crombé and Vanmontfort 2007; Hauzeur 2011; Jadin 2003; Jadin and Cahen 2003b; Robinson 2010). Radiocarbon dates and spatial association argue for a close chronological connection (Jadin and Cahen 2003b). Although there is no evidence for actual contact, around 4800 cal BC both LBK and BCQ occupation cease, contrasting with the Paris Basin homeland of the latter where post-LBK groups such as Cerny develop (Crombé and Vanmontfort 2007, 268; Jadin and Cahen 2003b). What we can hypothesize for this western development is that similar to what went down further east, important changes took place within LBK communities. The centre of these changes can be placed in the Paris Basin and adjacent area where the development of LBK into VSG and the related BCQ took place. While we lack hard evidence for contemporaneous late LBK and BCQ sites in the Belgian area, all evidence points to a very close spatial and chronological "encounter". The Hinkelstein sherds present in the Rhineland mentioned above may appear to be the result of less intensive contact compared to what went on here in the west. Either way, the late LBK in Hainaut and Hesbaye area did not commit to the new reality that was on offer from the VSG/BCQ complex although the spatial and chronological evidence makes it likely they were aware of this. Instead, they also gradually faded away either before or during BCQ presence.

In conclusion when trying to understand the demise of the NW-LBK it may be argued that on a regional perspective we are faced with a classic pincer movement. In itself the later LBK world was in a phase of disintegration, increased localization and internal struggle and competition. In some areas this phase of crisis resulted in something new: Hinkelstein, leading on to Grossgartach and Rössen in the southeast, the Stichband/Stroke Ware Culture in central Europe, Villeneuve Saint-Germain and its associate Blicquy in the west. In themselves these new developments may have had a certain attraction to some people or communities in the Euregion, thus adding to the tensions and depopulation there. At the same time, they were either too distant, or too unfamiliar (or both) to be taken as a serious alternative, or a way out of the crisis for the remaining Euregion communities on the Aldenhovener Platte, the Graetheide, around Maastricht and further west. In interpreting this decision to not adopt the new we should probably not think of one single factor, but of a series of mutually re-enforcing and closely related factors (also see Modderman 1988). These include depopulation and resulting from that economic stress, lack of marriage partners, increased intercommunal violence, the breaking down of resource networks or changing access rights, and perhaps increasing pressure from non-bandkeramik communities etc. What triggered them is unknown to us, but it is not unlikely that the change in hereditary system (introduced above), or rather in this case the resistance to that may have formed an important impetus. Another element to be considered is the degree to which these communities were really integrated in a long-range network. While objects, people and information may have travelled considerably, the strong connections and hence the mitigation of changes and solution to problems may only have been relevant in relation to other communities in the same Siedlungskammer. As such these local networks at the level of one or several villages could very well have been crucial in what decisions were made and to what extent things remained the same or changed. In any case if a solution was offered elsewhere from communities that had faced and surfaced similar problems, they were not taken up. One could say that the horizon of the NW-LBK communities in the Euregion was no longer familiar and could no longer offer an escape from an unavoidable end.

3.4 A note on networks: lost in translation

Perhaps it is useful to make some further remarks on this break in continuity. Jeunesse (2011b) discussing the end of the LBK importantly remarks that the destruction of symbols and the creation of a new identity and ideology are at the heart of these changes. Many of the changes in economy, settlement structure, or house construction would in themselves not have disrupted the existing LBK world if they were not the result of a deliberate change in the symbolic system and the choice of a new ethnicity (ibid. 184-185). Nevertheless, if one takes all these slightly changed elements that characterised the changed LBK world in the southern Rhineland, or in the Paris Basin into account, their integration requires a to some extent flexible, non-conservative mind-set of the 'receiving' party. One could argue that the changes surrounding the development of Hinkelstein-Grossgartach and Villeneuve-Saint-Germain/ Blicquy in themselves would have already caused a stir, but that their introduction in communities elsewhere can be understood as a confrontation with something even more alien (Amkreutz 2016, 381). With the benefit of hindsight we can argue that the LBK in the Euregion, which was itself under pressure, would have arrived in the stage of acquaintance with the new, either by hearsay, but perhaps also from own experience as the close spatial presence of BCQ villages or the presence of Hinkelstein pottery in the Rhineland may allude to. However it never got beyond that stage; in the Euregion, new elements were never seriously considered a candidate for incorporation. They were too alien and became literally ‘lost in translation’. This rejection may potentially have considerably contributed to the breaking down of the network. The reasons for the way this unfolded eventually were probably complex and interrelated: after crossing certain social thresholds (with often stringent, underlying biological and economic repercussions) there is no turning back. The root of these problems may however have importantly been the conservative elements in the NW- LBK of the Euregion (specifically the kinship and hereditary system which we have described above, as signified by the decorative patterns on the pottery). At the same time the more central position of the changes taking place to the southeast and southwest may have contributed to this development. The Euregion being geographically remote from both ‘centres of change’ may have been the latest to be confronted with the new developments. Before long-held traditions could be abandoned it was too late and the vital networks of interaction and exchange had ceased to exist or became too local to be sustainable for long.

4 Conclusion

This paper has attempted to sketch the outline and factors that were at play at the end of the LBK in the Euregion. In contrast with developments to the southeast and the southwest (*e.g.* Jeunesse 2011b; Zimmermann *et al.* 2005), LBK occupation here ceased in the early fifth millennium without any evidence of continuity in any recognizably ‘Danubian’ form. We have sketched two stories that, depending upon the viewpoint one takes, appear to be able to explain what happened. Both are related, but also place different accents. Archaeologically there is the evidence of a rapidly petering out of the LBK in the Euregion; elsewhere there is evidence across the later LBK for crisis in the form of violence, ritual, earthworks, increased regionalisation etc. Archeologically there is also the evidence for continuity in Central Europe into the Stichband/Stroke Ware culture, in the southern Rhine area with Hinkelstein and Grossgartach, in the west with Villeneuve-Saint-Germain and to some extent Blicquy. These facts may lead to a number of conclusions regarding the demise of the LBK in our study area, ranging from intergroup violence and attacking Mesolithicians, to epidemics, failed harvests and climatic issues (*e.g.* Modderman 1988; Gronenbron 2010). In our opinion these are probably only part of the story and perhaps more emblematic for it, then at its root. The fact that elsewhere in the rather homogenous LBK world different solutions to similar problems were found (cf. Modderman 1988) indicates that the situation in the Euregion is not comparable and should be judged on its own merits. Approaching the LBK world as a networked community allows for the detection of flaws in that network. The increasing regionalisation and the development of different systems of symbols elsewhere are the result of a collapsing/re-orientation of networks and in themselves support this development. There were some communities where the ‘revolution’ succeeded and others where it didn’t. In any case the latter may have managed to continue on shorter networks and with a more regional focus but in the end they were no longer able to participate in the changed LBK world and rapidly became more isolated in many ways. They eventually crossed demographic and economic thresholds that prevented their survival. Both of the aforementioned aspects appear more descriptive then explanatory. At the heart of this contribution, however, is an attempt at a sociological explanation. Much evidence from anthropology and LBK burial research points in the direction of communities with a disharmonic kinship system with patrilocality and matrilinearity. In the long run such systems tend toward homogeneous arrangements, patrilocality and patrilinearity (succession at the father’s place, heredity of offices from father to sons) as it appears now, the larger part of the LBK world followed the latter trend, while the NW-LBK resisted change. Clearly such consequential system change will have developed from crises, but being only loosely connected communities, such crises were time and again on a local scale only. Whereas elsewhere we witness an extensive (re-)creation of new symbols, identity and ideology as argued by Jeunesse (2011b, 184-185), finally constituting the post-LBK traditions, we see that in the Euregion there is a continuous adherence to the old symbols and that while communities suffer from stress, much in the same way as elsewhere, we see that at its core in that region there is a strong persistence of tradition signalling resistance to change. The most emblematic aspect of this, the system of pottery decoration closely associated with matri-affiliation, continues largely unchanged. In conclusion we may therefore state that many different factors were at play that eventually orchestrated the disappearance of the LBK in our study region. The fact, however that no alternative seems to have been an acceptable option to these communities is largely explainable by the evidence we have tried to provide for their conservative disposition. The overall conservative nature of the LBK in its period of bloom, over large parts of Europe and for a long period of time is largely without dispute (Sommer 2001). It appears, however, that the Euregion may have been the most radically conservative amongst these.

5 Postscript

This paper has set out to explain the relatively swift demise of the LBK in the Euregion in contrast to its continuation in altered forms in other areas. Our explanations have sought to move away from external causes or factors such as population pressure, climate change etc. and find answers in the structure or character of LBK society itself. The approach by Van de Velde highlighted the importance of the social rules that governed LBK communities, in particular with respect to their kinship system with originally a combination of matrilinear and patrilocal successions. While elsewhere a homogenizing move from one to the other may be observed this change did probably not come about in our study region, resulting in its further isolation and untimely end. Here it is the distinct societal rules and the adherence to tradition (cf. Sommer 2000) that underlie the developments taking place. The second part of the paper by Amkreutz, adopts a wider regional perspective. Instead of the hereditary system, the networks of the LBK are set central to the argument. The evidence of long-distance exchange and movement in combination with the large distribution and the physical/material and most likely socio-symbolical similarities of the LBK argue in favour of a strong inter- and supra regional network. Once elements in that network start changing the corpus of communication and the rules of interaction and engagement change. At the start of the fifth millennium (probably with earlier roots) these changes took place, both to the east and west of the Euregion LBK. There was no longer one familiar LBK world, but there were new alterations, most notably HST to the south-east and VSG-BCQ in the southwest. The geographical position of the Euregion LBK furthest from these two developments may have contributed considerably to its increasing isolation. Vital long-distance networks and routes of communication were increasingly regionalized and localized, while the world around them changed and 'moved on'.

Both approaches are compatible and complementary. The social explanation isolates the actual cause of the sudden demise of the LBK by underlining the resistance to change from a system of patrilocality and matrilinearity to one of patrilocality and patrilinearity and the consequences of such a misbalanced system in the long run. The regional explanation zooms out and takes a geographical perspective whereby the Euregion is increasingly isolated in the wider NW-LBK and as it were 'lost in translation' with regard to the changes taking place to the southeast and southwest.

Of course it is likely to have been a combination of both to some extent. Changes take place that are accepted in some communities and not in others and over time this may lead to either development or further isolation, but there are also elements that differ and draw out questions. For instance to what extent were the communities of VSG/BCQ and HST really too different to remain part of a network? To what extent were changed socio-symbolic systems indeed a reality and moreover a factor that furthered animosity and isolation? Was it likely that changes elsewhere would have in fact reached or affected the Euregion? Or is it mainly the misbalanced hereditary system that is at the root of the Euregional LBK demise, despite the changes that took place elsewhere? And also if the changes that took place elsewhere were the result of the same crisis that was mitigated differently in the Euregion, then to what extent would there have been time or opportunity to incorporate or attune to the new communities elsewhere? How viable and large was the Euregion LBK and why did it not persist longer?

While the authors have their preferences they agree that elements of both, of tradition and change and of the increasingly regional versus the developments in the NW-LBK as a whole, form the important factors that help explain the rather sudden disappearance of the LBK in our study area. While the recipe for the end of the LBK in the Euregion is far from complete, we hope to have contributed some of its important ingredients.

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Notes

1 Unless otherwise stated, periodization is according to Meier-Arendt 1966.

2 *"Where we can build symbols according to a system, there this system is the logically important thing and not the single symbols."* L. Wittgenstein: Tractatus 5.555.

3 In present, traditionally patrilinear European societies a woman takes the family name of her husband after marriage, and her surname will be composite: <husband's name – wife's name>. The family name of their children will be <husband's name>, the matrilateral allusion omitted.

4 That it was the heir to the estate who would set up a new house near to his father's (and his brothers eventually moving out), is perhaps the most likely inference, also from ethnography (cp. Strien 2010.) However, it may as well have been tradition that the heir was to move out, leaving the estate to a brother. In both cases, the lineage would be extended into new territory.

5 To our knowledge, the transition from a disharmonic regime to an harmonic one has never been ethnographically observed (cf. our initial quote of Jeunesse's); it is merely postulated in ethnological texts (some refs below.)

6 Also, the number of Bandkeramians was low by our standards: at the height of their culture, the Rhineland counted perhaps 1250-1350 households (Claßen 2009, 98; Zimmermann and Wendt 2003; also see Lüning 1982, 23; comparable figures for other regions are lacking.) That is, in the Rhineland altogether some 9 or 10 thousand Bandkeramians; with no more than perhaps two able-bodied males per house capable of warring.

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Pieter van de Velde
Faculty of Archaeology
Leiden University
PO Box 9514
2300 RA Leiden
The Netherlands
pvandevelde@kpnmail.nl

Luc Amkreutz
National Museum of Antiquities
PO box 11114
2301 EC Leiden
The Netherlands
l.amkreutz@rmo.nl

Neutron-based analyses of three Bronze Age metal objects: a closer look at the Buggenum, Jutphaas and Escharen artefacts

Hans Postma, Luc Amkreutz, David Fontijn, Hans Kamermans,
Winfried A. Kockelmann, Peter Schillebeeckx and Dirk Visser

Three important Bronze Age copper-alloy artefacts from the permanent exhibition of the National Museum of Antiquity in Leiden (NL) have been studied by neutron-based methods. These artefacts are known as the Buggenum sword, the Jutphaas dirk, and the Escharen double axe. All three objects have been studied with neutron resonance capture analysis (NRCA), a non-destructive method to determine the bulk elemental compositions. The Buggenum sword is also studied with time-of-flight neutron diffraction (TOF-ND) giving additional information about crystalline properties and internal material structures, and neutron tomography (NT), showing details of the construction of this sword and voids inside the material. The composition of the Jutphaas dirk is compared with the compositions of two other dirks belonging to the group of six Plougrescant-Ommerschans (PO) ceremonial dirks. The Escharen double axe, identified as being of the Zabitz type, variant Westeregeln, is a rare object in the Low Countries. It is compared to finds from Central Europe. The results for all three objects are discussed with regards to their archaeological contexts and their relation to other finds.

1 Introduction

There is a strong need to develop analytical methods for studying object compositions that do not require the taking of samples and are thereby entirely non-destructive. Methods that use neutrons for such analyses hold great potential. This contribution will show the results of a number of neutron-based analytical techniques for three special objects, which are too unique for destructive sampling.

The large penetrability of neutrons through matter allows determination of bulk properties of objects. Neutrons can react in different ways with nuclei. A neutron can be captured by a nucleus, producing a new (compound) nucleus with one more neutron in a highly excited state, which in most cases will decay by emitting gamma radiation promptly. This gamma radiation can be detected by a dedicated set of special detectors. The probability of a capture reaction as a function of neutron (kinetic) energy shows peaks, which are known as resonances, and which are related to highly excited states of the compound nucleus. The energies at which these resonances occur are specific to the isotopes of the elements. Hence, elements of an object can be recognized in a neutron capture spectrum, often even already during data taking, on the basis of resonance energies. The numbers of counts in resonance peaks contain information about the amounts of the elements. To derive elemental amounts requires careful data analysis after the measurements. Knowledge about resonance parameters, neutron beam properties, and properties of detectors must be available for this analysis. Alternatively, calibration data can be used. The phenomenon of resonances in a capture spectrum is the basis of neutron resonance capture analysis (NRCA).

The energy of neutrons can be determined with the time-of-flight (TOF) method, which requires a pulsed source of neutrons to be able to measure the time (t) neutrons need to travel a known distance (L) to the object. That is, the pulsed neutron source gives a start pulse and the gamma detector the stop pulse for timing a neutron capture event in the object. This method gives the velocity $v = L/t$ of the neutron and thus its kinetic energy $E = \frac{1}{2}mv^2$, in which m is the neutron mass. The unit used for neutron energy is the electronvolt (eV)[1].

The neutron energy can be determined with the expression: $E = 5227.039(L/t)^2$, where E is in eV, L in meter and t in μsec. The TOF neutron capture spectrum shown in figure 1 is that which was obtained for the Escharen double axe, one of the objects under study (see below for further details).

The NRCA method as applied to archaeological objects has been developed at the GELINA facility by a team from the University of Technology in Delft (NL) and the EC-JRC Institute in Geel (B).

Neutron diffraction (ND) makes use of the wave properties of neutrons and uses scattering from regular crystalline planes in the material. ND provides information about the metal and mineral phase compositions, for example contents of different copper-tin phases in a copper alloy, as well as the microstructural properties, such as locked-in strains and other remnants of the working history of the alloy. To allow the matching of the wavelength with lattice dimensions, the energy of the neutrons must be low, in practice in the range from thermal neutrons (0.024 eV) up to a few eV. As the neutron energy can be determined by the time-of-flight method, these two components make up the time-of-flight neutron diffraction (TOF-ND) method. This kind of research has been carried out at the ISIS facility of the Rutherford-Appleton laboratory in Harwell (UK).

In neutron tomography (NT), a two-dimensional image obtained by transmission of thermal neutrons through an object is registered with a scintillator plate viewed by a CCD camera. By making a large number of such 2D radiographies with the object viewed under a large number of angles, and by applying dedicated computer algorithms, a 3D-data set of the object is obtained. With these data it is also possible to cross the object in different requested directions, produce slices, and also fly-through video presentations. The Buggenum sword has been subjected to neutron tomography at the FRM-II research reactor in Garching (GE).

During exposure to neutrons objects may become radioactive. The amount of activation depends on the neutron flux, their energy and irradiation time. Particularly (sub)-thermal neutrons activate objects. Since such neutrons are not needed for NRCA, they are removed from the beam with the aid of filters. In addition the detection of capture events is rather large, thus, objects are left with low activation after neutron capture measurements. Neutron diffraction and neutron tomography measurements are carried out with thermal neutrons. Consequently larger activations may exist after such measurements, notably for NT, which requires taking data for long periods with the object under a large number of orientations. For this reason it is advisable to carry out NRCA, ND and NT in this order. This approach was taken for the Buggenum sword in the course of the ANCIENT CHARM[2] collaboration (Gorini and Kamermans 2011). Waiting periods are observed to let the activity die out to a sufficiently low level before returning objects to the owner, applying very stringent official international rules for activities of objects in the public domain. For most of the reported experiments waiting periods were short, less than one day for NRCA experiments, of the order of a few days for neutron diffraction, and considerably longer for neutron tomography.

2 Copper alloy objects from the National Museum of Antiquity (NMA)

The following three artefacts from the prehistoric permanent exhibition collection of the National Museum of Antiquities (NMA) in Leiden (NL) have been studied: the so-called Buggenum sword (RMO inventory no. l 1999/12.1), the Jutphaas dirk (RMO inventory no. f 2005/3.1) and the Escharen double axe (RMO inventory no. K 1992/9.1). Their names are related to find locations in The Netherlands (fig. 2). These are well-preserved objects for which taking samples or polishing parts of the surface for study purposes is not allowed.

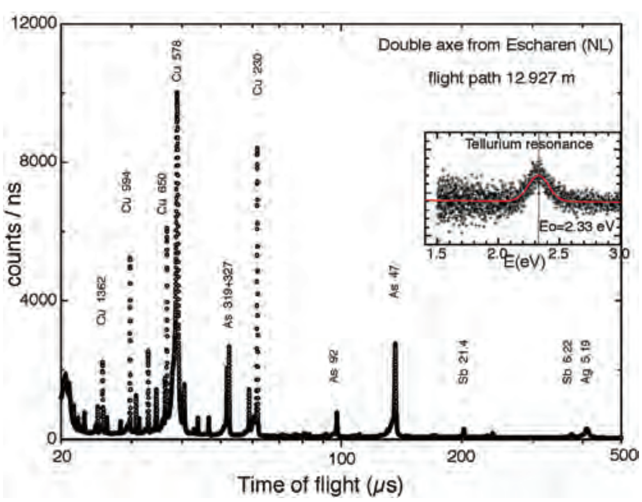

Figure 1 Time-of-flight capture spectrum of the Escharen double axe obtained at the GELINA facility in Geel (BE) using a beam with flight path of 12.927 m between the pulsed neutron source and the center of the axe. Resonances are indicated by the element symbols and resonance energies derived from the time-of-flight

Figure 2 Find locations of the three objects from the Dutch National Museum of Antiquities

All three neutron-based analytical techniques have been applied to the Buggenum sword. The composition of the Buggenum sword, resulting from the NRCA data and most of the TOF-ND data, is published in a technical paper (Postma *et al*. 2010). In the current paper additional information is given including the tomography results and a comparison with other Middle Bronze Age objects.

The Jutphaas dirk is one of the six known Plougrescant-Ommerschans (PO) dirks. These are very similar in shape and layout, although there are differences in size and composition. The Jutphaas dirk is the smallest of the group (see Butler and Sarfatij 1970/1; Fontijn 2001). Neutron resonance capture measurements of the Jutphaas dirk show a detailed elemental composition, which can be compared with the compositions of two other Plougrescant-Ommerschans dirks from Beaune and Oxborough, and the Kimberley dirk of a very similar shape, as published by Stuart Needham (1990). These artefacts are most likely ceremonial weapons dated to the Middle Bronze Age. Till recently five PO dirks were known. The latest addition was found at Rudham (UK, as yet unpublished).

The Escharen double axe is also a ceremonial object. It is recognized as a Zabitz type axe, which is a rare object in The Netherlands (Butler 1995/6, 167-70). It can be compared with a series of Zabitz axes described by Kurt Kibbert (1980, 35-54). The composition of the Escharen axe has been determined by neutron resonance capture, allowing a comparison with the list of 27 Zabitz axes given by Kibbert although their compositions are considerably less well determined. The Zabitz axes are from the very Early Bronze Age or from the end of the preceding copper Age.

3 SOME ESSENTIALS OF NEUTRON-BASED METHODS AND AVAILABLE EQUIPMENT

In this section some basic aspects of the three neutron-based methods, mentioned in the introduction, are briefly discussed. Since neutrons are unstable particles (half-life 882 s), they are not directly available and must be produced by nuclear reactions. This requires research reactors or dedicated particle accelerators.

3.1 Neutron resonance-capture analysis (NRCA)

The capture cross-section[3] of a single, isolated s-wave neutron-resonance can be approximated by the a Lorentzian shape[4]:

$$\sigma_\gamma(E) = \frac{\sigma_\gamma^o}{1+x^2}, \text{ in which } x=2(E-E_0)/\Gamma. \quad (1)$$

Herein E is the energy of the incident neutron, E_o the central energy of the resonance, Γ its width at half-height, and $\sigma_\gamma{}^o$ the maximum value of the cross-section at the central energy of the resonance. If only gamma-ray emission occurs after neutron absorption the width is the sum of the partial widths of the neutron entrance and gamma-ray emission channels: $\Gamma = \Gamma_n + \Gamma_\gamma$. To determine an elemental amount in a sample, it is important to know the area A_γ of the resonance. It is given by:

$$A_y = 4{,}097.10^6((A+1)/A)^2 g_J \Gamma_n \Gamma_y / E_0 \Gamma, \text{ (in units barn.eV)}. \quad (2)$$

A is the mass number and g_J a factor depending on the combination of the neutron and nuclear spins.

Before continuing the discussion about analysing NRCA spectra, it is important to mention three effects which modify the observed resonance profile. First the thermal motion of nuclei should be mentioned, which broadens the resonance and makes it resemble a Gaussian curve, at least around its central energy. The far-out wings of the resonance have still a Lorentzian shape. This so-called Doppler broadening effect widens and lowers the resonance peak, but its area remains the same.

The second effect modifying a resonance spectrum concerns the reduction of the intensity of the neutron beam when it traverses an object. There is a reduction due to potential scattering. This reduction is in first approximation energy independent. In the region of a resonance the neutron flux will be strongly reduced near the resonance centre and less at its wings. Consequently the capture count rate of resonance (μ) of an element will be reduced by an energy-dependent factor F_μ(E), which can be calculated on the basis of the total cross section and the amount of the element. Integrated over the resonance peak, the count rate is reduced by a F_μ, which is known as the self-shielding factor.

The third modification is the possibility of scattering (once, twice or even more) of a neutron in the object before it is captured. At each scattering the neutron loses an amount of energy depending on the scattering angle. As a consequence each resonance is accompanied by a wide structure at its high-energy side, while its size and shape depend on the thickness and form of the object. It may be partially underneath a resonance peak, especially in the case of low-energy resonances. Such a scattering-capture structure should first be subtracted from the resonance spectrum before the number of counts in a resonance peak can be derived. This may require dedicated analysing codes. For the applications described in this paper an empirical analysis often suffices. Figure 3 is an example taken from the resonance capture spectrum of the Jutphaas dirk, showing the 230-eV resonance of copper with its scattering-capture structure. For this resonance the peak and the scattering-capture structure can be well separated. For resonances at higher energies the scattering-capture structure moves away from the resonance becoming a lesser problem. For resonances at lower energies the structure moves underneath the peak and thus the separation becomes more difficult especially for resonances of a few eV.

In the case of a homogeneous and flat object the number density (n_X) of an element (X) in the object can be obtained by dividing the number of counts (N_μ) in the peak of a resonance (μ) by a number of parameters, that is:

$$n_x = N_\mu / \varepsilon_\mu F_\mu A_{\gamma,\mu} a_\mu \Omega \Phi(\varepsilon_\mu). \tag{3}$$

$\Phi(E_\mu)$ is the time integrated neutron flux at resonance energy, Ω is the area of the object illuminated by the beam, a_μ the isotopic abundance, $A_{\gamma,\mu}$ the theoretical capture area, F_μ the self-shielding factor, and ε_μ the efficiency to detect a capture event. The latter depends on the detector arrangement. With this expression it is possible to determine the amount of an element in an object in an absolute way. However, it requires knowledge of a large number of factors, some of which are hard to determine. It requires absolute monitoring of the neutron flux entering the sample. An added difficulty is that the shielding factor depends on the areal density, i.e. the total amount of the element per unit area of the object.

The efficiency for detecting capture events in particular is very difficult to determine precisely. In addition, it may even vary between resonances of the same nuclide, because their prompt gamma ray spectrums can be different. Furthermore, in archaeology objects have rarely simple flat shapes, and thus applying equation 3 can only be approximately valid, or requires an integration procedure.

For this reason the so-called double ratio method has been introduced for analysing archaeological objects. In this method the ratio of the count rates in two resonances (λ and μ) of two elements (X and Y) of an object is compared with the same ratio of a calibration sample of known composition. This method gives the weight fraction W_X/W_Y of two elements X and Y by the expression:

$$\frac{W_X}{W_Y} = K^{cal}_{\mu,\lambda} \frac{F_\lambda N_\mu}{F_\mu N_\lambda}, \quad \text{with} \quad K^{cal}_{\mu,\lambda} = \left(\frac{F_\mu N_\lambda W_X}{F_\lambda N_\mu W_Y} \right)_{cal}. \tag{4}$$

In the double ratio methods some of the parameters mentioned with equation 3 cancel to a high degree, and therefore it is not necessary to know them. The cancelling of detector efficiencies and flux ratios are especially important assets of this method.

Many elements have several resonances available for the analysis. For instance; copper has suitable resonances at 230, 650 and 1150 eV, and tin at 38.8, (45.7) and 111.0 eV. Hence

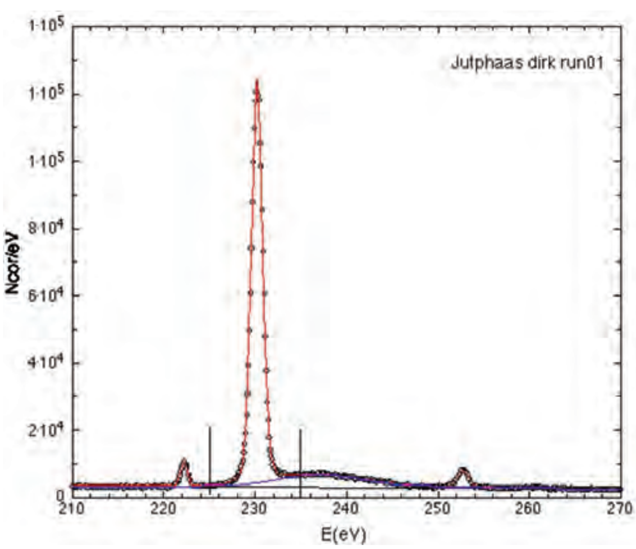

Figure 3 Part of the capture spectrum of the Jutphaas dirk showing the 230-eV copper resonance with its scattering-capture structure. The subtraction of the latter is important for determining the number of counts in the resonance peak itself. In addition two weaker resonances in this plot are from tin (222 eV) and arsenic (253 eV)

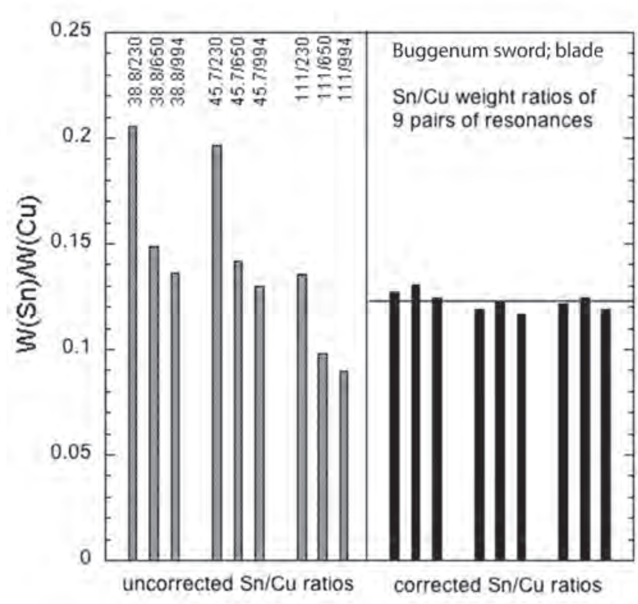

Figure 4 Bar plot of weight ratios of tin with respect to copper for nine pairs of resonances for the blade of the Buggenum sword. At the left side uncorrected ratios and at right side ratios corrected for self-shielding factors valid for the mean Cu-thickness, which is obtained with the variation method (Postma *et al*. 2010)

to determine the tin to copper weight ratio in a bronze object six (or nine) pairs of resonances can be used. Analysing the experimental weight ratios without accounting for self-shielding, that is with all F-factors assumed to be one, the obtained weight ratios of these pairs of resonances are quite different as is shown in the left side of the bar plot in figure 4 for the blade of the Buggenum sword. Using F-factors for the copper and tin resonances, the weight ratios can be made equal; see right side of figure 4.

This procedure leads to a variation method in which the weight ratios $R = W_{Sn}/W_{Cu}$ of several pairs of resonances are calculated from the data by varying the F-factors for copper and tin as a function of the areal density of copper and tin till the lowest value of the variance $\Sigma(R-\langle R\rangle)^2$ has been reached; $\langle R\rangle$ is the mean value of the ratio for all used resonance pairs. Figure 5 shows, as an example, the result of this variation method applied to the Jutphaas dirk. For clarity this figure is limited to two sets of curves for the mean ratio (left y-axis) and the variance (right y-axis) for two fixed values of the amount of tin while the amount of copper is varied (x-axis). With other chosen values of the amount of tin, the minimum values of the variance are higher than those shown in the figure. If the ratio of the amounts of tin and copper valid for the minimum of the variance curve corresponds with the derived value of $\langle R\rangle$ at the left y-axis, then this is a validation of the result. This is the case of the curves related to a tin amount of 0.30 g/cm^2, but not for the curves related to 0.25 g/cm^2 of tin. In addition the first case has the lowest value of the variance.

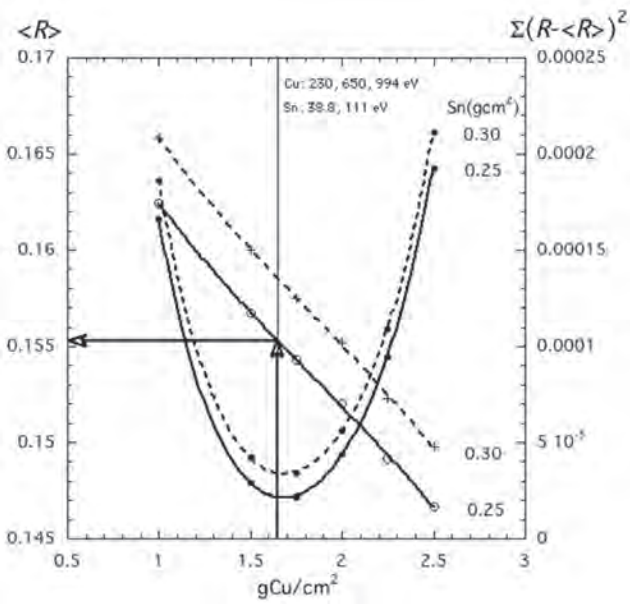

Figure 5 Example of the variation method as applied for the Jutphaas dirk and based on 6 pairs of resonances using copper resonances at 230, 650, 994 eV and tin resonances at 38.8, 111 eV

More technical details about NRCA and analyzing procedures can be found in Postma and Schillebeeckx (2010; 2017) and Schillebeeckx *et al*. (2012).

The reported neutron resonance capture experiments have been carried out at the pulsed neutron source of the GELINA facility which is operated by the Joint Research Centre of the European Commission in Geel (B). At this facility neutrons are produced in short pulses by stopping bursts of electrons from a 150 MV accelerator in a uranium disk with a maximal repetition rate of 800 Hz. These neutrons are partly moderated in two small, water-containing vessels above and below this uranium disk. Beam tubes are viewing these containers to allow neutrons to reach measurement stations at different distances from the neutron source. Two of these stations, made available for NRCA, are equipped with C_6D_6 detectors for detecting gamma radiation. These detectors have very good timing properties and are insensitive to neutrons. The nominal lengths of these flight paths are 12 and 28 m.

More information about the GELINA facility are given by Mondelaers and Schillebeeckx (2006).

3.2 *Time-of-flight neutron diffraction (TOF-ND)*

The wave property of neutrons makes it possible to study crystalline structures of objects by the diffraction method (ND). This method is non-destructive, like NRCA, as the neutrons penetrate through coatings and corrosion layers deep into centimeter-thick materials, thus providing information about the interior parts of an object. Metal and mineral phase compositions, texture and strain analysis can be performed, and hence information about working steps and fabrication techniques can be derived (Siano *et al*. 2003). The wavelength depends on the energy of the neutrons. In case of a polychromatic, pulsed neutron source it is possible to determine the neutron energy by the TOF-method. The ISIS facility at the Rutherford Appleton Laboratory in the UK, based on a spallation neutron source, provides a number of facilities for TOF-ND. The ENGIN-X instrument of the ISIS facility has been used for analysis of the Buggenum sword. The instrument has a collimated beam of cold neutrons and provides a set of two large area (of more than 2 m^2 in total) ZnS scintillation neutron detectors, with radial collimation viewing the sample. The two detector banks are at 90^o on either side of the object. Each bank has 1200 ZnS(^{6}Li) scintillators. Therefore it allows for TOF-ND to be carried out at small volumes down to 2×2×2 mm^3 size and inside objects. The diffraction spectra, one for each detector bank, are analyzed by the Rietveld method (Kockelmann *et al*. 2006).

3.3 *Neutron tomography (NT)*

The principle of neutron tomography is rather straightforward. A wide beam of low-energy neutrons transmits through an object, and produces a two-dimensional (2D) radiography of the object on a scintillator screen. The scintillator converts the neutron image into a visible-light image, which is registered with a CCD camera. Repeating this collection of a radiography a large number of times (a few hundred), with the object in different orientations, and using dedicated software programs it is possible to reconstruct from these CCD-images tomographic data sets, hence a three-dimensional (3D) presentation of the object. This kind of work is typically carried out at research reactors providing high intensity, low-energy neutron beams. The high penetration of neutrons in materials makes the study of the internal structures of objects possible, even features inside thick metal parts which X-rays cannot penetrate easily.

An example of a tomography facility is ANTARES at the FRM-II reactor at the Hans-Leibnitz Zentrum in Garching near München (Germany) (Calzada *et al*. 2009). This facility was used to produce tomographic data sets of the Buggenum sword.

The ANTARES facility for radiography and tomography uses neutrons moderated in a vessel containing liquid deuterium cooled to 25 K and placed near the core of the FRM-II reactor, thus providing a spectrum of cold neutrons that peaks at 1.6 Å with a long tail (of thermal and fast neutrons) at the high energy side[5]. The neutrons from this moderator travel through a collimating opening of diameter *D* (constituting a 'pinhole') installed 4.5 m from the cold source. Then the neutrons travel through 'flight tubes', filled with helium gas in order to avoid scattering of neutrons by air to the sample position at 12 m from the pinhole.

Thereafter, these neutrons traverse the object, which is mounted on a manipulator. With this manipulator the object can be moved in vertical and horizontal directions and it can be rotated over 360^o. Behind the object is a scintillator with a large area to produce a two-dimensional image of the object. This scintillator consists of zinc sulphide and contains lithium-fluoride. The reaction products (^3H and ^4He) from capture of neutrons by the ^6Li isotope generate a light flash in the zinc sulphide. A CCD camera which is installed away from the neutron beam and which views this scintillator via a mirror under 45^o, and an optical lens stores this image. To reiterate, radiographies are recorded with the object in many orientations to produce a tomographic data set.

The resolution of the images depends to a large extent on the divergence of the neutrons defined by the pinhole, that is on a typical length *L* and diameter *D*. ANTARES can be operated with two values of *L/D*, namely 400 or 800. The best resolution is obtained with the larger value at the cost of a lower intensity of the neutron beam.

4 Description of the Buggenum Sword

4.1 *History of the discovery*

The bronze sword from Buggenum was dredged from an old bedding of the river Meuse near Buggenum in the province of Limburg, the Netherlands in 1964. It was unknown to archaeologists until the early 1990's. The finder, Mr. Peters, kept it in his possession until 1999 when it was purchased by the National Museum of Antiquities in Leiden. Butler and Fontijn made a detailed study of the object (Butler and Fontijn 2007; Fontijn 2002, 166-168).

4.2 *Description*

The sword is an all-metal object of unknown, presumably bronze, composition. The length is 68.5 cm, at the shoulder of the hilt it is 3.8 cm wide, and it weighs 920 grams. Figure 6 shows a photo of the sword. The hilt has an oval cross-section with four ring-like ridges, it is slightly tapered and it has an intricate decoration. There are "running in-and-out spirals" between the rings of the hilt and the pommel. The nearly circular pommel is also beautifully decorated; at the top with connected spirals as well, and underneath with three rings of incisions. Furthermore, the short projection above the pommel is decorated with incisions. In the region where the hilt goes over into the blade it is decorated with incised lines and four little circles, which look like rivets. Two of them may actually replicate rivets but the other two seem to be genuine rivets hidden in the line-shape decoration. No traces of seams (brazing or soldering) could be recognized at the "omega shaped" connection of hilt and blade, or near the pommel. The way the blade and hilt are connected could therefore only be guessed. The blade is sharpened, but there is no evidence it was used as a weapon. The whole sword shows the skilled workmanship of the smith who made this object. Halfway along the blade a dent is visible, which suggest that the sword may have been bent. Whether this was done deliberately, as sometimes happened with metal objects during the Bronze Age (cf. Fontijn *et al*. 2012), or was a result of the dredging, is unknown.

4.3 *Place in European context*

Butler and Fontijn (2007) concluded that we are dealing with a so-called full-hilted decorated sword (German: *Vollgriffschwert)* of the Central European *Vielwulstschwert*-variety ('multi-ribbed grip sword'), sharing traits of the *Dreiwulstschwert* of type *Erding* ('three-ribbed grip sword') as defined by Von Quillfeldt (1995, 142-188; see also Müller-Karpe 1961, 7-48, and further references cited in Butler and Fontijn 2007). Two other *Dreiwulstschwerte* have been studied by Marianne Mödlinger with X-rays and with NRCA (Mödlinger 2007).

On typo-chronological grounds, the object could be dated to the Middle Bronze Age B in the Dutch chronology (more precisely, its latter part, Ha A 1, *c*. 1300 to 1100 BC; Butler and Fontijn 2007, 310). Our inventory of similar finds in Europe showed that this type of sword is uncommon in Western Europe in general, and in the Low Countries in particular (Butler and Fontijn 2007, fig. 27.4 and 27.5). It is known in large numbers in Central Europe, however. On typological grounds, Butler and Fontijn (2007, 305-7) deduced that the Buggenum sword was probably produced in Bavaria. This implies that the sword reached the Netherlands via long-distance exchange.

The sword is in splendid condition and nothing indicates that it was ever used in battle. In comparison to other swords found in the Low Countries and adjacent West Germany, the Buggenum sword stands out both by its richly decorated grip, and its unused and undamaged condition. This seems to be a sword with an exceptional biography that was used for display and ceremonial purposes only. It was argued that it ended its life by being deliberately deposited in the river Meuse or its back swamps where it remained for thousands of years until it was found by the dredgers (Butler and Fontijn 2007, 313-4). This long stay in a waterlogged environment explains its excellent condition of preservation. A further study of Bronze Age metalwork finds in this part of Europe showed that the riverine context of the Buggenum sword is not exceptional: this particular zone of the Meuse has so far yielded many Bronze Age swords, the majority of which must have been deliberately deposited there by Bronze Age communities (Fontijn 2002, fig. 8.11). Full-hilted swords, however, are rare among the river finds, let alone lavishly decorated swords. In this aspect, the Buggenum sword, then, surely is an exceptional case. This made a follow-up on Butler and Fontijn's investigations worthwhile, and when the opportunity arose to do new research on technological properties of precious prehistoric artefacts within the framework of the ANCIENT CHARM project, the Buggenum sword was an obvious candidate.

4.4 Research questions

Given the opportunity to apply the newly developed neutron-based techniques for material characterization, and the new possibilities of tomography for studying the mechanical construction in particular, the Buggenum object seemed interesting, as Butler and Fontijn suspected that the sword was made in two separate parts which were joined together later in the production process (Butler and Fontijn 2007, 301). This idea was based on parallels from Central Europe, where casting moulds for full-hilted swords are known where hilt and blade were separate, as well as from X-ray inspections of swords (Mödlinger 2007). It should be remarked though, that a joint between hilt and blade is not immediately apparent when one studies the lower parts of the hilt.

5 Neutron based measurements of the Buggenum sword

In the framework of the ANCIENT CHARM project (Gorini and Kamermans 2011) the Faculty of Archaeology (Leiden

Figure 6 Photo of the Buggenum sword (photo National Museum of Antiquities RMO, Leiden)

University), the section Radiation, Detection and Medical imaging (RD&M) of the Faculty of Applied Sciences (Delft University of Technology), and the National Museum of Antiquities (NMA) in Leiden (NL), owner of the Buggenum sword, decided to study the Buggenum sword, however only with non-destructive methods. The goal was to obtain information about its elemental bulk composition, including a number of minor and trace elements, its construction and the way it may have been manufactured and worked on. Three types of neutron-based measurements were carried out in the following order: i) neutron resonance capture analysis (NRCA) at the GELINA facility, ii) time-of-flight neutron diffraction (TOF-ND) at the ISIS facility, and iii) neutron tomography (NT) at the Garching research reactor. The GELINA facility was also used to get a radiographic picture of the hilt in order to understand the NRCA data of the hilt. The NRCA and TOF-ND measurements and data of the Buggenum sword are described and discussed in a technical paper (Postma *et al*. 2010).

5.1 NRCA results

The neutron resonance capture measurements were carried out at eight locations on the blade, at four places on the hilt and one location where hilt and blade are connected, using a beam with 2.2 cm diameter at half-height (Postma *et al*. 2010). The data were analyzed with the double ratio method explained in section 3.1 and are presented as weight ratios with respect to the major element copper. Analysed elements concern copper, tin, antimony, arsenic, silver, indium, cobalt and zinc. Since tin and copper each have three resonances, Sn/Cu weight ratios of nine pairs of resonances could be obtained. Without correcting for self-shielding, these ratios differ considerably; see left side of figure 4. When correcting for self-shielding in a variation approach a mean value of the tin to copper weight ratios was obtained together with a mean thickness of the blade in gram copper per cm^2; see right side of figure 4. The derived mean thickness has been used for correcting weight ratios of the other elements to copper with proper self-shielding factors. The weight ratios are plotted in figure 7 for the 13 locations of the Buggenum sword. The vertical line in this figure goes through the middle of the “Omega” location where blade and hilt are connected and where run 4AB has been carried out. The locations of the runs 5AB through 5HI, 1AH and 1BG are on the blade from the tip to the connection with the hilt. 1CF concerns the hilt plus tang of the blade and 1DE the hilt only just below the pommel.

The weight ratios at the eight positions of the blade show little or no variation. The measurement at the hilt shows a larger variation at the various locations. In table 1 the weight fractions averaged for the eight positions of the blade, and the weight fractions at the positions on the hilt just underneath the pommel are quoted in columns 2 and 5.

In archaeological papers amounts of components are usually given in weight%. For reasons of comparison, the fractions have been converted into weight% in the two A-columns of table 1, assuming that no other components exist in the metal. Elements like nickel and iron may also occur in bronze artefacts in several per cent as residue from the copper smelt. Lead is often added in the melt of artefacts in considerable amounts. But these elements were not observed in the capture spectra of the Buggenum sword with estimated upper limits U given in the ratio columns of table 1. Taking these upper limits into account as ½(U±U), weight fractions of the detected elements change slightly as is shown in the B-columns of table 1.

The tin-to-copper ratios of blade and hilt differ by about 20%, which shows that both parts of the Buggenum sword are made from different melts. Given their errors the ratio values of the impurities Sb, As, Ag, In, and Zn do not differ for hilt and blade. The values for Co are somewhat outside their error ranges, however, the analysis of Co is based on one wide and small resonance within a complicated part of the resonance spectrum and is therefore rather difficult.

It can be concluded that the copper used for both parts is likely from the same origin.

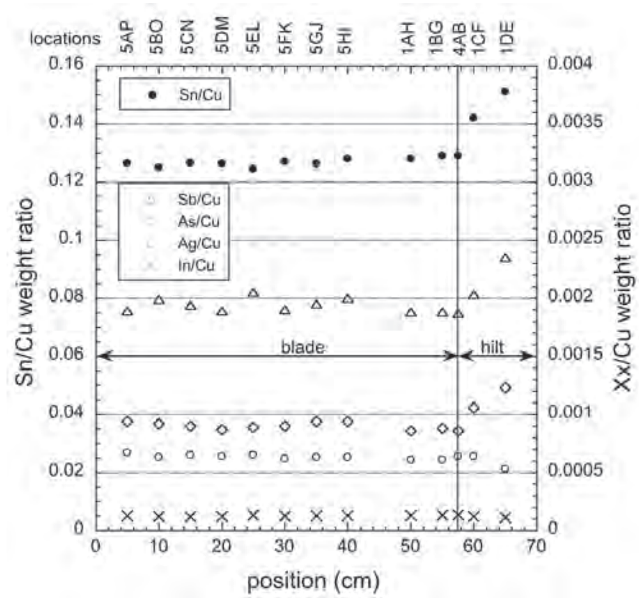

Figure 7 Weight ratios of elements observed for the Buggenum sword with respect to copper plotted as a function of the distance (*x*-axis) along the sword from the tip of the blade to the top of the pommel. Symbols of the runs given at the top of the figure are from figure 1 of Postma *et al*. 2010

Element	**Blade**			**Hilt**		
	Ratio to Cu	Wt% A	Wt% B	Ratio to Cu	Wt% A	Wt% B
Cu	1*	88.44 ±0.15	86.60 ±1.27	1*	86.40 ±0.15	85.77 ±0.49
Sn	0.1250 ±0.0018	11.06 ±0.15	10.82 ±0.21	0.1510 ±0.0020	13.05 ±0.15	12.96 ±0.17
Sb	0.00194 ±0.00010	0.172 ±0.017	0.168 ±0.019	0.00235 ±0.00020	0.203 ±0.017	0.202 ±0.017
As	0.00090 ±0.00010	0.080 ±0.009	0.078 ±0.009	0.00123 ±0.00020	0.106 ±0.017	0.105 ±0.017
Ag	0.00063 ±0.00004	0.056 ±0.004	0.055 ±0.004	0.00053 ±0.00008	0.046 ±0.007	0.046 ±0.007
In	0.000128 ±0.000007	0.011 ±0.001	0.011 ±0.001	0.000116 ±0.000020	0.010 ±0.002	0.010 ±0.002
Co	0.000136 ±0.000030	0.012 ±0.003	0.012 ±0.003	0.000046 ±0.000010	0.004 ±0.001	0.004 ±0.001
Zn	0.0020 ±0.0005	0.177 ±0.044	0.173 ±0.044	0.0021 ±0.0003	0.181 ±0.026	0.180 ±0.026
Ni	<0.020		0 - 1.74	<0.0045		0 - 0.38
Fe	<0.001		0 - 0.08	<0.0005		0 - 0.04
Pb	<0.027		0 - 2.3	<0.012		0 - 1.0

* by definition

Table 1 Compositions of the blade and hilt of the Buggenum sword quoted as weight ratios to copper and in weight% fractions; columns A without including upper limits for Ni, Fe and Pb, and columns B including these elements in calculating the weight fractions

5.2 Results of TOF-ND measurements

Neutron diffraction measurements have been carried out on 15 locations of the Buggenum sword, four locations on the hilt, one in the 'omega' area (where blade and hilt meet), five on the rib of the blade and four on the edges of the blade. All measurements showed that its tin-bronze is mainly in the alpha phase[6] with small amounts of the delta phase in accordance with the formation of the eutectoid in the as-cast bronze. Figure 8 shows the diffraction pattern obtained at two locations, one on the rib and the other on the edge. The alpha lines of the diffraction spectra observed at the rib are very broad and somewhat structured; see figure 8a. The general broadening is considered to be due to Cu-Sn heterogeneities in the metal, corresponding to dendritic tin segregation during solidification. The three-pronged structure can be related to mainly three alpha-phases with locally different compositions. The alpha lines are sharp at the edges of the blade due to homogenization of the bronze by repeatedly reheating, annealing and hammering for sharpening and strengthening the edges; see figure 8b.

In general, the delta phase fractions are small except for four of the rib positions with delta phase fractions of 4 – 6 wt% and the two rivets with 2.0 and 1.6 wt%. In all other positions the delta phase fractions are below 1 wt%.

The lattice constant of the bronze varies mainly by the addition of tin. With Vegard's rule and calibration data the apparent tin content can be obtained (Siano *et al*., 2006). Correcting for the contribution of minor elements, obtained from NRCA, to the lattice parameter gives the following results for the Sn/Cu weight ratios:

hilt just under the pommel:	apparent Sn/Cu ratio 0.155, corrected 0.1515,
rib of the blade:	apparent Sn/Cu ratio 0.132, corrected 0.129,
edges of the blade:	apparent Sn/Cu ratio 0.142, corrected 0.139.

The NRCA results for the hilt and blade are 0.151 (just under the pommel), respectively 0.125, as averaged over the full blade.

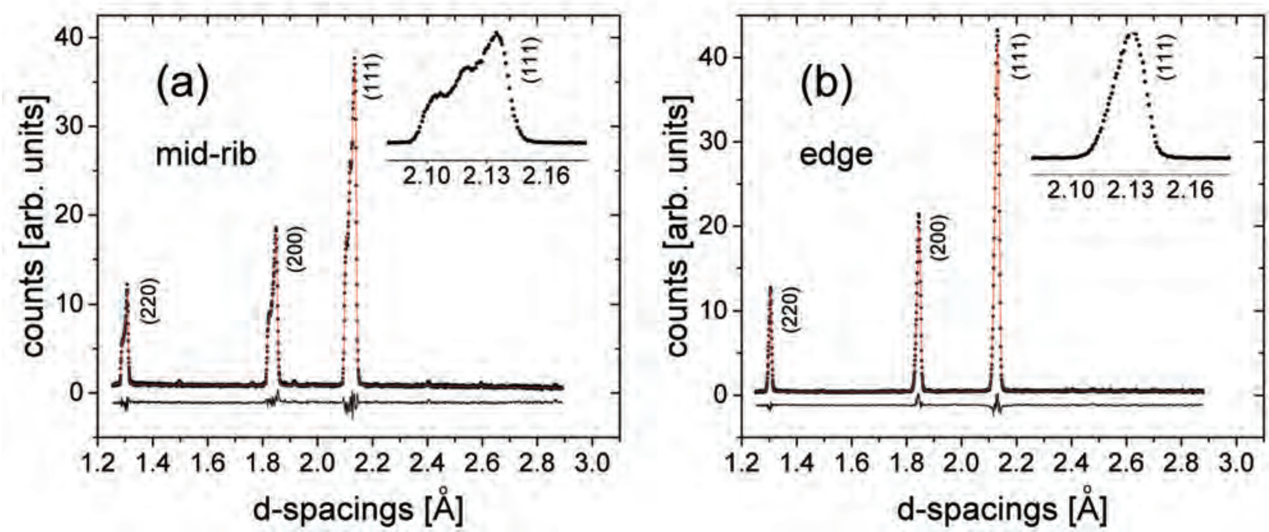

Figure 8 Diffraction pattern obtained at two locations of the Buggenum sword, one on the middle of the rib (a) and the other on the edge (b)

Copper and its alloys may contain elements or compounds, which do not dissolve and which can be detected by neutron diffraction because of their specific diffraction lines, for instance lead and CuS. The TOF-ND results of the Buggenum sword do not show such lines. It is concluded that this sword contains less than 0.5 weight% of lead.

5.3 Results of neutron tomography

Neutron tomography has been carried out on the Buggenum sword using the ANTARES facility of the FRM-II reactor in Garching (Ge) described in section 3.3.

Both the blade and the hilt have been investigated in order to learn more about the mechanical construction and quality of the object. From a large number of radiographic 2D-images taken with the Buggenum sword rotated in small steps over 360º, tomographic data sets of three parts of the sword have been produced. These data sets can be used to produce movies and slices as cross sections of the sword. For instance, one movie shows the rotating sword hilt with its external decorations in backlight. In two tomography movies the hilt is traversed in two perpendicular directions, which makes it possible to study the construction of the hilt and the way the tang of the blade was inserted into the hilt. Hence, these data show important details of the quality of the sword, for instance how the sword blade and hilt were joined, allowing a classification and comparison to other swords. From the tomography data sets two slices through the object are presented in figure 9. Both slices are through the middle of the sword and show the full length of the hilt; part A of this figure is in the plane of the blade and B is perpendicular to this plane. Together they give a good presentation of the construction of the way the tang of the blade is positioned inside the hilt. The tang of the blade does not penetrate fully into the hilt, but stops just over halfway inside the hilt. This was also concluded from a radiographic image of the hilt made with a beam of gamma radiation at the GELINA facility in order to be able to interpret the NRCA data. In figure 10, showing details of the hilt, it looks as if four rivets have been used to connect the blade to the hilt, however, two of them were suspected to be only part of the incised decoration of the sword. On the tomographic slice (fig. 9A) only two rivets are visible and thus the other two on the photograph are indeed imitation rivets.

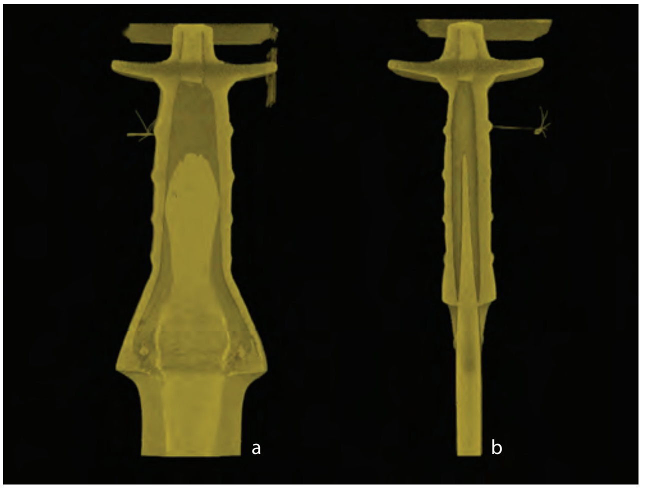

Figure 9 Two slices as cross sections of the Buggenum sword produced from the tomographic data sets; (A) the cross section of the hilt in the plane of the blade and (B) perpendicular to it

Figure 10 Photo of the hilt of the Buggenum sword (photo National Museum of Antiquities RMO, Leiden)

Another observation made possible by the tomographic data sets is the occurrence of a wide hole in the top of the pommel; see figure 9. This hole may have been essential for fixing the inner part of the mould. After casting the hole may have been important to remove the inner part of the mould used for casting the hilt. After constructing the sword, the hole could then have been closed with a plug, as is clearly visible from the tomography.

The two sets of tomographic data of the blade mainly show the homogeneity of the material. The blade is clearly a solid piece of metal with only a few small voids visible in the images.

5.4 Conclusions about the Buggenum sword

The Buggenum sword is an all-metal product from the Middle Bronze-Age and probably originates from the Danube region. Based on the different tin contents, the blade and hilt are from different casts both close to eutectic tin-copper. It has very precisely executed incised decorations and the absence of wear or damage implies that it may only have been used for ceremonial purposes. Nevertheless, the apparent work on the edges of the blade and the sturdy, solid construction of the sword show that it has been made as a potentially functional weapon, not as a showpiece with a ceremonial purpose only.

6 Description of the Jutphaas dirk

6.1 History of the discovery

The Jutphaas dirk was found in 1946 or 1947 during dredging operations for the extension of a shipyard harbour in the Jutphaas county area just south of the city limits of Utrecht (Butler and Sarfatij 1970/1). While at first it was not recognized as such, the artefact decorated for years the room of the young nephew of the finder. When it became clear that it was apparently one of a very rare group of ceremonial weapons it was sold to the National Museum of Antiquities.

6.2 The Plougrescant-Ommerschans dirks

The Jutphaas dirk is one of six known ceremonial dirks of very similar design, including the recent find in Durham (UK), which is not yet described in the literature. Most of the dirks are around 70 cm, and show only slight differences in their execution. However, the Jutphaas dirk with its length of 39 cm is considerably smaller. In the literature this remarkable group of ceremonial objects is known as the Plougrescant-Ommerschans dirks, named after two find locations, one in France and the other in the Netherlands (Butler and Bakker 1961). Although very similar, the Jutphaas dirk is not an accurate miniaturization of the large specimens (Butler and Sarfatij 1970/1). Nevertheless the resemblances are so striking that it is assumed all may have derived from the same workshop (Butler and Sarfatij 1970/1; Fontijn 2001). This is of importance since these objects were dispersed over quite a large region, with two ending up in England, two in France (Brittany and Burgundy) and two in the Netherlands. Furthermore, there are no signs for hafting of these swords; the edges are not sharpened and they are simply too large to serve as weapons. They are dated to the Middle Bronze Age, *c*. 1500-1350 BC, maybe somewhat later (Needham 1990).

6.3 Elemental compositions

So far the only information about the elemental composition is from Butler and Sarfatij (1970/1), mentioning a qualitative measurement by J.N. Lanting (BAI, Groningen, NL) based on X-ray spectroscopy. It is said to be a tin-bronze with only a trace of nickel. This result does not allow a comparison with elemental analyses of the Oxborough and Beaune dirks presented by Stuart Needham (1990). Therefore neutron resonance capture measurements were carried out with the Jutphaas dirk using beam No.5 of the GELINA facility with flight path length of 12.116 m and a beam diameter of about 7.5 cm at the sample position. Figure 11 shows the Jutphaas dirk in front of the two C_6D_6 detectors of the NRCA equipment. It is mounted on an aluminium plate for easy transport and safe handling. Overlap filters of bismuth, cadmium and sulphur were inserted early in the beam. The measurements concern the hilt and the tip of this dirk. The resulting elemental compositions from this analysis are given in table 2 in weight % with estimated errors largely based on systematic trends. For tin the errors are of the order of 1 wt%. For copper the errors are compounded from the errors of the other elements. Iron, nickel and lead at the bottom section (tip) of the Jutphaas dirk could not be determined satisfactorily by NRCA due to limited beam time for this run. Due to the beam filters used during these experiments, it was not possible to derive the amounts of bismuth and sulphur. These elements are expected to occur in small amounts at most.

Stuart Needham (1990) reported analyses of the Oxborough and Beaune dirks and three other objects, indicated as the Essex/Kent rapier, the Kimberley dirk and Wandle Park spearhead. Multiple samples were taken from each of these objects with a 1 mm drill. Samples were taken to obtain reliable averaged compositions in three regions (hilt, middle and tip) of the Oxborough and Beaune dirks. The samples were dissolved in *aqua regia* for inductively coupled plasma (ICP) spectroscopy using the equipment of the Mineralogy Department of the National History Museum (London, UK). The resulting compositions of the Oxborough, Beaune and Kimberley dirks are quoted in table 2 except for gold, bismuth, cadmium, manganese and phosphor which were below their detection limits of respectively 0.003, 0.01, 0.007, 0.003 and 0.02 wt%. The errors for the various elements are said to be of the order of 1 % for copper and 5 % for tin. The precisions for the minor and trace elements worsen from about 10 % to 50 % at their respective detection limits. Lead is not detected by NRCA; the detection limit is about 0.5 wt%. Sulphur included in the analyses given by Stuart Needham is well below 0.1 wt%, however, it cannot be detected by NRCA. Indium detected by NRCA occurs in very small amounts in the Jutphaas dirk. This element is probably not seen with ICP spectroscopy.

Table 2 includes the minor elements silver, arsenic, cobalt, iron, nickel, and antimony usually occurring in Bronze-Age copper. These elements dissolve in copper during the

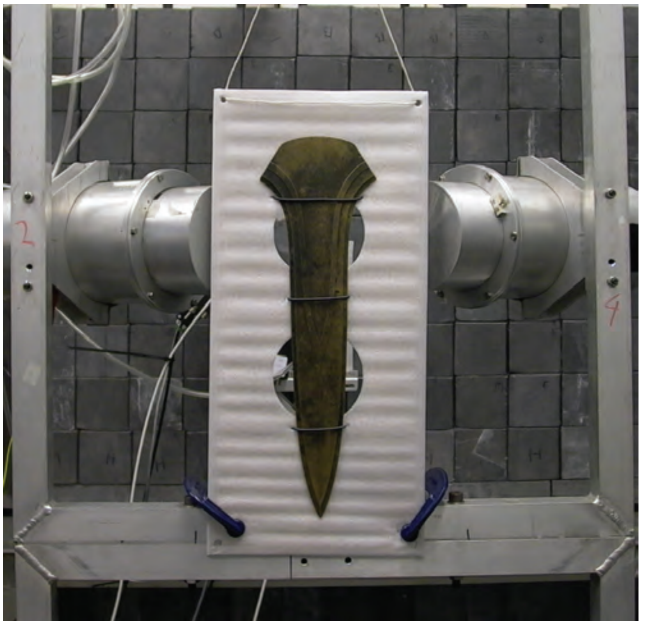

Figure 11 The Jutphaas dirk in front of the two C_6D_6 detectors of the NRCA equipment (photo National Museum of Antiquities RMO, Leiden)

	Ag	As	Co	Cu	Fe	In	Ni	Pb	S	Sb	Sn	Zn
Jutphaas												
Top	0.0160	0.297	0.035	85.46	0.022	0.0028	0.34	< 0.5		0.106	13.50	0.105
	±0.0008	±0.015	±0.002	±0.15	±0.002	±0.0002	±0.03			±0.003	±0.15	±0.006
Tip	0.0124	0.226	0.033	86.07	–	0.0028	–	< 0.5		0.114	13.39	0.153
	±0.0011	±0.017	±0.002	±0.15		±0.0002				±0.003	±0.15	±0.014
Oxborough												
Hilt	0.018	0.35	0.027	83.7	0.035		0.54	0.168	0.05	0.09	13.8	0.03
Mid	0.017	0.36	0.028	85.8	0.040		0.54	0.148	0.04	0.10	13.9	<0.007
Tip	0.017	0.34	0.029	84.4	0.036		0.53	0.170	0.04	0.10	13.5	<0.007
Beaune												
hilt **repair**	0.023	0.27	–	81.6	0.214		0.039	3.85	0.04	0.03	4.96	7.58
mid	0.019	0.23	0.026	84.6	0.023		0.544	0.138	0.09	0.10	13.6	0.012
Tip	0.020	0.22	0.025	85.4	0.029		0.547	0.138	0.09	0.12	13.7	<0.007
Kimberley												
	0.013	0.33	0.031	84.2	0.201		0.733	0.13	0.07	0.08	14.8	<0.009

Table 2 Compositions in weight% of three Plougrescant-Ommerschans and the Kimberley dirks from Stuart Needham (1990), and NRCA measurements

smelting process. This is probably also true for iron, but it cannot be excluded that some iron is present due to taphonomic processess. Lead occurs as globules in copper. In small quantities it may also come from the smelting process. Larger amounts of lead such as the 3.85 wt% in the hilt side of the Beaune dirk are presumably added while melting the metal for the casting process.

The indicated parts of Jutphaas and Oxborough dirks and the middle and tip sections of the Beaune dirk are remarkably identical tin bronzes with very similar amounts of tin and made from copper with nearly identical impurity patterns. The averaged value for tin of these seven measurements is 13.63 wt% with a variance of 0.06 wt%. It seems likely that these dirks are made from the same metal production by the same smith, probably at the same location.

The hilt section of the Beaune dirk is a tin-lead-zinc bronze produced by adding considerable amounts of tin, lead and zinc to the copper melt. Stuart Needham (1990) assumes that the hilt section of the Beaune dirk is a modern cast-on repair. However, the copper used for this repair contains the minor elements silver, arsenic and antimony. On the other hand, bronzes with large amounts of zinc do not occur in the Bronze Age (cf. Henderson 2000, 212 ff.). To get zinc into copper requires difficult procedures not known in the Bronze Age.

The zinc results quoted in table 2 have to be discussed in more detail. In the case of the Oxborough dirk the zinc values for the three regions differ considerably, that is, 0.03 wt% at the hilt region and below the detection limit of 0.007 wt% for the middle and the tip. Similarly for the middle and tip positions of the Beaune dirk the values are 0.012 wt% and below 0.007 wt%. However, the zinc contents of the two regions of the Jutphaas dirk are larger and of the order of 0.13 wt%. This variation in zinc contents may be related to the sample taking, or measurement techniques. Another reason for these differences might be related to the casting process. Zinc has a boiling temperature of 907 ^{o}C, which is near the melting temperature of bronze. Thus zinc has a high vapour pressure during the melting and casting process, and as a consequence part of the zinc may evaporate. Thus it is difficult to draw conclusions on the basis of the zinc contents.

The tin content of 14.8 wt% of the Kimberley dirk is larger and outside the range of values for the three Plougrescant-Ommerschans dirks. Its nickel content is also larger, but the other minor element compositions, Ag, As, Co, Fe and Sb, are similar considering the errors for these elements. Zinc again is below the detection limit. It seems reasonable to conclude that the Kimberley dirk is from a different production but probably made from a similar kind of copper alloy in terms of metal compositions.

The column bar plot of figure 12 shows weight ratios of elements with respect to copper for the three Plougrescant-Ommerschans and the Kimberley dirks as averages of the

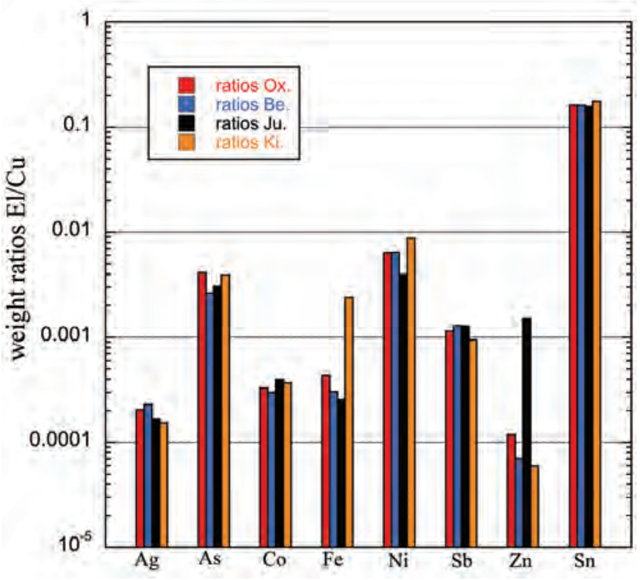

Figure 12 Weight ratios of elements with respect to copper for the Oxborough, Beaune, Jutphaas and Kimberley dirks. See the text for discussion

regions, not including the hilt region of the Beaune dirk. It is a useful plot to appreciate the equality of the compositions of the three Plougrescant-Ommerschans dirks and some of the differences with the Kimberley dirk.

6.4 Concluding remarks concerning the Jutphaas dirk

The Jutphaas dirk belongs to the group of ceremonial Plougrescant-Ommerschans giant dirks. The composition of the Jutphaas dirk is very similar to those of the Oxborough and Beaune (unrepaired part) dirks. These results strengthen the supposition that this set of dirks shares many similarities and perhaps a common origin. This supposition is visually convincingly underlined by the similarities in shape and design. The current study adds to this that there are also very distinct similarities in composition, hence leading to choices concerning the manufacture of these giant dirks. These similarities underline that the group of swords may have been devised and made in a relatively short amount of time and possibly in the same place. This is of importance for studying the reasons behind the fabrication of these impressive ceremonial objects.

7 The Escharen double axe

7.1 History of the discovery

This axe is a very rare find from the Netherlands. In the published information by Butler (1995/6, 167-70) this double axe was said to have been found accidentally at a depth of circa 1 meter during the building of a garage in the village of Escharen near the city of Nijmegen (NL). In a series of notes about the village of Escharen it is mentioned that the Escharen double axe has been found in the mid-seventies by Cor Emons during the building of his garage at the Beersemaasweg 51 (Esters Heem, bodemvondsten 2015/6). He dispatched it in a bucket with junk matter in order to pick it up later. That happened a decade later in 1986 when it was given to a flea market. There it was sold to Jo van den Hoogen. He was sure the object was ancient and tested the composition. As the shining bright orange copper emerged from underneath the patina he was sure and went out of his way to re-trace where it was found, eventually locating the finder through a newspaper advertisement. Thanks to the intervention of Van den Hoogen the Escharen double axe found its way to the Dutch archaeological community and eventually to the National Museum of Antiquities.

The find area is locally known as 'De Bullen'. Such a name is typical in that area for describing wet meadowlands, and the area was known to flood relatively quickly. According to Van den Hoogen, the find may have been situated on a piece of elevated land close to the Beersemaasweg, it is clear that its deposition, burial or abandonment occurred in a dynamic area that was characterized by water and floods covering the axe with layers of sediments. Moreover, Escharen itself is situated near the confluence of a small stream called the Raam and the river Meuse. These wet locations are classical sites where deposition of metal objects took place in later prehistory (see Fontijn 2002).

The axe is currently on display at the National Museum of Antiquities as part of its permanent prehistoric exhibition. Figure 13 shows a picture of this axe. It is 36.9 cm long, the widths of the two blades at the ends are 7.5, respectively 7.35 cm; it weighs 980 grams. It has a hole in the middle, which appears to be too narrow for hafting this axe for a practical purpose. Butler (1995/6) recognized it as a Zabitz type double axe, variant Westeregeln. It is of interest to determine the elemental composition of the Escharen axe and see whether this agrees with the compositions of the double axes reported by Kibbert (1980). Presumably these double axes are ceremonial objects.

The Escharen double axe is in good shape except for two small damages (see fig. 14); one is a set of cuts (with a saw or a file) at its edge done by Jo van den Hoogen for inspecting the composition. The other damage is in the same place and clearly done with a bore apparently to get a sample. The conic hole has a maximum diameter of 2 mm and has a maximum depth of 2 mm. It is not known who took the sample at this location and no result of an analysis is known.

Figure 13 The Escharen double axe (photo National Museum of Antiquities RMO, Leiden)

7.2 Elemental composition

The composition of the Escharen double axe has been determined with neutron resonance capture measurements using beam No.5 of the GELINA facility with a flight path length of 12.927 m to the sample position and a beam diameter of about 70 mm. The centre of the beam coincides roughly with the middle of one of the wings of the double axe. Bismuth, cadmium and sulphur have been used as neutron filters to keep the activation during the run as low as possible. The collected TOF spectrum is shown in figure 1 presented in the introduction. In this figure several of the resonances are marked with their element symbols and central resonance energies. There are a number of strong resonance peaks related to copper, while other marked peaks are from arsenic, antimony and silver. Already during the data taking it was clear that this double axe is made from some sort of arsenical copper. Other weak peaks, identified after the run, are related to silver, gold, cobalt and, interestingly, tellurium. Upper limits of count rates are estimated for some resonances expected to occur for tin, iron, cobalt, nickel and indium, elements which often occur in copper-based artefacts.

Weight fractions of the elements with respect to copper were obtained by the usual analysing methods of NRCA. The variation method in which several pairs of resonances of copper and antimony (or arsenic) are used, and in which the copper thickness is used as a variable parameter, did not work well, as has been experienced with tin-bronzes, for instance in the case of the Buggenum sword; see section 3.1. The amounts of arsenic and antimony are clearly too small for this method to work properly for the Escharen double axe. In this case variations in count-rate ratios depend mainly on the difference of shielding factors for the copper resonances. The obtained apparent copper thickness is in the broad range of 4 to 7 g. Cu/cm^2. Using the specific density of copper this leads to a thickness of order of 5 to 8 mm, which is consistent with the averaged thickness of 6.5 ± 0.4 mm derived from measurements with a micrometre carried out at five locations of the part of the artefact illuminated by the beam.

Figure 14 The Escharen double axe with damages for inspecting the composition, and to get a sample (photo National Museum of Antiquities RMO, Leiden)

element to copper	weight ratios and errors	element	weight % and errors
		Cu	98.4 ± 0.5
Sb/Cu	0.00122 ± $6x10^{-5}$	Sb	0.120 ± 0.006
As/Cu	0.00747 ± 0.00040	As	0.735 ± 0.004
Ag/Cu	0.00043 ± $4x10^{-5}$	Ag	0.044 ± 0.004
Au/Cu	$21x10^{-6}$ ± $4x10^{-6}$	Au	0.0021 ± 0.0004
Co/Cu	$29x10^{-6}$ ± $3x10^{-6}$	Co	0.0029 ± 0.0003
Te/Cu	0.00015 ± 0.00001	Te	0.015 ± 0.001
Sn/Cu	$<12x10^{-6}$	Sn	< 0.001
Zn/Cu	<0.00018	Zn	< 0.018
Fe/Cu	<0.0005	Fe	< 0.5
Ni/Cu	<0.0086	Ni	< 0.8
Pb/Cu	<0.005	Pb	< 0.5
In/Cu	$<10x10^{-6}$	In	< 0.001

Table 3 The composition of the Escharen double axe as based on neutron resonance capture data

Find location	Sn	As	Sb	Ag	Ni	Bi	Pb	Fe	S
Hämerten	0.03	1.5	0.10	trace	trace	0.07		0.15	
Petersberg	trace	0.05	trace	trace	trace	trace			
Pyrmont	0	0	0	0	0	trace		0.1/0.04	
Ketzin	trace	1.05	0.05	0.01	0.01	0.015			
Altenburg	trace	1	trace	trace	trace	trace			0.47
Worms	trace	0.40	0.50	0.80	0.80	trace		0.10	
Westeregeln	0	0.52	0.03	<0.01	<0.01	0.005			
Börssum	0.04	1	0.1	trace	trace	0.005			
Nienburg	0.03	1	0.05	trace	trace			0.40	
Grasrup-Hölsten 1	trace	0.49	0.09	<0.01	0.019	0.009	0.02		
Grasrup-Hölsten 2	0	0.23	0.07	0.013	0	0.001			
Ellierode	“pure copper”								

Table 4 Minor elements in wt% and “trace” elements of twelve Zabitz axes, Westeregeln variant, taken from Kibbert (1980)

The composition of the Escharen double axe, as derived with NRCA, is quoted in table 3 in weight %. The errors are mainly determined by uncertainties of the analysis, notably in the variance of ratios of pairs of resonances (*e.g.* nine in the case of antimony). Table 3 also includes elements for which upper limits could be estimated. In the case of nickel and lead the upper limits are rather large, 0.8 and 0.5 wt%, due to the low sensitivities to observe these elements in neutron capture experiments.

The very weak resonance peak at 2.33 (±0.01) eV observed in the analysis of the Escharen axe (see fig. 1) could only be related to tellurium isotope ^{123}Te with a resonance at 2.334 eV as quoted in the literature. The estimated amount of tellurium in the Escharen axe is 0.015 wt%. Tellurium has not been seen in earlier NRCA experiments, and as far as we know, also not mentioned in the literature about elemental analyses of copper-alloy artefacts.

The Escharen double axe is made from arsenical copper with relatively low values for arsenic and antimony, and with some very small (trace) amounts of silver, gold, cobalt and tellurium.

7.3 Comparison with other Zabitz axes

Kibbert (1980) collected information about 32 double axes of the Zabitz type and divided them into three groups according to their weights; 1) above 2 kg and up to 3.5 kg, 2) a group between about 1 to 1.6 kg, and 3) a group below 1 kg. He recognized three variants named "Cochem", "Flonheim" and "Westeregeln". These variants correlate quite well with the three weight groups. The Westeregeln axes are undecorated and shaped like an hourglass. Butler (1995/6) recognized the Escharen double axe as a Zabitz axe, Westeregeln variant. With its weight of 980 gram it is a relatively heavy member of this variant. There are two other heavy double axes of the Westeregeln variant mentioned by Kibbert (1980), one from Petersberg weighing about 1000 g and one from Hämerten of 1490 g. The lightest double axe (Gastrup-Hölsten 2), accepted by Kibbert as a Westeregeln variant, weighs 278 g.

Table 4 shows the elemental compositions of 11 Zabitz double axes, Westeregeln variant, taken from Kibbert (1980, 291). They can either be considered as pure copper artefacts (Bad Pyrmont and Ellierode) or they are made from arsenical copper with small amounts of arsenic ranging from 0.23 to1.5 wt% (average 0.7). The Escharen axe (0.73 wt% arsenic) fits well in this group. Quoted amounts of antimony range from 0 to 0.1 with an average value of 0.07 wt%. The Escharen axe has a somewhat larger value. Tin is observed in three of these axes with amounts of about 0.04 wt%, it is mentioned as trace elements, or tin is apparently below the detection limit indicated as "zero". Amounts of other elements, Ag, Ni and Bi, are in most cases not given but are also indicated as "trace" or "zero". Lead is in one case (Altenburg) mentioned, iron in three cases (Hämerten, Bad Pyrmont and Nienburg) with maximum value of 0.40 wt% and sulphur in only one case (Altenburg) as 0.47 wt%.

Other Zabitz axes of the variants Cochem and Flonheim have similar compositions with at most small or trace amounts of Sn, As, Sb, Ag, Ni and Bi.

It is apparently, after Otto and Witter (1952), generally accepted that arsenical copper is obtained by smelting fahlore, (ideal formula $Cu_{12}(As/Sb)_4S_{13}$), and is noted in the literature as "fahlore copper". The Zabitz double axes are clearly made from arsenical copper. Therefore some sulphur is expected to occur in these artefacts. Unfortunately, sulphur could not be detected with neutron resonance capture because of the sulphur disk inserted into the beam to remove high-energy neutrons from the beam to reduce activation of the Escharen axe. Sulphur is reported only for the Altenburg axe, Westeregeln variant.

Fahlore minerals contain considerable amounts of arsenic and antimony. However, all 27 analysed Zabitz double axes contain small or very small amounts of these elements. This may be related to low-temperature smelting of fahlore. On the basis of experiments by R.G. Thomas, as reported by Budd as unpublished data, smelting of fahlore below about 900 °C produces a semi-copper product with less than 2 wt% of arsenic. At higher temperatures up to 8 wt% is expected (Budd *et al*. 1992, Budd 1993). The low-temperature smelting could have been carried out at the mining site. Further reduction of the arsenic and antimony contents, and also sulphur, may have occurred during melting of the fahlore copper for casting the artefacts.

Tellurium is a very rare element chemically related to sulphur and selenium. As a first thought one might think that the observed tellurium can be an impurity replacement of sulphur in fahlore. However, there are two factors that make this hypothesis unlikely. Firstly, the atomic radius of tellurium is much larger than that of sulphur; 143 pm compared to 103 pm for sulphur. Secondly, the occurrence of tellurium in the earth crust is very small; about 0.001 mg/kg compared to 350 mg/kg for sulphur. Hence, geological processes must have been very favourable for tellurium to replace sulphur in fahlore. Tellurium has been found as poly-metallic compounds in minerals. It was discovered in Europe in the gold mining area of Romania (Spiridonov 2013) and recently in the Erzgebirge (Förster 2004) as intermetallic compounds with gold and silver.

7.4 Find locations and origin of the copper of the Zabitz axes

The find locations of Zabitz double axes, Westeregeln variant, are shown on the map of figure 15. The locations of the axes of this variant are mainly in Central-Germany, in a region north of the Harz between the rivers Weser and Elbe, with a cluster near Magdeburg. Therefore, the copper used for the Zabitz axes may have come as a semi-product from the Harz where large amounts of sulphide ores occur in its western mountains (Lüders *et al*. 1993).

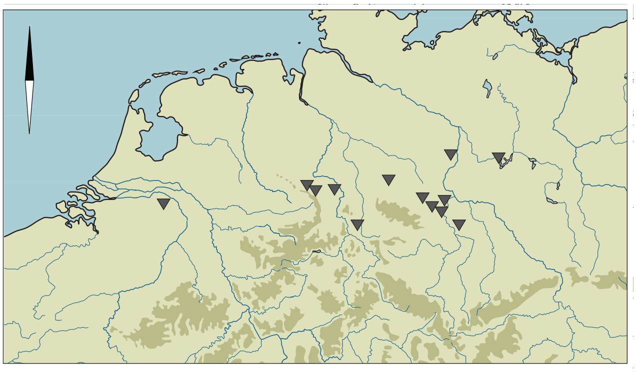

Figure 15 Map showing the find locations of Zabitz type double axes, Westeregeln variant. After Butler 1995/6, figure 5

However, the Erzgebirge might be another possible mining area for the copper used for the Zabitz axes because of the occurrence of tellurium recently shown to exist as Ag_2Te (Hessite) in the nearby Erzgebirge (Förster 2004). Tellurium also occurs in combination with gold for instance as $Cu(Au,Ag)Te_4$ in the Carpathian region where considerable gold deposits exist (Spiridonov 2013). But this region is likely too far away to be a source of copper for the Zabitz double axes.

7.5 Conclusions concerning the Escharen axe

The Escharen double axe is a rare find in the Netherlands. It was recognized as a Zabitz type axe of the variant Westeregeln. Its composition corresponds well with other axes of this type. The Escharen double axe is very likely a long-distance export from a region in Central-Germany near the city Magdeburg and a little west of it. The fahlore copper used for the production of this type of axes may have come from the Harz, but the Erzgebirge is also a reasonable candidate for this copper because of the occurrence of tellurium. It is of interest to analyse some of the Zabitz double axes again to check the occurrence of gold and tellurium. The find location of the axe indicates it was most probably a deposition in or near a wet context.

In the Low Countries, double axes are largely absent and both in shape and use (its non-functional hafting) the object seems out of the ordinary – having a shape that largely lacks counterparts in both previous, contemporary and later material culture in Lower Rhine Basin (cf. Butler 1995/6, 167-70; Fontijn 2002, 66). Among contemporary copper-alloyed objects, arsenic objects have been detected particularly for objects dated to the early Bronze Age (in the Dutch chronology, cf. Butler and Van der Waals 1966). The NRCA results show the Escharen one is not as uncommon in composition as it is in shape. More comparative research on bronze compositions is needed, however, to verify this.

8 General remarks and conclusions

Summing up, the above described analyses show that two of the artefacts (the Buggenum sword and Jutphaas dirk) are tin-bronzes with several impurity elements like antimony, arsenic, silver, indium, cobalt and zinc presumably from the smelting process of copper minerals or recycling of that metal.

NRCA demonstrates that the composition of the smaller Jutphaas dirk clearly belongs to the group of aggrandized ceremonial weapons to which it bears such strong similarities. It fits in well with previous ideas that all these ceremonial dirks were produced in one workshop. The Escharen double axe is an arsenic-bronze with quite a different impurity spectrum of antimony, silver, gold, cobalt and tellurium. It is a long distance exchange object coming from a region in central Germany. Its copper may have been obtained by smelting fahlores mined in nearby regions like the Harz and/or Erzgebirge.

The tomography of the Buggenum sword gives valuable information about the mechanical construction of the object in general and in particular of the way the tang of the blade is positioned inside the hilt.

Thus the three objects from the National Museum of Antiquity, discussed in this paper, originate from three different regions each with different mining areas. The current paper demonstrates that non-invasive, non-destructive techniques, such as NRCA, TOF-ND and NT are very suitable for investigating the composition and discussing the origin of these objects. While there are of course certain aspects, or dangers, such as over-exposure and mounting of the objects in experimental equipment to consider, it is clear that from a museal perspective these techniques offer viable alternatives to destructive sampling as has been the case for the Escharen double axe. The integrity of the objects remains unaltered, while, in contrast to for example handheld XRF-measurements, a much higher level of information is retrieved. It is subscribed by the National Museum of Antiquities and may be considered one of the major outcomes of the Ancient Charm collaboration, that these techniques form an important step forward in the way valuable objects from both public and private collections may be researched in a 'sustainable' manner. It is stressed here that for most archaeological questions and composition analysis these techniques suffice and are to be chosen instead, or before destructive sampling takes place. Having said that, a major point remains that these analyses should in the future be embedded in research programs with a distinct archaeological question at its core (see Amkreutz 2014). While it is interesting that these techniques work well for archaeological objects they form a means to an end. The authors hope that this contribution may to some extent have 'shown the potential' of neutron-based analyses.

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Notes

1 1 eV is equivalent to 1.6×10^{-19} joule, this is the energy an electron gains when accelerated over 1 volt.

2 The European FP6 project ANCIENT CHARM used non-destructive neutron-based techniques and studied a number of cultural heritage objects from Hungary, Italy and The Netherlands. The goal of the physicists in the project was to develop a 3-D imaging technique based on epithermal neutron absorption and the archaeologists wanted to use the various methods to characterize the heritage objects and, in one case, suggest methods for preservation or restoration.

3 As common in nuclear physics reaction strengths are expressed in effective areas, the cross sections in units of barn equal to 10^{-28} m^2.

4 The Lorentzian shape $1/(x^2+1)$ of a reaction channel is based on the Heisenberg uncertainty relation (energy x time), while in a statistical process like thermal motion the distribution is well described by the Gaussian function $\exp(-y^2)$.

5 The terms "thermal" and "cold" are somewhat confusing. Neutrons in thermal equilibrium within the reactor are named "thermal". Their mean energy is about 0.025 eV. Neutrons coming from a moderator at a low temperature, which is placed close to the reactor core, are named "cold".

6 Alpha and delta phases occur during the solidification of tin-bronze after casting. They are equilibrium phases in the copper-tin system. Both phases have face-centred cubic crystal structures. Copper with up to about 10 atomic % of tin solidifies in the alpha phase with tin distributed randomly in the copper lattice; its Pearson symbol is cF4. The delta phase occurs at the eutectic point. Its composition is $Cu_{41}Sn_{11}$ with Pearson symbol cF416.

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Hans Postma
RD&M
Department of Applied Physics
Delft University of Technology

Mekelweg 15
2629 JB Delft
The Netherlands
postma-bosch@dataweb.nl

Luc Amkreutz
National Museum of Antiquities
PO Box 11114
2301 EC Leiden
The Netherlands
l.amkreutz@rmo.nl

David Fontijn and Hans Kamermans
Faculty of Archaeology
University Leiden
PO Box 9514
2300 RA Leiden
The Netherlands
d.r.fontijn@arch.leidenuniv.nl
h.kamermans@arch.leidenuniv.nl

Winfried A. Kockelmann
ISIS Facility
STFC, Rutherford Appleton Laboratory
Chilton OX11 0QX
UK
winfried.kockelmann@stfc.ac.uk

Peter Schillebeeckx
European Commission, Joint Research Centre
Retieseweg 111
B-2440 Geel
Belgium
peter.schillebeeckx@ec.europa.eu

Dirk Visser
Loughborough University
Department of Physics
Loughborough
UK
d.visser@lboro.ac.uk

Late Neolithic V-perforated buttons from a female burial in SE Poland: a comprehensive study of raw material, bone technology and use-life

Kinga Winnicka

V-perforated buttons are usually associated with Bell Beaker sepulchral finds. An assemblage of eleven buttons originating from a Late Neolithic female grave found in Sandomierz-Zawichost Hill site in south-east Poland has been analysed using several low-invasive techniques. The analysis encompassed assessment of the state of preservation, raw material identification and technological and use-life study of the objects. With the aid of conventional light microscopy, scanning electron microscopy, microcomputed tomography and zooarchaeology by mass spectroscopy it was possible to establish that the buttons had been made of compact tissue of Bos bone. Microwear analysis allowed for a better understanding of bone technology involved in the manufacture of the objects. It has also been established that the buttons were used/worn prior to their deposition in the grave. The results indicate that it required skill and knowledge of the raw material to manufacture the buttons, and the archaeological context suggests that they might have been connected to the status of older women in Bell Beaker communities.

1 Introduction

The so-called V-perforated bone buttons can be found across the whole Bell Beaker Europe in the Eneolithic – from Iberia (Aranda Jiménez *et al*. 2014, 104) to Central Europe (Makarowicz 2003, 145), and from the British Isles (Sheridan and Davis 2002; Woodward and Hunter 2015, 148–155) to Sardinia (Pau 2012). The buttons are usually made of osseous materials (bone, antler and ivory), but also amber, jet and other lithics. First detailed studies date to the early 2nd half of the 20th century (Arnal 1954; Hájek 1957), but the most extensively analysed collections of V-perforated bone buttons originate from the Western Mediterranean where a lot of attention is given to the raw material (ivory) provenance (*e.g*. López Padilla 2006a; 2006b; 2009; Schuhmacher *et al*. 2009; 2013).

Poland is the easternmost territory under the Bell Beaker influence. There are only three published assemblages of V-perforated bone buttons from Polish sepulchral sites, all of which were excavated more than 30 years ago: Sandomierz-Zawichost Hill (Świętokrzyskie Voivodeship) in the 80's, Strachów (Lower Silesia Voivodeship) in the 70's and the oldest – Złota 'Upon Wawer' site (Świętokrzyskie Voivodeship) in the late 20's. Nine buttons from the Złota site come from three graves: two female and one male, but with a female right-sided lateralisation (Budziszewski and Włodarczak 2010, 32–35, 87; after Żurowski 1932). The only published assemblage from the Silesia region (Strachów site) has been found in a female grave and it consists of eight well preserved buttons (Noworyta 1976, 52–56). The analysis and interpretation of the third assemblage will be presented hereby.

2 Materials

The analysed V-perforated bone buttons come from a single Bell Beaker grave found in the Zawichost Hill in the town of Sandomierz in south-east Poland and were recovered in 1985 during a rescue excavation led by H. Kowalewska-Marszałek of the Institute of Archaeology and Ethnology, Polish Academy of Sciences in Warsaw (Kowalewska-Marszałek and Cyngot 1988). The grave was radiocarbon dated yielding an uncalibrated result: 3 790 ± 40 BP (2 203 ± 72 cal BC), which is consistent with recorded 'late' Bell Beaker burial practices in Eastern Europe; especially lateralisation of the dead and grave inventories (Włodarczak and Kowalewska-Marszałek 1998, 56). Anthropological assessment revealed the skeleton to belong to a ca. 30 year old female (adult/mature), lying on her right side with bent legs (in foetal position) in N-S orientation, facing the East (fig. 1). She was accompanied by other grave goods beside the buttons: two ceramic vessels and a small copper awl. Eleven V-perforated buttons were found in three groups in the upper part of the skeleton, close to the ribs, which is consistent with what has already been established for Bell Beaker female graves with V-perforated buttons in Central and Eastern European context (Hájek 1957, 389–421).

The artefacts have been divided into two groups, in accordance with their shapes and sizes. The hemispherical buttons (3 pcs.) are slightly larger with base diameter of 18–22mm (I/II group after Pau 2012, 68–69). The second group – conical buttons (8 pcs.) have smaller base diameter: 10–14mm (after: Kowalewska-Marszałek and Cyngot 1988, 134). In cross section the buttons are either half-oval or triangle. The characteristic V-shaped perforation is located

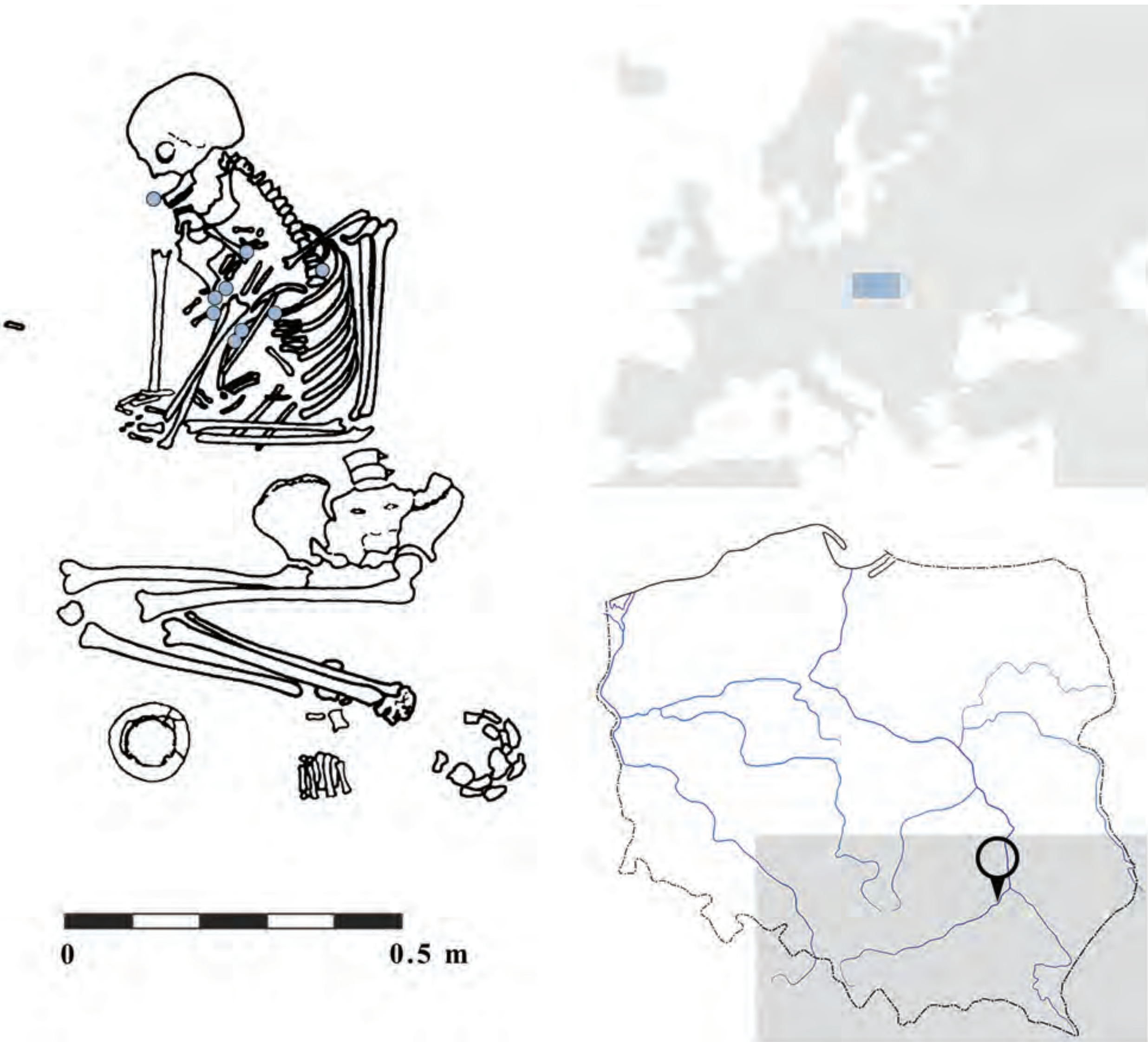

Figure 1 A schematic grave plan with the V-perforated buttons (blue dots) and the location of the Sandomierz-Zawichost Hill site in SE Poland (grave plan drawing after Kowalewska-Marszałek and Cyngot 1988)

centrally or closer to the edge in relation to the artefact's base. All macro- and microscopic measurements are enclosed (table 1).

3 Methods

Microwear analysis is based on using microscopic technique(s) to analyse the surface of an artefact in order to establish how it was made and how it was used. Microwear studies of osseous materials are being developed since at least the early 80's (Olsen 1984; also van Gijn 2012; Almeida Évora 2015, 159–170; Bradfield 2015). It is a techno-functional approach, but microscopic analysis may also include assessment of the state of preservation, raw material differentiation and identification of mineral and organic residues (Almeida Évora 2015, 162). In the case of V-perforated buttons from the Sandomierz site, the analysis allowed to assess the state of preservation, determine the raw material, and identify technological and use-wear traces. No mineral and/or organic residues of anthropogenic origin were detected.

First part of the analyses was conducted using light microscopy: stereomicroscope Olympus SZX9 (magn. 6,3×–57×) and metallographic Nikon Eclipse LV 100 (magn. 50×–1000×) at the Laboratory for Archaeometry and Artefact

Conservation, Institute of Archaeology, University of Wrocław (Poland). Additional observations were made under private stereomicroscope Bresser Advance ICD (magn. 10×–160×). Photomicrographs were taken using Olympus C-5060 WZ and HDCE-X5 cameras, the other coupled with ScopeImage 9.0 software (live). Second part of the investigation was carried out at the Laboratory for Artefact Studies, Leiden University (Netherlands). Both metallographic and stereo-microscopes were utilised at this stage: Nikon Optiphot-2 (magn. 50×–1000×), Leica DM2700M (magn. 50×–200×) with Leica MC120 HD camera, Leica DM600M (magn. 50×–500×) with Leica DFC450 camera and Leica M80 (magn. 7,5×–64×) with Leica MC120 HD camera. Photomicrographs and measurements were registered and edited with the use of Leica dedicated software – LAS Extended Annotation.

Another stage of the analyses was completed using scanning electron microscope (SEM) Hitachi S-400N with EDS (Noran System7 and Thermo Scientific Ultra Dry Lithium Drifted Silicon detector) at the Laboratory of Electron Microscopy, Faculty of Chemistry, University of Wrocław, Poland. Samples (hemispherical X-05-7 and conical X-05-14) were not sputter coated. Observation parameters, such as detector type (BSE, SE), pressure (Pa) and accelerating voltage (kV), and also magnifications used are present on every photomicrograph.

Visual and morphometric analysis using microcomputed tomography (microCT) was carried out at the Department of Biomedical Engineering, Mechatronics and Theory of Mechanisms at the Faculty of Mechanical Engineering, Wrocław University of Technology (Poland). Five samples were chosen for this procedure – four V-perforated buttons from Sandomierz-Zawichost Hill (X-05-6, 7, 11 and 13) and one button from Strachów, lent by the Archaeological Museum – City Museum of Wrocław (Poland). The analysis was conducted using Bruker's SkyScan 1172 with 11 Mp X-ray detector. All samples were analysed using the same parameters: microfocus X-ray tube voltage (89 kV), tension (112 μA), Al-Cu filter and scanning mean resolution (12 μm). Scanning procedure was completed with the use of 360° rotation, with 0.4° step and window averaging from two projections. Additionally, ring artefact effect occurring close to the centre of the scan was reduced by random window shifting. Object reconstruction and morphometric analysis was carried out using Bruker's dedicated software: NRecon, CTAn, CTVox, DataViewer (after unpublished report: Wojtków and Nikodem 2015).

ZooMS (Zooarchaeology by Mass Spectrometry) analysis was carried out at the BioArCh laboratory of University of York (United Kingdom). Due to potentially invasive procedure, an artefact in poor state of preservation was selected for the analysis (X-05-16). ZooMS analysis allows for species identification based on differences between type I collagen in teeth or bone samples (for method description see: Buckley *et al*. 2009; Kirby *et al*. 2013). The analysis consists of collagen extraction by immersing the sample in ammonium bicarbonate solution, trypsin rinsing (causing further disintegration into peptides) and MALDI-MS analysis (Matrix Assisted Laser Desorption and Ionisation). Results can then be compared with the BioArCh's reference base and raw material identification can be made on this basis (after unpublished report: Collins and Spindler 2015).

Inventory no.	**Shape**	**Base diameter (mm)**	**Max. length (mm)**
X-05-5	Conical	13	7
X-05-6	Hemispherical	22	4,5
X-05-7	Hemispherical	20	6
X-05-9	Hemispherical	18	3,5
X-05-10	Conical	8 × 10	8
X-05-11	Conical	12	7,5
X-05-12	Conical	11 × 9,5	8
X-05-13	Conical	13	8
X-05-14	Conical	12	7,5
X-05-15	Conical	13 × 14	10
X-05-16	Conical	13	7

Table 1 V-perforated buttons from the Sandomierz-Zawichost Hill site: shape and basic dimensions (measurements by H. Kowalewska-Marszałek)

All visual aids were made using Adobe Photoshop CS5.1 and CC 2015.5 software with the use of photomicrographs taken by K. Winnicka, W. Gil (SEM), microCT scans made by M. Wojtków and A. Nikodem, and drawings of the Sandomierz objects by M. Krakowiak (published in: Kowalewska-Marszałek and Cyngot 1988, 135) and one Strachów artefact by an anonymous author (published in: Noworyta 1976, 53).

4 Results

4.1 State of preservation

Already during initial macroscopic observations it has been established that the artefacts are strongly affected by taphonomic processes (3–4 stage after Lyman 1994, 355). The surface is uneven, with cracks from the top to the base (especially X-05-13, 15 and 16). Low power microscopic analysis (up to 50×) revealed layers, stacked parallel or perpendicular to the artefact's axis; their presence can be contributed to the natural microstructure of the raw material.

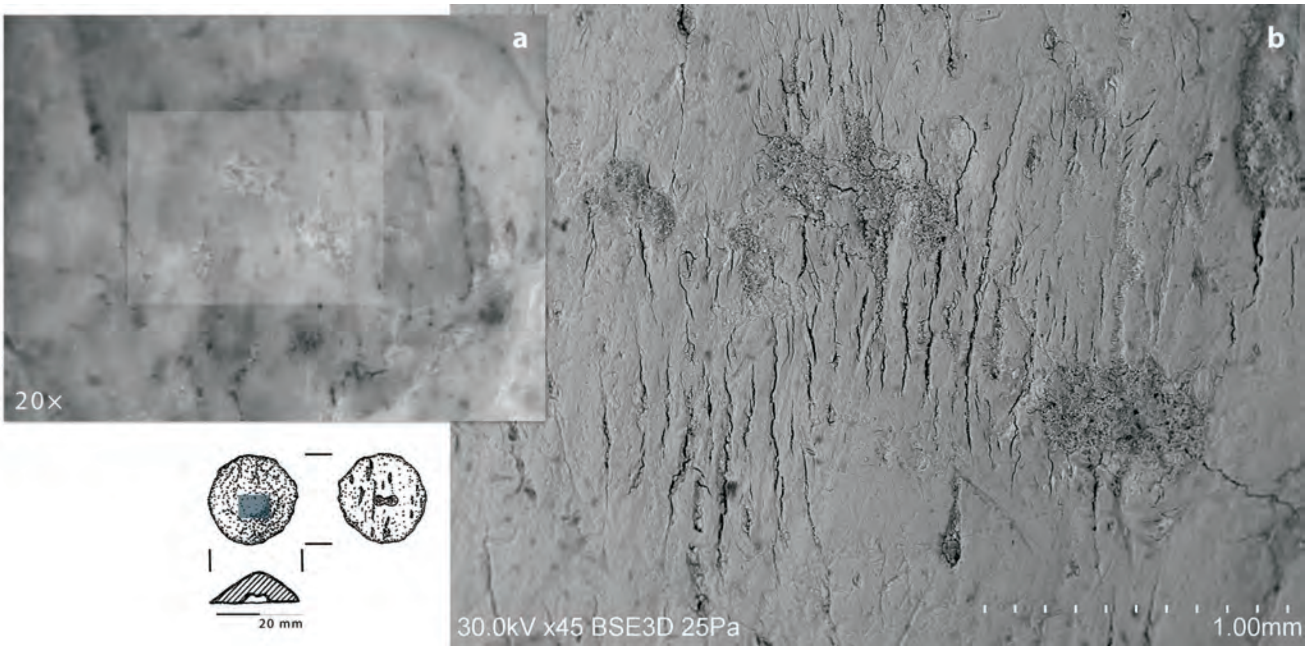

Figure 2 Hairline cracks on the surface of X-05-7 in the top area: a – conventional photomicrograph; b – SEM image

Additionally, during SEM analysis it was possible to observe hairline cracks on the surface, *e.g.* near the top area of X-05-7 (fig. 2a–b), indiscernible under light microscopy. On the other hand, analysis of microCT scans revealed that micro-cracks penetrate further into the body of some of the artefacts, even those seemingly well preserved (fig. 3).

Microscopic observations also allowed to estimate the degree of preservation of the original surface of the artefacts – it seems that it is preserved only in small areas on base and lateral surfaces of the objects (X-05-9, 12 and possibly 5), and only in one case (X-05-7) in ca. 30% in the top area. Preserved original surface is smooth with yellow colouring and bright polish, visible in some instances only under the microscope. On the other hand, eroded areas have uneven texture, they are lighter and duller (fig. 4a–b). On the surface, especially inside the erosion areas, there are residues of small fraction deposit (loess) and CaCo3 crust connected to the taphonomic processes in loess soils (Becze-Deák *et al.* 1997). There are also golden-brown, irregular humic acid stains (Saña *et al.* 2014, 75) on the surface, especially on three artefacts (X-05-10, 11 and 12), which might be related to slightly different biogeochemical conditions during deposition. All of the above mentioned traces can be observed on the surface of all analysed artefacts under magnifications >50×.

It is important to note that the legibility of the surface is obscured not only by the taphonomic processes and post-depositional factors, but also post-exploration activities, such as cleaning, processing (*e.g.* ink and graphite stains on the surface), storing, moving, etc. All these factors could have affected the objects by generating smoothing and polishing on strongly eroded and thus susceptible to modifications surface of the artefacts.

4.2 *Raw material identification*

Understanding the criteria for raw material selection allows to answer vital questions about the community in which the object was manufactured. Raw material identification is thus crucial, also in the case of artefacts made of osseous materials. A. Choyke underlines the following interconnected factors affecting raw material selection for the manufacture of bone implements and adornments: availability of the raw

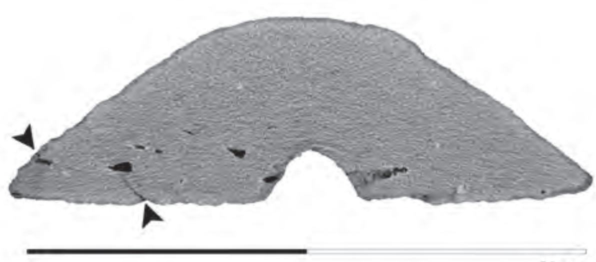

Figure 3 Cracks inside X-05-7; cross section made with the use of microCT

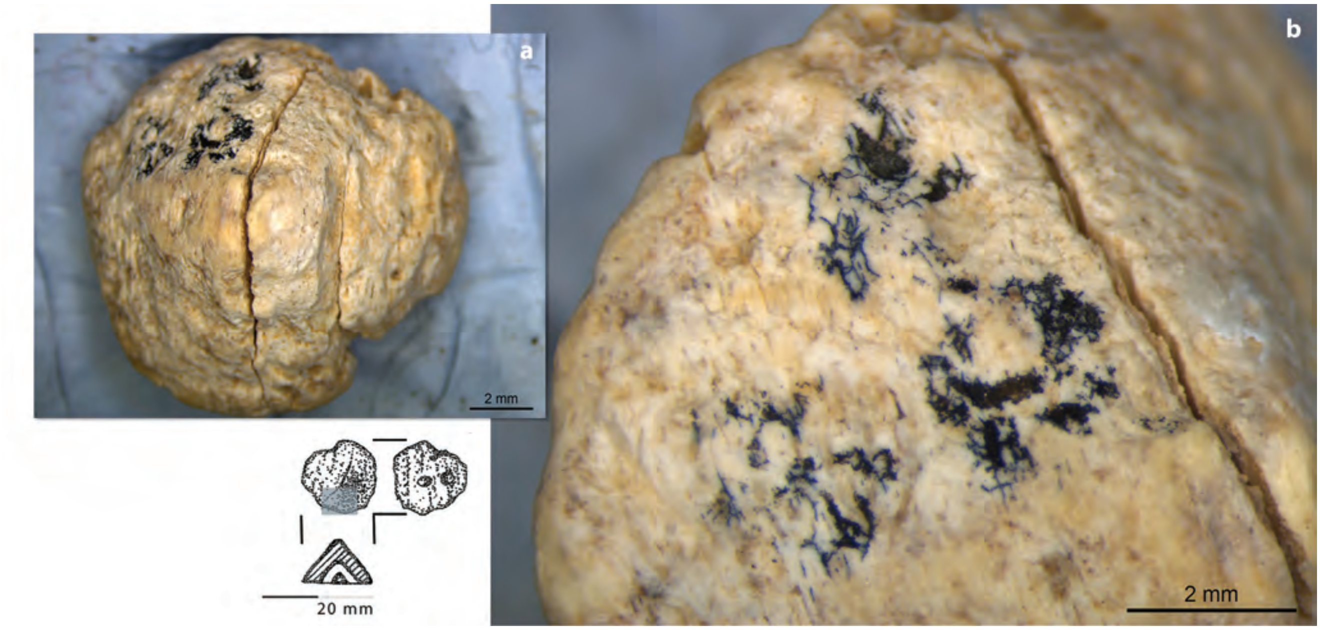

Figure 4 Surface of X-05-16: a – top view; b – heavily eroded lateral surface with ink stains and a deep crack running from the top to the base of the artefact

material, its physical properties (*e.g.* shape, brittleness), beliefs regarding the animal and its skeletal elements, and local butchering and carcass processing traditions. She also accentuates the importance of family related, local and regional beliefs and traditions in respect to the raw material selection for the manufacture of particular objects (Choyke 2013, 2). Differentiating between osseous materials, skeleton parts and animal species is imperative, because raw material selection was never random, but it was determined by the set of above mentioned factors, relating not only to a technological knowledge, but also to a symbolic culture of a particular group of people.

During initial microscopic analysis it was noted that strongly eroded surface of the artefacts does not allow for straightforward raw material identification. The most obvious choice would be compact tissue of bone or antler, however some properties pointed towards dentine. In order to establish what kind of raw material was used for the manufacture of V-perforated buttons, four analytic techniques have been employed. These techniques are: conventional light microscopy (stereo- and metallographic microscopes with a total range of magnifications 6,3×–1000×), scanning electron microscopy – SEM, microcomputed tomography – microCT, and zooarchaeology by mass spectroscopy – ZooMS (table 2).

Microscopic observations made under stereomicroscopes (magn. <100×) revealed qualitative features in regard to colour and microstructure of the analysed objects. First set of features relates to the variability in colour, which might point towards dentine: eroded areas are creamy-white while the original surface is yellowish. However, M. Rijkelijkhuizen underlines that colour is not a distinction feature, because of taphonomic modifications and the influence of light

Inventory no.	Light microscopy	SEM-EDS	MicroCT	ZooMS
X-05-5	YES			
X-05-6	YES		YES	
X-05-7	YES	YES	YES	
X-05-9	YES			
X-05-10	YES			YES
X-05-11	YES		YES	
X-05-12	YES			
X-05-13	YES		YES	
X-05-14	YES	YES		
X-05-15	YES			
X-05-16	YES			
Strachow 1	YES		YES	

Table 2 Overview of the analytical techniques employed in this study

(Rijkelijkhuizen 2008, 55). Histological properties are more confident in differentiating between raw materials: in the case of dentine, dentinal tubules that are packed into microlayers are a distinction feature (Locke 2008), while bone tissue is characterised by the occurrence of osteons (compact tissue) and bone lamellae (spongy tissue; Malluche and Faugere 1986, 2–11). During microscopic observations using magnifications up to 50× it has been noted that the raw material tends to split into thin layers, from the top parallel or perpendicular to the base of the artefact. It is especially pronounced in the case of one button – X-05-7 (fig. 5a–b). Additionally, it has been observed that on the surface of the artefacts (notably X-05-6 and 7), near the top area and on the lateral surface, there are dark lines and points connected to the microstructure affected by the taphonomic processes (fig. 5c). On this it was established that in all probability the artefacts were made of bone compact tissue.

A follow-up SEM procedure was conducted for selected samples (X-05-7 and 14). The analysis allowed for a more detailed examination of previously observed microstructures, and the application of high accelerating voltage (30 kV) revealed micro-canals inside the sample, running perpendicularly to the lateral surface (fig. 6a–d). A comparison with published literature (especially Ahamed *et al*. 2012; Reiche *et al*. 2011; Tolksdorf *et al*. 2014; Yin *et al*. 2013) did not confirm the hypothesis that the buttons had been made of dentine. Size and distribution of the micro-canals revealed by SEM analysis appears to be more similar to that of bone canals (canaliculi) rather than dentine tubules (Rensberger and Watabe 2000).

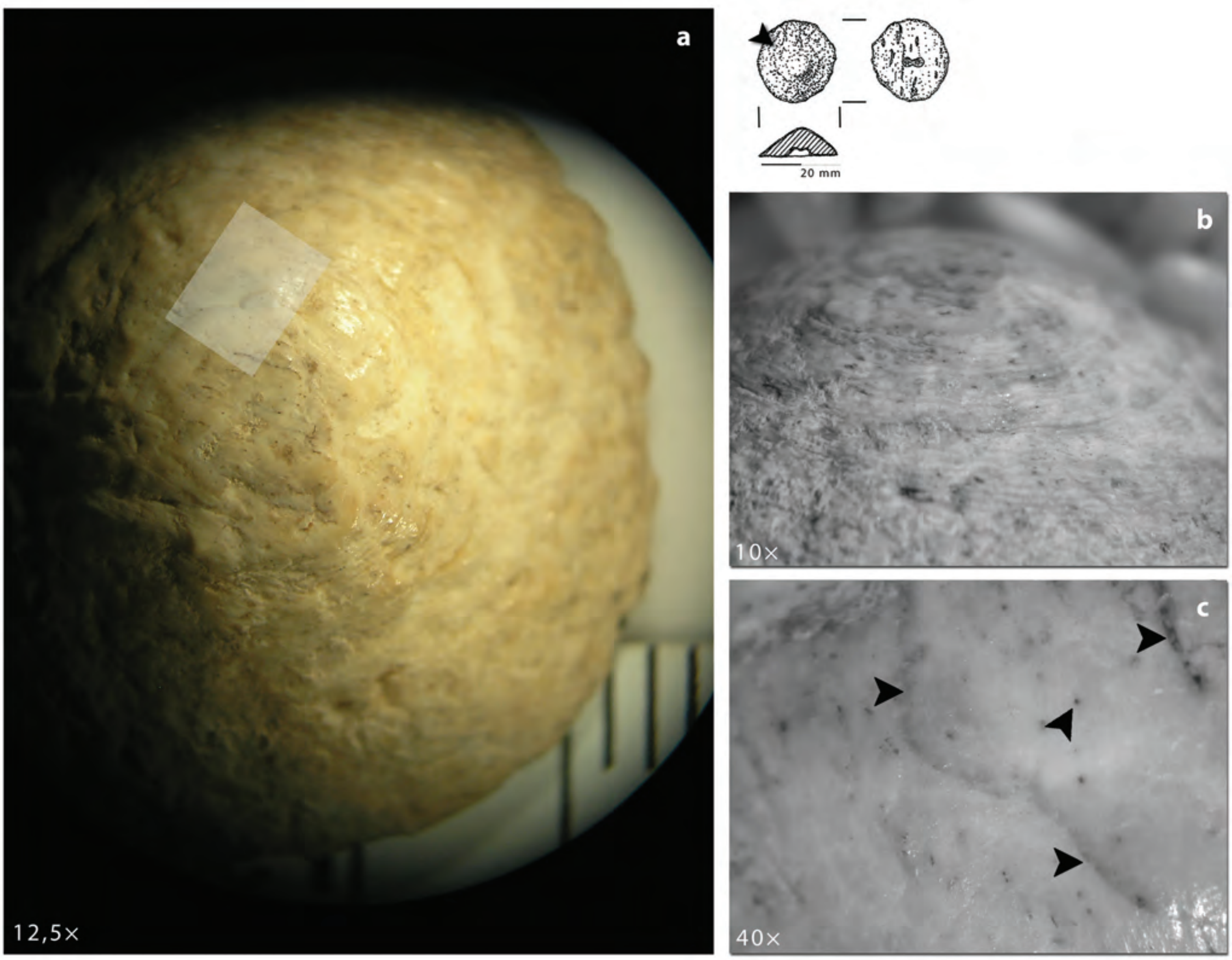

Figure 5 Surface of X-05-7: a – top view; b – splitting into micro-lamellae from the top to the base of the artefact; c – bone microstructure in the top area (arrows)

Another part of the investigation has been completed using imaging and morphometric analysis by microcomputed tomography. Five samples (X-05-6, 7, 11 and 13 and Strachow 1 for comparison) were scanned. Structural analysis revealed that the porosity of the raw material ranges 91.6÷99.5%, which is consistent with bone compact tissue (table 3). 3D scans allowed to observe internal structure of the samples, and, especially for X-05-7 and, less pronouncedly, X-05-6 and 16 there are apertures indicating that some spongy tissue is also present (fig. 7a–b). It can be concluded that the buttons were made of animal bone consisting of a thick layer of compact tissue with a fringe of spongy tissue, *e.g.* proximal area of long bone diaphysis.

At this stage of the analyses it was hypothesised that the artefacts were made of bone/bones of a substantial animal and not of animal teeth. In order to verify this, ZooMS procedure was conducted, at the same time additional microscopic observations were carried out at Leiden University using magnifications 100× and higher. The observations revealed poorly visible osteons, mainly on the lateral surface of the artefacts: X-05-5, 6, 10, 11, 13, 14, 15 and 16 (fig. 8a–f). Osteons are a characteristic feature of compact bone, they build long bone diaphyses (and cover long bone epiphyses) and external layers of short and flat

Inventory no.	BV/TV [%]
X-05-6	98.05
X-05-7	99.21
X-05-11	99.51
X-05-13	91.63
Strachow 1	99.04
Mean value	97.49
Standard deviation	3.32

Table 3 Bone volume/tissue volume ratio parameter, or bone percentage in a sample for the V-perforated buttons analysed by microCT (after: Wojtków and Nikodem 2015)

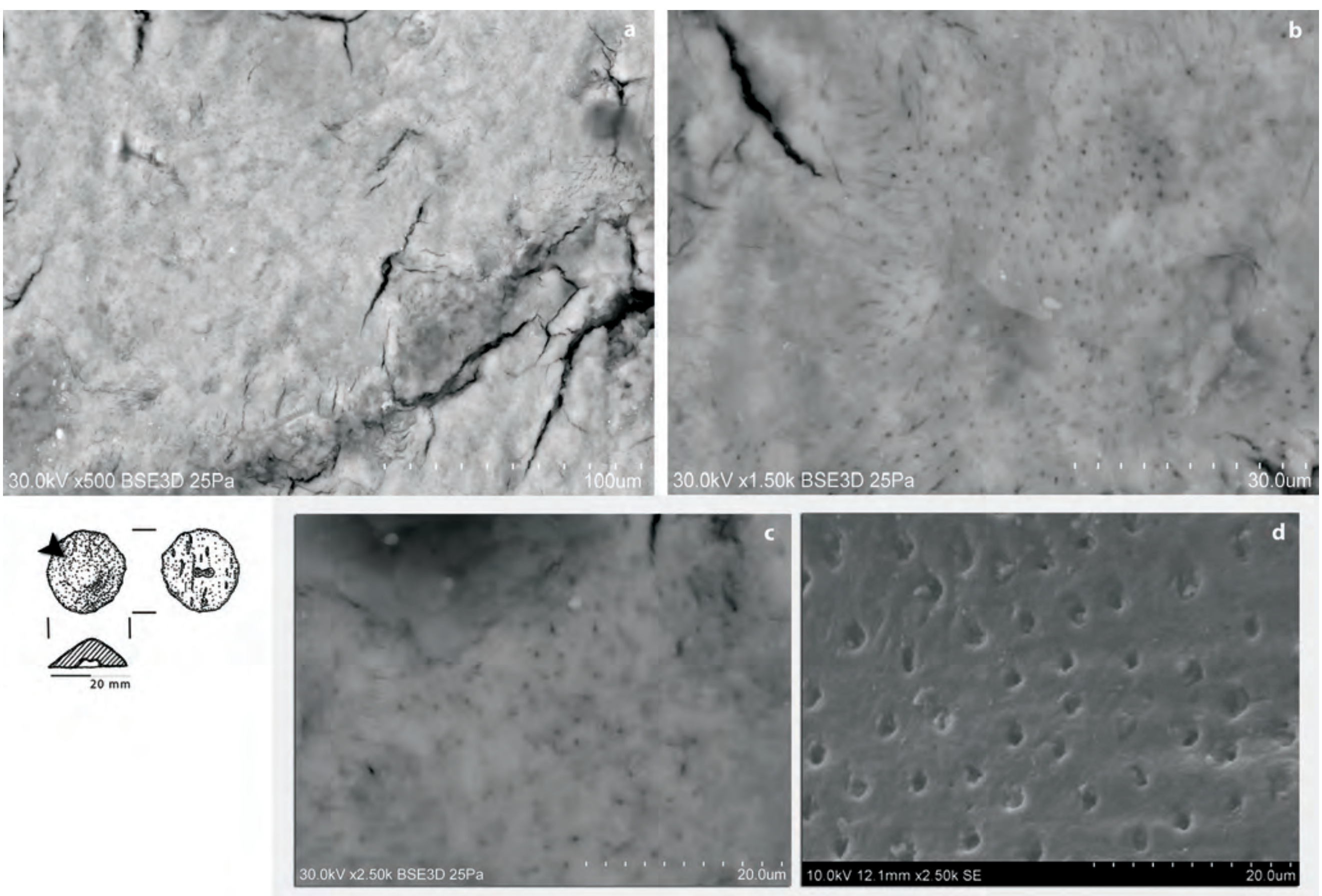

Figure 6 SEM images: a–c – bone canals in different magnifications (500×–2 500×); d – dentinal tubules after Ahamed *et al*. 2012, 55

bones (Malluche and Faugere 1986, 2). The observations confirmed thus that the majority of buttons had been made of compact tissue of large animal bones.

A final confirmation has been delivered by ZooMS analysis. The acquired spectra indicate that the collagen sample (button X-05-16) contains a peptide characteristic for cattle (*Bos*), but without further differentiation between domestic (*Bos taurus*) and wild aurochs (*Bos primigenius*).

On the basis of all conducted analyses, as well as the archaeological context, it was possible to affirm that the analysed V-perforated buttons (notably X-05-5, 6, 7, 10, 11, 13, 14, 15 and 16) had been made of bone compact tissue or a borderline area between compact and spongy tissue of a long bone, in all probability belonging to domestic or wild cattle.

The results indicate that in order to manufacture the buttons a common raw material was utilised, which is also substantiated by the prevalence of cattle bones in Bell Beaker settlement sites in Central and Eastern Europe (*e.g.* Liptice site – from this largest Bell Beaker settlement in Czech Republic nearly 60% of animal bones belongs to cattle – Turek and Peška 2001, 420–421). The utilisation of cattle bones was dictated by their availability and raw material properties known to the manufacturer, *e.g.* substantial thickness of compact tissue optimal for the formation of larger buttons. Raw material selection underscores the importance of *Bos* genus for the Bell Beaker economy in south-east Poland.

4.3 Manufacturing techniques

Identification of the raw material allows for a better understanding of the technology involved in its working: in the case of osseous materials it is possible to discern morphologic properties, which might help to understand the manufacturer's approach to the raw material. In this instance substantial thickness of the bone tissue was preferred by the craftsman, because it allowed for the manufacture of larger pieces. Although, in one case (X-05-7) the analysis of 3D scans has revealed that some remains of spongy tissue did not affect the final shape of this hemispherical button (Fig. 7b). Microscopic observations and microCT scans shown that the half-product had been worked mainly along the long axis of the bone, which can be substantiated by 1) the way the raw material splits due to erosion – parallel to the base of the artefact, and 2) the presence of osteons on the lateral surface (X-05-5, 6, 10, 11, 13, 14, 15 and 16). The raw material's orientation is confirmed by observations made on two artefacts (X-05-13 and 15) – the osteons are visible on the opposite sides of the object. Three artefacts (X-05-6, 7 and 16) had been worked perpendicularly to the long axis of the bone, which is confirmed by the osteons both on the lateral surface and on the base surface. These are two slightly larger hemispherical pieces and the smallest of the conical buttons. In the case of X-05-9 and X-05-12 it was not possible to establish the orientation in relation to the long axis of the bone. Working the half-product in regard to the

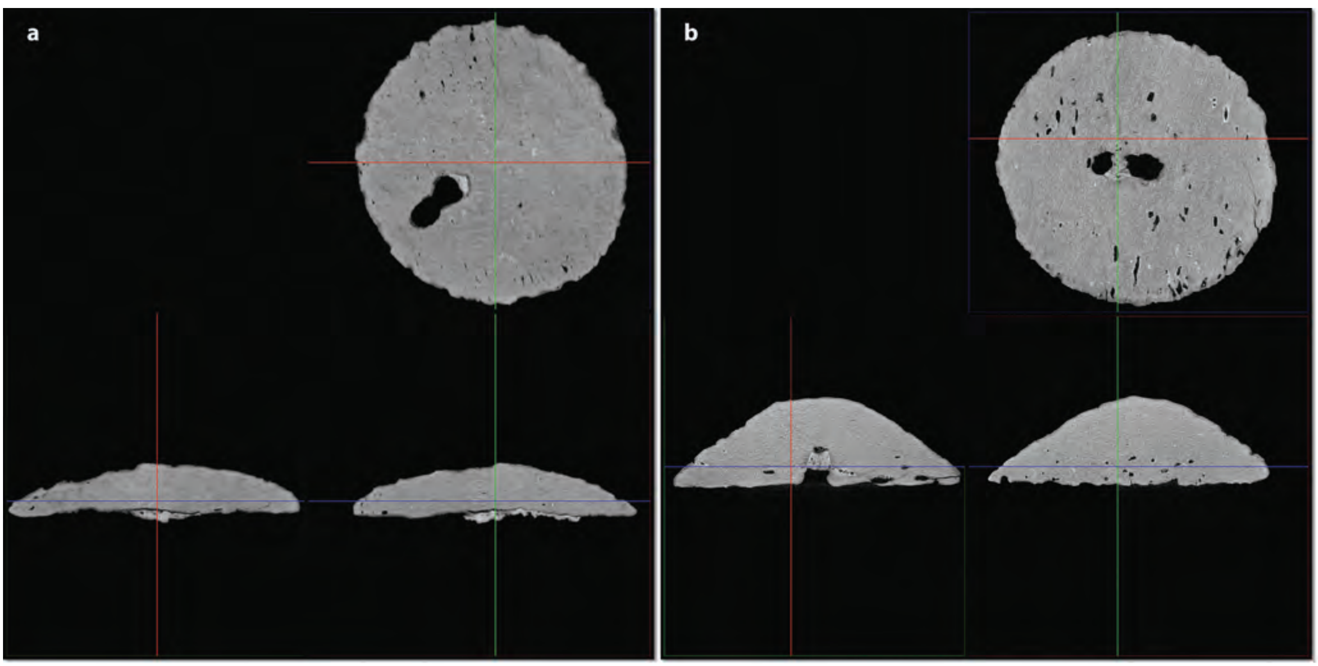

Figure 7 Cross sections made with the use of microCT: a – apertures in the bone indicating presence of spongy tissue – X-05-6; b – apertures in the bone indicating presence of spongy tissue – X-05-7

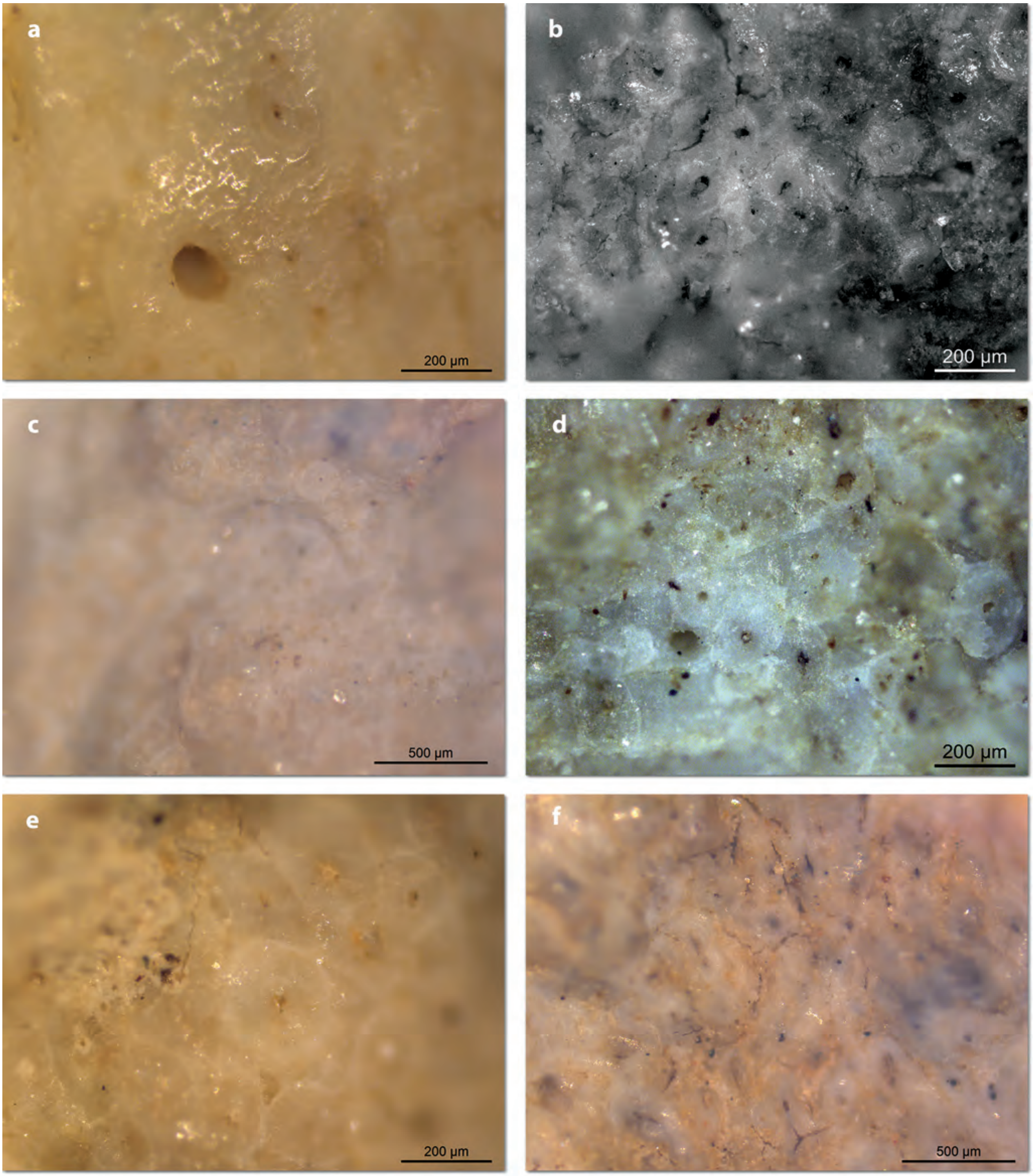

Figure 8 Osteons on the lateral surface of the buttons: a – X-05-6; b – X-05-10; c – X-05-11; d – X-05-13; e – X-05-14; f – X-05-15

orientation of the raw material indicates manufacturer's preferences and skillful handling of the osseous material, *e.g.* splitting the bone along its long axis.

During the analysis no traces of forming techniques, nor implements used were detected, which is in all probability due to the strong influence of the taphonomic processes upon the surface of the buttons. The raw material must have been altered by some kind of thermal treatment (*e.g.* boiling) or other form of softening. It can also be assumed that the bone had been worked in such a manner as to acquire half-products consisting primarily of compact tissue. In the next manufacturing stage the half-product was fragmented and each fragment was formed into a desired shape – hemispherical or conical. Fragmentation techniques employed by the manufacturer were simple – cutting and/or sawing, *e.g.* by the use of sciage au fil sablé (abrasive cutting – using string/tendon and sand or other abrasive material), which was suggested by V. Mérida González in relation to V-perforated ivory buttons (Mérida González 1997, 3–5). The final touch (smooth surfaces) was accomplished by grinding the lateral and base surfaces on a small fraction stone (*e.g.* sandstone).

The most characteristic feature that can be analysed microscopically is the V-perforation. The artefacts differ concerning the placement of the aperture (centrally or closer to the base's edge), its depth, diameter of each hole and distance between them. Additionally, in the case of two buttons, it can observed that there is another hole in the lateral surface (X-05-6 and 11). The first one (X-05-6) was probably caused by the high degree of surface erosion – the bone must have collapsed which created an aperture. In the other instance (X-05-11) – a hole was drilled or punched from the base with an exit in the lateral surface – indicating deliberate action. This additional hole may be related to another decorative element connected to this button that had not been found in the grave. It does not seem that this additional feature appeared due to the curation of the object, because the original V-perforation allowed for a secure fastening of the button in the same way the other buttons could have been fastened.

Based on the measurements of distances between the holes it was established that a sharp and precise implement must have been used to make the V-perforation. It was probably not a bow drill as suggested by V. Mérida González (Mérida González 1997, 7) – however a bow drill might have been used to make the additional aperture in button X-05-11. Drilled holes tend to have parallel walls, but the analysed V-perforations are shallow (fig. 9a–c), which indicates that they were scooped from both sides repeatedly until an aperture appeared, allowing for a string to fasten the button unto a piece of clothing. Making this aperture must have required controlling the force of the impact – it must have been substantial enough to work the hard material, but at the same time precise allowing to make a small aperture in a small object – all of which points towards the skill of the manufacturer.

All of the above observations suggest that the buttons have been made by a person familiar with working with osseous raw material, its physical properties and knowledgeable on different bone working techniques.

4.4 Use-life and interpretation

Unfortunately, poor state of preservation of the surface does not allow for an advanced interpretation of the way the buttons were used. Strong use-wear traces are visible on the surface of the Strachów button – there is a pronounced rounding and polishing in the perforation area and on the base's edge suggestive of wearing (fig. 10a–b). Also, the lateral surface is smooth, which is due not only to the post-depositional processes and cleaning but also use-life (fig. 10c).

All of the Sandomierz buttons have areas of smoothness and polish, but the original surface is very limited (fig. 11a–d; fig. 12a–c). Those areas are located mainly near the top (X-05-5, 7, 14), between the holes (X-05-5, 9, 10, 13, 15), but also on the base surface (X-05-5, 9, 10, 11, 12, 13, 14, 15) and on the lateral surface (X-05-6, 9, 10); rounding of the edge is also visible (X-06-16).

The presence of the characteristic V-perforation indicated the means of suspension, which purposefully exposes the lateral surface and preferred shape of the objects. A row of buttons might have had an aesthetic function. It is difficult to ascertain whether they were also a functional element of dress – despite the similarity in form sensu stricto buttons sewn onto clothing do not appear until the Middle Ages (White 1962, 500). The context in which the buttons have been found suggests their possible social and symbolic meanings. During the Bell Beaker period, V-perforated buttons are usually associated with graves of adult and older women, or with graves with individuals of typically female lateralisation (*i.e.* right-sided), and their concentrations can be found in the upper part of the grave – in the head and thorax area. This relationship was confirmed for the southern enclave of the Central and Eastern European Bell Beakers (Hájek 1957), including Polish finds (Budziszewski and Włodarczak 2010, 32–35, 87; Złota 'Upon Wawer' site after Żurowski 1932; Noworyta 1976, 52–56). It can be also said for the original Bell Beaker territory – Iberia (M. Altamirano García, personal communication – May 2016).

It can be assumed that V-perforated buttons as a visible dress element constituted a way of expressing collective identity: it identified the wearer as a part of the local community, and this community made part of a cultural complex with its characteristic elements of material

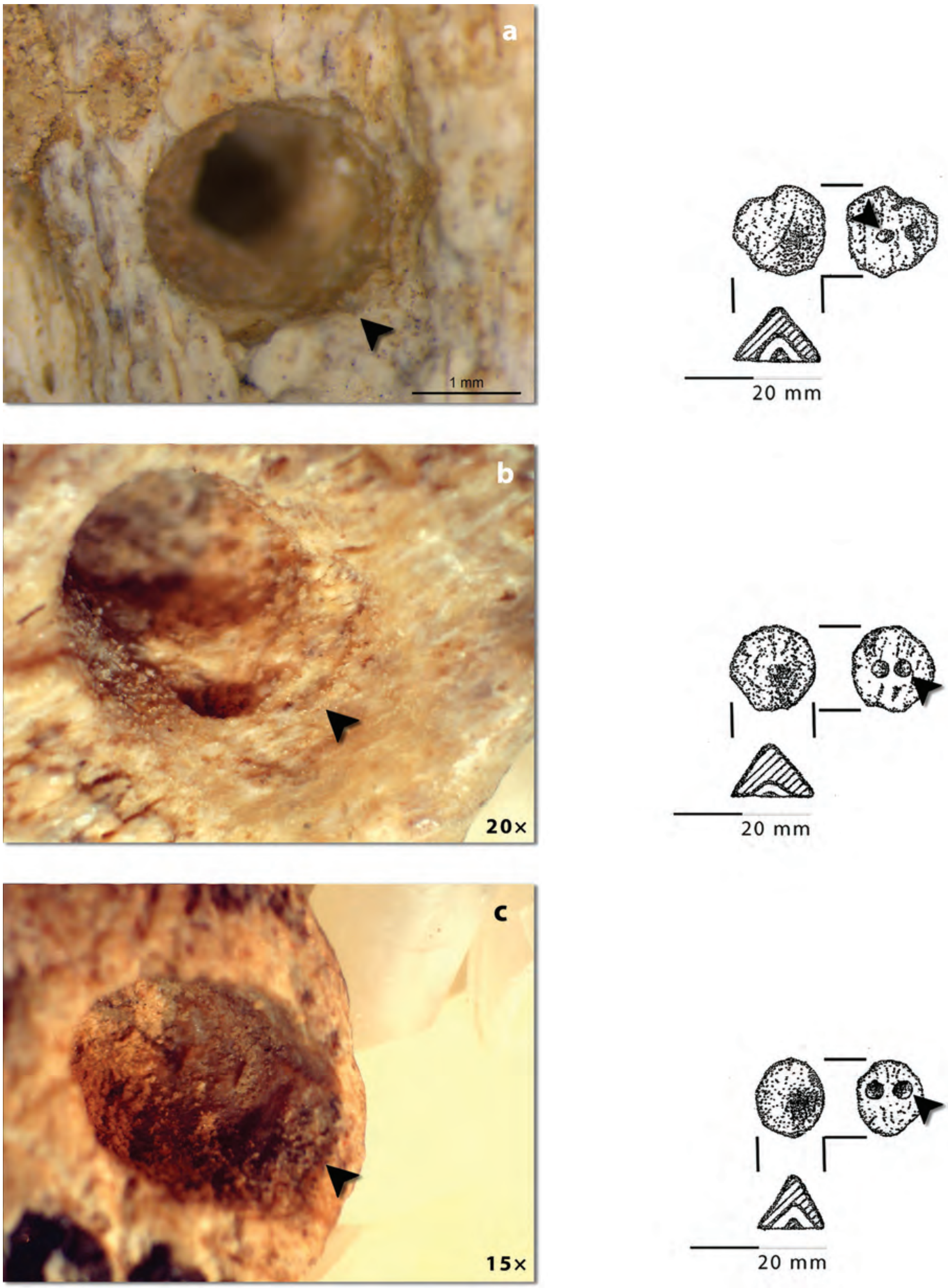

Figure 9 V-perforation in detail: a – X-05-16; b – X-05-14; c – X-05-12

expression of symbolic meanings (including V-perforated buttons of different raw materials). Substantial mobility connected to exogamy practiced by the Bell Beaker people (see *e.g*. Grupe *et al*. 1997) explains the appearance of buttons across the continent and on the islands – these items travelled with their wearers. Their occurrence in adult and female graves along other prestige items – *e.g*. copper (Kowalewska-Marszałek and Cyngot 1988, 134, 137) and amber (Noworyta 1976, 54–55) – can point towards the social status and importance of adult women in local and regional communities.

5 Conclusion

Despite the artefacts' poor state of preservation, this study allowed to identify the raw material, manufacturing techniques and use-life of an assemblage of V-perforated bone buttons originating from an adult female grave from Sandomierz-Zawichost Hill site. The most important findings are related to the raw material identification – the buttons have been made of a common raw material (cattle bones), which the manufacturer was familiar with. Probable working techniques have been suggested, especially in regard to the characteristic V-perforation. It has also been established that on the surface of some of the artefacts areas of use-wear (polishing, rounding) are preserved. The results and the find's context indicate that the V-perforated buttons constituted an important dress element connected to the status/social role of adult and older women in Bell Beaker societies.

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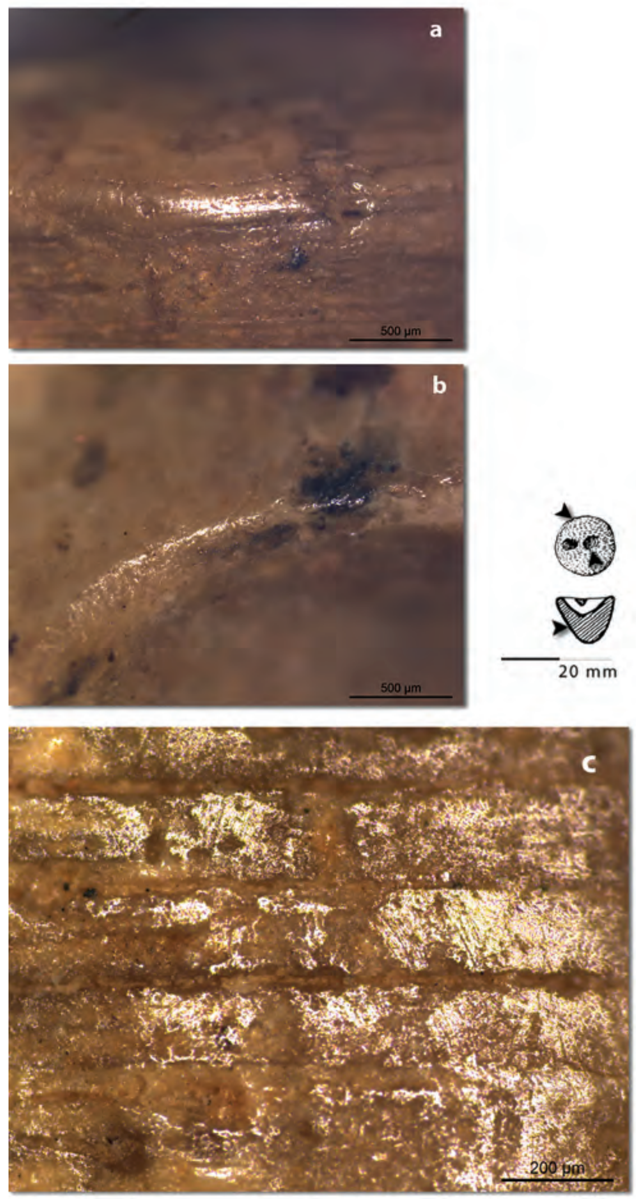

Figure 10 Use-wear microtraces on the Strachów site button: a – edge; b – hole area; c – lateral surface

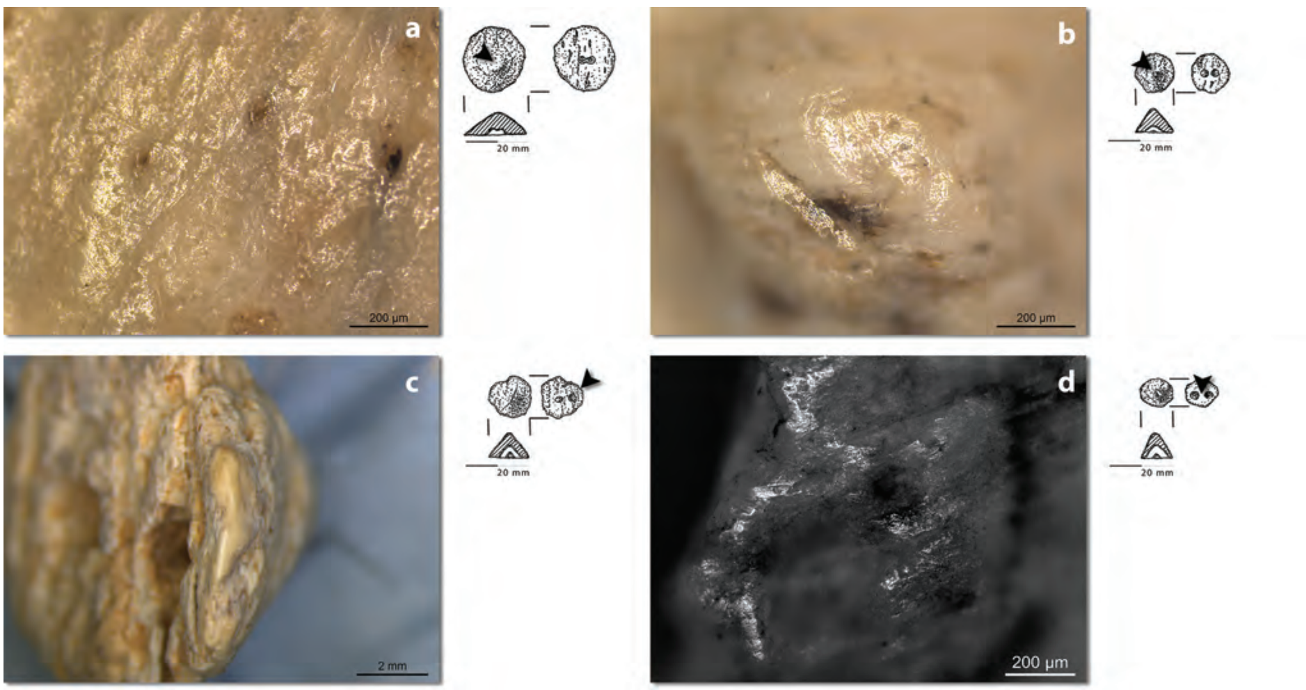

Figure 11 Preserved original area of the artefacts: a – top of X-05-7; b – top of X-05-14; c – edge of X-05-16; d – area between the holes of X-05-10

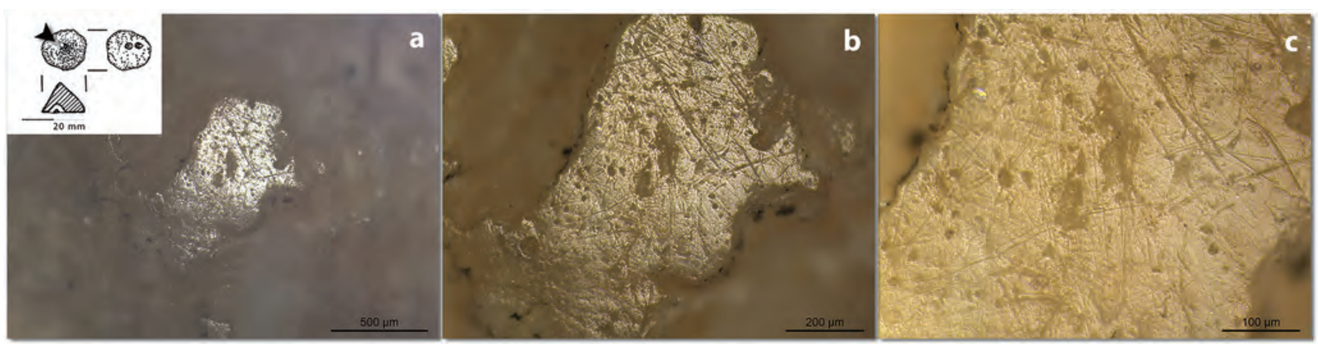

Figure 12 Preserved original area of the artefact X-05-9; different magnifications of the same area: a – 50×; b – 100×; c – 200×

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Kinga Winnicka
Institute of Archaeology
University of Wrocław
Wrocław
Poland
kinga.winnicka@uwr.edu.pl
ul. Szewska 48
50-139 Wrocław
Poland

Social space and (self)representation within Late Bronze Age Aegean and East Mediterranean palatial architecture

Ann Brysbaert

This paper aims to relate the technical processes of painted plaster production and consumption in Bronze Age Aegean elite complexes to their architectural contexts. It investigates how the (intended) technologies, style, and imagery, embedded in these specific painted plaster decorative surfaces and their architectural supports, may have been crucial active players to achieve group bonding, status, and social identities, and how this may have been achieved. This is done in order to investigate the potential social role(s) these may have played, together, in forging social identities, status, and group belonging through both the social processes of production and consumption alike. Specific groups of people – not all – interacted with these material surroundings at various points in their lives. This depended on their age, social belonging, skills and, often, the intention of other agents, human and material. Under the impulse of the built environment and their decorative surfaces themselves, it is argued that several communities of practice were involved in continuous building and decorating, and these were not only artisans.

1 Introduction

This paper aims to relate the technical processes of painted plaster production and consumption in Bronze Age Aegean elite complexes to their architectural contexts. This is done in order to investigate the potential social role(s) these may have played, together, in forging social identities, status, and group belonging through both the social processes of production and consumption alike. Therefore, the paper investigates how the intended technologies, style, and imagery, embedded in these painted plaster decorative surfaces and their architectural supports, may have been crucial active players to achieve group bonding, status, and social identities, and how this may have been achieved.

Most of these paintings adorned the walls of specific rooms, corridors, and also several floor surfaces of Minoan, Cycladic, Mycenaean, and east Mediterranean architectural (palatial) complexes in the Late Bronze Age. Apart from purely decorative bands and emblems (overview in Immerwahr 1990), many of their figurative scenes are very well known to us: la Parisienne (Knossos), bull leapers (Knossos, Mycenae, Tell el-Dab'a), hunting scenes (Tiryns, Pylos), boxing boys, and fishermen (Akrotiri), to name a few. A decade ago it was confirmed that the main painting technique that came to be used from the Neopalatial period on Crete onwards, and not before (see Cameron *et al*. 1977), was the *al fresco* technique. In contrast, paintings pre-dating this period were executed *al secco* which is illustrated by plenty of examples. The *al fresco* technique appeared rather suddenly on Crete and several reasons for this change have been suggested (Brysbaert 2004; 2008). It seems though that also the *al secco* technique continued to be employed after the *al fresco* technique was already in use (*e.g.* at Pylos: Brecoulaki *et al*. 2008; 2012). This is very understandable since working on damp lime plastered walls may be hampered by climatic and other conditions after which only painting *al secco* would be possible. In some contexts, such as Pylos, it seems to have been even the preferred *modus operandi* while M. Lang's (1969, 10-25) intensive macroscopic observations recognized clear *al fresco* painting at Pylos, contra Brecoulaki (2008, who, subsequently, does not recognize *al fresco* anywhere). Based on the published evidence to date, one can safely conclude that in Crete, before the Neopalatial period (1700-1600 BC)[1] there was no sign of any fresco painting. This changed however, once figurative painting came into existence by the start of the Neopalatial period. From then onwards many paintings were carried out *al fresco*, even into minute details. Based on evidence to date, the entire skill of painting on lime plaster seems to have disappeared again on Crete, the islands, the Greek mainland and in the East Mediterranean overall, at the end of the Late Bronze Age at about 1200 BC. The reasons and circumstances for this occurrence have been extensively discussed (Brysbaert 2008) and seem to coincide with the disappearance too of Linear B writing and a slowing down of glass items made, in use and in circulation especially in the Mycenaean mainland.

The main differences between painting *al secco* and painting *al fresco* are as much rooted in technology as in style (Brysbaert 2008). Painting *al fresco* requires specific materials and conditions: pigments (most often of inorganic origin) suspended in water to be applied onto a *damp lime* plaster surface. The drying of the wall as a chemical process locks the pigments into the top plaster coat to form an irreversible unit. Practically, this implies that mistakes cannot easily be reversed, which is clearly visible, for example, in the bull painting from Tiryns displayed at the National Archaeological Museum in Athens. Equally, the *al fresco* technique requires highly skilled painters and plasterers with steady hands to finish certain detailed scenes in time before the plaster dries up entirely. If, however, all goes wrong one would need to scrape off the decoration and, with it, the top surface of the underlying plaster in order to undo the *al fresco* painting. The *al fresco* technique, thus, implies that iconography and technology are completely interwoven and interlocked with each other as a unit even if the technique is not used throughout the entire surface. This unit is a clear example of what Lechtman and Steinberg (1979) have called a 'technological style'. This, however, does not apply to *al secco* paintings where one can remove the iconographic programme from the surface without interfering with the actual plaster surface because one can simply dissolve the binding medium that 'glues' the pigments onto a dry wall of any type of plaster.

In studies of painted plaster, we cannot separate technologies and representations from their larger context in architecture or from concepts of space in general. In considering buildings and the treatment of architectural surfaces within them, such as paintings on plaster, we need to investigate more specifically what their technologies and representations may tell us about the relationships between spaces and buildings, on the one hand, and people's day-to-day social lives, on the other. We therefore need to think about the very people who created, constructed, inhabited and experienced these spaces, and what these (decorated) spaces meant to them. Past research on painted plaster in the Aegean has frequently focused on either iconographic programme *or* technological features, while only very few papers have been combining both fields and published integrated results. While treating technology, iconography, and style of this specific craft holistically, important questions have come to mind that go beyond the pure technological issues of painting *al secco* or *al fresco*. These questions, for example, relate to the potential social role that the *al fresco* technology and style may have played in people's identity formation and building, group belonging and bonding. Arising from this, can we suggest that there were any social implications linked to the difference between *al fresco* and *al secco* paintings and, if so, what are they?

The mere identification that a wall has been painted *al fresco* or *al secco* does not contribute much to the deeper understanding of the role these paintings may have played in their architectural, socio-political, and temporal setting (Brysbaert 2008). The questions posed above integrate the technical observations into a wider discussion concerning social practices performed within the context of an elite Late Bronze Age culture in the Aegean and the east Mediterranean. In considering the relationships between the architectural context, on the one hand, and their surface treatments, on the other, both should be better understood as 'active' if we want to grasp what the paintings meant to various people within these places, but also what this architectural decorative context *itself* constructed in terms of meaning when in interaction with people. In order to make these points clear, the paper discusses first the role of space and architecture, including its decorative surfaces, as an active player in forming and maintaining social relationships, status, and identities. Second, in order to understand why the *al fresco* technique in painting on damp lime plaster held in itself the potential to play important role(s) in the social relationships between people and these decorative locales, a discussion of intentionality follows.

Al fresco painting could, in theory, be achieved by accident, but such accidental occurrences cannot explain an east-Mediterranean-wide phenomenon that seemed to have consisted of a 'package' of technological features and knowledge that was passed on in specific elite contexts over a limited time span, and within a limited but well-connected geographic region. Moreover, the purely technical requirements to achieve true *al fresco*, for which *lime plaster* is crucial, are far more labour intensive than painting *al secco* on dry plaster of *any* nature. Those involved, as has been argued well before, clearly knew what they were doing. They were doing this intentionally and intentionally different than their Old Palace Period predecessors on Crete.

2 Active Architecture and Social Space

Architecture has traditionally been seen as a theatre for actors and their performances, a mere backdrop, stage or arena on which social life unfolded (Goffman 1959; 1963); or as a container of situated practices that does not encode original meaning (Barrett 1994, 92). Architecture has been understood as both art and technology, but it is in fact a hybrid form of both. Furthermore, most buildings are less meaningful if they are dissociated from their use because they are often valued and assessed through their quality of use and their 'fullness' (*i.e.* in the relationship established with those for whom these buildings were designed). Hillier and Hanson (1984, 1) state that buildings are objects, on the one hand, consisting of materials such as masoned stones, mudbrick, wooden beams and plaster, and techniques including dry masonry and pointing brickwork joints, (architecture is produced). On the other hand, buildings also create or order empty volumes of space (architecture produces). So architecture 'becomes' itself and modifies itself by being used by a wide range of people who initially construct, and by other people who later may move within and around it. Architecture, decorated or not, thus becomes embedded in and forms part of its surrounding landscape through, for example, the use of local materials for its construction, which may change over periods of time (Brysbaert 2013; 2015). As such, architecture produces history and narratives and assumes an active role, it has agency in that it may further or hinder human activity, and it may even directly or indirectly condition people's behaviour, speech, and perceptions. Maran (2006a; 2006b) perceives architecture as an active force or actor in social relationships. These relationships may change over time and so may the actual architecture, while links based on memory may draw people back to the same architectural spaces (Brysbaert and Vetters 2010; Maran 2016).

Thus, space, as it can be created by physical architectural forms and techniques, is a historical production, both as a medium for and as the outcome of social being (Borden *et al*. 2001, 5). The postmodern geographer and urban theorist Soja (1989) talks about a socio-spatial dialectic: 'people make places and places make people'. Giddens (1984, 69-72) suggests a dual 'being together' or the co-presence of body and space (*e.g*. person-painting). Space is also social production and social reproduction, and since social relationships are gendered, we tend to believe that this also counts for space and architecture, through its occupation and through its representation (*e.g*. male-female-child-elderly and human-divine-shaman). However, gender seems difficult to pin down in architecture. Stöger (2011, 13; 2015) cites Wallace-Hadrill's thorough study of 234 houses in Pompeii in which he could not identify, for example, spaces for children or the elderly, nor a clear male-female space divide. In Roman houses it seems that gender and age are not represented as axes of differentiation. This stands in contrast to social rank as the prevailing spatial differentiator within the Roman house (Wallace Hadrill 1988, 50-52; after Stöger 2011, 13). However, gender differences did seem to exist in the Greek houses of the Classical period at Olynthos (Wallace-Hadrill 1988, fig. 1, 50-51, n. 31) in which, for example, the typically male or public reception space of the *andron* (Nevett 1994, 108 for this reading of *andron*) was emphasized by its decoration in mosaics and its closeness to the entrance of the house. The more private rooms were located further away and were perhaps harder to reach.

The relationship between space and gender is often also defined as a power relationship. A typical example of its time shows how the Great Megaron at Tiryns was interpreted by its excavators (Schliemann 1886) as the throne room for the king while the Small Megaron was assigned to the queen at Tiryns. Another example illustrates a complex pattern of access rules embedded in the architectural layout of Islamic houses in which the women of the household can circulate perfectly freely within the confines of the house but out of view and reach for non-related male visitors. These men are catered for in specific parts of the building but with no links to the rest of the house (Nevett 1994, 106-107). As gender differences may thus imply differential social status, gender differences in such contexts seem linked to power differences, but power does not always lie only in the hands of the most obvious groups. Buildings and space may thus relate to power, and as such, Foucault (1979) sees buildings as instruments that act upon the body and transform the character and personality of the individual; he thus ascribes architecture an active character. Markus (1993) links buildings and architecture to power since different buildings classify and order social relationships differently.

In the last decade, the relationship between power and architecture in Minoan, Mycenaean, and east Mediterranean contexts has been extensively discussed in several contributions (*e.g*. Maran *et al*. 2006). Among other topics, aspects of accessibility and the issue of boundaries in architecture were explored, both of which are completely interrelated. An interesting study on entrances into Minoan palaces, applying spatial analysis tools (Adams 2007), emphasised the importance of people's experiences while moving in and around the palaces. Adams (2007, 365-370) concluded that palaces were accessed as private areas by rulers, but also as workspaces or social gathering spaces by many other people of all ranks. In her study the palace as a structure was, at least in part, fulfilling an active role in forcing people to behave in certain ways and in creating the effects the building design may have had on visitors. Minoan palaces as architectural features were not just seen any longer as the theatrical backdrops for people's social interactions and performances (but see Adams 2007, 379). In another case study applying access analysis to Pompeian houses, Grahame (2000) differentiated between inhabitants and strangers but subdivided them further (table 1). He theorised that a high level of familiarity is present if space within the house allows people to come together (*i.e*. gathering spaces). And space may be very private if smaller spaces are present or if spaces are well shielded off through boundaries or difficult access routes. However, not all boundaries are physical such as doors, staircases, slopes in corridors, and windows. Some may be understood or created by differences in light, floor materials, or the presence of guards, or perhaps

Inhabitants	Familiar	Parents, children
	Not familiar	Personnel, lodgers
Strangers	Familiar	Uncles, close neighbours
	Not familiar	Anyone else

Table 1 Inhabitant-stranger divisions for a domestic context (based on Grahame 2000, 21-22)

even announced in advance (Maran 2006a; 2006b, Thaler 2008, pers. comm.). More recent syntactic studies comparing Roman city blocks from Ostia revealed that individual neighbourhoods had different spatial strategies to foster community building (Stöger 2011; 2014). Some city blocks focused on shared internal courtyards for social encounters. The boundaries of these blocks, defined by the grid structure of the street network, seem to have encouraged the development of collective space within their own perimeters. Other blocks appear to lack shared interior spaces but seem to have extended their social reach beyond the physical confinement of the block structure. These neighbourhoods look outward towards external community building with activities centred on the streets that confine but also connect the block to the wider city.

In this context, Grahame (2000, 22) sees architecture as an active force that sets up and sustains categorical distinctions between people in society, thus institutionally creating social inequality. Maran (2006a) is, furthermore, convinced that architecture deliberately influences our behaviour: it makes us walk in certain directions and guides us into avoiding particular features or areas, while being drawn to others for specific reasons. Through recursive patterns of movement these paths and features become embedded in our knowledge, conscious or not, and determine what we can and cannot do in the specific context we are in. Consequently, architecture plays an active role and has an active function in people's social lives. Whenever there is a group of people in a given setting, the architecture creates a physical organisation of space, which is fundamental as a necessity of social existence and as a direct way of communication via materialised systems of self-representation (De Carlo 2005, 13). Also, the need for architecture is connected to the concept of knowledge of the other and the self. Within the surroundings of architecture, we may exchange knowledge that helps to form trust between each other so that bonds and friendships can grow.

Architecture needs to be looked at even more closely as a functional space and hence needs to be more specifically defined. On the one hand, there are different users of architecture: the architects themselves and their activities that create the built environment, *by design*, and the users of architectural constructions, also producing architecture, *by use* (Hill 1999, 6 on the architect as user and the user as 'illegal architect'). Many archaeological studies that recognise space and its societal role in shaping identities, actions, and social processes, have been and still are influenced by Lefebvre's and Foucault's writings on space from the 1960s and 70s, through which the 'spatial turn' movement saw space as a generative force (*e.g.* Blake 2004). Lefebvre's (1991 [1974]) triad on production of space is useful in looking at architecture as a functional space (table 2). His analytical formulation and the detailed explanation of each of them – spatial practices, representation of space, and space of representation – would provide material for an extensive discussion in its own right. Instead, limited space allows just some examples to illustrate the variety of perspectives from which architecture needs to be considered.

It is then the life history, the life cycle or the biography of a space that accounts for the complete interrelation and linkage of Lefebvre's triad with social practices. Under the denominator of 'architecture', we understand categories such as house, palace, funeral monument, religious or cult place, farm and workshop. None of these defined places, however, reflect any specific bond that people may have with them. It is through connecting these places with people and their feelings evoked *during their interaction with these places* that we may come up with meaningful functions and linkages. Places too can, in themselves, actively inhibit or encourage these specific social interactions. So, once a house is inhabited by people, it may become a 'home', and once linked to those people's feelings about their home, it may mean a place full of warmth, safety, cosiness and intimacy (see table 3). Once places, people and their feelings about these places are interwoven and the active agency of a place is recognised and respected (or not), they may also change their behaviour and conduct, the way they are dressed, speak, and interact.

Spatial practices: as it is perceived	Defines actions, signs, spaces of everyday and those made special by symbolic means
	Kitchen, workshop, bathroom, church
	Space of objects and things and space of movements and activities
Representations of space: as it is conceived: concept without life	Conscious codifications of space typified by abstract understandings: maps, 3D model
Spaces of representation: tend toward systems of nonverbal symbols and signs: life without concept	Spaces experienced as symbols and images: they condition possibilities for action, spaces of the experienced and the imagined
	'Wild West', doll house, …

Table 2 Lefebvre's triad on space production with examples (based on Lefebvre 1991)

House or home is an especially important place, at least in our Western cultural understanding. On the one hand, it (hopefully) is a stable container (which does not mean 'static' or inactive) for the formation and maintenance of the personal identity of its occupants – the home as a mirror to the self (Hill 1999, 111). As such it is a place for the expression of intimacy, for empowering the self. Many can recall memories of the house or home they grew up in, some related to visual or other sensory memories. Home can be seen as a locale where memories are embodied, and upon (re)entering that home these memories may even (un) consciously prompt specific actions/performances (*e.g.* entering through the front door and taking off your shoes). As adults we may retain these memories from our childhood, and our current and future conceptualizations of what a house/home is like, or should be like, are based upon these memories. Many remember particular sounds, smells, views and spaces or items associated with specific, often repeated, activities. When we remember these, we are almost thrown back in time and different time cycles, past and present, become intertwined (Jones 2007). When such experiences were positive, the home would be remembered as a safe place for its inhabitants. On the other hand, however, 'home' may also be a response to insecurity and change. Therefore, a home *has* to appear stable (but not static) because social norms and personal identity are shifting elements in our lives and are thus slippery. According to Grahame (2000), architecture, while empowering the self and personal autonomy as well as providing a sense of freedom, can also become a form of control. Control, together with loss of personal autonomy, is linked to inequality of power and inequality of knowledge between the observer and the observed. A house under constant surveillance through phone tapping, for instance, forms a good example. This shapes our social behaviour and conduct within the house, and the conditions in which we may '(re)shape' or adapt the house (for example, creating a space for privacy with non-fixed feature elements or using sign language). Architecture thus plays an active role through its fixed, semi-fixed, and non-fixed features (*e.g.* Rapoport 1982; cf. Thaler 2006 on the archaeological application of these concepts), in (re) shaping relationships. This shaping of relationships seems, in some cases, to have a cyclic aspect to it: it may happen repeatedly, independent of the intervening time. Some examples of that will become clear in the discussion further on. The cyclic character of relationships between people themselves, and between people and their material surroundings can be deduced from cyclical features in material culture.

Architecture	Primary function	Possible feelings
House	Home	Safety, warmth, intimacy
Palace	House of king	Awe, fear, subservience, hate
Funeral monument	Last rest place for the beloved	Sadness, closeness, relief
Cult place	House of God	Awe, fear, humbleness
Farm/market	Place to get food	Excitement, entertainment, satisfaction, competition
Workshop	Place to earn a living	Keenness, importance, stress

Table 3 Variety of architectural classes, their primary function, and possible feelings associated with these

This is why technological studies of painted plaster within their architectural contexts, combined with stylistic and iconographic studies, become increasingly important (on the cyclical nature of shaping, both technical and social, see Brysbaert 2011). Such studies reveal people's social practices (intended or not, see below), and through these, several communities of practice, such as, for example, the builders, the architects, and the inhabitants (Lave and Wenger 1991, 29-34, 104; Wenger 1998; Wendrich 2012, 2-5; see also Brysbaert 2017). Each such community is responsible for their interactions with their built surroundings and the outcome of these interactions.

3 Intentionality

Intentionality implies 'being conscious', or 'being aware', and this feature makes people stand in a specific relation to their environment: we are not just affected by things, events, and people; we are aware and conscious of these, of all that we bring before our mind (Woodruff Smith and McIntyre 1982, xiii, on Husserl's theory of intentionality). So intentionality characterises the 'consciousness' of people. Intentionality can also be seen as a 'mental representation'. An important aspect of Husserl's approach to intentionality is that he focuses not only on the objects of our intentions but more specifically on their content; unconscious aspects, for example, are not part of intentionality (Woodruff Smith and McIntyre 1982, 5). In this, he follows Brentano, for whom intentionality can be characterised as the 'directedness' of consciousness to an object (Husserl unpublished notes cited by Rinofner-Kreidl 2000, 175[2]). In this, both Brentano and Husserl distinguished mental from physical phenomena: physical phenomena were not intentional since they did not have a consciousness that could be directed towards an object of that consciousness. Intentional phenomena include acting, desiring, perceiving, hoping, and judging, each of which ‘aims at’ or is ‘directed towards’ something: one hopes for something, does something, and/or perceives something. In opposition to other philosophers, Husserl did not see sensory-influenced expressions and outcomes such as moods and feelings as intentional. He believed further that there is a fundamental difference between the content of an act of intention, and the meaning that is perceived by someone. They actually may fall together but not necessarily.

Bratman (1999) holds the concept of ‘intention’ to be of central importance if we are to understand ourselves or each other, and he connects intention to both people’s actions and their minds even though intentions expressed by both people’s actions and thoughts may not mean the same. While I do not agree with his separation of people’s actions and their mind, one could argue that people’s actions and their thinking, even when relating to the same issue, may occur at different points in time. For example: I intentionally go to all the classes in order to pass exams (intention characterises my actions after having thought about it), or I intend to go to all classes (while I miss several) to pass exams (intention characterises my thinking but is not followed up by action). Intentions are important because they tie us closely to a wide range of emotional reactions, moral attitudes, and legal institutions.

Our common sense conception of intention is inextricably tied to the phenomena of plans and planning. Bratman (1999, 2) sees people as planning agents: we plan simple or complex things for our future, and then let these plans guide us in our subsequent conduct/actions, so we form and execute plans. Plans may equally not be acted upon for various reasons, and those that are may change as the result of, for example, unforeseen events or a change of plans. This suggests that planning and executing do not need to follow each other in a linear way but may influence each other at various points in time and space. Some plans involve others: coordination of time schedules and actions, sharing resources, passing on knowledge in a structured way and so on (*e.g.* Brysbaert 2013 for planning in the context of construction). Finally, in both Husserl’s and Bratman’s work on intentions and intentionality, the level of unconsciousness, the unplanned and the invisible are not considered a part of intentionality (see *e.g.* Rinofner-Kreidl 2000, 176-179). However, specific levels of invisibility in discussions of production processes and specific social practices in the context of crafting do not necessarily stand in contrast to intentionality (see below).

While necessarily brief and coarse, I outlined above how architecture is important in people’s lives and what roles it may play in shaping social relationships, guiding behaviour, and forming identities. I next wanted to clarify how intentional actions function in people’s daily lives as part of being conscious humans and as part of how our mental capacities are directed towards an object, in this case the processes of building and decorating surfaces. With these considerations in mind, I discuss below the role that painted plaster in Minoan, Mycenaean and east Mediterranean elite buildings (*cf*. Brysbaert 2004; 2008) may have played in group bonding, forging identities and establishing and maintaining social status. These paintings, independent from the technique(s) employed in executing them, roughly cover the period from 1900 to 1200 BC.

4 Bronze Age Aegean and East Mediterranean Architecture and its Paintings

Many Bronze Age elite complexes in the Aegean and the east Mediterranean have often witnessed several periods of construction and decoration, expansion, repair, and rebuilding, spanning many generations of workers. For the Aegean, this is especially clear at the multi-period sites of Knossos (Evans 1921-1935), Phaestos, Mycenae (esp. French 2002), Tiryns (Maran 2001, 113, 119; 2010, 2012, 2016), and Thebes (see Dakouri-Hild 2001), but can also be observed at many other palaces and sites with elite structures such as Phylakopi (Renfrew 1978; Renfrew *et al*. 2007; Whitelaw 2005, 38) and Palaikastro (MacGillivray *et al.* 1992; 1998) (fig. 1). The same trend can be observed in east Mediterranean contexts such as Tell el-Dab’a (Bietak and Forstner-Muller 2003), Tell Alalakh (Woolley 1955; Bergoffen 2005), Miletus (Niemeier and Niemeier 1999, 543-44), Hattusha (Neve 1993), Tel Kabri (Niemeier 1991, 196; Cline *et al*. 2011), and Qatna (Novák 2005). Many of these multi-period structures were at some point lavishly decorated with paintings on plaster. The first signs of a tendency towards such decoration (but with abstract designs only) were noted at Knossos and Phaestos during the Old Palace Period (Immerwahr 1990, 22-23), while plaster had already been painted red or yellow in Early Minoan II Knossos (Momigliano and Wilson 1996). Paintings of these periods were carried out only *al secco*. Full-blown figurative paintings appeared with the beginning of the New Palace Period on Crete. Decorated paintings appeared in some Cycladic centres (Phylakopi on Melos and Akrotiri on Santorini), on Rhodes (Trianda), and on Kos (Seraglio). A little later, paintings decorated an elite structure at Ayia Irini on Kea and also most Mycenaean palaces became plastered and painted. Generally speaking, one can safely say that Minoan iconography and style of execution had strongly influenced Mycenaean paintings although some themes and motifs, for instance hunting and battle scenes, seem to have been limited to the Mycenaean centres, and also the Cycladic paintings were influential in iconography and style. In a comparative study carried out between Aegean and east Mediterranean plaster, there was strong physical evidence that the Late Bronze Age paintings were carried out *al* *fresco*, and that this was clearly intended from the beginnings of the process. In contrast, *al secco* paintings or details were added once the plaster was dry, or in other cases *al secco* may have been used exclusively (Pylos, see Brecoulaki *et al*. 2008; 2012; contra Lang 1969). Technological studies have clarified that some of these paintings on plaster have known several phases of *production* (*e.g*. at Thebes, Dakouri-Hild 2001; Brysbaert 2008), *repair* (*e.g*. Evely 2000, 474), *recycling*, and *destruction*. Recycling can manifest itself in the form of over-painting with even repainting of the same scenes (summary in Brysbaert 2003; 2004), and hearths' multiple replastering and repainting at Mycenae and Pylos (Lang 1969, 183, 187, 200). Destruction can sometimes be carried out purposefully and can be followed by careful and attentive deposition (Knossos: Brysbaert 2003; Chapin and Shaw 2006, 60-63; Gla: Brysbaert 2003; Pylos: Bennet 2004, 99-100).

The similarities and differences between Aegean paintings and those found in the east Mediterranean (Turkey: Tell Alalakh, Hattusha, Miletus; Syria: Qatna, Tell Sakka, Mari; Lebanon: Tell Burak; Israel: Tel Kabri; Egypt: Tell el-Dab'a, Tell el-Amarna, Malkata) have been attracting wide scholarly attention in past and present scientific discussions. This has been demonstrated most recently at the ICAANE conference in Vienna, 2016. The wide scope of research on painted plaster includes iconographic themes and motifs as well as the style of execution. There seems to be consensus among most scholars that a sort of 'international style' in elite iconography

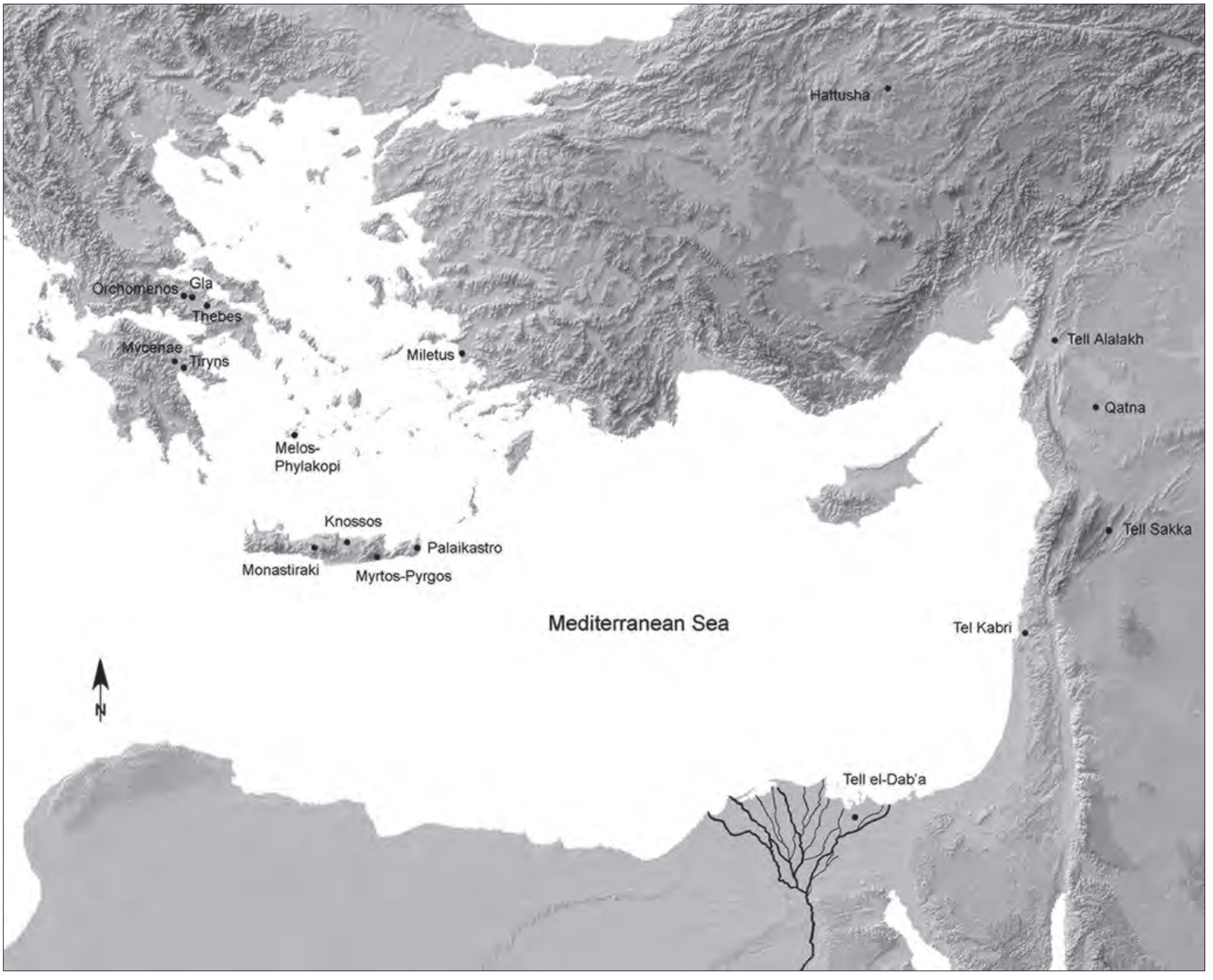

Figure 1 Map of the east Mediterranean indicating the sites from which painted plaster has been studied by the author (map Anavasi editions. Modified by Hans Birk and Roxana Docsan)

came to be established during the Late Bronze Age (*e.g.* Cline 1994, xvi; Knapp 1998, 198). However, not everybody seems to agree that these paintings formed part of an elite assemblage (*e.g.* Feldman 2006) even though they disappeared at the end of the Late Bronze Age together with the elite powers, and with them the skills and crafts associated with elite culture. In studying these paintings we address iconography and style, combined with technological processes and craftsmanship, and the social practices identified in the materials themselves including the built spaces in which they appeared. Only then will we be able to fully understand concepts such as an 'international style' and to appreciate its full meaning within the context to which it belongs. The 'international style' does not represent a solid and static phenomenon but needs to be seen as a dynamic and adaptable, yet a recognisable entity which intersects with local tastes and technologies at specific times and/or locations. These dynamic characteristics are also reflected in the varieties of paintings encountered and in the architectural complexes they decorate: not two of these are the same, but the 'package' of features (technology, iconography, style, and context) taken *together* is clearly recognisable among them all.

5 People's Intentions through Building and Decorating

In all these elite locales, while carrying out paintings *al fresco,* at least a group of painters and a group of plasterers were at work simultaneously. Such production processes occurred clearly more than once, some areas even required frequent repainting, such as the painting of hearths. Hence, plans (Lefebvre's representation of space) must have been prepared, by one or more artisans and perhaps also 'architects' to proceed with the work, especially when *al fresco* painting was intended. That this was the case is visible in the physical evidence such as finger and fingernail impressions, snapped ropes, plaster being dragged up by the paint brush, the use of templates pressed into the surface, and polished areas (most prominently Cameron *et al.* 1977; Jones 2005; Lang 1969; Brysbaert 2008, 112-28). Such evidence for *al fresco* has also been reinforced by means of experimental replications (Chryssikopoulou *et al.* 2000) and should not be ignored in view of more recent instrumental analyses indicating *al secco* painting since *al fresco* painting does not exclude the use of *al secco* (esp. Cameron *et al.* 1977; also Brysbaert 2008, 165).

The planning of the *entire* construction, the building *and* its paintings, must have necessitated the strict coordination of many people involved in a wide variety of tasks. These tasks range from the extraction of the necessary materials to processing and refining them, and include work on the building site and on the building and its decoration, with careful supervision needed at many if not all stages (also Brysbaert 2013). This planning of people's tasks and the actual tasks themselves are all technological advances that must have gone hand-in-hand with the expansion of the reach of the palace administrations. The magnitude of these planning efforts seem to demonstrate the involvement of various generations of builders and artisans, including people of different ages who likely learned from each other through apprenticeship periods and form, what has been called 'communities of practice' (Wendrich 2012; Wenger 1998; also Brysbaert 2017).

Aspects of planning, timekeeping, training and apprenticeships, and workforce coordination, which were brought into a complex synchronic interplay in a specific and confined space, can be understood as technologies in their own right, somehow dictated, or even instigated, by the architecture in which it all took place. Most of these technologies are invisible to us now, but they were nevertheless there and well understood by those who executed the work. Very often they can only be understood if we place a specific technology in context with other technologies. Furthermore we need to have a keen eye for all minute technological and material details. A place like Versailles, for example, with all its richness of architecture, decoration, gardens, and beauty, is bound to impress every visitor (*e.g.* Duindam 2003), regardless of whether one likes the style of the place or not. The impressive effect is further enhanced by details about the way such a mega-project had been accomplished. This includes the amount of people involved, their skills and the vast variety of materials utilised. It suggests that the role of technology in such a context was to impress at a grand scale, further shown by the demographic figures (Lepetit 1978) indicating a large influx of people to the region to be part of the workforce. Perhaps this was also true for the Aegean and east Mediterranean Bronze Age elites who, through their official and private residences ('home'), were able to impress people, to include some and exclude others, and through which they could demonstrate their power. In trying to interpret what the iconography of these paintings represented, it seems that the elites had the intention to show their power one way or another: battle and hunting scenes, procession scenes, banqueting and feasting. The expressive power of these scenes was enhanced further by employing a wealth of materials and techniques in painting these. These forms of conspicuous consumption had the sole intention of displaying wealth and emphasizing the elite's superior place in both religious and political matters.

Once in place and ready to be seen (by a selected few?), the iconographic content of these paintings gives us (in)direct clues as to the many intentions that creators, users and viewers of architecture had over time (Davis and Bennet 1999, 107, 110-11). The people who viewed these scenes also must have had partial understanding of what these images meant. Some of the scenes may have been frightening to viewers, and may have served as memory triggers intended by the elite to keep people in submission or direct their behaviour in specific ways (McCallum 1987; Thaler 2012). Other scenes may have evoked emotions of awe or enjoyment. According to Wright (2006, 55), scenes depicted on the painted plaster, at least on Crete, function as representations or commemorations of real events relating to rituals, divine epiphanies and specific cosmic cycles and people's positions and duties within these. While Wright (2006, 50) goes on to say that we *experience* space biologically (he probably means physically), whereas its *production* is socio-cultural and its inception is inculcated, clear boundaries between these spheres cannot be maintained since all spatial processes, production, repair, recycling, consumption, and representation are overlapping. We can also experience a space socio-culturally, and it is also produced biologically (physically). If we allow these spheres to overlap and intersect, this will lead to an experience of more than just the building as a theatre backdrop for social interaction and as a container for its paintings. The images and the style in which they are executed may have come to life in the experiences of those present or passing through the painted palace spaces. These paintings thus become agents of intent, and together with the building itself they interact with people. They may guide people in what to do, how to do things, and how to move around. Indeed, two ways of guiding can be distinguished: a) through what is depicted (Cameron 1970; McCallum 1987; Thaler 2012), and b) through changes in surface treatment contributing to sensory thresholds (*e.g.* Sanders 1984; Thaler 2006), all essentially influencing people's behaviour and their social interactions. These very colourful paintings may come to life as the result of specific rituals performed by the passers-by, including their bodily gestures and their subsequent reactions (McGowan 2006, 43-49), alcoholic drinks, hallucination inducing products, and spinning during dancing. People may also have felt 'looked at' or forced into specific behaviour not just because of the presence of the images on the paintings and perhaps the narrowness of spaces, but also as the result of social peer behaviour and culturally imposed rituals. Equally, people taking part in rituals and maybe even suffering bodily harm and pain, may have temporarily altered their social status during such acts and may have become closer to certain deities (by being in trance). An understanding of what was expected, allowed, necessary, and desired certainly was an integral part of the ability to act in a socially meaningful or perhaps responsible way for those who entered those building complexes.

This bringing to life of paintings and depicted scenes can possibly be identified as the way in which the elite wanted to impress the palace visitors, both during specific acts that took place on a cyclical basis (*i.e.* yearly or seasonally), and during daily passage through the building. People will have also visited the palace and will probably have seen these paintings when they were merely carrying out quotidian tasks. Even then, the paintings may have evoked or invited a range of feelings and reactions, or perhaps none at all. Confronted with whole series of life-size figures while proceeding in a specific direction on a specific occasion may have had several effects upon people, and may even have influenced the way people walked past the paintings. Elite intentions and strategies resulted in impressing, perhaps even frightening people (especially the non-initiated), and, as such they seized every possible occasion to display their power with all means available.

If we consider the entire palace in conjunction with the paintings themselves, their specific location, access routes and boundaries, and mechanisms of inclusion and exclusion, we may finally reach a deeper understanding of how architecture itself, in conjunction with these paintings, may have actively created social inequality. For example, if some paintings in roofed but half-open spaces like porches were visible from outside, they may have transformed neutral outside space into ritual/religious or ceremonial space when they were activated through ceremonial processions or celebrations. In these cases, neutral spaces are temporarily transformed into religiously or politically charged spaces through the performance of certain rituals or political acts (analogous with the event of carrying the *epitafio* on Orthodox Good Friday in the streets of Greece and similar processions in several regions of the catholic Mediterranean).

As already hinted at above, equally important in comparison to the imagery of these paintings must have been the style of execution (Brysbaert 2008). In the present context, the style of presenting specific scenes and themes forms a means to indicate either familiarity or to express the opposite: otherness. Furthermore, the very possession of these paintings also strongly demonstrated alongside their iconography a sense of style – an 'International Style' – and the techniques of execution, the membership of an elite class excluding other ranks of society and thus marking social boundaries. These paintings represented a very important part of the elite's 'furniture' in expressing who they were in contrast to other social groups. Also the elites acting in specific ways as a group can be understood as a community of practice: i.e. those who learn from their peers what materials and knowledge are needed to belong to the peer group or not. However, the possession of the technology embodied in these paintings cannot have been entirely controlled by the elite, since the artisans themselves were the ones gifted, possibly exclusively, with the relevant skills and knowledge. When finishing their *al fresco* paintings at the end of each day, they left a damp grey surface behind, which dulled the richly coloured scenes until the entire plaster thickness had dried completely. The artisans were certainly aware of the effect of, and likely even intended, this 'invisible technology' that only radiated to its full capacity possibly days or weeks later. While these paintings continued to change well after they were executed, the artisans likely formed an important community within the production processes of these elite architectural complexes, and they could therefore have possessed and exerted a certain degree of influence. In being aware of this, artisans could thereby have acquired a specific form of social status, at least in the eyes of the elite who required their services (Brysbaert 2004; 2008).

A significant distinction seems to have existed between those social groups who could produce, view and perhaps experience the paintings, in contrast to those who could only hear about them. The ability to manipulate this inclusion and exclusion can be considered a technology in itself, when employed to maintain superiority. However, reactions of fear and awe could only have been incited if the image, style, technology and presence of these paintings were perceived by the beholder in the way they were *intended* by the owner. This might not always have been the case. For a variety of reasons, the paintings could have elicited reactions other than those intended. Those groups who were excluded from access to these paintings, or from any material expression of elite power, should not be thought of as passively waiting for the political system to change in their favour. What we may call 'resistant behaviour', whether manifest or not, characterises those people who subscribe to new values that exist, for the time being, only in the margins of society. These new values have therefore not yet been incorporated into the control mechanisms of the institutional power (De Carlo 2005, 18). Growth of resistance may thus manifest itself in 'disorder' that renews itself constantly, and may have been one of the many causes of the final disappearance of the Mycenaean palace economies. One way such disorder may express itself is through the refusal to read or react to wall paintings, or any form of material wealth, as intended by their owners (similar examples: Given 2004, 8-25). There are always at least two parties involved: those who intend and the 'target group'. If, over time, the latter could no longer be manipulated in the traditional way, the intended content of the elite's action in their official (and private) residence no longer has the desired result. This resistant attitude may have prompted the elite's need for change in images and themes, for new, larger buildings to be constructed and even more lavishly decorated. Hence, the repainting of the architectural surfaces, either with the same themes or with new ones, may have been commissioned out of fear of growing unrest and loss of personal autonomy.

These redecorations potentially occurred in full or partial knowledge of any reaction to what was taking place outside palace walls, since, almost by definition, members of the elite had quite a bit more to lose than the people they ruled over. These elites hence aimed for a reaffirmation of their control over their world. From a different perspective, architecture and its decoration, and the varied technologies that aided the elite in showing off their status, may help to indicate that the so-called collapse of the Bronze Age palaces (c. 1200 BC) did not take place overnight. Rather, it was perhaps a gradual and complex process that found expression in the elite's tendency towards ever more luxurious displays and their fear of losing status and face. Therefore, these paintings—within their architectural and functional settings related to a range of activities—show, perhaps, two faces:

(i) A conscious one: Those who own such paintings belong to the elite and have control over technical resources; others do not.
(ii) An unconscious one: Those who own these paintings are nevertheless insecure towards others and try to keep them at a distance.

Over time, the changing scenes in the same rooms of specific buildings may indicate changing tastes or growing instability, but they may also indicate the need for change, since the first set of scenes had lost its desired effect. However, several forces may be at work simultaneously. (Yearly) cycles of replastering hearths (such as at Pylos and Mycenae) and floors (see for example Qatna, fig. 2), or replastering and repainting the same scenes on top of each other, may have been combined with feasting and celebrating in honour of the ruler in his multiple functions (Thaler 2007). Equally, the frequent reuse of painted plaster in floor fills may be purely practical, because of the compatibility of materials. In addition, though, plaster as fill may have taken on further significance when paintings with specific meanings were not

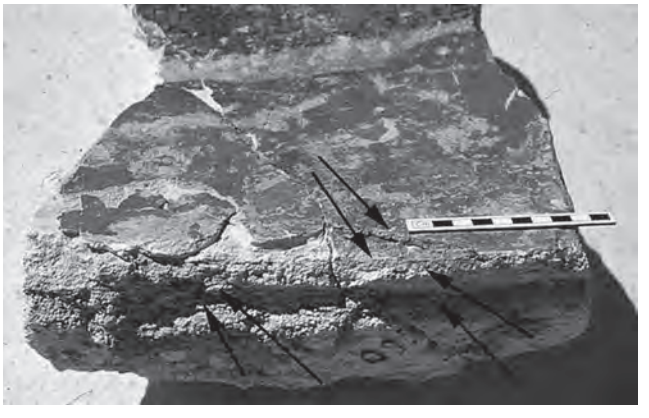

Figure 2 Multiple plaster layers on painted floor section (Qatna, Syria) (Photo Ann Brysbaert)

just thrown out but became part of life as floor fill within the building, in a different setting (see Schulz 1988 on the reuse of the Tiryns throne base). Equally, materials and features that are hidden and were incorporated in later constructions were not necessarily forgotten, but may have continued to function as powerful links to earlier periods and presences (Brysbaert 2015; Maran 2016).

6 Architecture's Intentions Through People

So far, architecture itself has remained rather out of the picture; it seems, however, to produce reactions within and among people (awe, fear, comfort) and thus seems to play an active role in social identity formation, relationships and people's life in general. But, can we go as far as assigning specific intentions to architecture and specific spaces? The meaning of the palatial paintings was previously discussed in the social context of six relationships (fig. 3), while it is now clear that the architecture itself is equally significant because of the active role it plays in meaning-making *together* with the paintings. These paintings sat on specific surfaces and in restricted spaces, both physical and symbolical, where people passed by. Architecture is generally not movable unless it becomes dismantled for reuse, so we relate to it spatially and temporally in ways fundamentally different from the ways in which we engage with movable objects (figs 4 and 5). Since architecture is also fully incorporated in and may be restricted by its surrounding landscape, it also needs to be considered in light of this (Ingold 2000,154, 195-200).

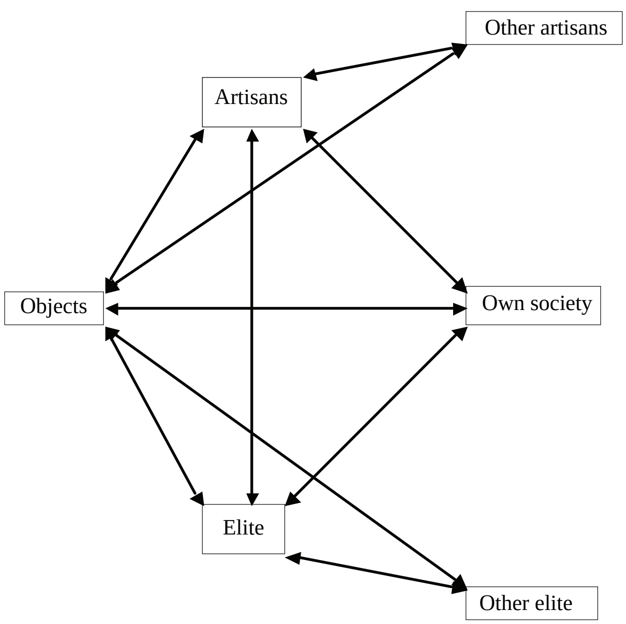

Figure 3 The relationships between each of 6 agents. Each arrow signifies a two-directional relationship or contact

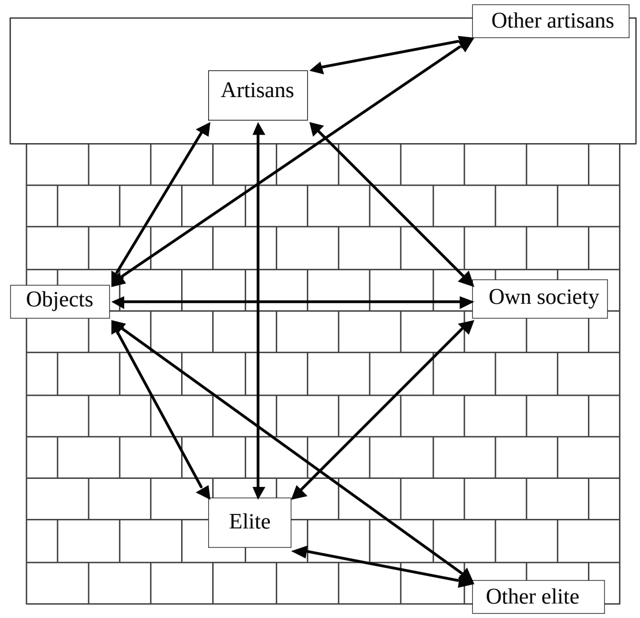

Figure 4 The relationships between each of 6 agents. Each arrow signifies a two-directional relationship or contact. Architecture surrounds all groups and relationships

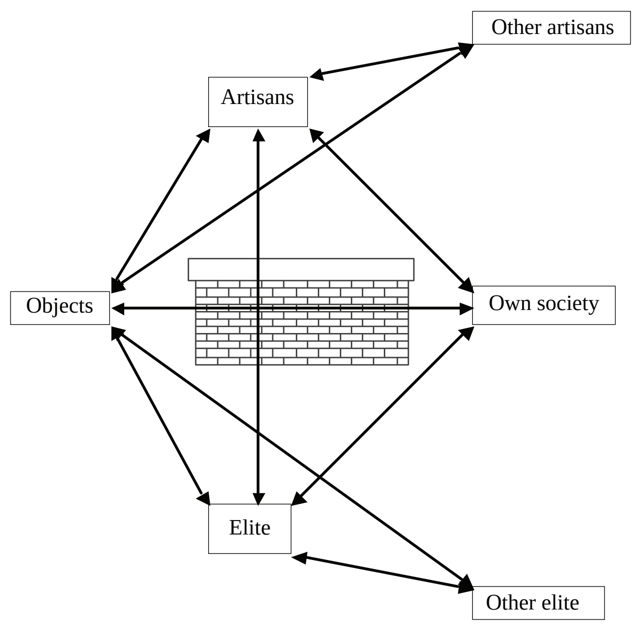

Figure 5 The relationships between each of 6 agents. Each arrow signifies a two-directional relationship or contact. Architecture stands in the centre of all groups and relationships

The production processes (or *chaînes opératoires,* fig. 6) of painted plaster revealed the materials and techniques employed, and we can estimate the amount of people involved in each task, based upon experiments and people's real experiences in doing so. It is the social practices within this craft, however, that illustrate communities of practice as the groups of people that may work *together*, having the *intention* to join forces to produce these paintings or buildings. They may have passed on skills and knowledge to the next generation, possibly in an almost repetitive motion (Wright 2006, 50 calls this 'ritual', but see also Ingold 2011, 51-58). This was possibly carried out through strict control over the younger participants, who learnt via imitation patterns and through active teaching (see Jamshid and Riede 2008, 318-19). In such an actional context, the more experienced workers did not just pass on their knowledge but involved interactively and socially the younger ones in processes that gradually increased the complexity of their participation, engagement, and responsibilities in the work they undertook (Lave and Wenger 1991). These teams, very likely made up of experienced artisans and learners, thus guaranteed the continuity of quality, standards, and ideal recipes. Plasterers intended (planned) to apply plaster onto the wall, in coordination with the painters, so the latter group could, as they had intended (planned), paint the desired scene *al fresco* as much as possible. These artisans thus created *together* amazing decorative programmes in employing a largely 'invisible technology' in confined spaces, which may have confirmed their own status as excellent artisans (see figs 7 and 8; Brysbaert 2008, 112-128).

If these artisans did *not* intend to work together, the plasterers could have started in the morning, while the painters may have been involved in other tasks and only came to the site when the wall was dry, much later on. Precise timing and planning would not matter in that case. So the human intent in painting *al fresco* is crucial for the strict planning, while studying the *chaîne opératoire* of painting on damp lime plaster in confined spaces may reveal social practices and interactions between the two groups that *necessarily* need to work together. Understanding the different processes of painting *al fresco* as social practices entails that architecture as an active and interactive force, paintings included, constructs its own *self*—or at least, it plants the seeds to do so. How does this work?

Material	**Action/technological**	**Number/social**
Plaster Pigments	Extract Extract	Miners, transport: >2 Miners, transport: >2
Plaster	Load kiln, calcine, check fuel	Plasterers: >2
Plaster	Slake	Plasterers: >2
Plaster	Prepare, apply to wall	Plasterers: >1
Pigments	Prepare from ore: grind…	Plasterers?, painters?: ≥1
Pigments	Prepare, apply to plaster surface	Painters: >2

Figure 6 Two main *chaînes opératoires* within the painted plaster craft

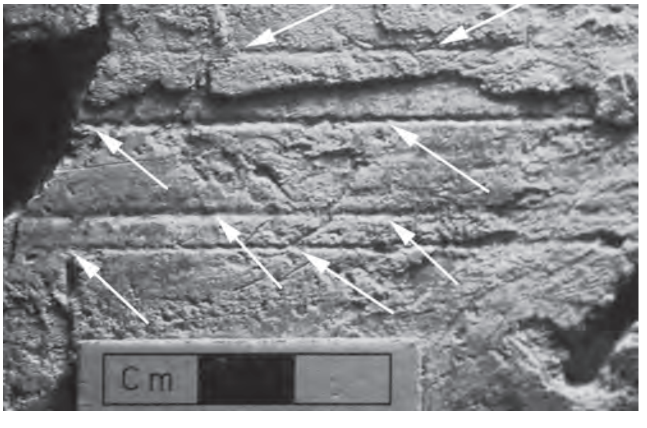

Figure 7 String impression in damp plaster on two different plaster layers, indicated by arrows in different directions (Tell el-Dab'a, Egypt) (Photo Ann Brysbaert)

Figure 8 Fingernail impressions near detailed painting *al fresco* (Tell el-Dab'a, Egypt) (Photo Ann Brysbaert)

Earlier we saw that buildings *create* or *order* (my emphasis) empty volumes of space (Hillier and Hanson 1984, 1): architecture produces, and is thus active. Moreover, constructions even become mobile when their building blocks are dismantled and reused elsewhere (*e.g.* the so-called 'wandering temples' in the Athenian agora, brought in during the Roman period: Camp 2001, 184-192). According to McFadyen (2006), builders who work closely together can be seen as fusing together with what they produce, and in doing so, they need to be able to rely on each other (see also Ingold 2011, 51-62). The boundary between the builders and the architecture in/on which they work becomes blurred (see also Mellström 2004, 373 for this same boundary dissolution in men working on machinery). We may see this in, for example, the amount of building material on their clothing and skin, in their hair, under their fingernails, even within their lungs, both during work and after they leave the building site. But this merging of the person with the construction can also be observed in the actual construction, whether building or object.

Evidence of people's bodily presence in buildings and objects has been amply noted in many material remains. Some were intended, some were not: fingerprints in clay visible on pottery (Hruby 2011), on mudbrick, figurines (Vetters 2009) and imprinted on plaster (Palaikastro and Knossos); tool marks on stone, plaster and metal; mason marks on stone; clothing impressions on plaster (for Thebes, see Brysbaert 2008); fingernail impressions in painted plaster (fig. 8); deep finger impressions (fig. 9), used to key lime plaster to the backing support (*e.g.* Qatna, Tell el-Dab'a and Knossos).

All of these examples indicate an intimate and fully sensory contact between the people and the materials they worked with. These materials pass through their fingers, get under their fingernails; they walk on it while possibly feeling the cold and wetness, perhaps also experience a range of different textures. Artisans test, by touching, if a surface is damp enough, smooth enough; they tap it to hear if it sounds correctly in relation to that stage of the working process. While working, people may have even smelled and tasted some of these materials (plasterers certainly do) and thus absorbed these materials inside them. If they inhaled very fine plaster dust, for example, it may have also affected their health, thus affecting their future in their craft. We only need to look at modern Materials' Safety Data Sheets to understand the extensive hazards of prolonged exposure to quicklime, affecting, for instance, eyes, skin and lungs (*e.g.* http://cockburncement.com.au/wp-content/uploads/2014/05/Quicklime-15May12.pdf [16.1.2015]).

Two final examples of this intimacy between people and materials (see also Ingold 2011) will reinforce the idea that architecture and its materials are indeed active and that built spaces and their decorative surfaces represent more than a backdrop to social activities. In her ethnographic work on Indian vernacular architecture, Boivin (2008, 6) mentions: '...As humans shaped soil, so it likely shaped them and their world', while Follet (2007, 573) writes: 'The stone had a will of its own, and if he [the mason's apprentice] tried to make it do something it did not want to do, it would fight him, and his chisel would slip, or dig in too deeply, spoiling the shapes. But once he had got to know the lump of rock in front of him he could transform it.'

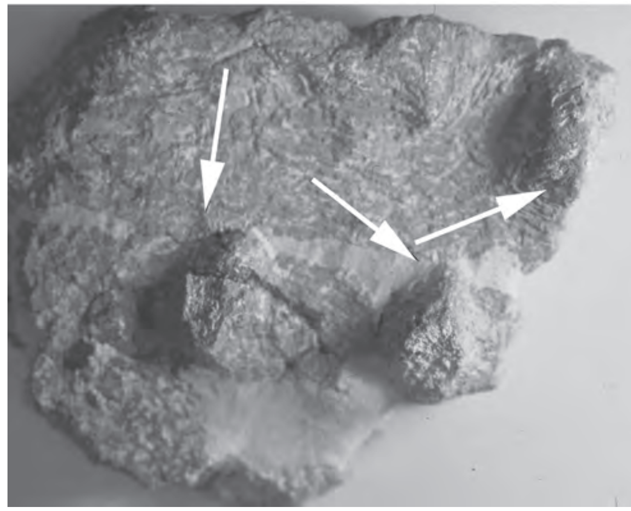

Figure 9 Finger impressions in backing material, now preserved as cast in lime plaster (Gla, Greece) (Photo Ann Brysbaert)

7 Conclusions

During construction or repair events of both architecture and painting on plaster, builders and artisans of the Minoan, Mycenaean and east Mediterranean palaces and other elite buildings were confined by the spaces which they produced and in which they spent considerable amounts of time. We know (Coopman 2004: pers. comm.) that it may take two plasterers eight hours per day for an entire week to plaster the walls of a 50 m² building with four rooms and one corridor, six doors and four windows, and walls of 3 m height. These figures, however, cannot be taken as the sole parameter to measure time in this context. Of importance too are environmental influences – light, temperature, and relative humidity – and human factors such as levels of skill in carrying out the job well and speedily, the quality of the work, and the tools employed to get the job done. The plasterers interviewed only worked during specific seasons of the year during which the drying rate of the plaster they worked on was relatively stable; we can imagine that plasters in the past would make similar choices if at all possible. In a similar vein, levels of skill will have varied in the past as much as they do now. The translation of the above-mentioned figures to palatial contexts can, therefore, only be suggested cautiously.

For the purpose of this paper, the above mentioned figures may help us to understand that both plasterers and painters spent *quite a bit of time* with each other if *al fresco* was intended, in a limited or enclosed space. Having had several chances to interview plasterers and to listen in on conversations between them while they were sitting on the scaffolding (see *e.g.* fig. 10), it became clear that, depending on the stage of their work, they are often very quiet because they concentrate, but they also discuss things. While they talk about many different work-related aspects, sometimes very personal issues are addressed too, such as financial matters, their own personal joys and problems, and even marriages between their children. None of these topics are completely separable from each other.

This was likely not different in similar past working conditions. During these work experiences that brought or forced people together into small spaces and encouraged co-dependence on each other for the success and safety of the work, close bonds must have been created between these workers on many occasions. Moreover, in order to achieve a successful outcome for their work, they *needed* to trust each other and to continue building and maintaining solid trust in the good intentions of the other. It is, therefore, not too difficult to imagine that some of these builders, plasterers, and painters, while interacting with each other across-crafts, passed on their skills to their children and grandchildren, who, in fact, may have continued to work on the same decorated building complexes.

Figure 10 S. Furnari's 2007 sculpture 'Lunchtime on a skyscraper – a tribute to America's heroes' (inspired by Ch. C. Ebbets' photograph of 1932) (Photo Ann Brysbaert)

In this way, I suggest that architectural complexes, their decorative programmes, and their respective technological processes, styles, and imagery looked after their own inception, growth, changes, repairs and additions. These buildings had, in fact, the capacities within their own structures and materials, and were enhanced through the intent of the interacting artisans and their elite owners. The cycles of planning, building and decorating, rebuilding and redecorating, and repair, on the one hand, thus seem to match with cyclic building, rebuilding, and repairing of social and professional relationships between people working in them from generation to generation, on the other. Both people and the decorated architecture they produced and used played active roles in producing and reproducing each other and themselves, whether artisans, or elite communities, or the decorated spaces. As much as there were levels of co-dependence between different groups of artisans while working on a common project, there was co-dependence between artisans and elites too. These levels of co-dependence resulted in forging, realising, and maintaining their own social identities and group belonging. They thus foresaw in the continuation of each other and themselves, and to this extent, each also carried the 'building blocks' within themselves.

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Notes

1 All dates mentioned: after Cline 2010, xxx.

2 "Wenn ich den Kaufvertrag im Wissen um die Bedeutung einer solchen Handlung unterzeichnet habe und dabei "im Geist" auf das zu erwerbene Objekt gerichtet war, dann habe ich gewiß ein intentionales Erlebnis gehabt – auch dann wenn ich mir zu diesem Zeitpunkt des Betrugsrisikos gar nicht bewußt war: wenn ich die intentionale Handlung nicht im BewuBsein der möglichen Nichtexistenz des intendierten Gegenstandes vollzogen habe."

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Web resources

http://cockburncement.com.au/wp-content/uploads/2014/05/Quicklime-15May12.pdf

Ann Brysbaert
Faculty of Archaeology
Leiden University
PO Box 9514
2300 RA Leiden
The Netherlands
a.n.brysbaert@arch.leidenuniv.nl

Excavations of Late Neolithic arable, burial mounds and a number of well-preserved skeletons at Oostwoud-Tuithoorn: a re-analysis of old data

Harry Fokkens, Barbara Veselka, Quentin Bourgeois, Iñigo Olalde and David Reich[1]

In 1956 and 1957 prof. A.E. van Giffen, the nestor of Dutch Archaeology, excavated two burial mounds near Oostwoud, on a parcel named 'Tuithoorn' in de province of Noord-Holland. These mounds appeared to have been erected in the Late Neolithic between 2500 and 1900 cal BC. They contained at least 12 well preserved skeletons dating to the Late Neolithic and the Early Bronze Age. Until today these are the only burial mounds from that period in West-Frisia, moreover, they contained the only skeletons from that period in the area. Yet, apart from a few brief overviews the data has not been published. The present article is an attempt to re-analyse the data of the investigations by Van Giffen, but also of later research by M. de Weerd in 1963 and 1966, and by J.D. Van der Waals in 1977 and J.N. Lanting in 1978 in the same mounds. In the framework of the NWO-project Farmers of the Coast, the first author undertook the task to collect the dispersed data and to try to unravel the sequences of burial. Aided by the Leiden University Bakels fund, and a fund of the Province of Noord-Holland, we also had the opportunity to sample the bones for DNA and isotopes, and to study the pathology of the skeletons. Some of the analyses are not yet finished, but here we publish the excavation data using the original field drawings and day notes, and much of the original photography. We have done this in some detail because the site is one of the most important in its kind in the Netherlands and because it will play an important role in the discussion about Bell Beaker mobility and genetics in the near future. We used already some of the skeletal and DNA data in this article, but more detailed studies are following.

In tumulus II all skeletons were buried in a crouched position typical for the Late Neolithic. The oldest burial (575 also known as 'Jan van Oostwoud') was buried in a wooden chamber without grave gifts other than two small flint blades and without a burial mound. After that the burial site was converted into arable land. At least two layers of arable land are present over this Bell Beaker period grave. The plough lands contain many small Bell Beaker and Barbed Wire Beaker potsherds. Next a low burial mound was erected in at least two phases, which is contested by bundles of Late Neolithic plough marks marking its limits. In this mound at least nine other skeletons were buried, men and women. The youngest person was a person of minimally 15 years old.

1 Introduction

In 1956 and 1957 A.E. van Giffen excavated two burial mounds near Oostwoud on a parcel of land called 'De Tuithoorn'. Both were erected on ploughed arable land that was provisionally dated to the Late Neolithic on the basis of potsherds present in the prehistoric plough soil (Van Giffen 1962, 204). One of the burial mounds (indicated by Van Giffen as Tumulus I) was dated to the Bronze Age, the other (Tumulus II) to the Late Neolithic. Van Giffen very briefly published the results in 1961 in an English language paper, and in 1962 he published the Dutch translation of the same article. Van Giffen had been unable to finish the work in the NW quadrant of Tumulus II, therefore in 1963 new excavations were carried out by De Weerd, which were continued in 1966. Both campaigns remained unpublished apart from brief notes (De Weerd 1966; 1967). Finally, in 1978, Lanting excavated the site when it was going to be deep ploughed. This was the first large scale excavation at Oostwoud involving hydraulic diggers. All previous work had been done by hand. The 1978 excavations remained unpublished as well, apart from a short account (Lanting and Van der Plicht 2002, 86-89). A detailed and very useful overview and plan of the site history was published by Van Heeringen and Theunissen (2001).

The first campaigns by Van Giffen yielded spectacular results. Even today, the Oostwoud tumuli remain two of the very few burial mounds in the Netherlands that contained several well preserved skeletons from the Late Neolithic and the Early Bronze Age. In addition, they provided the first clear evidence of extensive plots of Neolithic arable land. The excavation was initially carried out by the *Instituut voor Prae- en Protohistorie* (IPP) of the University of Amsterdam, of which Van Giffen was the director for a long time. It was his last excavation as director of the Institute; he was succeeded by W. Glasbergen in 1957. At Oostwoud Van Giffen used technicians from all institutions with whom he was or had been associated as director: the Rijksdienst voor het Oudheidkundig Bodemonderzoek (ROB) at Amersfoort of which he became the first director in 1947; the IPP at Amsterdam which he had founded in 1952; the Biologisch Archeologisch Instituut (BAI) at Groningen which he had founded in 1923.

Because of the involvement of several institutions, the finds and the documentation became dispersed. The institutes at Groningen and Amsterdam had original field documentation, the IPP also housed finds. When the IPP was dissolved as a separate institute of the University of Amsterdam in the nineteen-nineties, the finds and documentation were transferred to the Provincial Archaeological Depot (now at Castricum). The field drawings of the 1956, 1957, and 1978 excavations were kept in Groningen at the BAI until 2015. Then they were handed over to the depot at Castricum as well, as the result of an effort of the first author to bring all documentation and finds together at this Provincial Depot. In January 2017 the field diary of the 1978 excavation and other documentation until then kept by J.N. Lanting was transferred to the Depot as well. Again and again, however, finds and documentation keep turning up in other places. Some of the material, for instance, is still present in the town hall of the city of Hoorn, which inherited the collection of the West-Fries Museum in Hoorn.

The complex and fragmented nature of the data is partially responsible for the disjointed publication history. In the framework of the NWO project ‘Farmers of the Coast’ (NWO-160-300-30), focusing on the Middle Bronze Age settlement landscapes of West-Frisia, the first author made efforts to bring all data together and to prepare a final publication. In the course of this study, the skeletal material was re-analysed as well (Veselka 2016). In addition, the skeletons were sampled for DNA by E. Altena (Leiden University Medical Center Leiden). They are presently being analysed as part of a combined Copenhagen-Jena-Harvard research program. The results of this study are presently not yet available, but the preliminary findings from Harvard (D. Reich) are very promising indeed, including proof of family relations between some of the skeletons. In this paper some of these results are briefly discussed.

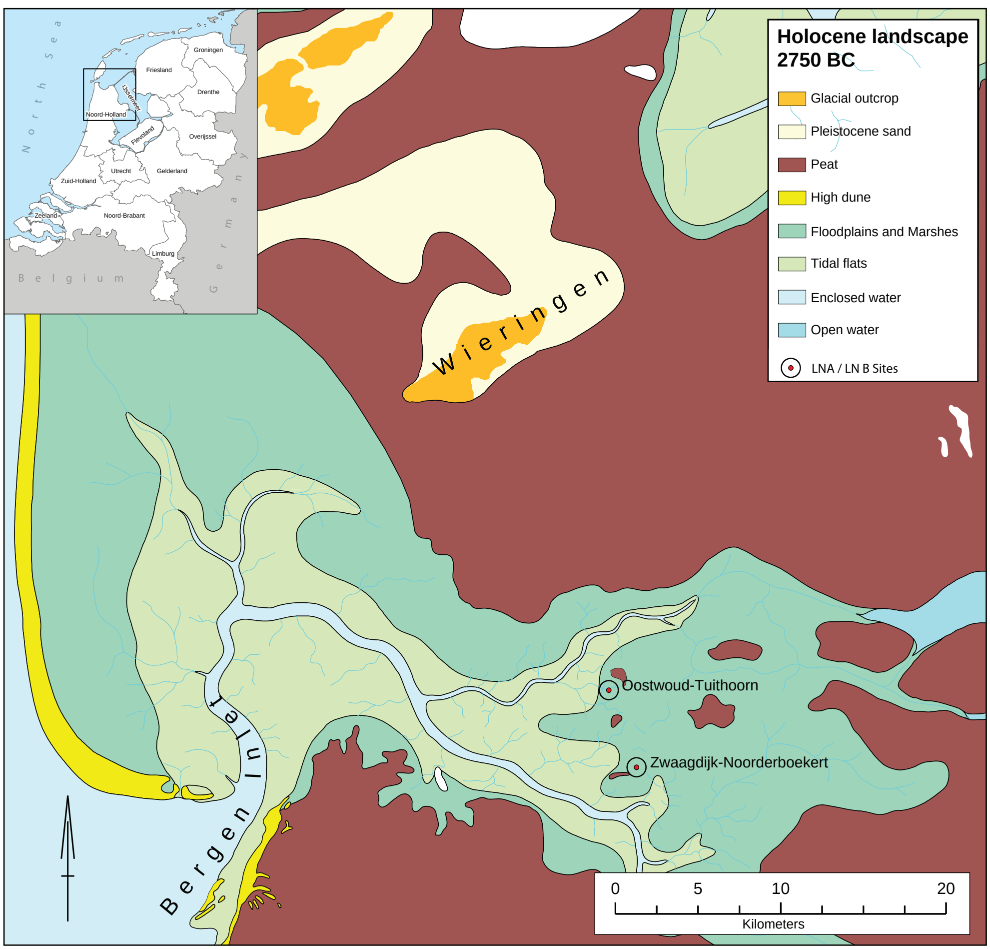

Figure 1 The site of Oostwoud in the paleogeographic situation around 2750 cal BC (modified after Vos & De Vries 2013 and Beckerman 2015, 33)

2 Environment

The West-Frisian landscape around 2500 cal BC has always been characterised as a tidal marsh environment. In the most recent paleogeographic maps of the period, Oostwoud was situated on the east end of a tidal marsh area, probably with relatively little sea influence, even though the tidal channels were still active. The Bergen inlet also was the place where the river Vecht ended in sea. In the reconstruction of Vos and De Vries (2013), Oostwoud is situated in the flood plain east of the active channels (fig. 1). The sites to the west are sites that were occupied during the last phase of the Corded Ware culture, probably around 2600 cal BC.

In his recently published dissertation, however, Van Zijverden (2017; fig. 2) gives a different reconstruction. In his view, the Bergen inlet was a relatively narrow inlet resulting in a large basin behind the coastal barriers in which tides could run up higher than in the coastal area proper. This also meant that levees were higher and the hinterland wetter than previously reconstructed. This situation changed in the Early Bronze Age, probably around 1800 cal BC after a severe storm or series of storms. These blocked the river Vecht outlet to sea and made it change its course south wards around West-Frisia.

The subsoil of the site consisted of layered 'marsh' deposits that always have been indicated as mud flat deposits. However, in view of the different reconstruction by Van Zijverden, it is much more likely that we are dealing with an extensive crevasse splay. Such splays develop when the levee of a channel brakes through during a storm event or high water discharge. Around the break-through channel (the crevasse), coarse sands and silts are sedimented in the back swamps (crevasse splay) as a result of the high dynamic floods. The channel gradually silts up, decreasing the water velocity, and resulting in a fining upward sedimentation pattern of the crevasse splays. Eventually, what remains is an elevated area which forms a well-drained island in the midst of back swamps and tidal channels (Baeteman, Beets and Van Strydonc 1999). Such splays can be extensive, even up to 1 km^2, which would also have been the case at Oostwoud, given the extensive arable land present there. According to Van Zijverden (oral information Jan 2017) this is the most likely explanation given the overall environment. His reconstruction differs from that of P. Vos, the geologist who produced the most recent paleogeographic reconstuctions, with respect that there is much more water and much less flood plain and marshes (fig. 2, 3). In figure 4 we have

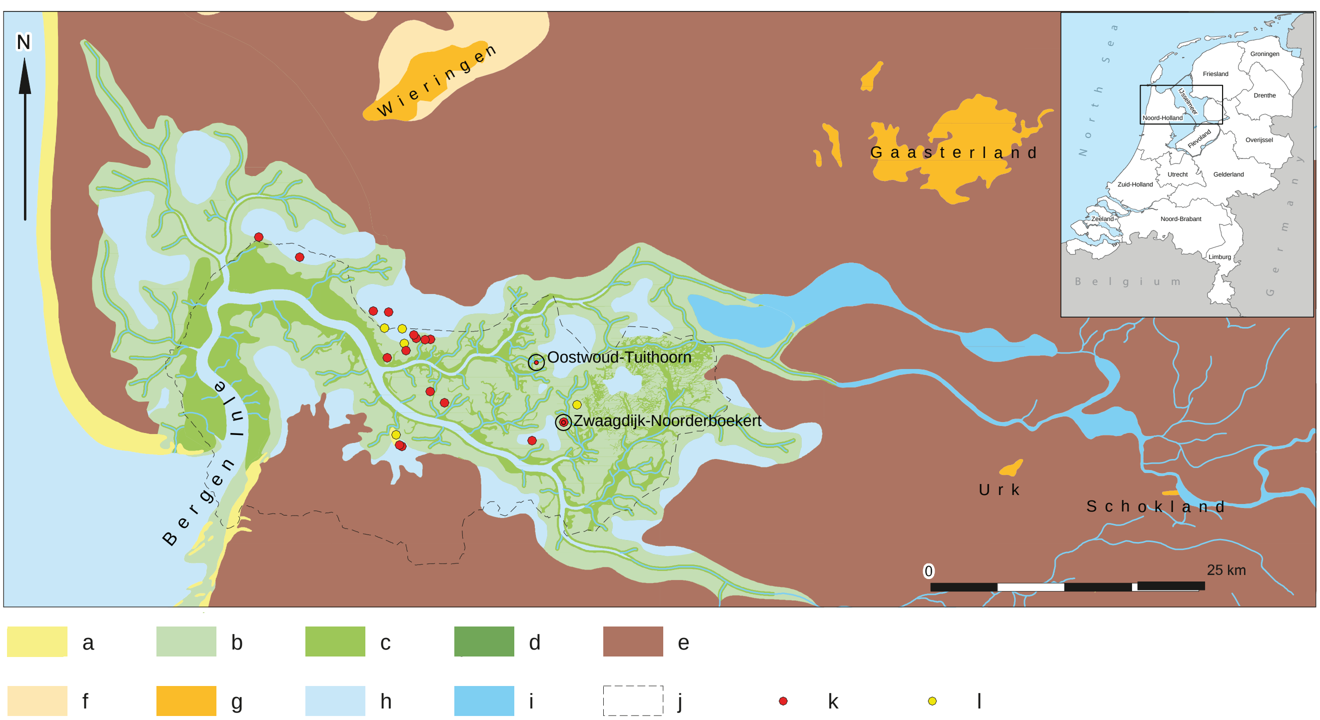

Figure 2 Paleogeography of West-Frisia approximately 2100 BC. Legend: a: dunes and beach ridges, b: tidal flats, c: tidal marshes and levees, d: former tidal marsh, e: peat, f: Pleistocene sand areas, g: ice pushed ridges, h: mainly brackish and salt water, i: mainly freshwater, j: West-Frisia, k: excavated sites, l: sites only surveyed (after Van Zijverden 2017, fig. 3.12)

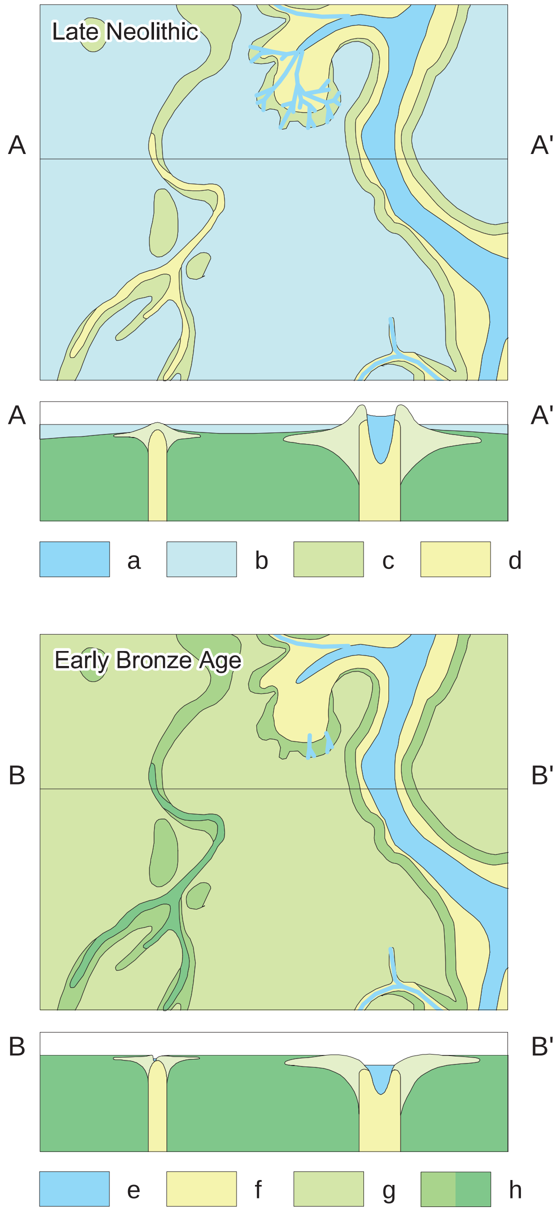

Figure 3 Reconstruction of the former landscape of eastern West-Frisia c. 2100 cal BC (A) and c. 1800 cal BC (B). Legend: a: salt to brackish water, b: brackish to freshwater and or reed swamps, c: irregularly flooded levees and creek ridges, d: regularly flooded flats, splays and residual gullies, e: salt to brackish water, f: tidal flats, g: irregularly flooded tidal marsh, h: regularly flooded tidal marsh and former gully (after Van Zijverden 2017, fig. 3.13)

combined all presently available information about the orientation of the landscape and creeks. It shows that large creeks, probably considerably older than the excavated remains, cut through the landscape in a WNW-ESE direction.

This situation is more or less confirmed by an unpublished pollen analysis carried out by W. Groenman-Van Wateringe in 1956 and 1957 based on samples from the two barrows (fig. 5). She states that '........ the area around the barrows was grown with a vegetation, poor in trees.' Yet we should add that there is a rather high percentage of hazel (*Corylus*) as well as alder (*Alnus*). The latter indicates the presence of wet areas, whereas the former could have grown on the crevasses and on the levees. Willow might be expected as well, but Groenman decided, after a discussion with Van Zeist at Groningen University, that the pollen she had counted in the first year as Salix (13%) probably were fragments of *Triglochin maritima* (sea arrowgrass; *schorrezoutgras*) that have a similar reticular structure (Letter of Groenman-Van Wateringe to A.E. van Giffen 8 March 1958; Provincial Depot Noord-Holland).

The present elevation of the Oostwoud buried soils is 1.70 below Dutch datum, indicating that without dykes, the area would be covered with more than 150 cm of water. Indeed the site was partly covered by later clay sediments, indicated by the excavators as '*Zuiderzeeklei*'. Presently the area is a polder within the perimeter of the 126 km long *'Westfriese omringdijk*' a dyke built in the 13th and 14th century AD. Before the area within the dyke was reclaimed, West-Frisia was largely covered with peat. We have to be aware that subsidence of the unstable subsoil with several peat layers is partially due to this low situation, while later sediments also cover the area as a whole. Without going into further detail about these sequences, it is clear that due to water-logging and clay sediments that prevent air from getting into the soil, the preservation conditions are excellent in Oostwoud, and in the entire part of the province of Noord-Holland indicated as West-Frisia. In this landscape, presently barren and used as grazing lands, cross-cut by many ditches to drain the soil, prehistoric burial mounds have always remained visible as low elevations. There is only one archaeological monument left, at Zwaagdijk, where this situation has been preserved, but a little is visible in figure 6.

Late Neolithic and Bronze Age farmers alike appear to have been living in an environment that we would not consider a first choice for farming. Yet the extensive plots of arable land such as those at Oostwoud, Zeewijk (Theunissen *et al*. 2014) and at Noorderboekert-Rijweg (Knippenberg 2014; Fokkens *et al*. 2016) show that the Corded Ware and Bell Beaker people living in this area were not just marginal farmers. They had plots of over one hectare that they ploughed regularly. In addition, they fished, hunted, and caught birds (cf. Fokkens *et al*. 2016). It is clear that they lived a stable life in this wet environment which enabled them to supplement a farming existence with all other sources that nature provided. It is in such a context of farming life that we have to place the Oostwoud-Tuithoorn barrows. We do not know, however, where the people who were buried there actually lived. It is likely that they did not live far away, probably within the same kind of environment. The excavations never yielded conclusive evidence for a settlement, apart from many bone, pottery and flint fragments dispersed in the arable land underneath the barrows.

In the following sections we will first discuss the excavation history (section 3), next sequences of the arable land (section 4), then the burial mounds proper (section 5), and finally the skeletal remains found in them (section 6).

3 The excavation history

3.1 The 1956 excavation of Van Giffen (9 April – 18 May)

Since the information we have on the burial mounds, the stratigraphy, and the burials is very limited, we have made a reconstruction of the excavation process from the field diaries, the drawings, and short notes written by different people who were called in by Van Giffen to aid in scientific analyses.

Van Giffen states in his account that the Oostwoud excavations were the last ones he carried out as professor and director of the *Instituut voor Prae- en Protohistorie* of the University of Amsterdam. In 1954 he had reached the age of 70 and had retired from the positions he held at

Figure 4 The excavated area at Oostwoud-Tuithoorn (center-left) with a cut out part of the Google Earth map of 4 May 2005 which shows the course of many tidal creeks in the subsoil. These probably antedate the arable land and burial sites. They are projected on the topographical map 1:25.000 of 1999 (sources: Google Earth; http://www.topotijdreis.nl/ (visited 1 Feb 2017)

Groningen, Amsterdam and Amersfoort. Yet he still was appointed as *State Advisor for the protection and conservation of megalithic monuments and restored archaeological monuments,* which was officially based in Groningen at the Heresingel 15a (his private address), but which was *de facto* run from an office he still kept at the BAI. Even though he was retired and had passed on his positions in Groningen to H.T. Waterbolk, and in Amsterdam to W. Glasbergen, Van Giffen still determined to a large extent what happened in the field of research. Therefore, it is no surprise that a combined team of field technicians and staff of the Groningen and Amsterdam Universities and the ROB at Amersfoort were mobilized and went to Oostwoud: Professor Van Giffen could not be refused assistance.

The excavation started 9 April 1956. The field diary (*dagrapporten* in Dutch) contains entries for every day by one or two persons. The leading technician (Knottnerus, field technician of the IPP) wrote entries on progress, but very little on content. He also kept the find list. When he was at the site, which he was most of the time, Van Giffen also wrote daily reports; actually this was most of the time (fig. 7). These reports were later (in 1960) compiled by his successor at Amsterdam University, W. Glasbergen, from hand-written notes.[2] The team of technicians and draughtsmen consisted of Osinga (BAI), Knottnerus and Kikkert (IPP), Bekker, and Van Duyn and Van den Berg (ROB). As was the custom at the time, workers (about nine) were made available through the *Heide Maatschappij (HeideMij)*, an idealistic organisation (founded in 1888) which at that time still aimed for the reclamation of heath for agriculture, for planting forests in vast wind-blown sands, and for the improvement of employment under poor people.[3]

The workmen first worked under supervision of technician Knottnerus of Amsterdam. But from the diary it is clear it that after the first week Van Giffen was not really satisfied with the Amsterdam team, especially Kikkert. He complains in the diary about the quality of the contour maps and of the drawings in general. Kikkert is relieved of fieldwork duty

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	Heuvel I monster 9	Heuvel I monster 11	Heuvel II monster 261
	%	%	%
Alnus	27	27	56
Quercus	2.3	3.5	3.8
Ulmus	1.2	1.1	-
Tilia	0.3	1.3	-
Fraxinus	0.4	-	1.2
Corylus	59	51	30
Fagus	0.1	0.2	-
Pinus	8.9	15	8.8
Picea	0.6	0.2	-
Σ AP - Betula + Corylus	900	452	161
Betula	7.1	10	54
Calluna	5.1	7.1	14
Gramineae	9.4	16	28
Cerealia	0.7	0.4	3.1
Chenopodiaceae	3.1	4.4	17
Plantago lanceolata	0.4	0.2	-
" major	-	-	0.6
Compositae liguliflorae	2.6	5.3	3.1
" tubuliflorae	2.0	0.7	4.4
Artemisia	+	-	0.6
Umbelliferae	2.3	5.8	-
Galieum um.	0.4	0.2	-
Caryophyllaceae	0.7	2.4	1.9
Labiatae	0.7	1.8	1.9
Juncaginaceae	5.6	6.2	3.8
Rumex acetosa	-	1.1	-
Epilobium	-	+	-
Rosaceae	-	-	0.6
Filipendula ulmaria	-	-	1.2
Cruciferae	-	-	1.2
Cyperaceae	29	55	4.9
Filices	24	60	33
Sphagnum	9.7	11	111
Lycopodium	3.0	2.2	3.1

Figure 5 Pollen counts of three out of thirteen samples that actually contained pollen. All samples were taken from the old surface outside the barrows (copy of a letter sent by W. Groenman-Van Wateringe to A.E. Van Giffen 8th of March 1958)

Figure 6 Images of the start of work at tumulus I, taken 9 or 10 April 1956. The images indicate the slight elevation of the barrow in the landscape of 1956

1956	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
April	9	10	11	12	13	14	15
	16	17	18	19	20	21	22
	23	24	25	26	27	28	29
May	30	1	2	3	4	5	6
	7	8	9	10	11	12	13
	14	15	16	17	18	19	

30 May	Queens Birthday	7	Free Sunday
5 May	Liberation day	7	VG present
10 May	Asuncion day	7	Normal work day

1957	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
May	27	28	29	30	31	1	2
June	3	4	5	6	7		

Figure 7 Work scheme for 1956 and 1957 and the presence of Van Giffen at the excavation

and sent back to Amsterdam on the 17th of April. After three weeks, Van Giffen decided that he needed Praamstra and Meijer, his experienced team from Groningen, both to supervise the workmen and to make drawings of the sections and the surfaces. They arrived on the site on May 1, and immediately sacked five of the workmen. In the field diary of the 19th of April Van Giffen had already complained that they were slowing down. Praamstra and Meyer stayed on until the end of the excavations on May 18th 1956. Praamstra's fine and detailed drawing of the plans and sections are very valuable for our research and determined much of what we know about the excavations.

In 1956 Tumulus I was excavated first. They started lying out the section dams after having determined north with the compass. Next, a 1 meter wide trench was dug along the mid-west section in the SW quadrant until they reached the natural soil (field diary Knottnerus 9 April 1956). According to Van Giffen they already found a human tibia on the same day in the 'loose soil'; this must have belonged to skeleton 230. He thinks the barrow had already been levelled in the past. There is no mention of plough marks in this first trench, which accounts for the fact that in the plans a one meter wide strip just south of the w section dam lacks plough marks (fig. 8). The next day, they uncovered the skeleton near the centre and the skull of the one further south, in the SW quadrant. Elevation levels were taken, demonstrating the skeleton near the centre (230) was found at 1.12 – NAP, the skeleton 'in the south of the SW quadrant' (231) was found at 1.26 – NAP, so 14 cm lower. Some potsherds and flints were also discovered.

On the third day, they enlarged the trench in the SW quadrant to 3 meters and discovered plough marks. It was Van Duijn who first recognised them (field diary Knottnerus 11 April). Both skeletons were left on pedestals of soil (fig. 8). Next they started on the NE quadrant, followed by the SE quadrant. Here they discovered the skeleton of a pig (fig. 9). This is situated next to a more recent pit with a layered fill, but it may have been a prehistoric deposit. The excavators started to realise that the plough soil contained Bell Beaker pottery. Van Giffen returned on Friday 13th of April to the excavation and wrote that he was upset about the quality of the drawings and elevation plans. In the next week the NE quadrant was finished and they started the work in the NW quadrant.

Van Giffen noticed that the plough marks continued outside the barrow (tumulus I), which was an important finding to deconstruct the theory that these marks were the result of purely ritual ploughing underneath barrows. He noted that there are two levels of plough marks, the lowermost organized in a criss-cross grid, but the higher,

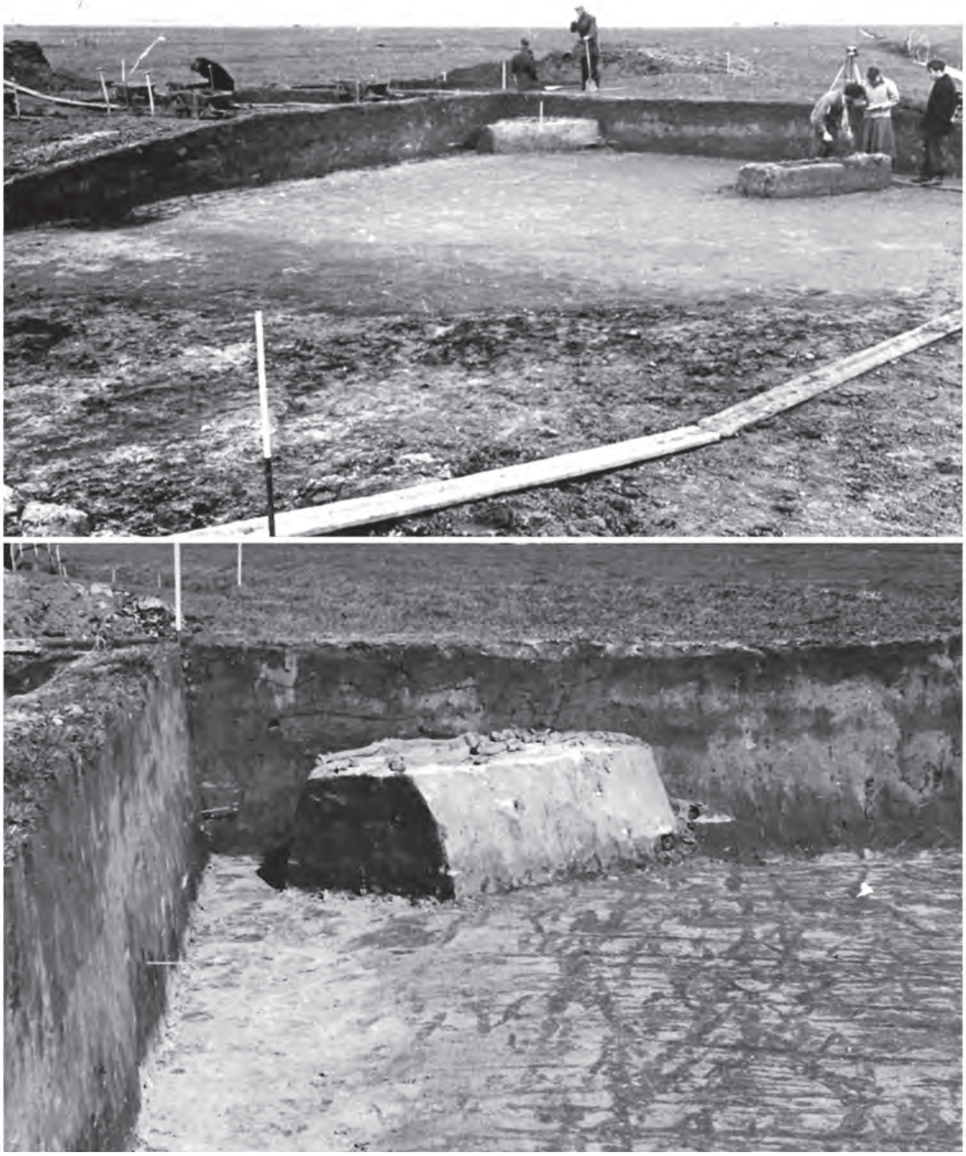


Figure 8 The SW quadrant of tumulus I with skeleton 230 (near the centre) and 231 left of pedestals of soil. Work in the NE quadrant had just started (11 April 1956). The bottom image clearly shows a strip without plough marks that was excavated just too deep, and the elevated position of skeleton 230 in relation to the plough soil

younger system appears more curved (field diary Van Giffen 18 April). They took pictures to document this (fig. 10). On the 19th of April the last skeleton in the SW quadrant was further excavated by Mr. Bijlsma, assistant of prof. De Froe.[4] The skull of skeleton 230 was embedded in the section dam, which was excavated for this reason (cf. fig. 42c). No drawings seem to have been made, only photographs. Skeleton 231 and the skeleton of the pig had already been transported to Amsterdam two days earlier. In the SE quadrant the skeleton of a cow was also found (first mistaken for a human). It was considered recent and there is no record of its documentation. The excavation of tumulus I finished 24 May.

Praamstra stated that he started drawing the plan of tumulus I on May 1st (field diary Praamstra 1-9 May). This was long after the skeletons had been removed; therefore no field drawing of them exists. Praamstra apparently had the assignment to redraw all surfaces and profiles. That is possibly the reason that no drawings made by Kikkert, Trimpe Burger, or Van Duijn survived, at least not in the BAI in Groningen.

The work on tumulus II started on the 24th of May with a 3 meter wide trench in the SW quadrant creating a west and south section through the barrow. Here they found two

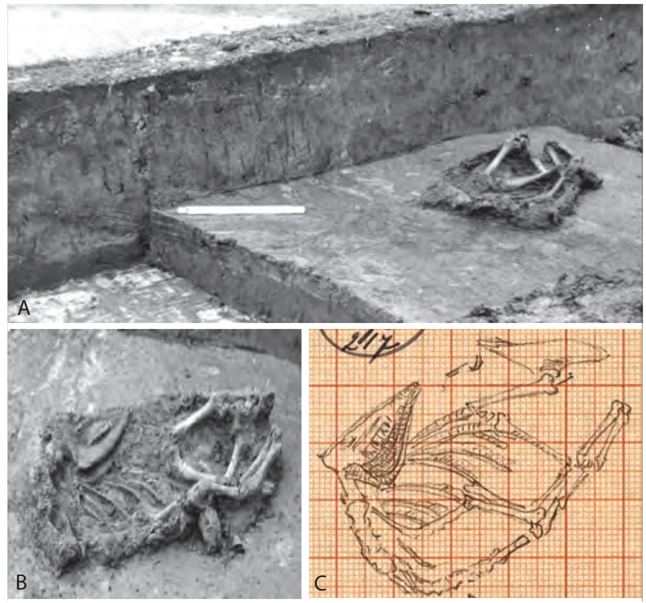


Figure 9 The skeleton of a pig found in the SE quadrant of tumulus I. A: with the sub-recent pit with a layered fill clearly visible in the horizontal and the section. The pig skeleton is situated outside that pit, and is considered a prehistoric deposit. B: skeleton of the pig seen from above. C: drawing of the pig made by Praamstra

Figure 10 The SE quadrant of tumulus I with the pig skeleton seen from the SE. The plough marks clearly extend beyond the large pits that once formed a circle around the burial mound

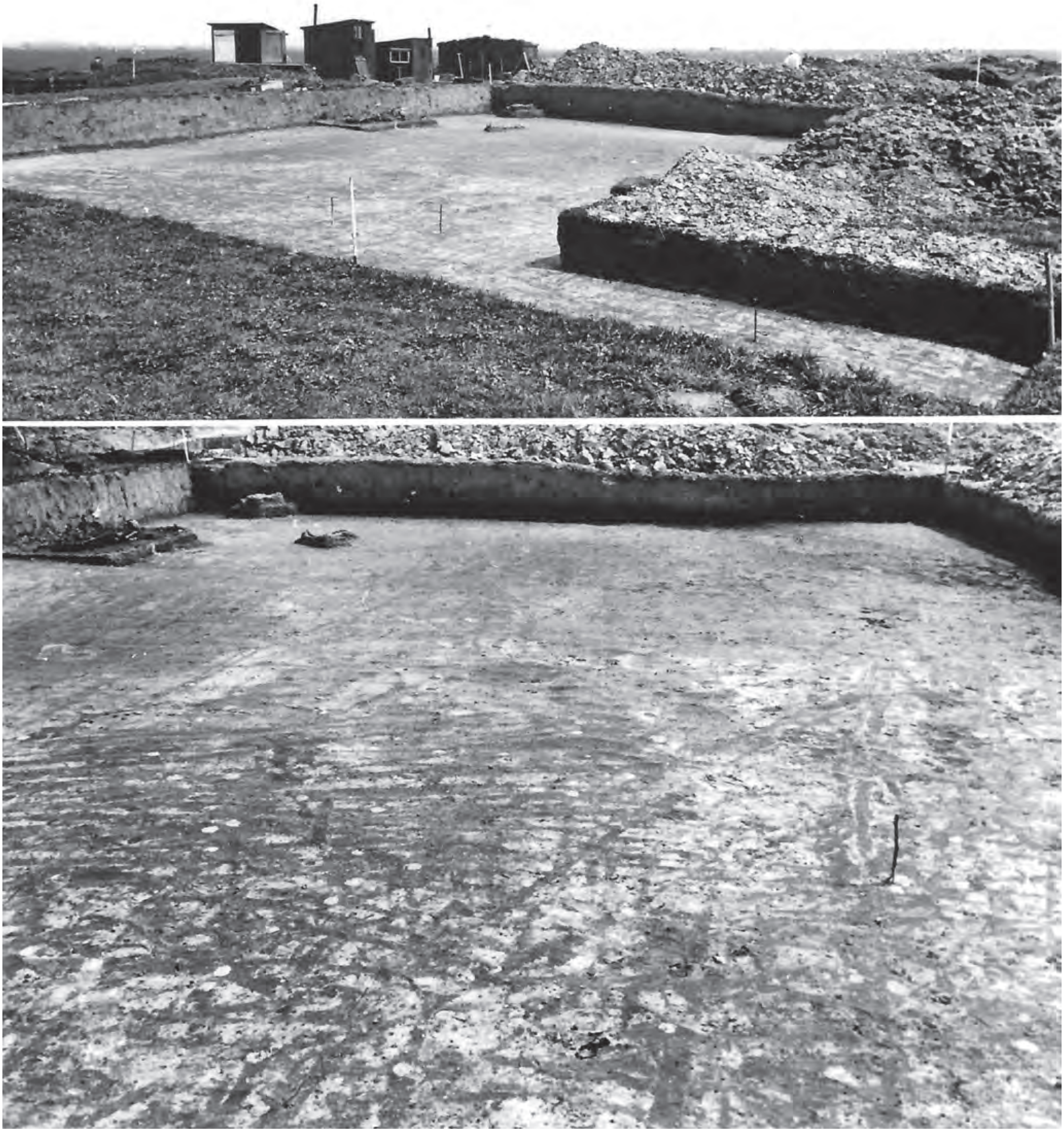


Figure 11 The SW quadrant of tumulus II, seen from the sw (top) and from the w (bottom), with from left to right the pedestals of skeletons 228, 229 and 127. The photographs are taken on 3 May 1956. The lowermost photograph also brings the bundle of plough marks around the burial mound into view (see also fig. 27)

skeletons in a crouched position (skeleton numbers 228, 229), which contrasted with the stretched skeletons in tumulus I. In the next days this trench was enlarged and a third skeleton was found (skeleton number 127; fig. 11). The NE quadrant was also prepared for excavation, this time with a 4 meter wide trench parallel to the east section. Knottnerus states that a 3 meter wide trench was also dug parallel to the south section in the SE quadrant, but this probably is a mistake. On the aerial photograph taken the next day, we can see that this trench was located in the NE quadrant (fig. 12). The plane came from the airfield at Valkenburg and was especially arranged by Van Giffen to take photographs of the excavation.

In the NE quadrant two skeletons were found, one half underneath the section dam (skeleton number 233), one that was placed on a mat or in a basket made of bulrush (skeleton number 232). The latter was lifted as a block later in May and is now in the Provincial Depot at Castricum. They decided not to excavate the NW quadrant since they would not be able to finish it (field diary 14 May).

Several geologists visited the site: C.H. Edelman, L.J. Pons, A.J. Wiggers, S. Jelgersma, but also P.J. Ente from the Soil Survey at Wageningen. Ente was the expert on West-Frisia, but especially on the top 1.20 m that was augured for the soil characteristics. Miss Jelgersma made several augurings around the site, but since their location is only documented vaguely, it is difficult to interpret them. Saturday the 19th of May the excavation was officially finished.

3.2 The 1957 excavation of Van Giffen (27 May – 7 June)

In 1957 the remaining SE and NW quadrants of tumulus were supposed to be excavated. This time Van Giffen compiled a small team with Van Delden as the leading technician and three to six workmen. Van Delden had just been appointed as a field technician on the 20th of May 1957 at the BAI in Groningen, so he was new on the job and probably sent to be trained by Van Giffen. The excavation started on the 27th of May. Van Delden was assisted by three

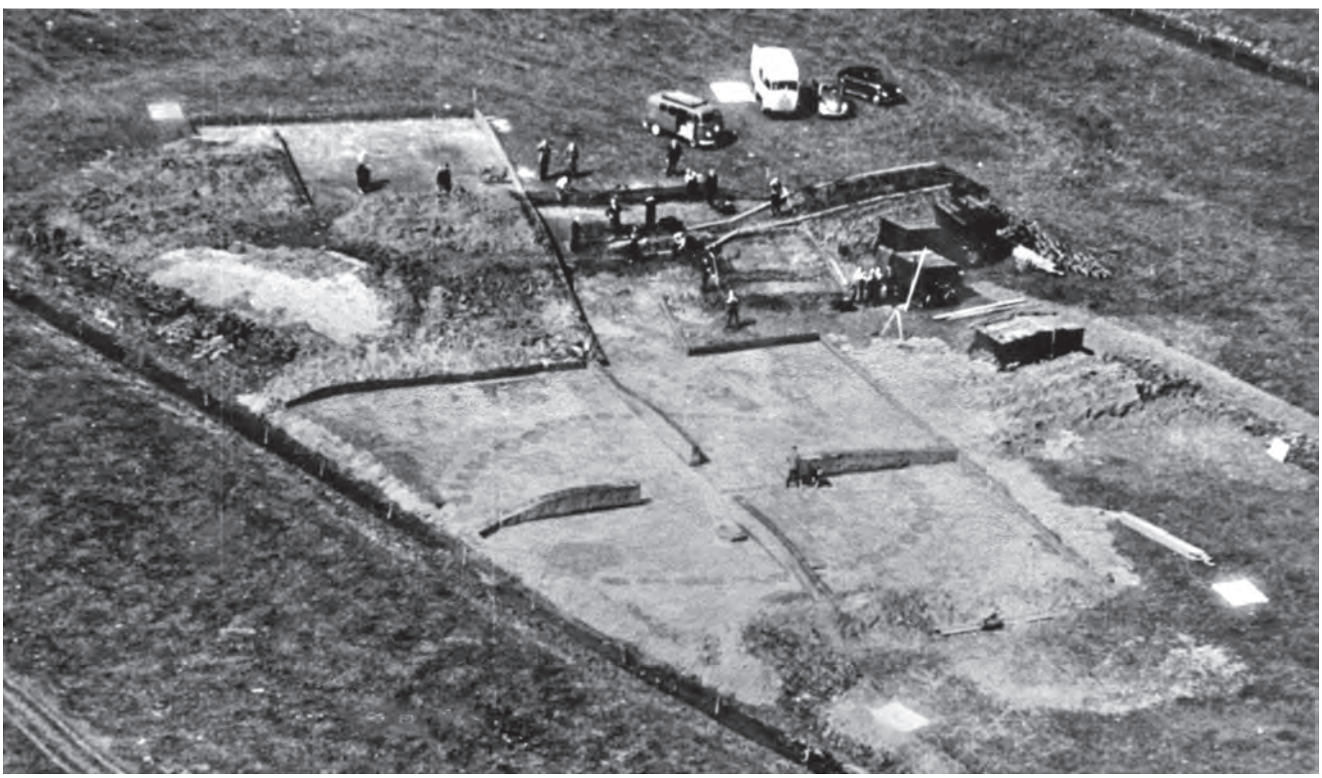


Figure 12 Aerial photograph taken on request of Van Giffen on 3 May 1956 by a plane from Valkenburg airfield. It shows tumulus I completely excavated with the pig skeleton still in place, and the sw quadrant of tumulus II (top left) with skeleton 228. In the NE quadrant of tumulus II trenches have been dug parallel to the section

workmen from the HeideMij in the first week, though six had been promised. Therefore, the work progressed slowly. It was only on Saturday the 1st of June that more workmen arrived with a foreman. In the field diary, Van Giffen mentions a problem with the find numbers. The idea was to continue the numbers from the 1956 excavations. Apparently, they did not know them precisely, so they started with number 200 first, but renumbered that to 220. Later it became clear that the numbers 220-233 already were used in 1956, so these are now double. The confusion that occurred happened because in 1956, the numbers 220-233 had been given to skeletons excavated and taken by prof. De Froe (field diary 31.V.1957).

The team started with trenches alongside the section dams in the already excavated SW and NE quadrants. The NW quadrant was excavated next; on Friday the 31st of May they had already discovered three skeletons (however, the notes give no indication of which and how). Monday the 3rd of June skeleton 235 was removed and skeleton 236 was cleaned (fig. 13). They also cleaned skeleton 239 and left both skeletons uncovered because of the rain. Here the field diary ends for reasons unknown. This has puzzled later researchers as well. The find list, however, contains entries until the 6th of June. On the 4th of June skeleton 236 and 239 were removed, on the 5th of June skeleton 242 and 243, on the 6th of June, finally, skeleton 247. All skeletons were excavated and removed by Mr. Bijlsma of the Antropobiological Laboratory. Number 250 is the last find number According to the find list, the work ended on the 7th of June.

The SE quadrant had been excavated by then and yielded no skeletons. The NW quadrant had not been excavated

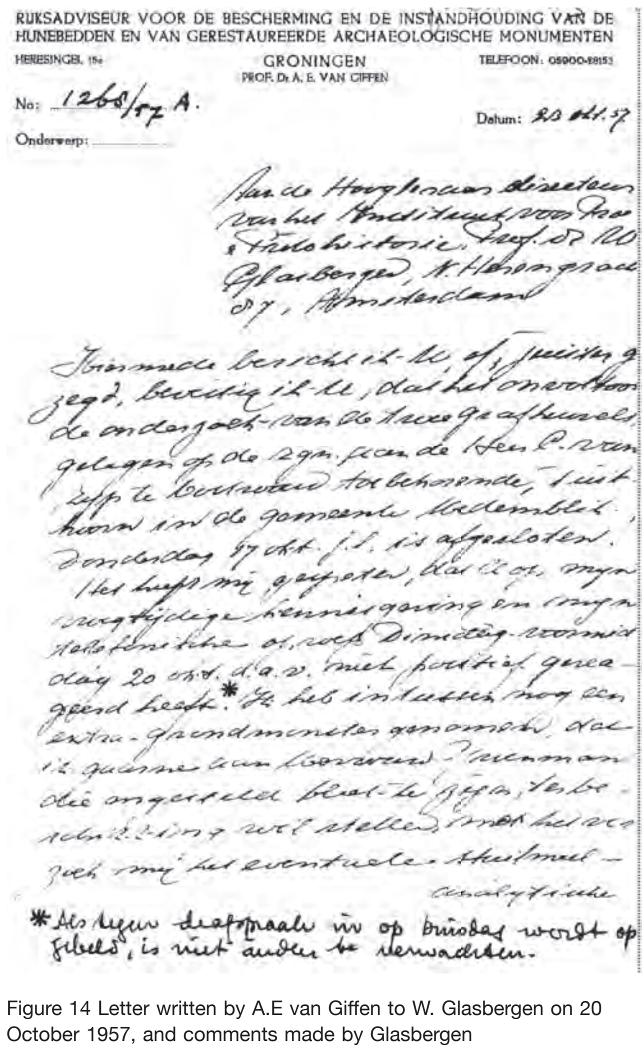
Figure 13 NW quadrant of tumulus II, seen from the NW. It shows Mr. Bijlsma cleaning a bone. On the foreground skeleton 239, Mr. Bijlsma is standing next to 242, behind that 236 has been exposed. Nothing is visible of either 247 of 235. According to the coordinates given, 235 must have been situated just behind Mr. Bijlsma. This photograph was taken on June 4 or 5, while 235 had been removed a day earlier. Since nothing is visible of its removal, this would mean that it was placed higher in the mound than 242 and 236, possibly on the same level as 239

completely. Here, several skeletons had been found, but the documentation is minimal. The field drawings of the NW quadrant were made on the 4th of June, and judging the hand writing they were made by Praamstra. This creates the impression that Van Giffen realised he could not cope with only Van Delden and a few workmen and asked Praamstra to assist. Since skeleton 235 had already been removed on the 3rd of June, while the drawing was made on the 4th of June, this may explain why all burials have been recorded on the drawing as they were present in the field, apart from skeleton 235.

Ultimately, Van Giffen was unable to conclude the excavations as planned. The NW quadrant in particular was not excavated completely. The reason for ending the excavations remains unclear; it is likely that Van Giffen realised that without his trusted team of excavators it would be impossible to achieve proper documentation and excavation. On the 23rd of October 1957 he writes to Glasbergen that the unfinished excavation at Oostwoud was concluded on the 17th of October, probably by backfilling the excavated quadrants (correspondence between Van Giffen and Glasbergen in dossier 137; fig. 14). This indicates a hasty ending in June.

From this account it becomes clear that in 1957 Van Giffen had much less influence on the archaeological community in the Netherlands than in 1956. His team was minimal; there was little or no assistance from his successor at Amsterdam, nor from Amersfoort, only from Groningen. From the letters exchanged between Glasbergen and Van Giffen in 1957 it is apparent that Glasbergen also kept his distance from his dominant and demanding predecessor. In his letter dated the 23rd of October, Van Giffen complains that Glasbergen did not give a positive answer to a request he made on the phone (fig. 14). Glasbergen's comment in the margin of the letter is clearly dismissive: '*als tegen de afspraak in op Dinsdag wordt op gebeld, is niet ander te verwachten*' (if against what has been agreed one is called on the phone on Tuesday, one cannot expect anything else).

This leaves the 1957 account of the excavations very limited indeed. In fact, the find lists contain the majority of information. This is a pity, because the NW quadrant of the excavation yielded several skeletons that ended up being poorly documented. A few sketches remain on the field drawings, accompanied by a few photographs. It is not clear who made the drawings. The situation of trenches and features recorded in the end was as indicated in figure 15a and b. These drawings of the excavations of 1956 and 1957 were published by Van Giffen in 1962.[5] We have reproduced them here, but added colour and accents to make them better readable on the present scale. These drawings are the ink versions of the originals drawn by Praamstra in the field, and they were also prepared for publication by Praamstra in his meticulous and very well readable manner. The published sections of tumulus I are especially important because these were not amongst the original drawings that now are stored in the depot in Castricum. Moreover, it is only in the published plan that Praamstra has indicated the location and position of the skeletons in tumulus I, and of skeleton 243 in tumulus II. This skeleton was found in a crouched position facing north, while most others face south. Only skeleton 235 is not indicated on this plan because it had already been removed when the field drawing was made. Careful consideration of the section drawings demonstrates how different features are related to the plough marks and the skeletons. We will discuss this in sections 4 and 5 below.


RIJKSADVISEUR VOOR DE BESCHERMING EN DE INSTANDHOUDING VAN DE HUNEBEDDEN EN VAN GERESTAUREERDE ARCHAEOLOGISCHE MONUMENTEN

HEERESINGEL 15a GRONINGEN TELEFOON: 05900-28153

PROF. Dr. A. E. VAN GIFFEN

No: 1268/57 A.

Datum: 23 okt. 57

Onderwerp:

Aan de Hoogleraar directeur van het Instituut voor Pre- & Protohistorie, Prof. Dr. W. Glasbergen, N. Herengracht 87, Amsterdam

Hiermede bericht ik U, of, juister gezegd, bevestig ik U, dat het onvoltooide onderzoek van de twee grafheuvels, [illegible] Oostwoud toebehorende, [illegible] in de gemeente Medemblik, Donderdag 17 okt. j.l. is afgesloten. Het heeft mij gespeten, dat U op mijn [illegible] telefonische [illegible] Dinsdag [illegible] dag 20 okt. d.a.v. niet positief gereageerd heeft.* Ik heb intussen nog een extra-grondmonster genomen, dat ik gaarne aan [illegible] ter be[illegible] wil stellen [illegible] eventuele [illegible] analytische

*Als tegen de afspraak in op Dinsdag wordt op gebeld, is niet ander te verwachten.

Figure 14 Letter written by A.E van Giffen to W. Glasbergen on 20 October 1957, and comments made by Glasbergen

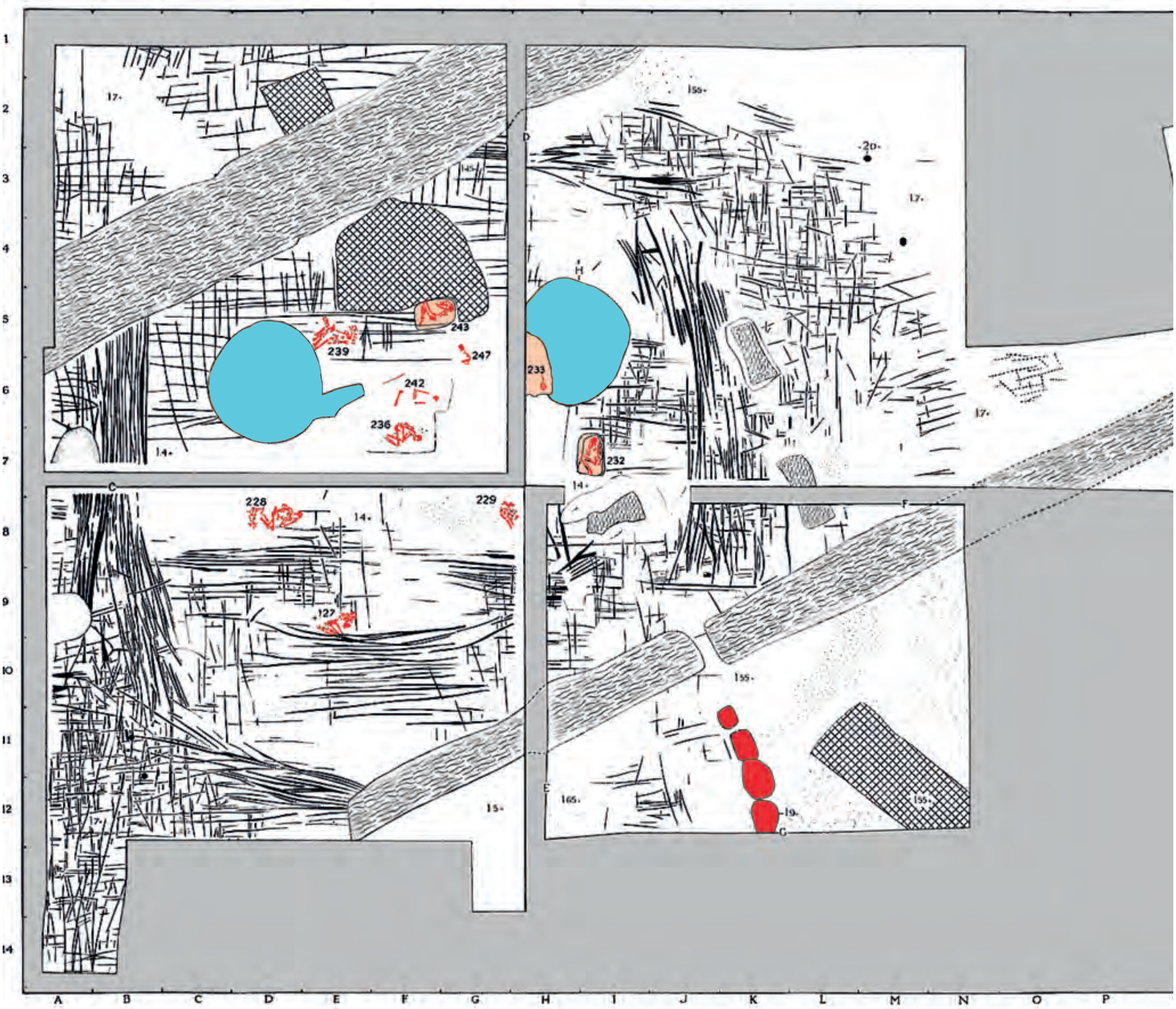
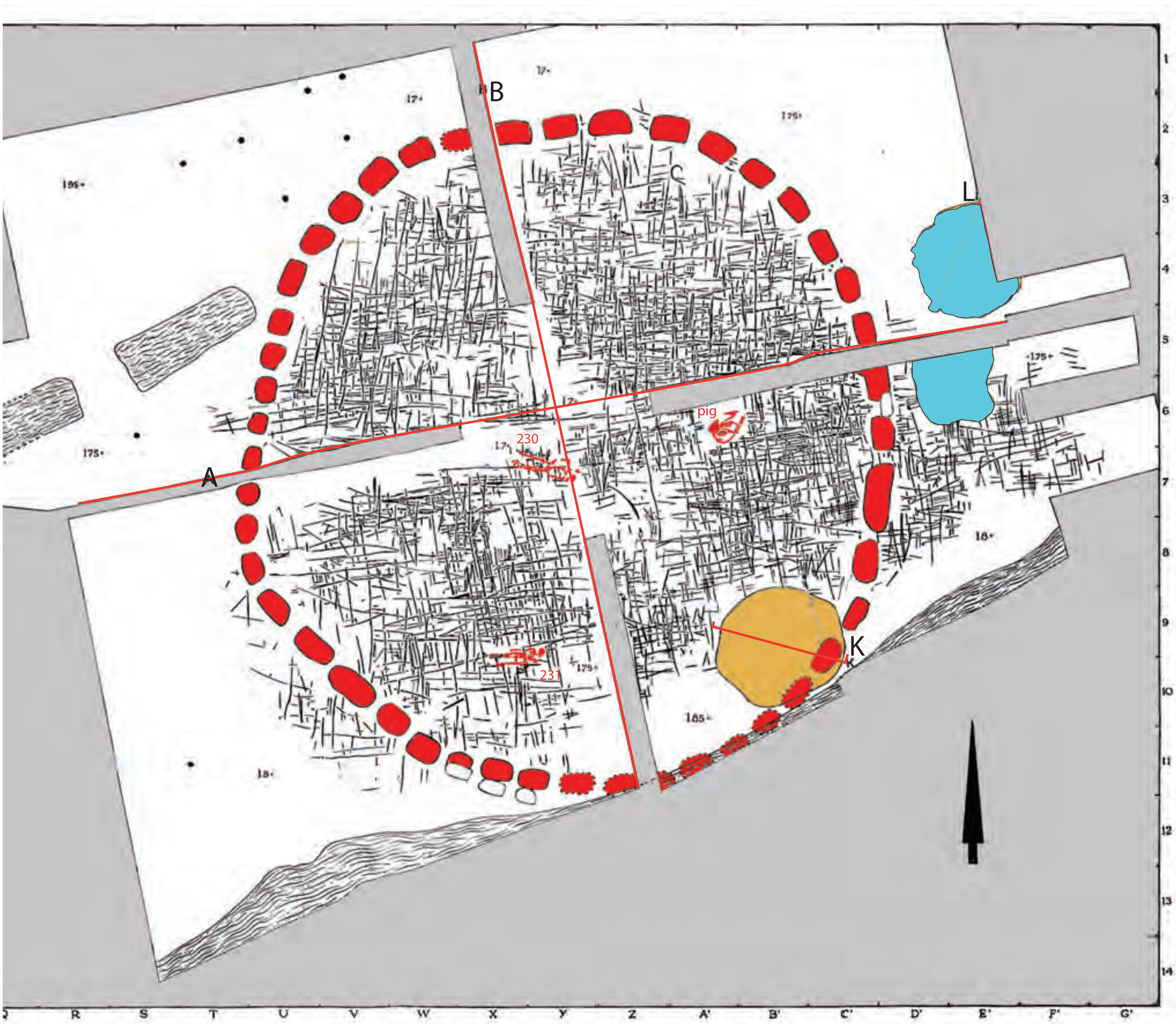


Figure 15 Tumulus II (left) and Figure 15b tumulus I (right) as published after the 1957 campaign (compiled and amended after Van Giffen 1962). Blue: Medieval features; orange: Late Neolithic features; red: Late Neolithic or Early Bronze Age features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3.3 The 1963 excavations by De Weerd (29 May – 19 September)

After 1957 no efforts were made to conclude the work in the NW quadrant, which had evidently not been excavated completely. In 1961 Van Giffen was honoured with a *liber amicorum* of the staff of the IPP (*In het Voetspoor van Van Giffen:* Glasbergen *et al*. 1961) in which he published the preliminary results. (Van Giffen 1961b). This may have contributed to the emphasis of the potential of the barrow, both for the skeletal remains as for the arable land underneath the barrows. An opportunity arose when Glasbergen was able to obtain a 7000 guilder grant from the Pieter Langerhuizen Lamberteszoon fund for anthropological research. The proposal was for 'The ecology of the bearers of the earliest phase of the Bell Beaker Culture in Europe', and aimed at another excavation at Oostwoud to recover more skeletons for antropobiological research (report De Weerd 1963). At the time, the general idea was still that the Bell Beaker people were immigrants with typical brachycranic skulls. Van Giffen and Glasbergen were therefore interested especially in skull measurements in order to find out whether the people from Oostwoud were indeed Bell Beaker immigrants. In his well-known 'Voorgeschiedenis der Lage Landen', for instance, he assigns the Oostwoud burials to a 'colony' of immigrants (De Laet and Glasbergen 1959, 95).

Glasbergen assigned the work to his assistant, the doctoral student Maarten de Weerd, who started May 29th with the experienced technician H.N. Donker of the IPP as his second, a student and one workman. This was approximately the entire team. Yet another student (Ph. J. Woltering) occasionally came to help, and sometimes Gijbels, the photographer and P.S.A. Kikkert, the technical assistant who also had been present in the first weeks of the 1956 excavation, also provided assistance. However, De Weerd was also often alone with the workman (G. P. Nes). In the period between 14 June and 19 September he carried out all of the work together with Nes, sometimes assisted by Donker from Amsterdam. De Weerd stayed in a small hotel in Oostwoud and wrote excellent, sometimes very detailed field diaries, especially about the different levels and dating of the plough marks ('I had nothing else to do' he commented December 2016).[6] The plough marks and the extension of the arable land were certainly also part of his mission. He excavated a number of small trenches outside the southern part of the NW quadrant in order to investigate the plough marks as well as the settlement traces (fig. 16). He was convinced they had discovered the posts of a Bell Beaker house (field diary De Weerd).

In August, he realised they were not going to be able to finish everything. New skeletons were found, or at least a pit with human bones (533), and later also skeleton 575. Skeleton 575 was in fact one of the best preserved skeletons of the site and is well documented. On September 17 Glasbergen came to visit, accompanied by an English colleague, Van Giffen and his wife, and S. Jelgersma (fig. 17). They discussed the situation and Van Giffen asked if the skeleton could be lifted *en bloc*. They decided that the burial was older than the plough land because it had not been visible before; the plough land was documented at a higher level than the grave pit (field diary 17 September 1963). Friday the 20th of September, they lifted the skeleton in a wooden case and transported it to the West-Fries Museum at Hoorn. It is now on display in the Provincial depot under the name 'Jan van Oostwoud', initially as a personal loan from Glasbergen. The skull was removed separately and reconstructed by Kikkert in the IPP at Amsterdam. The reason for this was that they wanted to be able to measure

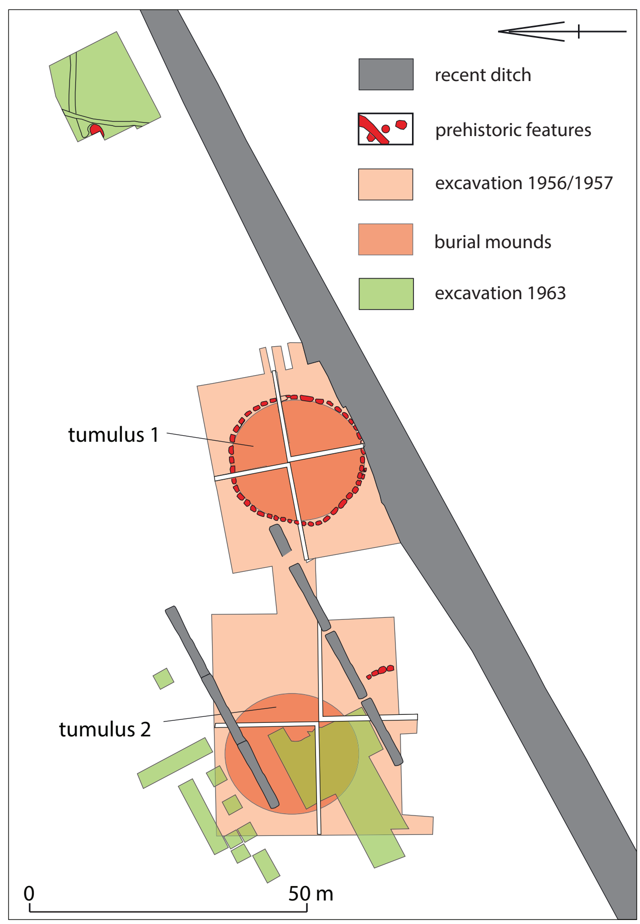


Figure 16 The excavation trenches of De Weerd in relation to the earlier trenches excavated by Van Giffen (compiled and amended after Van Heeringen and Theunissen 2005, 306)

the skull in detail since that was one of the goals of the grant they had obtained to excavate the site.

It was decided that they would continue the excavations in 1964, as the weather deteriorated and pouring rains sometimes made work impossible. However, because the owner of the land could not allow it earlier, De Weerd returned to the site two years later than planned, in 1966, just before the owner levelled the two barrows.

3.4 The 1966 excavation by De Weerd (18-20 October)

The original owner, Mr. Zijp, had always agreed to maintain the two restored barrows, but due to illness he had to sell the parcel. The agreement resting on his land was forgotten and the new owner wanted to level the two barrows. The remains could only be inspected just before the levelling (De Weerd 1967, *31). Only a small part (the centre) of the section

Figure 17 On 17 September 1963 a number of visitors discussed skeleton 575 and the excavation results so far on site. A: M.D. de Weerd, Brailsford jr. J.W. Brailsford, Tertia Veronica Glasbergen, W. Glasbergen, A.E. van Giffen, mw. S. Jelgersma (behind J.A. Bakker); B: M. de Weerd, W. Glasbergen, Brailsford jr., J.W. Brailsford, A.E. van Giffen; C: Glasbergen drawing and De Weerd measuring skeleton 575, resulting – see below – in figure 48; D: G.P. Nes and a young visitor (son of the mayor of Midwoud)

dams had remained intact over the years. De Weerd was able to study just that and discovered one last skeleton, or a large part of it.

De Weerd expected to find a skeleton because in 1963 he had recovered two fragments of a skull that could have belonged to a primary burial in the centre of the barrow (De Weerd 1967, *31). Cultivation of the land between 1963 and 1966 had already removed the top part of the section, so only the last remains were preserved (fig. 18). De Weerd found, in his own words 'an incomplete skeleton, not buried in articulation …..; skull, lower jaw, the majority of ribs and vertebrae, legs, feet, arms, hands were missing. A shoulder bone was broken already in the past.' (translation by the authors; De Weerd 1967, *31). He concluded that this was a skeleton that accidently had been dug up when a new individual was buried, for instance skeleton 229 which was situated nearby (De Weerd 1967, *32). We will discuss this option later.

3.5 The excavation by Van der Waals (24-27 May 1977 / March 1978)

In 1977 re-allotment program '*de Vier Noorder Koggen*' was going to affect the Tuithoorn parcel on which the former barrows had been situated. Since De Weerd had reported settlement remains of the Bell Beaker culture (post pits,

Figure 18 The excavation 'trench' of 1966 with the skeleton in the crossing of the section dams, seen from the north

possible houses) a final research campaign on the site was deemed necessary. The ROB and the IPP asked J.D. van der Waals to carry out that work, starting in 1977 with a survey with trenches in order to determine whether further research would be necessary. A final excavation would have to be finished before the end of July 1978, when the re-allotment work would start with deep ploughing the field (diary J.D. van der Waals Oostwoud 1977).

Van der Waals had excavated in West-Frisia before as an assistant of Van Giffen at Amsterdam (Tumulus 'de Ark' at Wervershoof), but was appointed in Groningen and also as extra-ordinary professor at Utrecht University in 1968. There he taught prehistory to History and Physical Geography students. Van der Waals asked the Utrecht Physical Geography students Pieteke Banga and Peter van Dijk to assist him. Both had previously written a doctoral study on the paleogeography of the Kolhorn area, therefore, they were familiar with the genesis and lithology of the deposits at Oostwoud.

On the 24th of May, they met in the field and decided that trenches would have to be dug in September, after the potatoes that were grown on the land were harvested. The field diary ends with a handwritten note by Van der Waals, documenting that they planned to excavate the trenches on September 26. These trenches were indeed dug, but the weather prevented good documentation. Therefore, the trenches were partly covered with plastic to be documented after the winter season.

That documentation was the aim of a campaign in March 1978 (14-17th of March). Van der Waals brought together a few Groningen students (Annelou van Gijn, Harry Fokkens, Bernard Wubbels, Menno Sijpkens Smit, Vincent van Vilsteren) and Pieteke Banga and Peter van Dijk to clean out and document the 1977 trenches.[7] It was extremely cold and wet, the first day a force 9 gale made working virtually impossible. The trenches A, B and C dug in 1977 (cf. fig. 20) were cleaned and a little enlarged (2 x 12 m), resulting in a good view of the plough marks which were also present in the extreme west part of the area excavated since the 1950's (fig. 19).[8]

The conclusion of this investigation was that further research was necessary in the summer period before the re-allotment would start.

3.6 The excavation by Lanting (29 May – 19 July 1978)

The 1978 summer campaign was carried out by J.N. Lanting. It was summarily published with a focus on the dates of the skeletons in 2002 (Lanting and Van der Plicht 2002, 86-89) and there is a detailed field diary by Lanting. The team consisted of Lanting, Meijer, Zwier, and students H. Fokkens and A. van Gijn (29 May - 19 June). P. Banga and P. van

Dijk were also the team to continue their work on the geology. Lanting tried to get workmen from the social service to assist in the digging. Basically, the same system as in 1956 was still intact in the nineteen seventies. However, no free workmen were available. In his field diary Lanting explains that these 'extremely cheap workmen (only 60 guilders per person a week overhead!) seem to work predominantly in the greenhouse industry; a remarkable form of public subsidy for the greenhouse industry.'

The entire area of the two barrows was uncovered and the trenches of previous excavators were drawn in when they were visible as disturbances (fig. 20). Van Giffen's section dams were visible as straight deep cuts filled with dark soil. Those were the remnants of one spit deep lines in front of the sections that were dug when the sections were drawn to get the natural soil in view. One of the new discoveries in the area of tumulus II was that De Weerd had overlooked an 8 meter wide ditch that surrounded his burial 575 (fig. 21). He had recognised the southern part, but not as a ditch around the burial. His trenches were just not wide enough. Van Giffen had not recognised it either because in 1957 the NW quadrant was not yet excavated deep enough. Both burial 575 and the ditch were overlain by the Neolithic plough marks. Since skeleton 575 is well dated between 2580 and 2234 cal BC (cf. table 1), the first plough marks are younger than that.

Plough marks were encountered everywhere, but recorded only by means of photography. The western end of the

Figure 19 Impression of the March 1978 campaign. Top left: J.D. van der Waals (left) and B. Wubbels (right) in the van of M. Sijpkens Smit we used as shed. Top right: V. van Vilstern (left) and P. Banga (right) standing on the west end of trench A. Below: plough marks visible in the extension of trench A (photos by the first author)

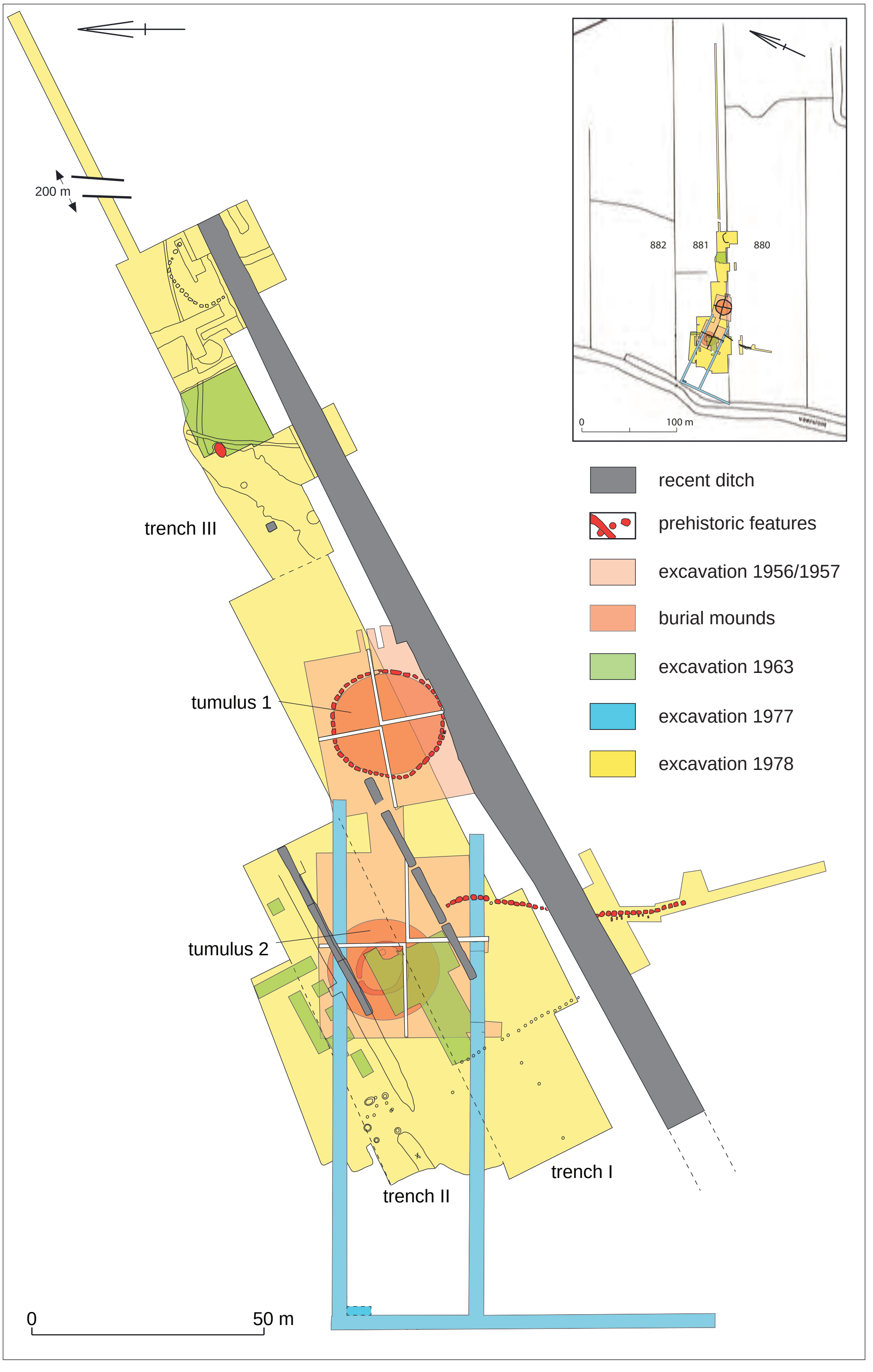


Figure 20 Plan of the different excavation phases and a selection of prehistoric features (modified and updated after Van Heeringen & Theunissen 2005, 306)

	gender	age	state	completeness	length	labcode	^{14}C	+/-	$\delta^{13}C$	$\delta^{15}C$	cal BC	2 σ	dated matter
Tumulus I													
Skeleton 230	male	26-49	reasonable	50-75%		GrA-17225	3440	40			1881-1658 1648-1646	0.997 0.003	collagen
Skeleton 231	male	36-49	reasonable	50-75%		GrA-17226	3450	40			1883-1665	1.000	collagen
Tumlus II													
Skeleton 127	n.a.	13-18	reasonable	50-75%		GrA-15602	3500	50	-20.89	14.40	1945-1692	1.000	collagen
Skeleton 228	male	26-35	good	50-75%	169.9								
Skeleton 229	male	26-35		25-49%		GrA-6477	3640	50			2188-2183 2141-1887	0.005 0.995	collagen
Skeleton 230 *extra*	male		good	(gender based on DNA evidence)									
Skeleton 232				50-75%		GrN-8801	3530	25			1934-1771	1.000	collagen
Skeleton 233	male		good	<25%									
Skeleton 235	male	26-35	very good	50-75%	161.4								
Skeleton 236	male	36-49	good	50-75%		GrA-15598	3660	50	-20.01	13.10	2196-2170 2146-1903	0.036 0.964	collagen
Skeleton 239			reasonable	50-75%	181.4	GrA-15601	3520	60	-20.09	14.70	2018-1994 1981-1692	0.026 0.974	collagen
Skeleton 242 / 533	male	26-35	good	25-49%	179.2	GrA-15597	3690	60	-20.16	14.00	2278-2251 2211-1914	0.026 0.969	collagen
Skeleton 243	female	36-49	reasonable	>75%	163								collagen
Skeleton 247	female	26-35	good	25-49%	167.3								collagen
Skeleton 575 "Jan"	male	26-35	very good	>75%	176.1	GrN-6650C	3945	55			2579-2284 2247-2234	0.992 0.008	collagen
Pit underneath plough soil t.p.q. mound 2						GrN-25316	3805	25			2336-2323 2308-2193 2178-2143	0.020 0.874 0.105	charcoal
Charcoal from plough soil underneath mound 1						GrN-797	3025	80			1395-1192 1439-1027	0.926* 1.000	charcoal

Table 1 Survey of skeletal and ^{14}C data from Oostwoud-Tuithoorn. Skeletal analysis according to Veselka; ^{14}C data from Van Heeringen and Theunissen 2001, and Van der Plicht 2002

trench was documented with vertical photography (Hasselblad). After 40 years, however, the colour quality of the prints of these photographs is not good enough to reproduce. The negatives probably still reside in Groningen.

The discussions about geology were manifold, but nevertheless inconclusive. It is clear that a pathway that De Weerd thought might have been a small path (field diary De Weerd 1963), was in fact a residual gully filled with very heavy clay.

4 The arable land and settlement remains

One of the aspects that made the barrow excavations at Oostwoud-Tuithoorn interesting was the discovery of plough marks and a plough soil that, based on the pottery and flint found in it, dated to the Late Neolithic Bell Beaker culture. This arable land, its meaning, the several phases in it, and its relation to the barrows or a possible settlement, has been the focus of all excavations at Oostwoud. Especially in 1963 and in 1978, the arable land was leading in the excavation strategy but the plough marks were a special research object in 1956 and 1957 as well. This had several reasons. The discovery of Late Neolithic or Bronze Age arable land was a rare find and therefore interesting in and of itself. In 1956, but even in later years, sites with Neolithic plough marks, let alone with a preserved prehistoric plough soil were scarce. The plough marks provided information on various aspects of prehistoric life. Firstly, the excavations at Oostwoud could provide insight into the extension of the arable land and the size of Neolithic plots. Secondly, the plough marks could be used as relative dates for features underneath the burial mounds. Lastly, the ceramics, bone, and flint fragments in the prehistoric plough soil gave insight into waste behaviour, and material culture of the prehistoric inhabitants.

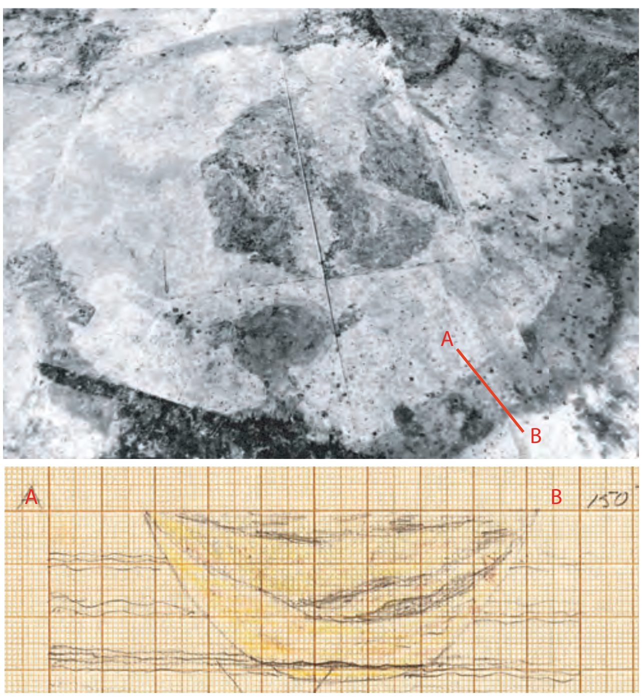


Figure 21 The ditch around burial 575 as was discovered in 1978. The disturbance in the centre is the pit dug to extract skeleton 575 in 1963. Below that a round feature is a pit with charcoal layers dated between c. 2300 and 2200 cal BC. The straight line with dark fill cutting the ditch on the underside of the photograph is the remains of the mid-north section dam of Van Giffen (photo H. Fokkens). Below: detail of the section drawing by J.H. Zwier (BAI) of the ditch, location of the section indicated with A-B

4.1 Extent and phasing of the arable land

The various excavators have explicitly explored the extension of the arable land. The question of whether different plots were visible was also a specific issue in the 1978 excavations. Trench III, which is the 40 meter long extension east of the barrows, was aimed at finding out the size of the arable land and whether parcel ditches could be found (field diary Lanting 16 June). Indeed, the plough marks continued, 'locally even in two levels, one of marks filled with black soil in a brown plough soil, and below marks filled with brown soil in the yellow subsoil'. This is in accordance with what De Weerd also had documented (fig. 22). There was also a ditch-like north-south oriented feature in this area that was first considered to have been a plot division (visible in figure 20 on the eastern side of the trenches). Lanting made a small trench south of the recent ditch to study its trajectory, but found that it ended. On the 21st of June, Lanting describes how they discovered that the vague feature traversing this end of the trench (trench III) was in fact a residual gully filled in, and that the 'ditch' is probably a natural feature associated with it. In any case, Lanting writes 'Now this "residual gully" has been found, it is not remarkable that to the west of the "parcel ditch" no plough marks occur' (field diary Lanting 21 June 1978).[9] After a discussion with J.A. Bakker on the phone, he decided to extend trench III 200 m further to the east 'without looking for plough marks' in order to look for parcelling ditches (fig. 20). 'This yields, to our relief, nothing' he remarks (field diary 27th of June), probably because finding parcelling ditches would have meant that further research might have been necessary, which time and money did not allow.

When all data is combined, the different observations show that the arable land stretched over a distance of at least 500 meters in east-west direction and about 70 meters in north-south direction. Parcelling ditches were not found. The

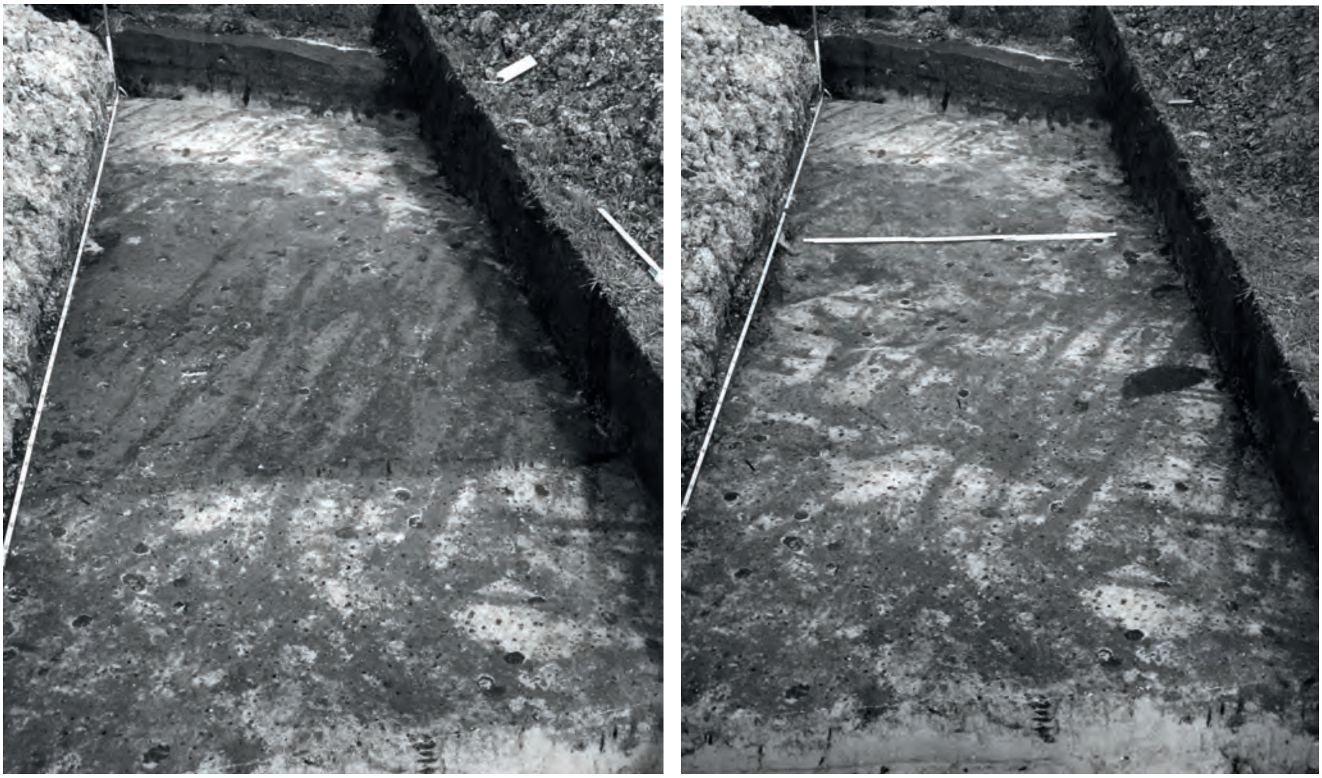


Figure 22 Two levels of plough marks in the same trench photographed by De Weerd in 1963

orientation was more or less the same in the entire excavated area. This implies that we are dealing with a large plot of arable land. This does not necessarily mean that the entire area was in use at the same time, but it is clear that both in the east and in the centre of the excavated area, which are over 300 meters apart, there were two layers of plough marks visible in a very similar fashion (fig. 22). The two levels were not far above each other. The easiest way to describe the situation is that there was a dark stained 'Bell Beaker' plough soil as it was called by the subsequent researchers. In the section drawings made by Praamstra it is clearly marked, including the plough marks 'hanging' under it (fig. 24). These were visible as dark lines in the yellow subsoil (fig. 23 left).

The top layer of plough marks was not visible everywhere, but where it was present; it was manifested as relatively wide marks filled with dark soil against the dark background of the older plough soil. Underneath tumulus II the two layers became particularly visible because the younger, wider marks were curved and indicated the outlines of the actual barrow (cf. fig. 15a). Underneath tumulus I, they were wider and sometimes curved (field diary Van Giffen).

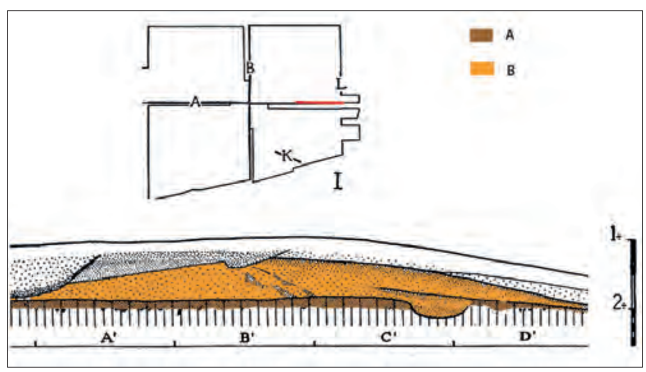


Figure 23 Detail of the ink drawing made by Praamstra of the eastern part of the w-e section through tumulus I. A: burial mound; B: plough soil with in black plough marks hanging underneath. Plough marks are visible also outside the mound on the right side. The limits of the mound are marked by the pit between C and D that cuts through the ancient plough soil (modified after Van Giffen 1962)

4.2 Time depth of the arable land

The plough marks underneath tumulus II gave rise to a discussion about dating. Van Giffen consistently talked about Bronze Age arable land, but others also about Bell Beaker arable land. One of the factors contributing to a solution was provided by the discovery of burial 575 in 1963. It is clear that this burial was not yet visible on Van Giffen's plan (fig. 15a, see also fig. 13). The plough marks continue over that grave, so it must be older. The grave itself dates between 2580 and 2234 cal BC (at 95.4% probability), therefore this burial provides a *terminus post quem* for the arable land. Lanting adds to this that the ditch around grave 575 was (unknowingly) drawn by Praamstra in section C and D of tumulus II, in which the arable is seen to continue over the ditch undisturbed (Lanting and Van der Plicht 2002, 87; fig. 24). In addition a 1 m wide pit was discovered east of the burial that had not been noted by Van Giffen and apparently was covered with plough marks as well. De Weerd has documented it, but left it unexcavated. It was most probably dated to the period between 2337 and 2143 cal BC (Lanting and Van der Plicht 2002, 87; Table 1). Combining both dates as a *terminus post quem* for the arable layer indicates that the arable layer must date to or after the period between 2284 and 1994 cal. BC (at 95.4% probability).

When the area was ploughed, the 'coffin' must have been completely covered by and filled in with soil. Even though burial 575 appears to have been a 'flat grave' the place may have been marked or otherwise remembered. This is demonstrated by the fact that other burials were placed in the close vicinity after the area had been ploughed, but possibly also before. The reason we suggest this is skeleton 242/533 – which now has been proven to constitute one skeleton – was torn apart in Prehistory and partly re-buried when it had not yet been decomposed. We suggest this was the result of ploughing over this grave one or two generations later, when the exact location was forgotten. This would imply it was a flat grave too, inserted before a barrow was built over the area. De Weerd, however, has noted that some of the bones of skeleton 533 were lying on and in the plough soil, so ploughing already had occurred when the grave was dug (field diary De Weerd 31 July 1963).[10] We will discuss this in more detail in section 5.

Most of the other skeletons were found on a higher level than the arable land, of which the top had an elevation of 140-145 cm below Dutch datum (NAP). Most burials lay higher according to the field diary. Skeleton 235, 239, and 242 were found at an elevation between 138 and 133 cm below Dutch Datum or in a pit cutting through the plough marks (243). We have projected the known elevations in the section drawing of tumulus I and 2 which demonstrates this (fig. 25), in addition the images of the SW quadrant show that the skeletons were situated above the level in which the skeletons became visible (fig. 11 and fig 13, fig 26). In 1957, only a few blurry photographs were taken of insufficiently prepared surfaces, so of those skeletons we know little more than what the find list in the field diary indicates.

How often the arable was ploughed is not clear from the drawings. This is a matter of discussion anyway. What can be observed may be the result of occasional (deep) ploughing, rather than the yearly sequence. The latter then must have entered the plough soil less deep. Especially in the case of tumulus II, a second and a third set of plough marks is visible (fig. 15a; fig. 39). These are the bundles of curved marks that seem to demarcate a circular area within which all skeletons are located (fig. 27; fig. 39). This has led to the idea that at some point a (low) burial mound was erected over the burial area that was subsequently avoided during

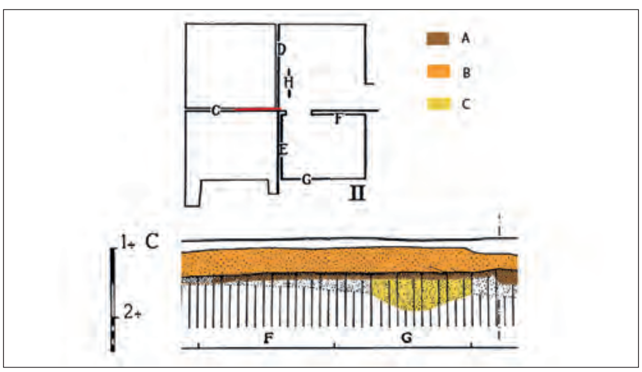


Figure 24 Detail of the ink drawing made by Praamstra of the western part of the w-e section through tumulus II. A: burial mound; B: plough soil with in black plough marks hanging underneath; C: probable ditch around burial 575 (modified after Van Giffen 1962)

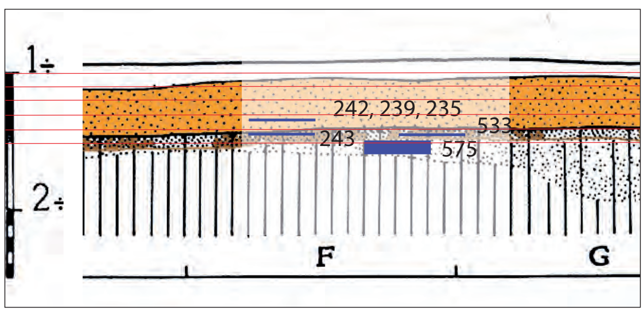


Figure 25 Known elevations on which the skeletons were found plotted on the section drawing of Praamstra

Figure 26 The SW quadrant of tumulus II, photographed from the west, showing on the foreground skeleton 228, against the section 229, and to the right 127

ploughing (*e.g.* Lanting and Van der Plicht 2002, 87). We subscribe to that idea and suggest that bundles of plough marks like the ones visible in figure 27 are the result of one plough event parallel to the mound. Cross ploughing would be difficult as that would infer that the team of draught animals would have to draw 'up-hill' when ploughing towards the mound. The result is indeed bent bundles of plough marks on either side of it, rather than sets of plough marks around the mound. The mound itself should projected at *c.* 2 meter distance of the last mark, as the team of draught animals would otherwise have had to walk on the mound, while the other was still on level terrain. That is not impossible, but less plausible (cf. fig. 39).

Lanting thinks that a third set of plough marks demonstrated that the mound was enlarged to the south by *c.* 4 meters (m (fig. 15a; fig. 39). Since all burials date to the end of the Late Neolithic or the Early Bronze Age (table 1), the extension of the barrow should, logically, also have occurred also in that period. Moreover, the same kinds of plough marks, in two different phases, are present underneath tumulus I according to Van Giffen (field diary). As the burials in that barrow date to the Early Bronze Age, the second phase of arable land must antedate those burials. In addition, the pits surrounding tumulus I clearly cut through the plough land. Our conclusion therefore is that the second phase of plough land must date to the very end of the Late Neolithic or to the Early Bronze Age as well, somewhere between 2200 and 1900 cal BC. This contradicts a date of the plough soil sampled by Van Giffen, which yielded a date between 1439 and 1027 cal BC. This is far too young. The pit from which this sample was taken must have been dug in the Middle or Late Bronze Age, but we conclude that it does not date the arable land proper (cf. table 1).

4.3 Settlement evidence

The argument for an early date of the plough land is completely in accordance with the finds from the arable: many very small potsherds, all with a clear Bell Beaker signature typology, some with Early Bronze Age decoration techniques, but still with Bell Beaker decorative motives. Middle Bronze Age pottery was not recognised. The Early Bronze Age decorative motives include barbed wire stamp

Figure 27 Detail of a bundle of plough marks in the sw part of the sw quadrant (see also fig. 13)

impressions and circular impressions made with a hollow stamp (bird bone or reed), characteristic for the Early Bronze Age. Van Giffen's selection of material also shows the presence of potbeaker material (fig. 28a and b). The complex is what one would expect on a Bell Beaker or Early Bronze Age settlement site. Comparable settlement complexes were present at for instance Schokland-P14 (Ten Anscher 2012), Molenaarsgraaf (Louwe Kooijmans 1974), Barendrecht-Carnisselande (Moree *et al.* 2011), Houten-Vleugel 20, and Oldeboorn (Fokkens *et al.* 2016). Flint artefacts have been found as well, such as button shaped scrapers (fig. 28a). The material, especially the flint, should be studied in more detail, but so far it has not been possible to study all finds discovered in the various campaigns in coherence. The pottery is indicative for an early dating of the prehistoric plough soil in which it was found for a date between 2000 and 1900 cal BC (Fokkens *et al.* 2016, 286 ff.).

None of the excavators discusses why these potsherds were present in the arable land. Generally, it is assumed that these represent household waste that was brought over the arable to fertilise it, possibly mixed with manure. Recently research has started to actually study this assumption (Bakels in prep.).

Apart from sherds in the plough soil, a few large pits have been documented. One of those has already been discussed: it was located next to burial 575 and was probably not much younger. Lanting has excavated this feature and states it to contain layers of charcoal (Lanting and Van der Plicht 2002, 87; cf. fig. 21). Whether or not this feature is a normal settlement pit is hard to determine. We know more of such charcoal filled pits in Late Neolithic and Early Bronze Age settlement context, but in general these are larger. On the other hand, at Schokland-P14 a small cemetery from the same period also contains two of such pits, similar in size and dating to the exact same period (Ten Anscher 2012; Fokkens *et al*. 2016, 107). There we suspect that these pits are related somehow to the burial ritual or to the ancestor rituals that may have been carried out after the burial. The large feature in the n-e quadrant is a younger pit (cf. fig. 15a). Praamstra states that it was filled with 'knikklei', which at the time was the name for heavy clay that was thought to be of medieval or later date.

The pits visible near and underneath tumulus I (cf. fig. 15b) are not all of the same age. The pit underneath the barrow is clearly cut by the pits surrounding the barrow, but it is dug into the arable layer (fig. 29). Therefore it must be younger than the pit near burial 575, but it is still an Early Bronze Age or Late Neolithic pit.[11] The two pits outside the barrow are of a much later date. Van Giffen discussed them in his field diary in the context of Medieval Pingsdorf pottery. Initially he thought they may have been the remains of sunken huts, but later he states they were just pits (field diary Van Giffen 8th of May 1956).

De Weerd discussed a Bell Beaker house, Bell Beaker post pits and a possible path (with a layered fill) in his field diary. However, these claims have never been substantiated. Lanting did not refer to the posts of De Weerd either. The drawings that De Weerd made of these features do not support such a claim. The 'path with layered fill' that De Weerd (field diary 20th of June 1963) documented, almost certainly was a small residual gully; Lanting explicitly stated in his diary (field diary Lanting 14th of June 1978). The conclusion is that a settlement must have been in the neighbourhood, which is attested by many potsherds and flint in the arable land. What the function of the pits that were dug near grave 575 and the one present underneath tumulus I was, is impossible to determine. The row of pits that was found south of tumulus II, is discussed in relation to that barrow.

5 The burial mounds

When the excavations started, two mounds were recorded, both of about 20 meters in diameter. Section dams were positioned over their centres and they were excavated in quadrants. The plans and sections show that for tumulus I the construction type was unmistakeable: the barrow was built of sods and surrounded by a circle of 'post' pits or 'pseudo post pits' as Van Giffen started to call them because post shadows were invisible (fig. 29, 30, 31).

For tumulus II the situation is different. In the sections a barrow is difficult to indicate, even if the area is clearly elevated. We must assume that over the ages the top has been eroded and as a result, the mound 'moved' to the southeast. This can be deducted from the position of the sections that Van Giffen has projected on tumulus II. The place where the sections meet must have been in the centre of the mound that was visible in 1956, but this actually is completely off centre in relation to burial 575 and to the mound indicated by the plough marks. On 2 May 1956 Van Giffen writes 'until now no barrow limits, other than in the bending of the plough marks.'[12]

5.1 Tumulus I

Tumulus I appears to have been surrounded by a pit circle of 20 meters in diameter (figs. 15b; 34). The pits were substantial (50 × 50 cm) and preserved 15 – 30 cm deep. At a slightly higher level of the excavation, individual pits connected in a circular ditch (fig. 31). Praamstra describes them as having a laminated fill near the bottom. He thinks they were left open for a while. Van Giffen says that the posts had probably been extracted, after which the pits were filled in (cf. Van Giffen 1962, 199). The fact that the fill of these pits had the same homogenous consistency and colour indicates this was not the result of a long natural process. Rather, we assume they were all filled in by hand after extraction of posts, if indeed there were any; the west Frisian Bronze Age is known for many pit circles that possibly never contained any posts (Roessingh in prep.).

According to Van Giffen, a primary central grave was absent in this burial mound. Since in the West-Frisian clays organic material should preserve well and since the original plough soil was still present, Van Giffen concluded that the monument must have been a cenotaph in origin (Van Giffen 1962, 199). Even so, a burial was found in the centre of the mound, but in the top part of it (skeleton 230; fig. 41). This was considered a later interment belonging to a second period of use of the mound (Van Giffen 1962, 201). In the southwestern part of the barrow another internment was found, which was also considered to have been a later burial (skeleton 231; fig. 41). Finally, in Tumulus I, the skeleton of a pig was discovered (cf. fig. 9).[13]

The photographs taken show that both skeletons (230 and 231) were laying stretched on their backs, a typical position for Bronze Age burials in NW-Europe (fig. 41). Charcoal present in the plough soil underneath the burial mound was dated to between 1400 and 1000 cal BC, but analysis of the skeletons showed that both were much older than the charcoal date of the plough soil appears to indicate. The centrally placed skeleton (skeleton number 230) probably dates between 1881 and 1658 cal BC, the other (skeleton number 231) between 1883 and 1665 cal BC (table 1). Both skeletons therefore date to the Early Bronze Age, suggesting that the charcoal collected by Van Giffen somehow must have been intrusive. There were no grave gifts that can support or contradict an Early Bronze Age date.

Theoretically there is a possibility that the skeletons are younger due to the reservoir effect: they most certainly had fish in their diet in addition to grain and meat. This effect

Figure 28a Finds from the arable land underneath and around the burial mounds. A: 'true' Bell Beaker material (drawings: Van Giffen 1962; photographs from the protocolboek of M.D. De Weerd); B: Early Bronze Age sherds; C: flint artefacts; scale as indicated in fig. 28b

Figure 28b Unpublished potbeaker and Early Bronze Age potsherds drawn on behalf of Van Giffen by H. Praamstra (from documentation at the BAI, now transferred to the Provincial Archaeological Depot Noord-Holland at Castricum)

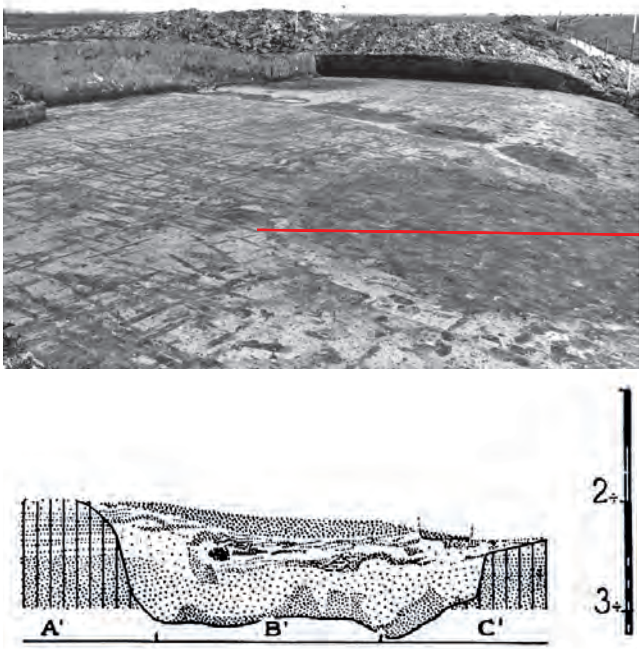


Figure 29 Large features in the se quadrant of tumulus I cut by a pit belonging to the pit circle around the barrow. The profile drawn by Praamstra is projected underneath (drawing from Van Giffen 1962); position indicated by the red line

Figure 30 Van Giffen presenting north section in the SW quadrant of tumulus I to his audience. In the barrow sods are visible, placed in an angle of about 45 degrees on a dark layer which is the Neolithic plough soil

can to some extent be estimated by looking at the $\delta^{13}C$ and $\delta^{15}N$ values of the collagen. The $\delta^{15}N$ values normally range between +13,2 - +16,3 and the $\delta^{13}C$ values between -18.2 and -19.5 (Cook *et al.* 2001, 457). Lanting and Van der Plicht (1998, 155) have analysed 81 prehistoric humans from the Netherlands; these yielded an average of -20 ± 0.86 pro mille. Humans that largely live on marine food show $\delta^{13}C$ values of -13 ± 1 pro mille (Lanting and Van der Plicht 1998, 155). In Table 1 these values have been listed for some of the skeletons of Oostwoud-Tuithoorn. These show $\delta^{13}C$ values of -20.01 to -20.89, which is in line with the average values cited by Lanting and Van der Plicht. Therefore it is unlikely that the reservoir effect contributed significantly to an older date (see also Lanting and Van der Plicht 2002, 87).

It is possible that different phases of use were present in this barrow. A photograph taken of an excavated pit in front of the section of the south quadrant seems to show that the barrow at some point had extended over the already filled-in pits (fig. 31, 32). This may indicate a second phase of barrow building, possibly related to the burials high up in the mound. The section drawings also appear to indicate, at least on the north side of the barrow, several layers that point to soil formation at different levels. However, these cannot be followed over the entire mound (fig. 33).

5.2 Tumulus II

5.2.1 The sequence

Tumulus II had no post setting or ditch that surrounded the mound. Instead, the original burial mound has become visible because the Bronze Age people ploughed around it (fig. 15a). We have already discussed the history of discovery; here we focus on the sequence of the burials, as far as it can be reconstructed on the basis of the presently available data. The radiocarbon dates that are mentioned in the text are obtained from a Bayesian model that has been derived from the stratigraphy and the sequencing of the events at the site (for the Bayesian model and the keywords that define it (see fig. 36; *cf.* Bourgeois and Fontijn 2015).

From the combined evidence it has become clear that the oldest burial in the area was burial 575, excavated by De Weerd in 1963 (fig. 34, 35). The individual was interred in a chamber-like structure, lying on its left side with the head facing southeast.

A narrow ring ditch with a diameter of about 8 m surrounded the grave (cf. fig. 21; fig. 34). Lanting notes that it had a laminated fill and therefore has remained open for a while (field diary Lanting 28th of June 1978). This happened between 2556 and 2204 cal BC (Table 1; fig. 36). What happened to the soil that came out of the ditch is not clear, but there is evidence that it cannot have formed a low mound of any kind (cf. below). A round pit was possibly dug near

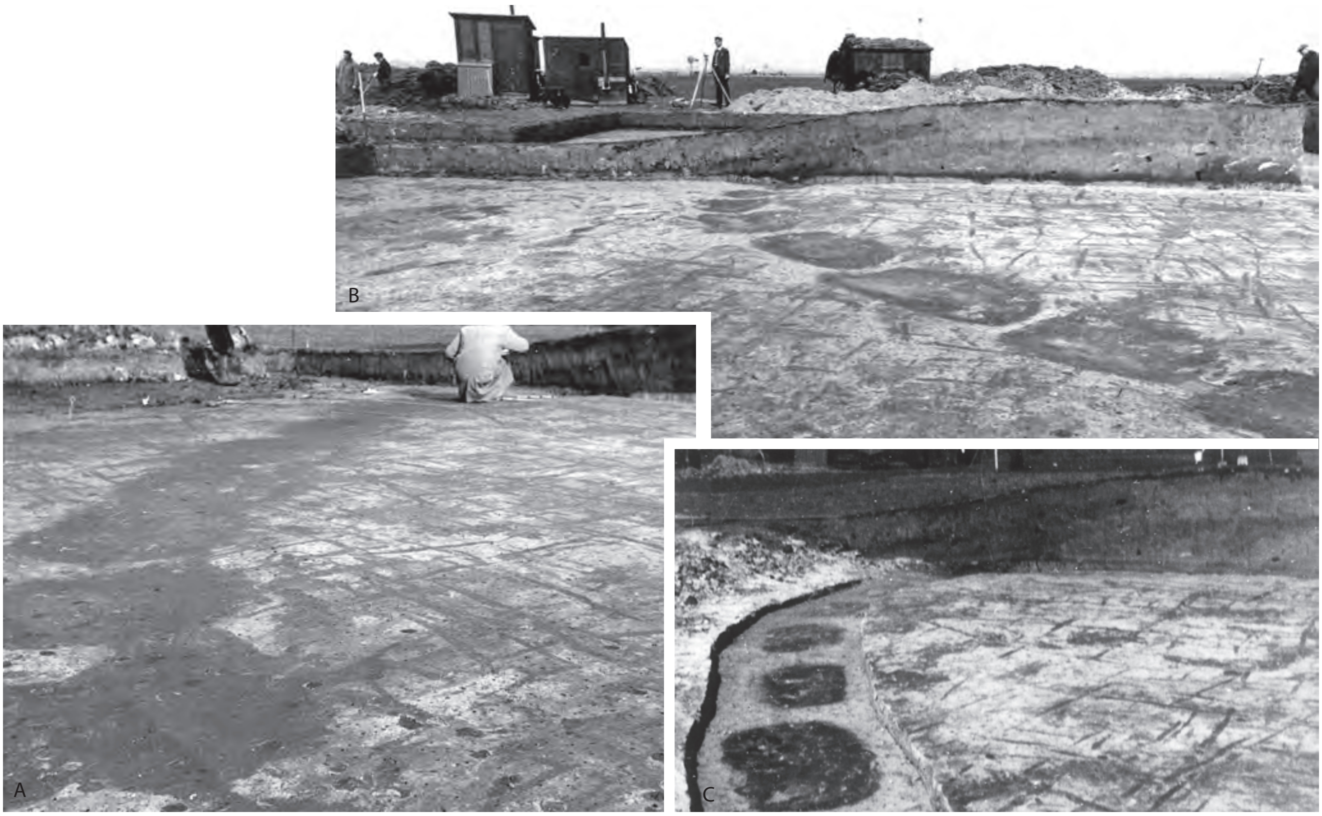


Figure 31 The pit circle around tumulus I at three different levels. A: at a higher level it resembled a wide ditch; B: at a slightly lower level individual pits appeared; C: these pits were of a regular rounded rectangular form. Note that the section clearly shows how the mound in a later stage (or stages) extends over the pit circle

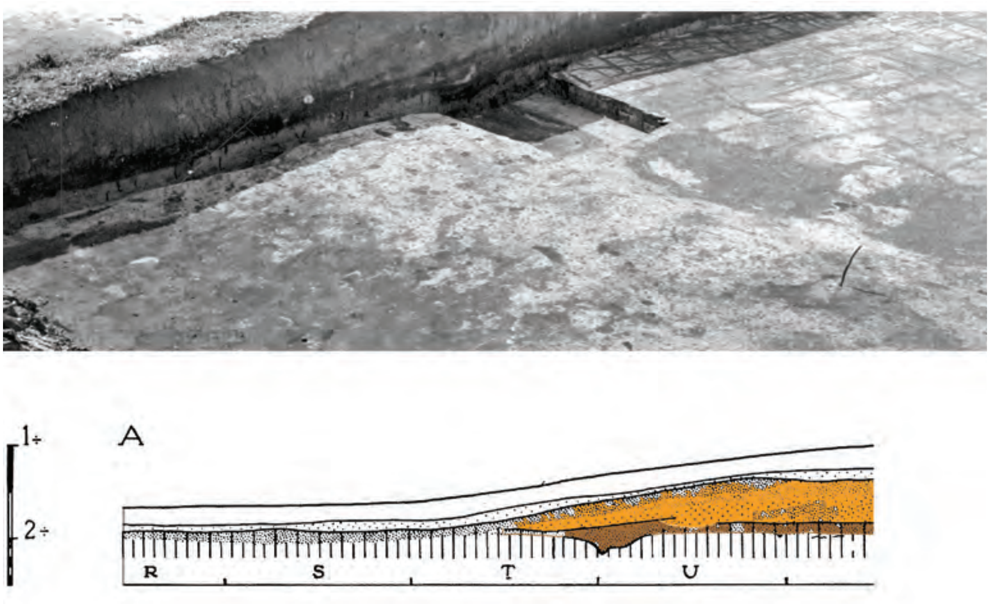


Figure 32 SW section of the south-west quadrant of tumulus I seems to indicate several barrow phases also on top of the already filled-in pit circle

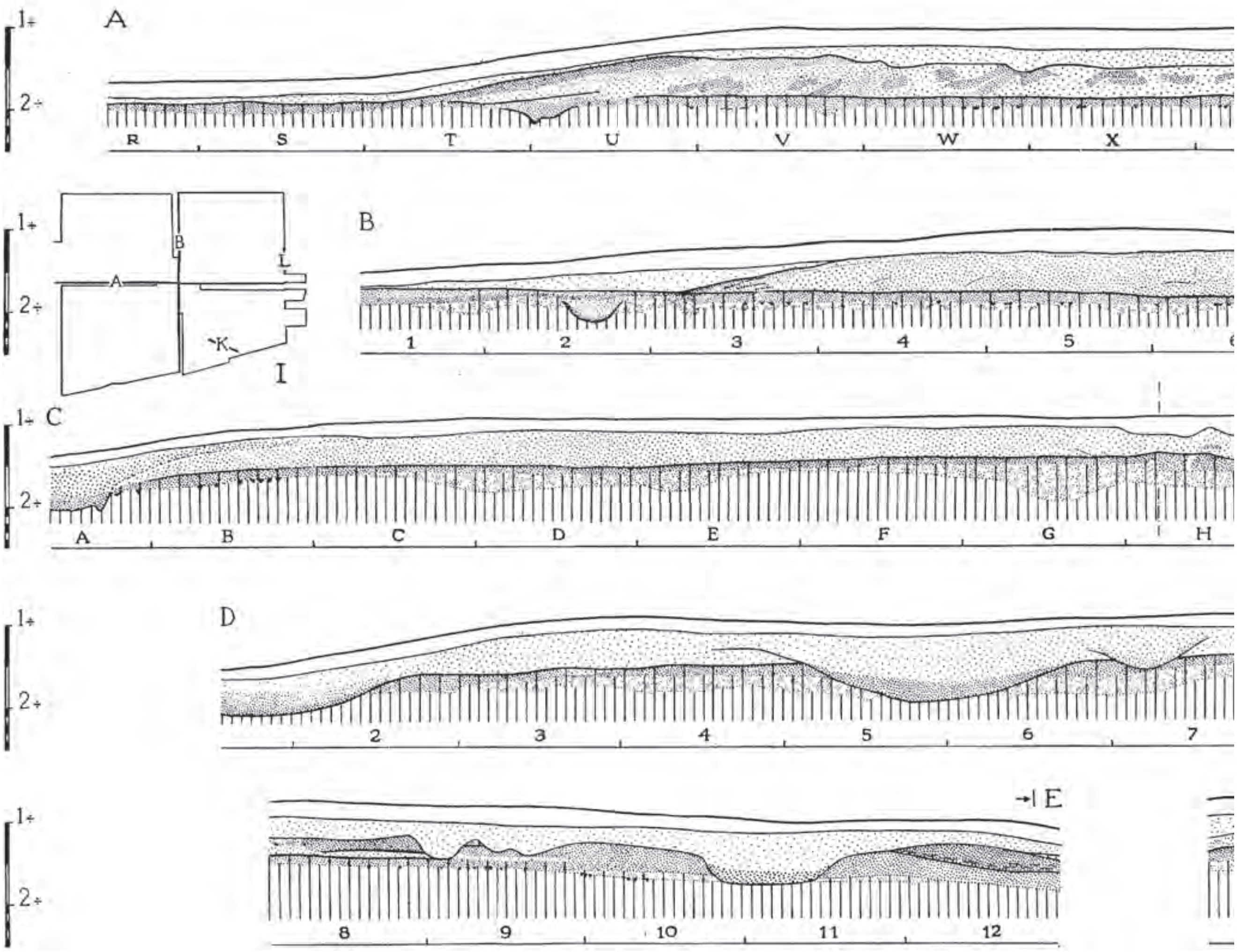
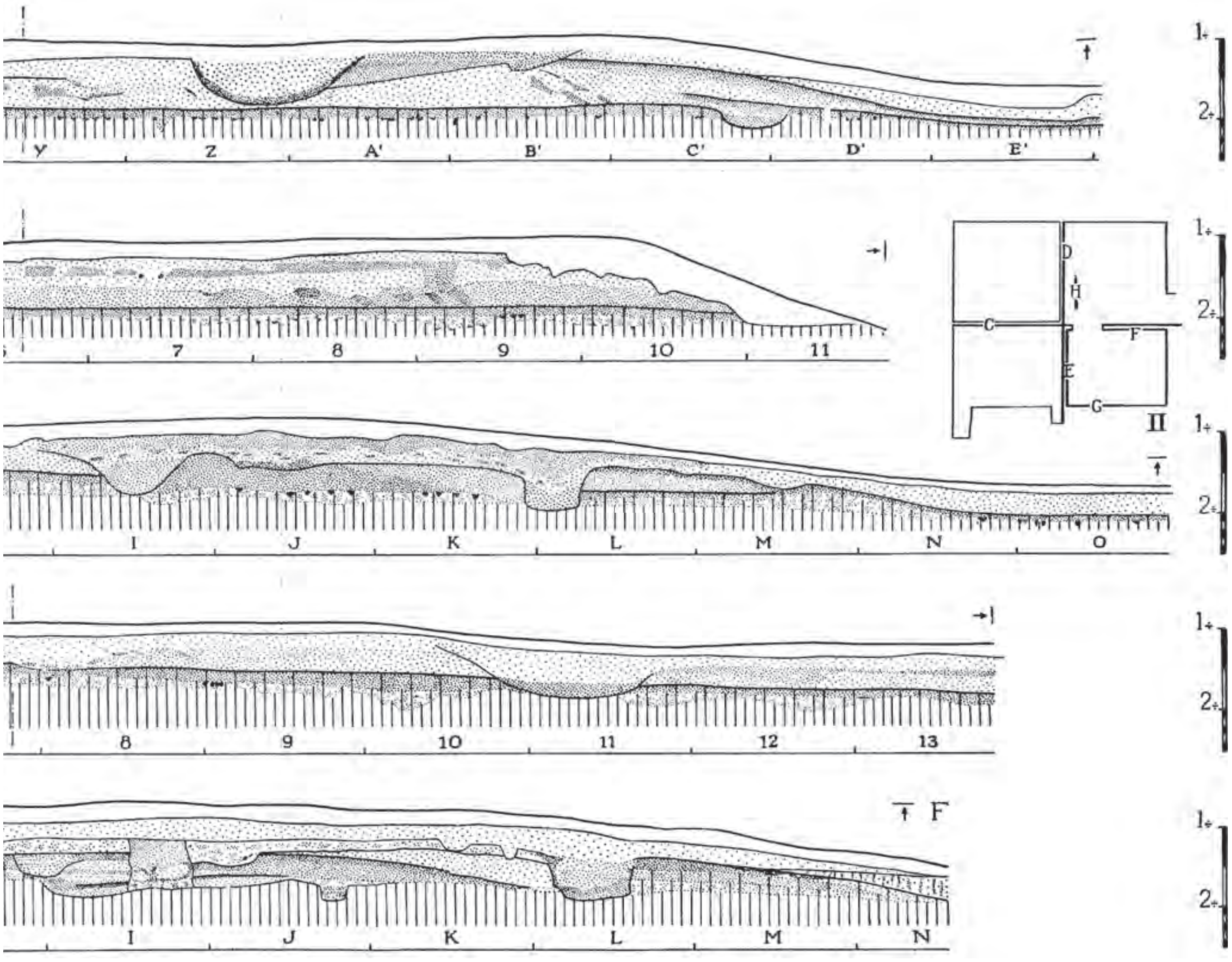


Figure 33 Sections through tumulus I and 2 published by Van Giffen (1962). These drawings are 1:1 copies of idealised field drawings made by Praamstra. These idealised versions were produced in order to make the present ink-drawings possible


Y
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the grave, in which several times fires burnt, somewhere between 2341 and 2149 cal BC.

After the burial event, the area was converted into arable land and a plough soil formed over the grave (fig. 37). This does not mean that the place was forgotten, because it is quite clear that this very area was covered by a low mound of *c*. 15 m in diameter (in its first stage) and eventually became a cemetery. We do not know the exact sequence in which the different graves were inserted, but we do know that most of them were situated above the arable land. It is not clear which of the graves were covered by the burial mound, or which were actually dug into a mound as a later interment. The latter is unlikely for at burial 242/533 at least, as this burial may have been disturbed by ploughing, and that can only have occurred when no mound was covering the cemetery yet. This hypothesis is the result of a complex set of observations by different people and therefore not the most reliable proof. In order to properly explain how our conclusion was reached, we have to tell the discovery story of skeleton 242 in 1957, and subsequently of skeleton 533/529 in 1963.

Skeleton 242 was discovered in 1957. Knotnerus described it in the find list as 'badly damaged' (field diary Van Giffen 5th of June 1957). The skull is present, as are parts of the arms and ribs, and one part of the leg, but otherwise it is incomplete (fig. 38C). In 1963 De Weerd re-excavated this part of the NW quadrant. In the same area, a little further south, he first observed a peat layer in the 'annex' that is attached to the east side of the mediaeval pit west of 242 (fig. 15A). This pit was already drawn by Praamstra in 1957. It was apparently a relatively shallow pit that had been dug in the Middle Ages or later, and had gradually filled with peat. In the annex, the peat layer rested on the old arable land in which the bones were scattered (fig. 38A). De Weerd first thought this to be the 'discarded remains of a meal', but the photographer (Gijbels) was certain they were human and belonged to a skeleton. De Weerd was confused, because the bones are displaced ('*verrommeld*') and a clear anatomical position could not be observed. Some of them were concentrated in 'a pit' in which a heap of bones appears 'to have been thrown' according to Glasbergen, who observes this on the 10th of September 1963. De Weerd addressed the bones as a construction 'à la Zadkine' (fig. 38B; field diary De Weerd 11th of September 1963), referring to the famous sculpture by Ossip Zadkine depicting the destroyed city of Rotterdam (after the bombing in 1940). They did not see the contours of a pit; the bones appeared to have been dumped. One of the large bones had already been broken in the past: the distal end had broken off. He expressed his 'surprise' about the fact that the bones occurred just one centimeter underneath the old surface of Van Giffen's excavation six years earlier. This tells us that in fact 242 and the bone found in 1963 were found nearly on the same level (see fig. 13).

But the situation is even more complicated. When excavating these bones in a larger area in order to register the position related to each other (fig. 38D), they discovered that these bones were on top of a complete older skeleton (skeleton 575). It became clear to De Weerd that the scattered bones did not belong to 575, but to 'someone else'. This is why they have recorded this find meticulously (fig. 38D).

A few years later part of the mystery was solved, when Runia took isotope samples of the skeletons. Runia suggested skeletons 242 and 533 to be the same because the remains were complementary and the isotope signatures 'conclusively proved' this (Runia 1987, 39). This has now independently been confirmed by DNA analysis. So, the conclusion is that the soil above 575 was converted into arable land, and that at some point after that, probably between 2284 and 1994 cal BC (table 1; fig. 36), skeleton 242/533 was buried a little south of 575, or possibly laid down on the plough soil and covered with a low mound. We think ploughing continued, and that at some point 242/533 was hit by the plough and torn apart while the ligaments were still intact. This resulted in dispersal of body parts near their original location, but damaged and maybe even trodden into the soil. The chamber around burial 575 must have been filled-up by then, because there is no sign that the plough sank into the chamber; the bones of 242/533 were found on a level just above skeleton 575, not inside the chamber. Lanting suggested that the bones may have been dispersed by a fox because fox bones were found mixed with the bones of 533 (Lanting and Van der Plicht 2002, 86). However, this appears to be unlikely: no gnaw marks were visible, and the body parts appear to have been displaced only one or two meter from each other resulting in parts that were still in articulation. That suggests 'brute' force, such as could be the result of an ard drawn by oxen or cattle. However, conclusive evidence for either of the explanations is lacking.

Our conclusion is that skeleton 242/533 originally was located directly near skeleton 575, on top of the plough soil covering the older burial. According to the model the interval of time between the first events prior to the arable layer and the subsequent burials is between 5 and 181 years (at 95.4% probability). DNA gives us another clue towards dating: skeleton 236 appears to have been a second or third degree relative of 242/533. This means they were probably two or three generations apart: about 30-40 years.

Skeleton 242 was dated to (most probably) 2193-1941 cal BC (95.4% probability), skeleton 236 to 2146-1925 cal BC (table 1). Both were placed close together on top of the arable land covering skeleton 575. Lanting thought that

Figure 34 Two of the ‘dream pictures’ made by the photographer of the IPP, Fred Gijbels, before skeleton 575 was lifted

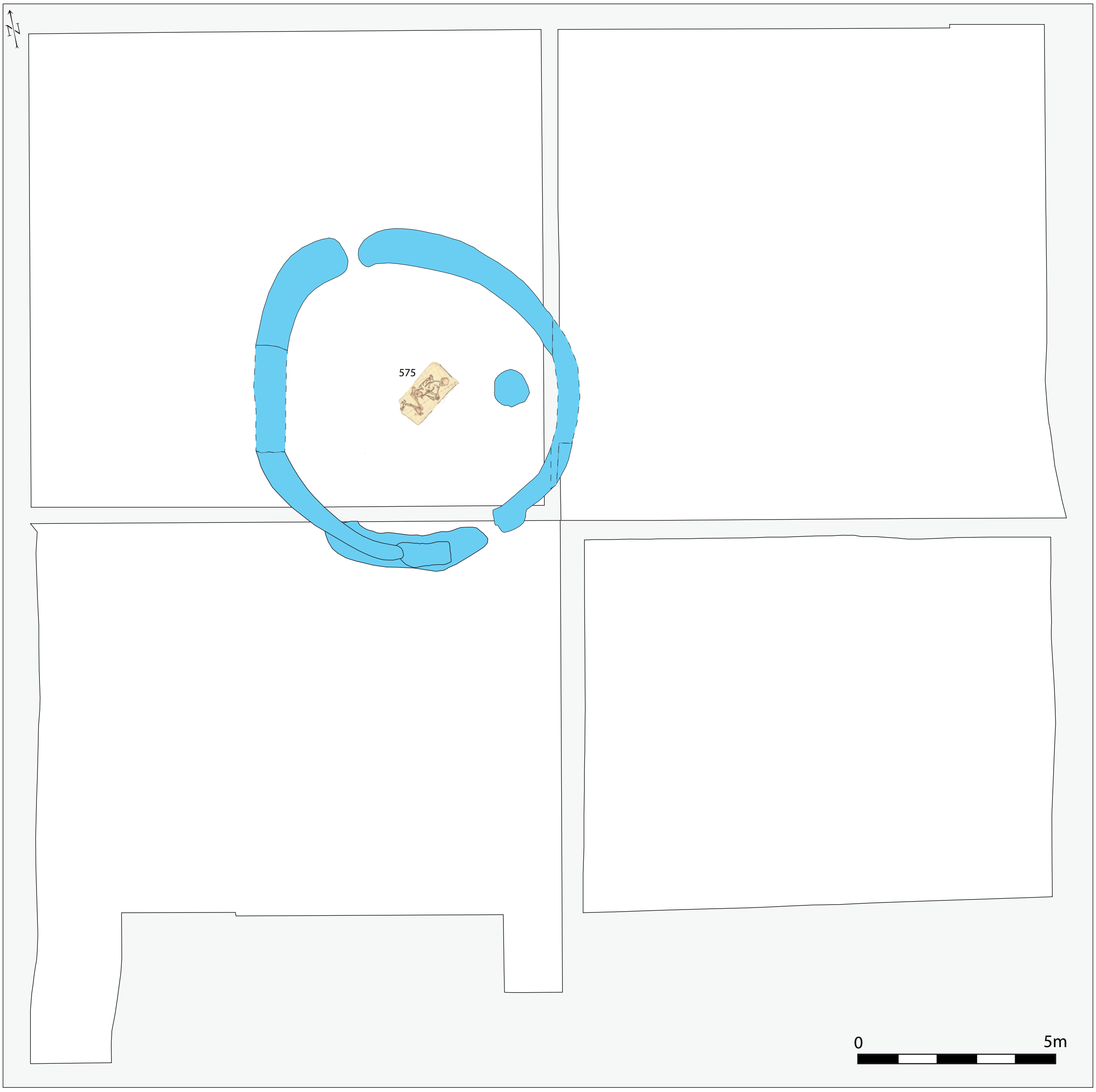

Figure 35 The first burial: a flat grave surrounded by a shallow ditch, the pit nearby was as dug a little later probably

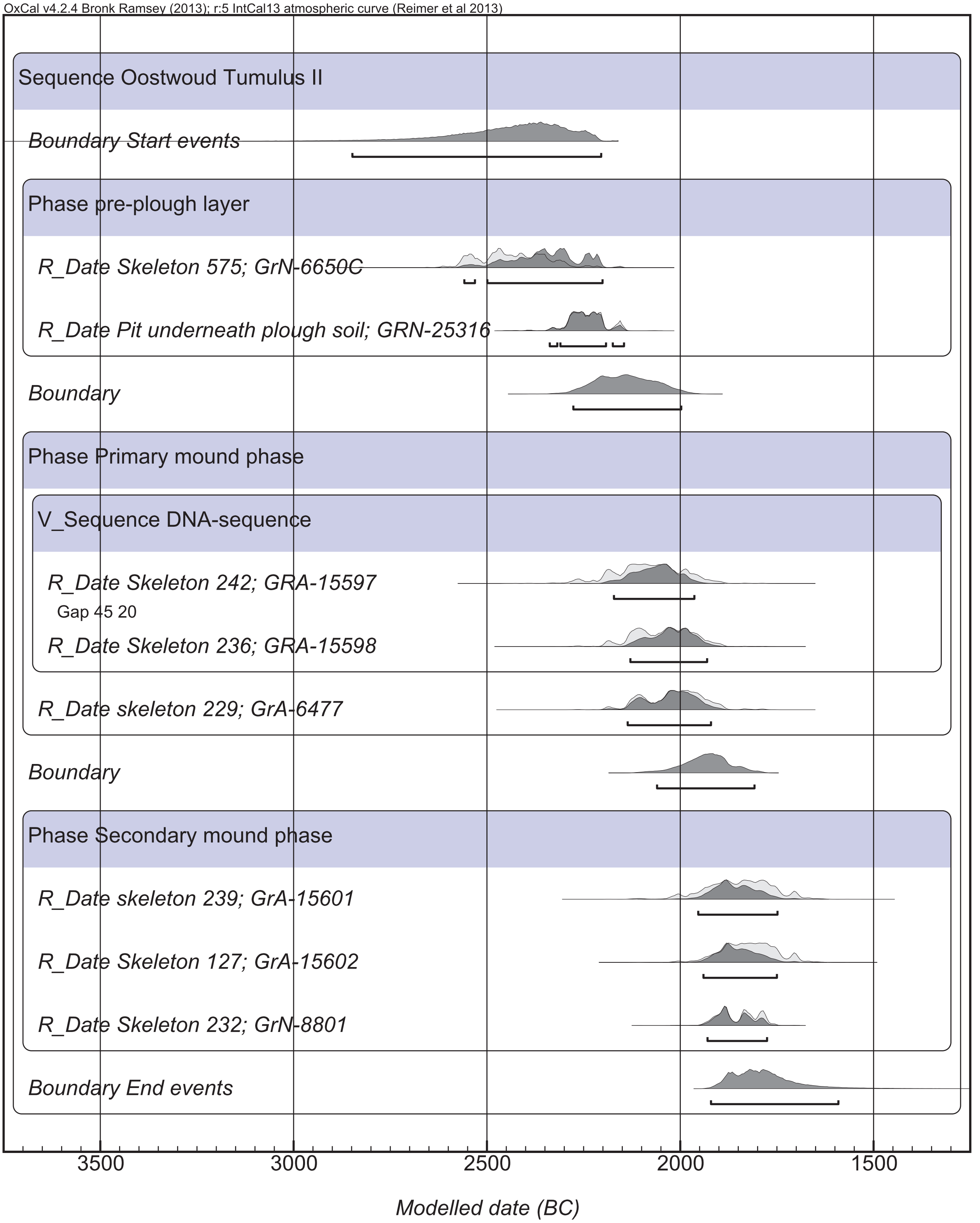

Figure 36 Probability distributions of dates from the burials of Tumulus II at Oostwoud. The model has been constructed with OxCal v 4.2. The square brackets on the left and OxCal keywords define the model exactly

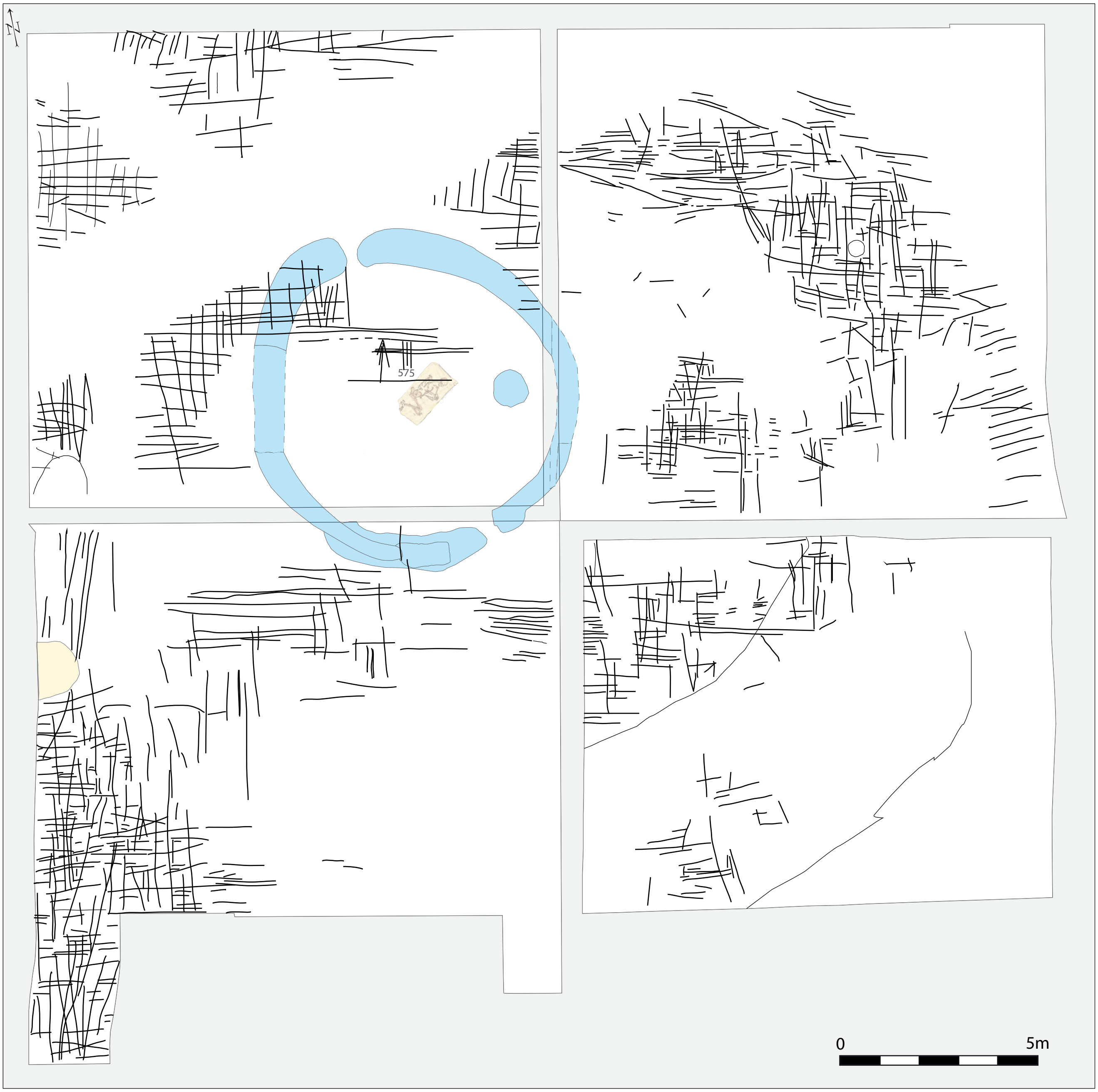

Figure 37 The second phase of events around tumulus II: the flat grave (in a central position within a circular ditch: blue) was covered by arable land, but somehow remained visible or at least remembered.

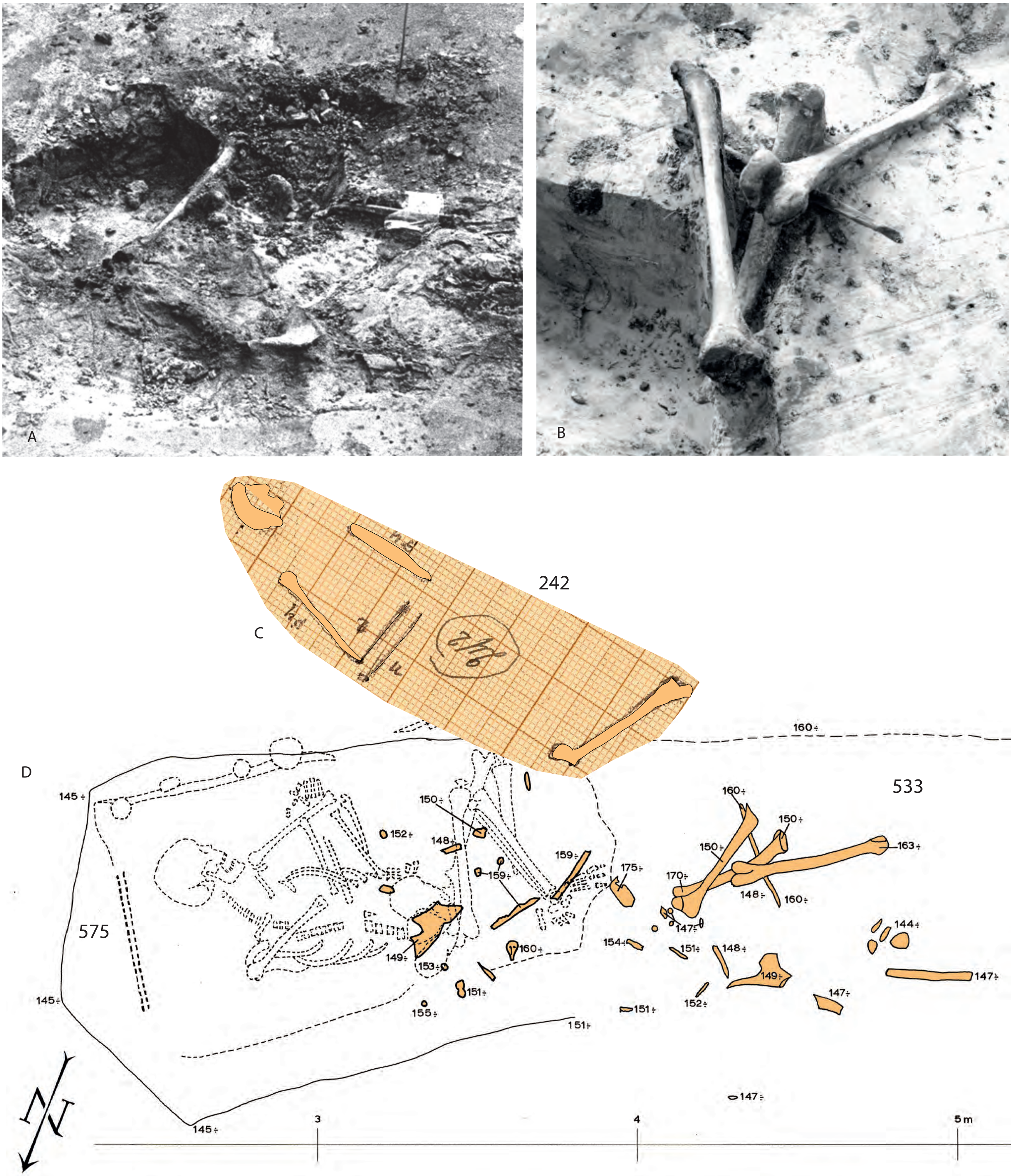

Figure 38 Various images of skeletons 533/242 in relation to the older skeleton 575. A: view of the peat-filled 'annexe' underneath which bones start to appear; B: the construction `à la Zadkine' cleaned before lifting them on 11 September 1963; C: part of the 1957 field drawing of Praamstra with the remnants of skeleton 242 indicated. It is projected on the drawing of the dispersed bones of 533 (and 529) as it was drawn by De Weerd. The numbers indicate depth measurements underneath Dutch Datum (NAP)

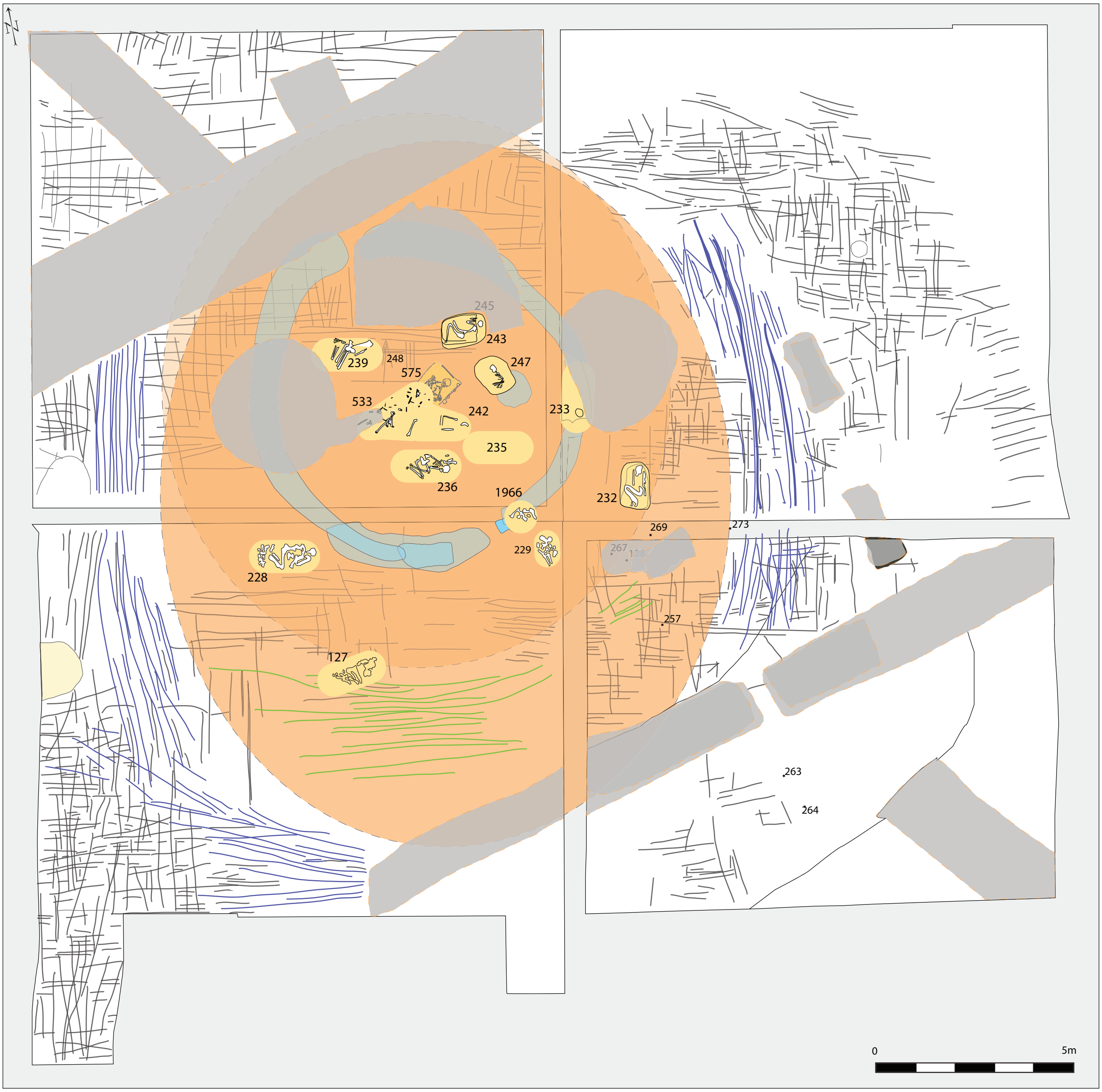

Figure 39 Phase two and three of tumulus II, indicated by series of blue (phase 2) and green (phase 3) plough marks. The grey features indicate relatively recent ditches and pits. The two phases of the mound have been projected at least 1 m within the plough mark bundles because we suggest that a team of draught animals would keep such a distance from the mound

242/533 was the primary grave underneath the first burial mound and that 236 underneath represented a second phase (Lanting and Van der Plicht 2002, 87). This is indeed a possibility, but in this case it might not be realistic to think in terms of primary graves *underneath* a barrow phase, and later interments *in* the burial mound. Since neither tumulus contained a primary grave, we may have to think in terms of a burial platform in which burials were inserted.

The plough marks do indeed suggest two phases. The first phase would have been 15 meters in diameter (fig. 39 blue series), the second phase about 19 meters (fig. 39 green series). Skeleton 127 appears to have been placed just on top of the blue series, which according to Lanting means it just may have been inserted in the first phase of the mound (Lanting and Van der Plicht 2002, 87). In our view this is impossible: it would have been on the very edge of that barrow and have been damaged by subsequent ploughing. Therefore, we suggest that it was inserted in the extended second phase of the mound. In terms of ^{14}C-dates, skeletons 127, 239, and 232 are the youngest (table 1; fig. 36), and probably indeed have been inserted in a mound that had already been in existence for one or two hundred years. According to the Bayesian model all three of these burials can be dated to the period between 1957 – 1752 cal. BC. They were not dug in very deep and were laid down on, or only one decimeter above, the arable soil underneath the mound. It is probable that the graves were all relatively shallow when they were dug.

6 The skeletal evidence, a preliminary report

In this paper we only present the data regarding sex, age, and position of the burials.[14] Most of the bodies underneath tumulus II had been laid down in a crouched position, in a more or less east-west orientation, with the heads facing south (this is true for skeletons 575, 236, 242/533, 239, 228, and 127). This is considered the normal posture for skeletons in Late Neolithic burials. Skeletons 247 and 232 were oriented north-south with the head towards the north and facing towards the west. Only skeleton 243 was facing north. In Tumulus I only skeletons stretched on their back were found, a normal position for the Bronze Age. This probably means that this transformation of burial position took place somewhere in the Early Bronze Age.

Of most of the skeletons 50-75% was preserved, and these remains were in a reasonable or good state. Only two skeletons were more than 75% complete (skeleton numbers 243 and 575), the others were less complete. There is no indication of why body parts may have been missing. In cases where the preservation is good, such as for instance skeleton 236, this incompleteness is hard to comprehend. It is difficult to relate it to selective or careless excavation since all skeletons were supposedly lifted by the same person, Mr. Bijlsma of the Antropobiological Laboratory of Amsterdam University (cf. fig. 13). It is possible that the excavators were predominantly interested in the skulls, and that less care was taken with the other parts of the skeleton. However, it must also be noted that the skeletons were all found by inexperienced workmen, who were taking large spits of soil from the ground. In case of, for instance, skeletons 236 and 229 this probably caused loss of body parts (see below). In the case of skeleton 247, we know that not the entire skeleton was excavated, as De Weerd found additional parts a few years later underneath the original location of the burial. Alternatively, secondary burial rituals may also have been practiced.[15] In some instances, only skulls were found, or skulls were entirely missing, like in the case of skeleton 235. We will discuss this in more detail below.

In the following we present the data on position, age, and sex as has become evident from studying the original documentation and the skeletal remains. In this we follow the skeletal numbers from low (127) to high (575).

Individual 127 was buried on the left side, body crouched, and head facing south (cf. fig. 26). Hands, feet, and axial skeleton were missing. It appears to have been the youngest person buried: age-at-death was estimated to be 15 years ± 1 year. A difference in age estimation was observed between age based on dental development and eruption (Moorrees *et al.* 1963; Ubelaker 1979) and age based on long bone length and epiphyseal fusion (Maresh 1970; Schaefer *et al.* 2009). This could be indicative of stunted growth which may have been caused by illnesses and/or malnutrition in his or her earlier years of life. Individual 127 probably was the last interment in tumulus II. The reason we think this is discussed above: the plough marks around the last phase of the burial mound pass just under the grave.

Skeleton 228 was well preserved (fig. 40). This individual was estimated to be a male aged 26-36 year old, buried on his right side, head facing south. His length was estimated to be 169.9 cm ± 3.27 cm. Curiously one of the hands is situated just below the feet (fig. 40). This was already noted by Bijlsma of the Anthropobiological Laboratory when he lifted the skeleton. Numerous photographs were taken to document this. The reason for the unusual position of the right arm is unclear. The hand appears to have been attached to the distal part of both the radius and the ulna. Based on similar morphology, the right hand appears to belong to 228, but there are no signs that the hand was somehow cut off, or that the manubrium, that was found with it, was forcefully removed. The difference in colour and the sharpness of the edges of the fracture surface suggests the fractures of the radius and ulna to be the result of recent activities. As shown on the photograph, a sharp line is visible in the soil where the radius and ulna are cut off (fig. 40C). Most likely, the fracture of the right ulna and radius was caused by the excavators. We should remember that these quadrants were excavated in 'spits' by ground workers, not archaeologists. They removed the soil by cutting into the ground vertically with their shovels and then shoveling the soil onto carts drawn by horses (fig. 39D). The arm easily could have been cut then and the remaining part, including the scapula, could have been 'shoveled' onto the spoil heap.

Since the right clavicle, scapula, and humerus are missing, it is possible that the entire right upper limb including the shoulder was removed and placed at the feet. Possibly the manubrium, which is attached to the clavicle, was removed in that same action. The hand and distal parts of the lower arms were still in articulation, suggesting the arm was removed when most of the ligaments were still intact. This could have happened during life, shortly after death or just before the connective tissue decomposed. Unfortunately, the bones from the shoulder are missing. Therefore it was not possible to assess whether the removal of the right upper limb was done with force. The rest of the skeleton was also in articulation, suggesting that the removal of the limb did not disturb the other bones. The position of the bones of the skeleton implies that the grave pit was filled in before decomposition could cause the bones to move from their original position. Most likely, the right arm was removed after death and before the connective tissue was decomposed, although the possibility of the removal of the arm during life cannot be ruled out. The reason why the entire right upper limb was placed near individual 228's feet remains unclear.

Skeleton 229 was partially preserved, with part of the cranium, left torso, left arm, both legs and part of the left foot present. Sex was estimated to be male and age-at-death 25-36 years. His burial position is not indicated on the field drawing, but there is a photograph showing some of his remains very close to the section dam (cut loose from it, actually), being lifted *en bloc* (fig. 41A). This photo and the

Figure 40 Different views of skeleton 228. A: the complete view taken from the north; B: view taken from the east; C. close-up of the arm and hand showing also the cut in the soil possibly made by a modern shovel; D: the practice of removing spoil with horse-carts. On the foreground Mr. Bijlsma near skeleton 228

view of the bloc on which it was preserved (fig. 41B) suggest that a considerable part of the body was cut by the excavators. On the photo the cranium is not visible.

This contributed to the idea that skeleton 229 is part of the same individual as the skeleton that was recovered ten years later by De Weerd in the remains of the m-w section dam (fig. 41C). Unfortunately, the location of remains from '1966' is unknown and therefore could not be analysed. Judging from the photograph of this skeleton, the remains appear to be complementary to 229. If that indeed is the case, it remains unknown why various parts of the same individual were retrieved apart from each other. Unless the remains obtained in 1966 can be located, it will not be possible to improve our understanding of both burials.

Individual 230 and 231 were both estimated to be males of 36-49 years old, buried in a stretched position on their backs in tumulus I (fig. 42).The right arm of individual 230 appears to have been moved and was placed near the surface of the mound. This most likely was the result of a later disturbance. These are in fact the youngest of all skeletons (dated between *c.* 1880 and 1650 cal BC cf. Table 1). They were inserted high in tumulus I, some 40-50 cm above the plough soil underneath the barrow.

Individual 232 was lifted *en bloc* in 1957 (May 17th) and presently is located in the Provincial Depot of Noord-Holland in Castricum (fig. 43). Its state is deplorable, however, and does not allow extensive osteoarchaeological analysis. Bones are glued in the matrix and cannot be taken out. This already was the condition in the 1980's. Runia (1987, 218) describes 232 as: 'Incomplete skeleton, removed *en bloc* in a fixed position. Individual bones cannot be taken out. Ribs, sternum and almost all hand- and foot bones missing. Skull fractured and pressed together. Pelvis broken and only partly visible. Most of long bones broken. Exact measurements cannot be made due to fixation and fractures. Length of femur *c.* 43 cm, tibia *c.* 37 cm, suggesting body

Figure 41 Reconstruction of the positions of 229 and the skeleton remains in 1966 in relations to the section dams of Van Giffen (in yellow). A: Some of the remains of skeleton 229 being lifted in a block to be cleaned elsewhere. B: detail of the sw quadrant showing the bloc of 229 and the gap between the bloc and the m-w section. C: possible location of the remains found in 1966

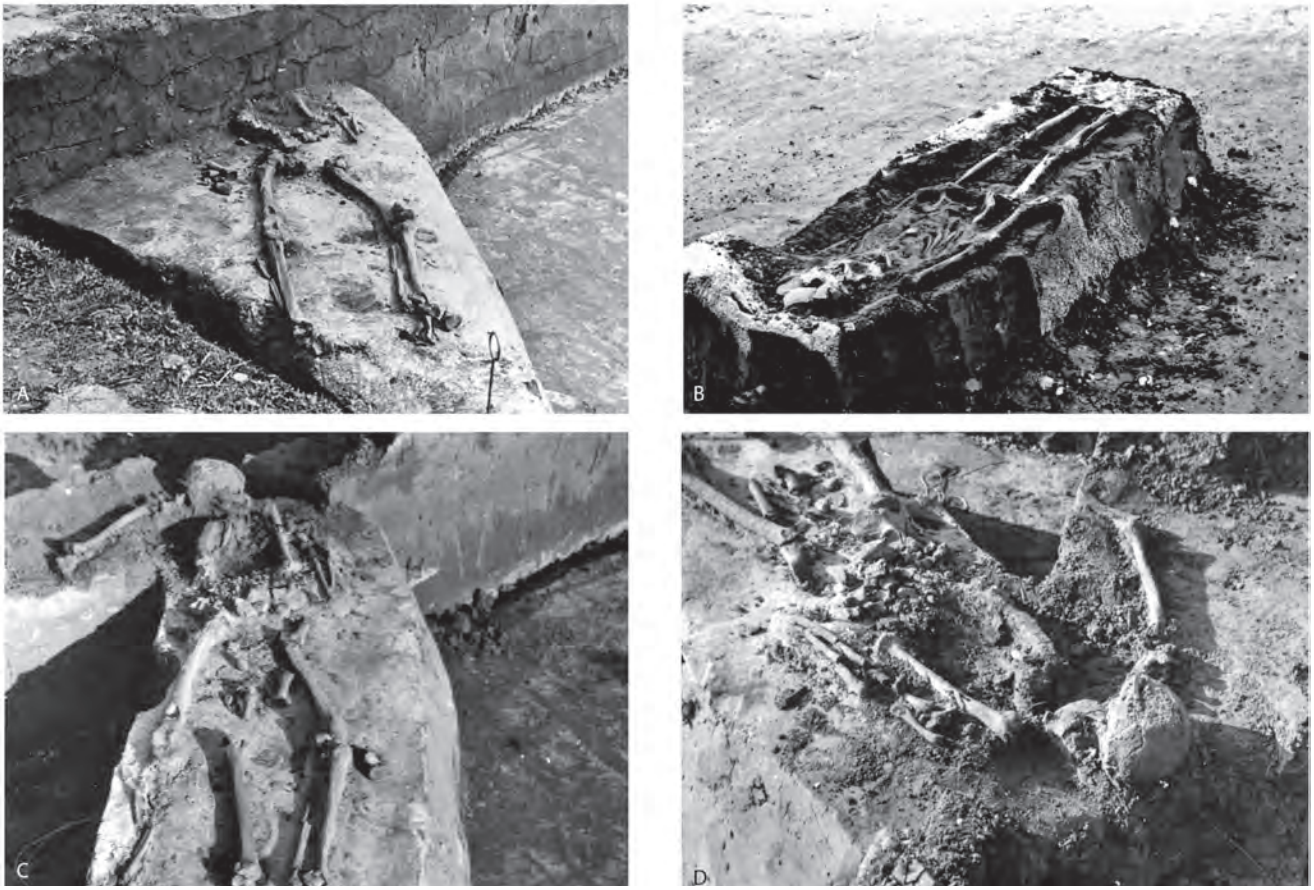

Figure 42 Skeleton 230 and 231 during various stages of the excavation. A: 230 as it was discovered and excavated on April 11, B: 231 as excavated on 19 April. C and D show the excavation of 230 on 19 April when both skeletons were lifted and transported to Amsterdam by Mr. Bijlsma of the Antropobiological Laboratory

length of 160 and 169 cm, respectively. Skull not suitable for sex determination. Pelvis broken and partly covered by soil. L half of pelvis visible from behind. Greater sciatic notch not easily visible, but probably rather wide. Preauricular sulcus appears present. Both characteristics suggest female sex. Age estimation difficult. Ml, M2 and M3 in upper and lower jaw L appear to be present. Occlusal surfaces not visible. Molar wear probably not very extreme, so an age of 25-35 is suggested.'

Van Giffen considered 232 to be the primary grave underneath tumulus II, but why is unclear. The most logical explanation is that it was close to the projected center of the barrow, indicated by the place where the section dams met (cf. 43A). Skeleton 229 was also found near the center, but that was incomplete. Moreover, 232 was laid on a 'mat van biezen', a mat or rather a basket, made of bulrushes (fig. 43C, D), which was the reason that Van Giffen decided to lift the skeleton *en bloc*. The reason we think it was a basket or a least a mat of which the rims protruded upwards, is that the outline of this mat was rather clear (fig. 43D). Unfortunately, no signs of this mat can be observed. Its shape and size (rounded rectangular) were comparable to the pit with a 'double fill' in which 243 was buried (cf. fig. 43A). Therefore we suggest also skeleton 243 was buried in a basket of bulrushes or the like.

Even though sex could not clearly be determined, Runia's suggestion that this is a female is in line with the different orientation of the skeleton. According to the published plan (fig. 15a) it is oriented north-south with the head in the north, facing west. This is in line with orientation of 247. Since all male skeletons are facing south, this orientation may be sex related. 243, the third female, also faces north, but is oriented west-east, like the male individuals.

Near skeleton 232, bones of a hare were found, according to Van Giffen, which was corroborated by Clason (n.d.): The fact that it was found near the skeleton proves, according to

Figure 43 Several images of skeleton 232. A: The ne quadrant with the burial pit before excavation; B: the skeleton as it looks now in its case in the depot at Castricum; C: the skeleton just before it was lifted in a bloc; D: detail of the drawing by Praamstra showing a 'double' fill. The inner fill and its darker limits (see also image C) was interpreted as a 'basket' of bulrushes in which the dead person was buried

Clason, that it was a grave gift, which ‘possibly then already had the meaning it has still today, the bringer of new life’. There is no indication where exactly the hare was found. As with the marten near skeleton 236 (cf. below), it may have been an accidental deposition.

Individual 233 was estimated to be male with an age-at-death of 36-49 years, but only a small part of his skeleton was retrieved. The preservation of the bones was good, suggesting other factors than taphonomic damage to the skeleton to be the cause of the incompleteness of his remains. On the field drawing, it appears that the body was laid down in a pit that cuts through a much larger round feature filled with medieval clay. That, however, was not the case according to Lanting (Lanting and Van der Plicht 2002, 86). Skeleton 233 was probably found when the Medieval pit was removed in the 3 meter wide trench that was dug in front of the section dam (cf. Section 3.1; fig. 14). When we compare all data, it appears to have been positioned almost on top of the older ditch surrounding burial 575. Whether this was intentional is uncertain. Probably, this ditch had been filled in and ploughed over long before. According to Lanting the documents of the Anthropobiological Laboratory indicate a north-south position on the right side with the head on the south side, facing east (Lanting and Van der Plicht 2002, 86).

Individual 235 presented us with several difficulties. The preservation of his skeleton was excellent, but we do not know its exact position since that was not recorded. There are two indications in the field diary of the 3rd of June 1957: ‘*skelet zonder kop in nw kwadrant: a: 2.50 W. M.-N as en 2.30 Ndl. M.-W as; b: 3.30 W. M.-N. as en 2.80 Ndl. M.-W. as opgenomen door de heer Bijlsma’* and ‘Zij nemen skelet in N.W. kwadrant op: I (235) beginnen met dat ten Z.Z.W, (236) daarvan.’ Both entries indicate a position N.N.E. of

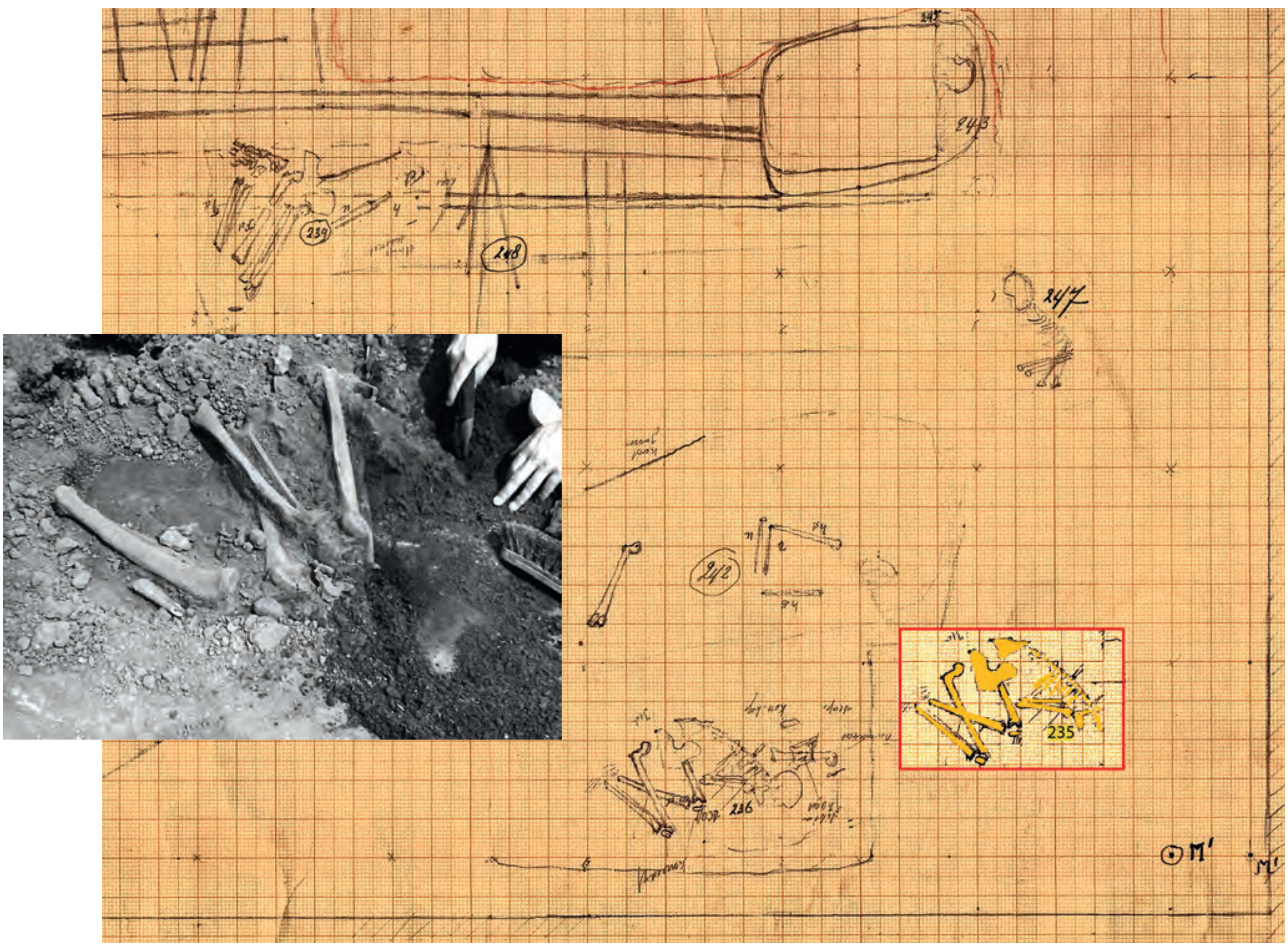

Figure 44 Projection of skeleton 235 (in a hypothetical posture) of the plan of the nw quadrant. Inserted a photo taken by Mr. Emmerik, assistant to the Anthropobiological Laboratory, probably showing some of the remains of 235. From this a crouched position may be deducted

236. That is not the same position as that of 242, which is described on the 5th of June as '*N. van 236'*. That leaves space for a (hypothetical) position as indicated in the plan on figure 44. His skull was absent, which is not due to an excavation error. It must have been taken or not interred at all in the past. His age-at-death was estimated to be between 26 and 35 years old. His stature was estimated to be 161.4 cm ± 3.27 cm, which makes him the smallest man in the sample. In the collection of photographs taken of the skeletons by the Anthropobiological Laboratory in Amsterdam there is one photo that cannot be attributed to one of the other skeletons (fig. 44). It showed the legs and pelvis of a skeleton. On the back was written in pencil 235, but later on changed in ink into '236'. This must indeed be 235, however (fig. 44); the size and form of the bones visible match with the actual remains. It shows that this skeleton was also placed in a crouched position.

The missing skull of skeleton 235 is an enigma. There are no indications the head was somehow severed from the body. It was definitely not an excavation error: from the beginning it was known as the 'skeleton without skull'. However, there may be a solution to the problem: a single well preserved mandibula (lower jaw) was found in the NW quadrant of tumulus II, 85 cm from the m-n section dam. This position is about 1.5 – 2 m. east from the position of skeleton 235 as indicated in the field diary. This mandibula was given number 230. That is confusing because that is the same number as skeleton 230 from tumulus I. We now have labelled it 230 *extra*. In theory that could be part of the missing skull, which then somehow must have become displaced in the Late Neolithic or the Early Bronze Age. The fact that only a mandibula was found indicates that the body already was decomposed when this happened. The DNA results of samples of 235 and 230 *extra* do not contradict that they are from the same person. Skeleton 235 and 230 *extra* have – as the only ones in the skeletal assemblage – the same mitochondrial DNA, and from that data it is also clear that 230 *extra* is the lower jaw of a man. Alas of 235 whole genome data could not be obtained, so there is no certainty.

Why it was not properly documented is unclear. Possibly the hectic situation with so many skeletons, and at the same time not enough skilled supervision of the workmen was one of the reasons that Van Giffen ended the excavation on the 3rd of June, sent home Van Delden and called in Praamstra to save what could be saved (cf. Section 3.2). By then 235 already had been removed undocumented.

Individual 236 had an age-at-death of 36-49 years and was estimated to be male. His skeleton was well preserved (fig. 45). It was photographed several times from different angles, apparently because of its excellent condition and complete state. The body was oriented west-east and facing south, placed on the left side. The body was almost complete, but the lower left arm, the right hand, and both feet were missing according to Runia (1987, 218). In the collection of bones now preserved, the right arm is also missing, even though this is clearly visible on the photographs.

Behind its back, the skeleton of a small rodent was found, indicated by Van Giffen as a rabbit or hare. Runia (1987, 219) states these are the skull, mandibula, and long bones of a marten. Whether or not this is an intentional burial is impossible to say. The fact is that near 232 a rabbit skull was found as well. Here again it could easily be an unintended part of the grave. Burial mounds are an attractive place for burrowing by rodents. This means they will occasionally die there too.

Individual 239 was one of the younger individuals, a man of 19-25 years old. He was more or less placed on his left side. His stature was estimated to be 181.4 cm ± 3.27 cm. Interestingly, the day-notes of the excavation state that it was 'the skeleton of a very large man that had been buried with the legs folded in a 'completely unnatural' way' (field diary 4th of June 1957). This is indeed visible in the photograph taken during excavation (fig. 46). It suggests the legs were bound together or tightly wrapped in a mat or cloth. The feet were still 'sticking out' in a natural position, which seems to imply these were not under the same stress of wrapping. This must have been done after rigor mortis had passed, some time after death when no muscular tension is present and the body is flexible again. This is not entirely unusual in this period, but systematic research is lacking. One other skeleton, excavated at Schokland-P14, buried between layers of oak bark, also appears to have been treated this way (Ten Anscher 2012, 334; Fokkens *et al*. 2016, 109). We cannot make any solid conclusions about the meaning of this burial disposal.

The circumstances of the skeleton of individual 242/533 have already been discussed (Section 5.2, cf. fig. 37). This was a male individual aged 26-39 years with a stature of 179.2 cm ± 3.27. His position was probably originally a crouched position on the left side, head facing south.

Individual 243 was reasonably well preserved, and the most complete skeleton of the assemblage. It belonged to a 36-49 year old woman with a stature of 163.0 cm ± 3.72 cm. Her position was recorded in the 1962 publication of Van Giffen (fig. 15a), but not indicated on the field plan drawn by Praamstra. She appears to have been placed on the left side with the head to the east, facing north. One photograph remains, indicating a rectangular pit, exactly as was indicated on the plan. A second photograph, available as thumbnail only, was glued to a provisional location plan made by the Anthropobiological Laboratory. Scanned with 1200 dpi and enlarged, it shows the vague contours of the body (fig. 47 bottom) in a clear crouched position. Even on this blurry

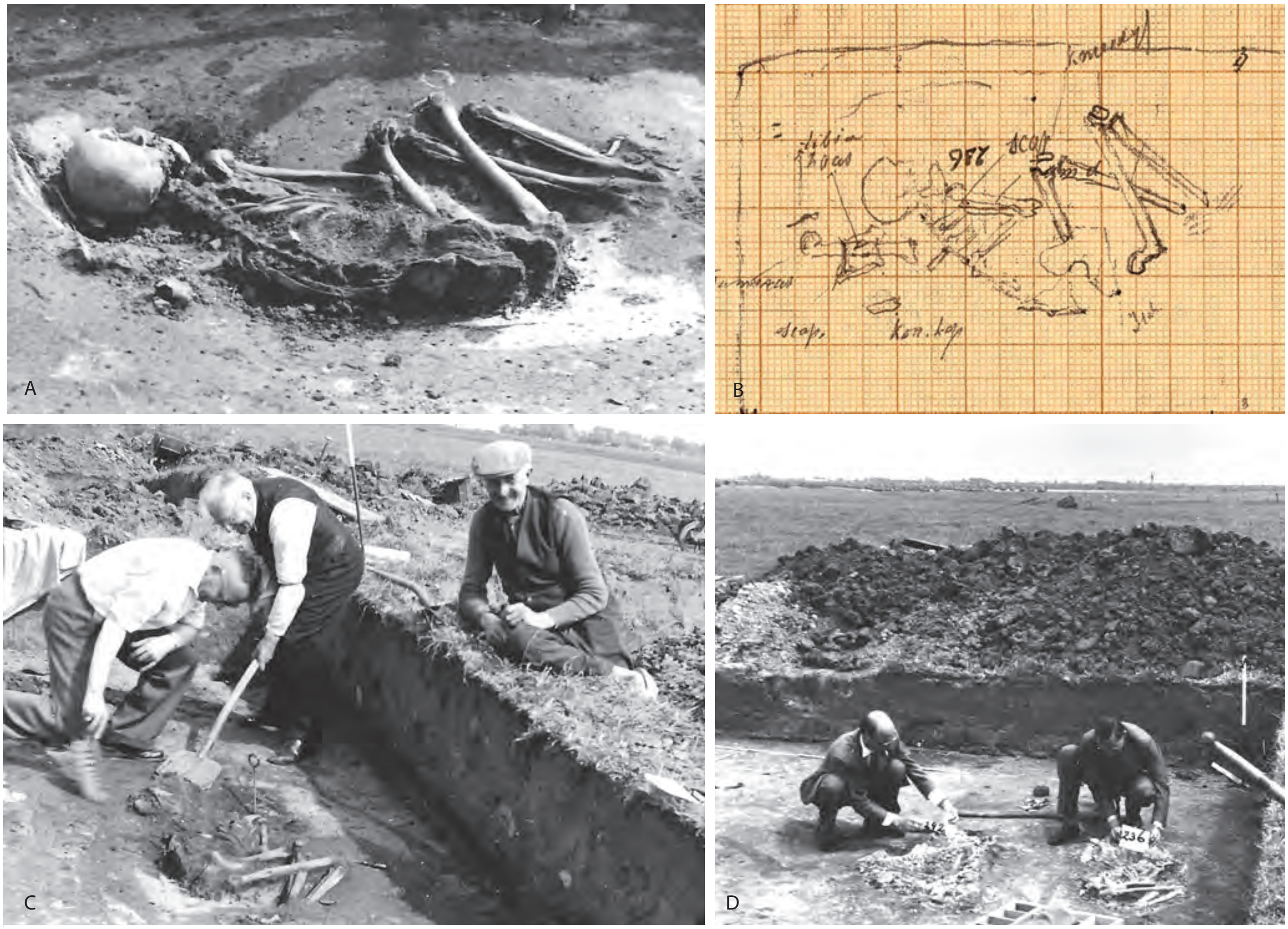

Figure 45 Skeleton 236. A: the skeleton just before removal. The skull had been removed, but was placed back for the photo. Van Giffen (1962) published this photo as well; B: the drawing by Praamstra shows that just behind the skull a long bone is present (indicated as ‘tibia haas’: tibia hare), and behind the back the skull of a marten (indicated as: ‘kon. kop’: rabbit skull). Both are indeed visible on the photo (A); C: prof. Van Giffen cleaning the soil after the skull had temporarily been removed; D: the skeleton during excavation by two people of the Anthropobiological Laboratory (Bijlsma and Emmerik). The numbers in ink were added by Praamstra probably

photograph the crooked form of the upper legs is visible. Most likely this can be attributed to vitamin D deficiency in childhood (Rachitis) of which the remnant bending deformities are still visible in adulthood and are referred to as residual rickets (Veselka 2016). Encountered pathological anomalies will be discussed in a different article.

Individual 247 was a female buried on her right side, oriented N-S and facing west. Her length was estimated at 167.3 cm ± 3.72 cm. Her skeleton was only partially present, but the preservation was good. The skeleton was described as a child burial in the field diary; Praamstra drew it as a very small burial (cf. fig. 44). Yet osteoarchaeological analysis of the remains made clear it was not a non-adult, but rather a 25-36 year old female. How this ‘mistake’ could occur is not clear. Possibly, it is the result of the fact that the skeleton was rather incomplete. Runia describes it as ‘Only skull and mandibula, and parts of the upper and lower limbs present’ (Runia 1987, 220). When De Weerd excavated the spot where skeleton 247 had been found, he discovered a few other bones that belonged to that skeleton. He recorded them as 465 (field diary De Weerd 3 Sept. 1963). It is also in this spot that a pit was discovered with charcoal layers in 1978, apparently only a few centimeters below the place where 247 was buried. No photographs of this skeleton were taken.

Lastly, there is skeleton 575 (fig. 34, 48), which is in fact the oldest burial, a ‘Bell Beaker person’ according to the

Figure 46 Skeleton 239 image taken on 5 June 1957. The curious position of its legs is clearly visible

dates. The burial was laid down in a chamber-like structure on its left side, in a crouched position, with the head facing southeast. For this period it is quite common that the dead were placed in a wooden chamber. Wooden bottoms have never been recorded, which is why we speak of covered chambers (Bourgeois *et al*. 2009, 97). According to De Weerd, it indeed did not have a bottom, but it probably did have a lid. This was not observed, but the position of the ribs and other bones of the skeleton suggest an open space (observation Veselka). Where it was more or less preserved, the planks were about 3 cm thick (field diary De Weerd). Two flint blades were deposited near the pelvis (fig. 48, indicated as '2 silices'). Skeleton 575 was partially excavated and lifted *en bloc*. Whereas nowadays it would have been automatically owned by the province, and hence belong to the Provincial Depot, in 1963, it was 'owned' by the excavator. Though De Weerd had excavated it, it was professor Glasbergen who took responsibility and eventually gave it as a 'personal loan' to the Westfries Museum in Hoorn. Eventually, it ended up at the Provincial Depot after all. The discovery of skeleton 575 was important for Glasbergen because it safeguarded the subsidy he had received for the excavation, which was aimed at 'The ecology of the bearers of the earliest phase of the Bell Beaker Culture in Europe' (cf. Section 3.3).

7 Concluding remarks

7.1 Oostwoud in a regional context

The Oostwoud burial mounds, and the skeletons found in it, have been discussed in detail in this paper. We have taken advantage of the opportunity the editors gave us to publish many of the original images and data. Normally, that is not possible in a journal article because of size limits. We felt that an elaborate discussion of data was necessary because of the unique preservation condition of the skeletons, enabling both detailed osteological analysis and DNA analysis. Moreover, since most Late Neolithic burials were discovered in acidic sandy soils, the Oostwoud burials are amongst the few that are actually preserved from this period in the Netherlands. In addition, stratigraphical observations were possible, which was not the case in contemporary cemeteries at Schokland-P14 (Ten Anscher 2012) and Hattemerbroek (Drenth *et al*. 2011).

To a certain extent the Oostwoud burials fit the patterns that we see at these other sites, but there are also quite a few differences. Similar to the Oostwoud skeleton 232 and probably 243 burials, at Schokland-P14, several of the bodies were laid down on mats, layers of bark, or hides supported by sticks (Ten Anscher 2012). In one case there was a chamber-like structure made of bark (burial 11, Ten Anscher 2012, 332, 335; cf. Fokkens *et al*. 2016, 109). The burials of Hattemerbroek showed a more 'conventional' Beaker pattern, although some of these burials were attributed to the Corded Ware Culture. Burial chambers had also been created, for instance for burial 2 at Bedrijventerrein–Zuid (Drenth *et al*. 2011, 235; Fokkens *et al*. 2016, 153). At both sites pits with a layered charcoal-rich fill were also found, like the pit found at Oostwoud next to skeleton 575.

The sequence of events that we were able to reconstruct at Oostwoud is also very reminiscent of patterns that have been observed elsewhere. Intriguingly, the location of Tumulus II was an area where a flat-grave was present, which only decades or even centuries later would become monumentalized and which then became the location for multiple internments. Apparently, the location of the burial remained in memory of the societies at Oostwoud even though the entire grave became ploughed over at some point. And then in two subsequent phases several people were buried within this monument, some of which may well have died within living memory of one another and some of which were part blood-relatives. This pattern has recently been discussed for a few other burial mounds in the central

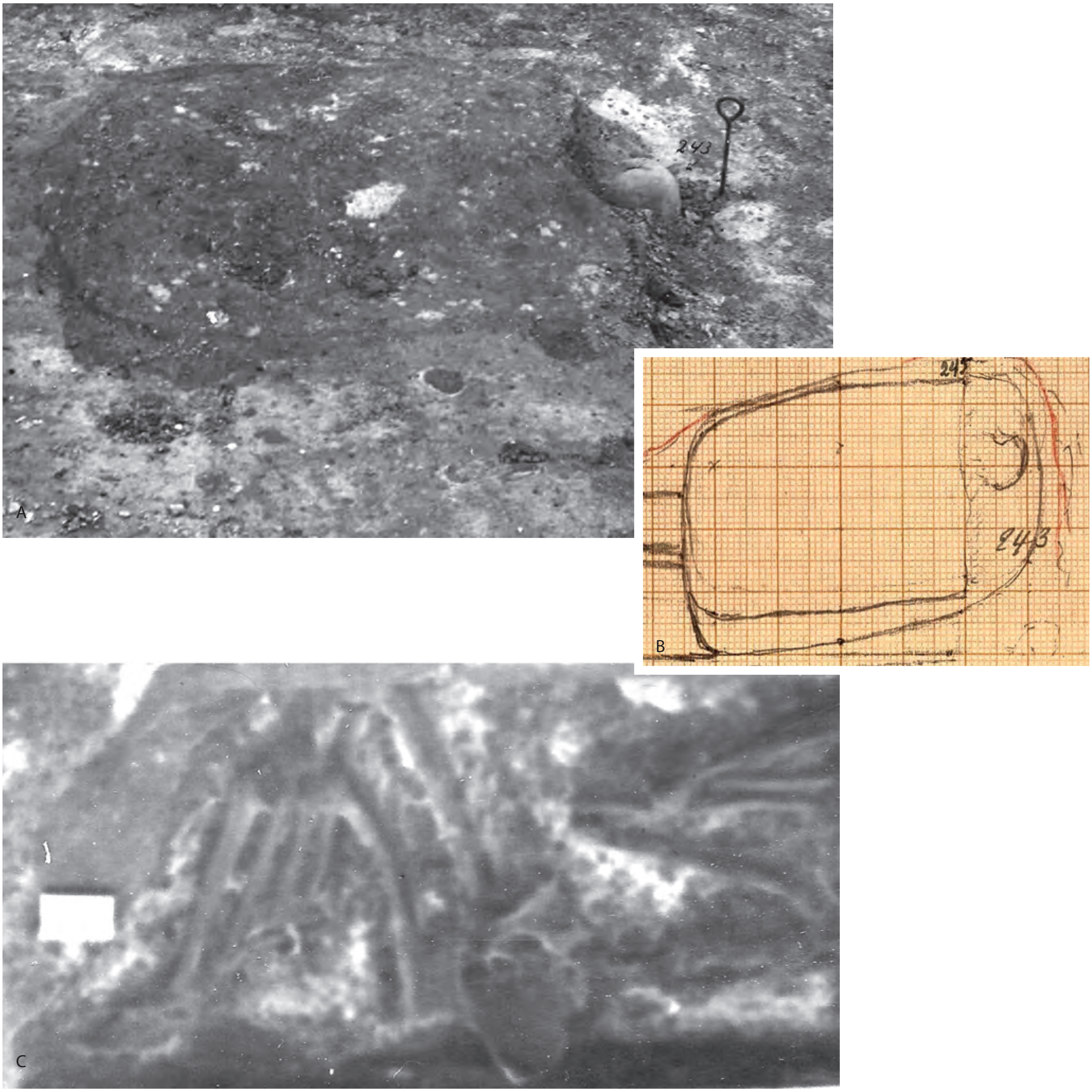

Figure 47 A: Photo showing the burial pit of 243 before excavation. Near the measuring pin the skull has already been exposed; B: fragment of the field drawing showing the same feature and skull. The ‘double’ fill of the pit is visible in both images, they indicate in our view the rim of a basket or mats. Note that the fill of the area inside this ‘basket’ is different from the outer fill, indicating a different process of filling; C: a ‘digitally remastered’ image from a thumbnail on a plan made the Anthropobiological Laboratory. It vaguely shows a skeleton in crouched position with crooked upper-legs

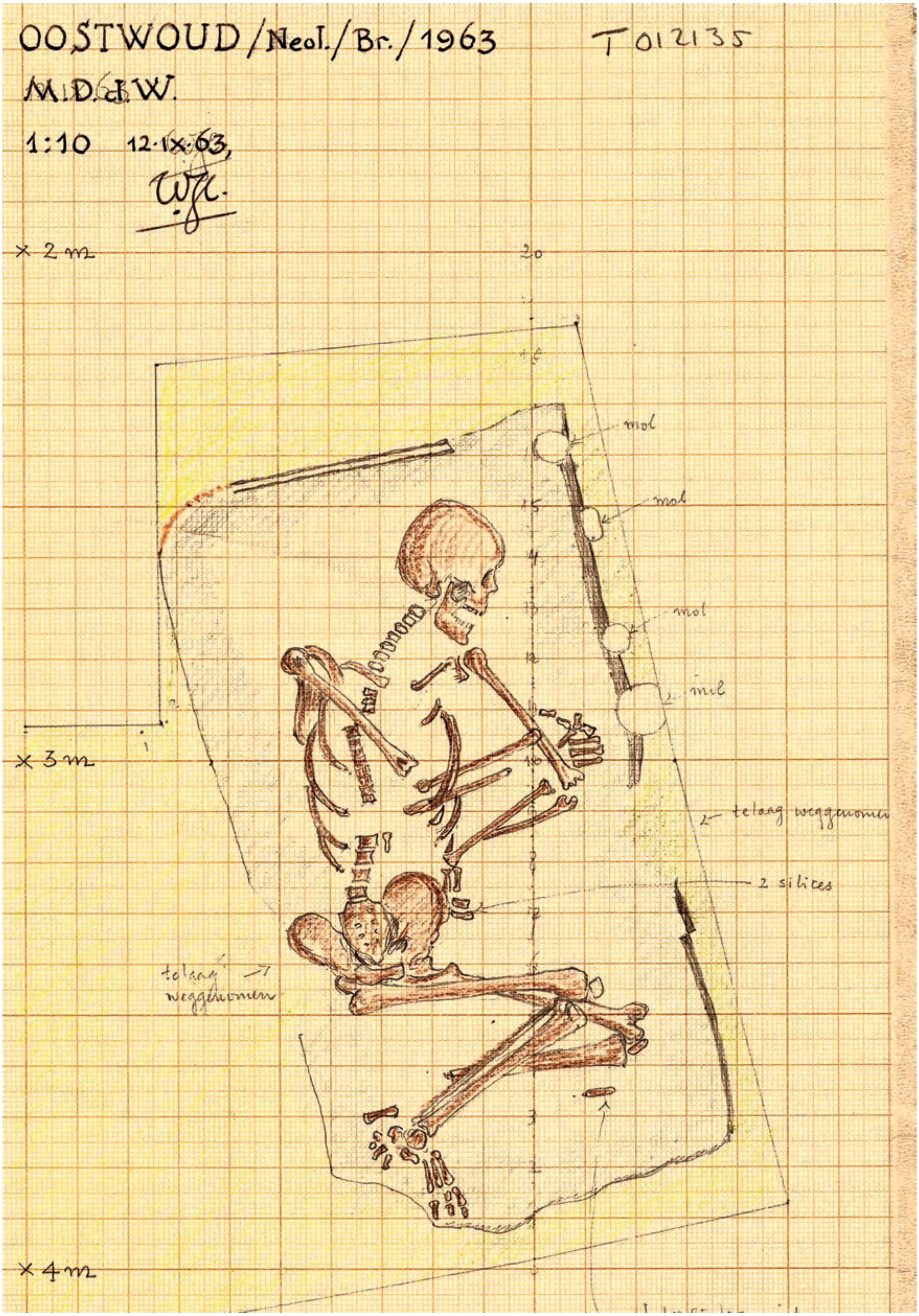

Figure 48 Drawing made in the field of skeleton 575 (see figure 17C: Glasbergen drawing and Maarten de Weerd measuring)

Netherlands (Bourgeois and Fontijn 2015), but highlights the complex interplay of memory and monumentality in later prehistory (Bourgeois 2013).

So the burials at Oostwoud fit a pattern to a certain extent, but they are different as well, as they are concentrated within the context of two burial mounds, which are absent or at least invisible at the other sites in the same area. For Bell Beaker graves, the absence of grave gifts other than flint artefacts is unusual too. At the Veluwe, The Utrechtse Heuvelrug, and the Drents Plateau many Bell Beaker burial mounds have been excavated, but these are generally easily recognised because of the Beakers and other grave gifts. In West-Frisia, there were none. Later interments from the same period are rare for most Bell Beaker barrows (Bourgeois 2013, 164). That is different in Oostwoud. Is this an exception? That is a question for further research. The fact is that most excavations of burial mounds have been carried out like they were in Oostwoud: with unskilled workmen and in spits. That implies that if bones were not preserved and no grave gifts were present, many later interments may have been destroyed unnoticed.

7.2 Treatment of the dead

An issue that is always speculated about in relation to Bell Beaker burials, is the sex-related position and orientation. Drenth and Lohof (2005, 435) for instance, suggest that men were positioned on the left side, facing south, head to the east. Women were placed on the right side, head to the west. At Oostwoud, it seems that there was indeed a difference between men and women. All men were oriented E-W or ‘kind of’ E-W. One female was also oriented E-W, but the other two were oriented N-S. The men were all placed on the left side and faced south, while the females were all placed on the right side facing west or north. Whether or not these patterns are indeed only related to sex is difficult to substantiate on the basis of this small sample.

The possibility of re-burial is underrepresented in Dutch archaeological reports concerning the prehistoric period. At Oostwoud, most of the skeletons were in relatively good condition, but even so parts of the skeleton are missing. The skull of 235 is absent; other skeletons lack arms or legs. The clearest example seems to be 228, where the entire right upper limb was removed from its original position to be placed at the feet. Although a degree of carelessness and lack of expertise of the workmen may have caused the absence of several skeletal elements, this factor does not entirely explain the lack of bones. The presence of single non-articulated bones cannot be attributed to poor excavation alone.

All in all, there are several indications that the prehistoric Oostwoud people manipulated the human remains after death. The extremely crouched position of 239 demonstrates that individuals were not simply subjected to standard rituals. Probably, there were many rules and taboos related to peoples’ functions and expectations of their role after death that determined the way they were deposited. It seems however that a certain standard in burying the deceased did exist: the men all were positioned on their right side facing south, and for all a crouched position.

What is noteworthy at Oostwoud is the shift from a crouched burial position to a supine position stretched on the back that is visible between the two mounds. That change is difficult to date exactly. Both skeletons 230 and 231 were inserted in an existing barrow between 1881-1658 cal BC, which is (at the end of?) the Early Bronze Age (cf. Fokkens *et al*. 2016, 286-287). What inspired the transition in this burial ritual is difficult to determine. It is not a local feature that was restricted to West-Frisia, but this change can be observed in large parts of NW-Europe. It is also something that appears to have been irrevocable. Once it was a custom, crouched positions became very rare indeed.

7.3 A ceremonial landscape?

What makes Oostwoud a special site as well, is the evidence for an Early Bronze Age ceremonial landscape. In figure 15, we see that Van Giffen has recorded four pits in the s-e quadrant of tumulus II. These had the same fill as the pits around tumulus I, an observation that is corroborated by Lanting (field diary Lanting 1978). Two of these pits were excavated in 1977, and in 1978 Lanting re-excavated all of them and tried to follow this alignment in the next field (fig. 49). This proved that we can speak of a true alignment of pits, not in a completely straight line, but nearly so. The length of the alignment is 35 m, and it consists of *c*. 39 pits that on a higher level of excavation nearly formed one continuous ditch, as was the case with the pit circle around tumulus I.[16]

Alignments associated with burial mounds are not unknown to the prehistory of Northwest Europe, but generally these are related to Middle Bronze Age monuments. Here, we seem to be dealing with an alignment that is more or less contemporary with the building of tumulus I, which means it must have been laid out before the date of burial 230 and 231 (*c*. 1880-1660 cal BC). An alignment is also known from Grootebroek (Van Giffen 1953), but in that case it relates to a Middle Bronze Age mound. Whatever these alignments may have meant to the people, one characteristic is clear: they are never oriented on the exact centre of the mound, and appear to have been added later (Fokkens 2013). In West-Frisia, we assume they did not contain posts, because no post shadows were found. Though this may mean the posts were extracted and the pits backfilled, we must certainly consider the option that the act

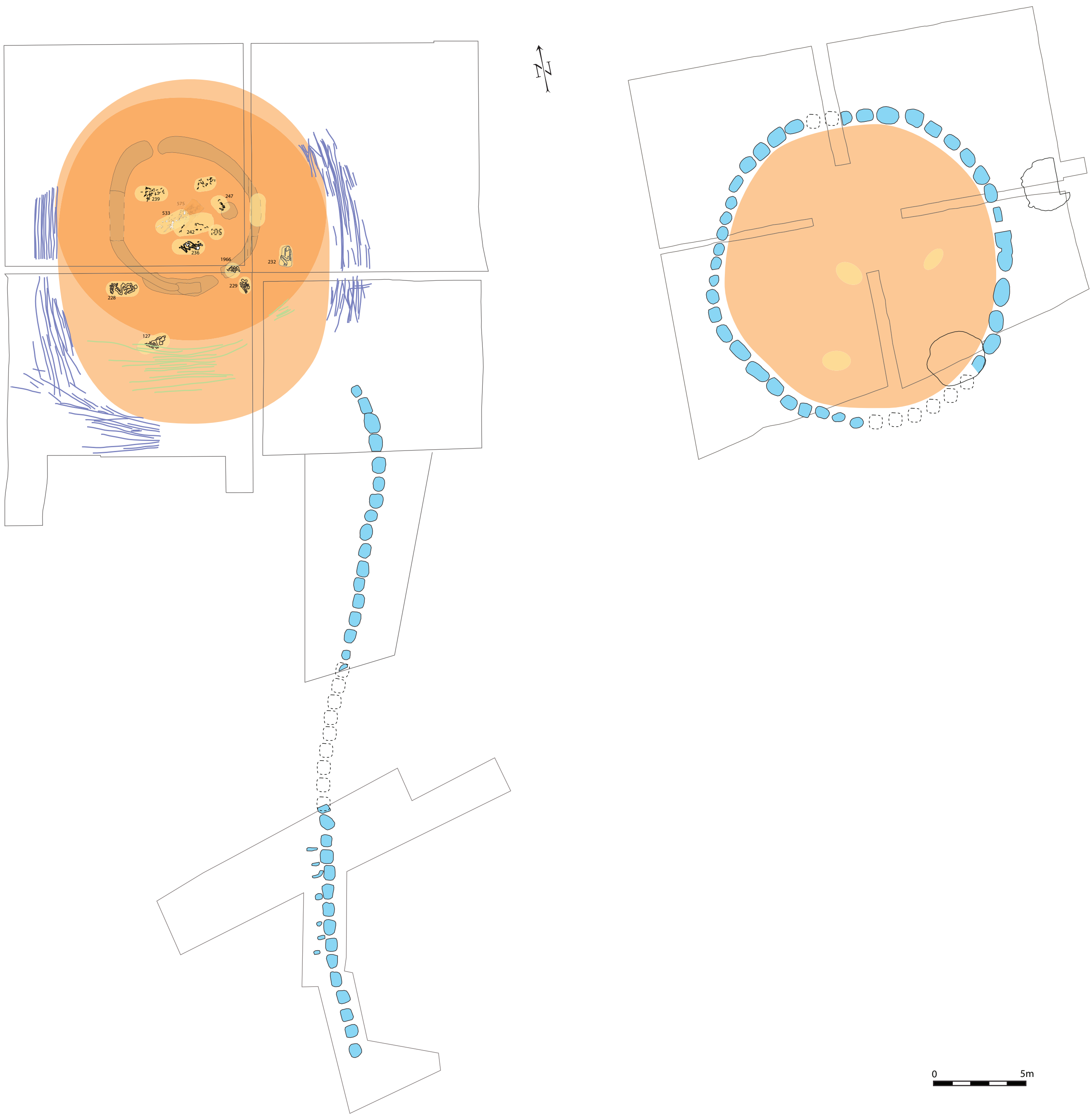

Figure 49 Ceremonial landscape: in the Early Bronze Age, probably at the same time as tumulus I (right) was built around 1800 cal BC, a pit alignment was dug south of tumulus II (left)

of digging was part of the ritual that was probably performed here.

A last observation to be made in this respect is that the pit alignment indicates that that area was not ploughed at the time of digging. Such an alignment would have impeded ploughing. We have no indications of later plough marks, or habitation. It may therefore mean that the area was not used for settlement or arable after the Early Bronze Age. Given the abundance and wide distribution of Middle Bronze Age remains in eastern West-Frisia, one would have noticed at least some features in the extensive 1978 excavations, if Middle or Late Bronze Age habitation had taken place at the site.

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Notes

1 Fokkens is responsible for the excavation analysis and text, Veselka carried out the skeletal analysis, Bourgois is responsible for the dating model, Olalde and Reich analysed and interpreted the DNA samples.

2 Both sets of notes are combined as type-written transcripts of the handwritten notes in dossier 137 at the Depot in Castricum. The transcription also accounts for some mistakes, for instance of the misspelling of prof. De Froe as prof. De Troc, which occurs several times. The hand-written notebook to date is still part of a collection of documents residing at the town hall of Hoorn to date, in a dossier of De Weerd.

3 http://www.knhm.nl/Wie+we+zijn/Historie/default.aspx visited 15 Jan 2017.

4 Mr. J.P. Bijlsma was a medical doctor attached to the 'Laboratorium voor Antropobiologie en menselijke Erfelijkheidsleer' at Amsterdam.

5 Plans and section drawings did not accompany his English language version of the same article (Van Giffen 1961a) or the publication in 'In het Voetspoor van Van Giffen' (Van Giffen 1961b).

6 In Amsterdam the 'doctoraalstudie' (master) had to be completed with the report on an independently conducted excavation. For Maarten de Weerd that was the Oostwoud excavation in 1963. The combined collection of field notes, photographs, find lists, and other documentation of this excavation was called '*protocolboek'*. In this article we will refer to 'field diary De Weerd' when referring especially to that part of the protocolboek.

7 The Leiden and Utrecht students knew each other from working at the Swifterbant excavations. Fokkens, Banga and Van Dijk (with Robert van Heeringen from Leiden University) had also prospected in the Swifterbant area for settlement layers with a three week auguring campaign. The account of the March 1978 campaign is based on the field diary of the first author.

8 The drawings of this short campaign are now stored in the depot at Castricum.

9 This is difficult to understand; we would expect that he meant the east side of the ditch. On the 16th of June he also writes: 'East of this ditch the prehistoric plough soil is still present as a rather thick layer, and there are plough marks present over the whole surface of the trench, west of the ditch the plough marks are almost completely absent.' (field diary Lanting 16th of June). On the 23rd of June, he clarifies this: in the west side of trench III the modern plough soil rests directly on the yellow natural soil. He suspects that recent use of the land has destroyed the Neolithic arable in this area (field diary 22nd of June).

10 'Dat de botten in en op de klokbekerlaag liggen, wijst er op dat het graf (als het een graf is) is ingegraven in het oud-oppervlak van de heuvel…' (field diary De Weerd 31st of July 1963). (translation: "that the bones are lying in and on a bell-beaker layer, indicates that the grave, if it is a grave, was dug into the old surface of the mound…")

11 Praamstra also describes this in his week notes.

12 'Tot nu geen heuvel-begrenzing, tenzij dan in ombuiging ploegsporen.' (translation: 'as of now no hill-limits, except in the curve of the plough traces').

13 On the 17th of April it was removed and taken to the Antropobiological Lab at Amsterdam (field diary 16 June 1956), but there are no other records of it, nor of were the bones preserved, as far as we know.

14 A more detailed osteoarchaeological study will be presented in a separate paper.

15 Here we should mention that in Dutch archaeological practice makes confusing use of the concept secondary. While in anthropology this means re-burial, in Dutch Archaeology a secondary burial has no connotation of re-burial. Dutch archaeologists distinguish between a primary grave, the first burial *underneath* a burial mound, and secondary burials, which are inserted later *in* the burial mound.

16 32 pits were recorded, but some 7 or 8 were probably present underneath the modern ditch that cuts through the alignment. The circle around tumulus I consisted of *c*. 47 similar pits.

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Harry Fokkens, Quentin Bourgeois and Barbara Veselka
Faculty of Archaeology
Leiden University
PO Box 9514
2300 RA Leiden
The Netherlands
h.fokkens@arch.leidenuniv.nl
q.p.j.bourgeois@arch.leidenuniv.nl
b.veselka@arch.leidenuniv.nl

Iñigo Olalde
David Reich
Department of Genetics
Harvard Medical School
77 Avenue Louis Pasteur
New Research Building, Room 260
Boston, MA 02115, USA
inigo_olalde@hms.harvard.edu
reich@genetics.med.harvard.edu

Figuring out: coroplastic art and technè in Agrigento, Sicily: the results of a coroplastic experiment

Gerrie van Rooijen, Loe Jacobs, Dennis Braekmans and Natascha Sojc

Figurines – or terracotta made figurative objects – are a frequently encountered material category in Antiquity. Their importance can be directly linked to an expression of socio-cultural phenomena. To understand the practices and techniques applied in the production of terracotta figurines from Akragas (Agrigento, Sicily), an archaeological experiment was carried out with the aim to reconstruct the full chaîne opératoire. This so-called coroplastic experiment focused on the large variety of female figurines from Akragas dated from the 6th-5th century BC. These form the majority of mould-made objects, which were placed as votives in high numbers at sanctuaries and were also applied as a grave gift. The demand for figurines to be dedicated and the flourishing business of terracotta production in Akragas can be explained by the presence of several nearby high-quality mineral resources, in combination with the craftsmanship of the local workshops. This availability sets the conditions for a strong tradition, resulting in a variety of moulded figurines. In this study, several clays and techniques are selected to re-create the production process with the aim of elucidating the technological capacity and choices made by potters and artisans. The outcome of tests with local clays showed that the materials nearby found fit the workability requirements, but also that by mixing several clays the colour of the figurines could be manipulated. Several generations of a figurine's genealogy re-created in the experiment show how details fade and explain the common solution to replace the head. The use of different tools, such as round sticks as well as metal blades could be distinguished by an interpretative approach to the traces on reworked figurines. The development of characteristics in both design and technique shows a local style, while moulds and figurines were exchanged with other Sicilian towns, such as Selinous (Selinunte, Sicily). However, the appearance, as well as specific production techniques, shows an influence of a different craft tradition, one which points to an eastern Greek origin. In order to distinguish the technological choices and their effect on stylistic developments, a technical approach was chosen to research the production technique and the use of materials by the workshops in Akragas.

1 Introduction

1.1 Akragas' terracotta production

Figurines were produced in high quantities in Antiquity. One of the reasons for this was practical: clay, a very workable material is found abundantly in Sicily. Therefore, figurines and other terracotta objects must have been relatively affordable. Specific designs were developed on the island, during the Archaic Period, lasting until half the 5th century BC (Pautasso 2012). In Akragas (Agrigento) (fig. 1 and 2)

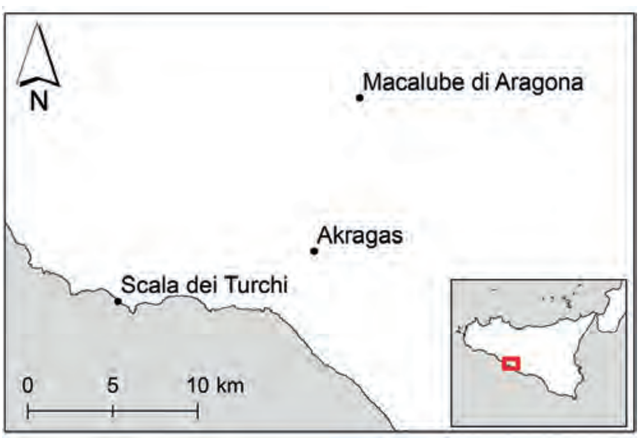

Figure 1 Map with the location of Akragas and the find spots of the clay (I. Dallmann)

Figure 2 Map of the southern part of Akragas with the city wall and three different sanctuaries: 1: S. Anna outside the city. 2: the sanctuary of the chthonic divinities inside the city. 3: S. Biagio at the edge of the city. The figurines used for the experiment (AGS273 and AGS901) were both found at the city sanctuary (After OpenTopoMap.org)

Clay	Consistency	Shrinking percentage	Munsell colour (fired)	Workability
Macalube naturale	Pure	7%	5YR 6/6 Reddish yellow	Highly suitable for making moulds; not very suitable for making figurines.
Scala dei Turchi	Pure	2.5%	5Y 8/2 Light gray (unfired)	Lacking plasticity; not suitable to use as the basic clay to make a figurine or mould. Preparation process: grinding dried pieces of clay and adding to another sort of clay, or adding water to the dry clay.
Macalube naturale / Scala dei Turchi / silt	45% Macalube naturale / 45% Scala dii Turchi / 10% silt	5%	7.5YR 8/4 Pink	Highly suitable for making figurines.

Table 1 The different clays and their features (Van Rooijen)

Generation	Number of figurines produced	Sharpness and visibility of details on the figurines	Shape of the mould and weathering after production
1	11	Sharp. Softer clay used for the face could cause a line. Small cracks at knees and neck with first figurines. Smoothening with water creates vagueness.	No weathering of the mould, slightly distorted mould because of uneven drying: sides bent to the inside.
2	4	Slightly less detailed than generation 1, e.g. flattened nose. Cracks on chest and neck. Damage on sides of the head.	Traces of clay leftover in the mould. Slight distortion. Difficult to unload figurine.
3	1	Vague, specifically the face, very flat nose. Small details, like the necklace, are not visible anymore.	Distorted: head and polos have become visibly thinner. Figurine stands asymmetrically.
4	1	Details are faded, arms and hands hardly visible.	Very distorted. Had to be reworked.

Table 2 An overview of different generations in the experiment comparing sharpness and details of the AGS901 series. The first generation here means the first in our experiment, i.e. made in the matrix, produced in the museum after patrix AGS901 (Van Rooijen)

	Chaîne d'opératoire of a terracotta figurine
1.	Collection of primary material: clay, patrix, tools
2.	Production of a mould of the patrix: matrix
3.	Production of statuettes out of the matrix: the first generation of terracotta figurine-series
4.	(selling and transport) application /use possible surmoulage
5.	deposition

	Steps of moulding	Time
1.	Preparation: kneading the clay, not too dry (cracks) nor too wet	5
2.	Pressing the clay into the mould	10
3.	Drying	40
4.	Additional reworking after taking out	5-10
5.	Firing (and painting)	720

Figure 3 Summarised overview of the steps of the chaîne opératoire and the specified steps in the moulding with an indication of the duration of each step in minutes (Van Rooijen)

such a figurine production became a successful business because of the application of moulds. The coroplastic art must have been a flourishing part of Akragas' economy, as hundreds of statuettes are found near sanctuaries, as well as in graves and living quarters. Its cultic importance created the premises of a local and potential regional business. The moulding technique did not only alter the socio-economical role of terracottas but had a large impact on the variety of designs as well. These effects on the iconographical development are the subject of this article. With his innovative method of classification Nicholls already started to emphasise in 1952 that understanding the production technique is key in completing the picture of terracotta objects, as well as defining the right terminology to describe it (Nicholls 1952). More recently, Arthur Muller described the technology of terracotta production extensively, and his work will act as the main reference for this study (Muller 2000; 2014). The technical aspects are reckoned as an important part of research in understanding the terracotta production as a whole (Burn 2011).

The newly introduced moulding technique replaced the hand-forming production in the 7th century BC. It made figurine production simpler but also created the effect of uniformity. The female terracotta figurines of Akragas, dated between about 525-475 BC, are, however, remarkable for their variety. This diversity seems to be a contradiction and raises questions. Why would such a new technique be implemented, extending the possibilities for the production of rather straight bodied figurines? The manufacturing process of statuettes with a simple rendering of the body, the characteristic block-like design, seems most common in the second half of the 6th century BC. Their production would be speeded up through the use of moulds. The designs of larger and more detailed figurines, however, originates around the transition from the 6th to the 5th century BC. Despite the introduction of a new shaping technique, the characteristics of the traditional design are still visible. This article focuses on the impact technological and skill development had on the design, the tension between a comfortable production and a wish for a more complex and varied design. A second question is whether another group of terracottas, that of the piglet-carrying figurines, from the second half of the 5th century BC relates to the main production as well, and whether the variety appreciated earlier is replaced by a single design.[1]

To answer the questions and comprehend the (dis-) advantages of this technique, practical research was necessary to fully understand the coroplast's work (fig. 3). For this purpose, the characteristics of the clay from nearby Agrigento were examined (fig. 1 and table 1). Furthermore, figurines were moulded after two examples from the Museo Archeologico Regionale "Pietro Griffo" di Agrigento: one smaller simple type (AGS273, fig. 4) and one bigger (AGS901, fig. 5) sized with a higher resolution of details.[2] Specific questions we had regarding the moulding techniques and the figurines of Akragas could be answered by reconstructing a genealogy with moulds and figurines of four generations (table 2). The objects chosen as patrix in this experiment are exemplary for two sorts of figurines and are common designs among the statuettes from Akragas. They are typical for the range of variations in size, adornments and sharpness.

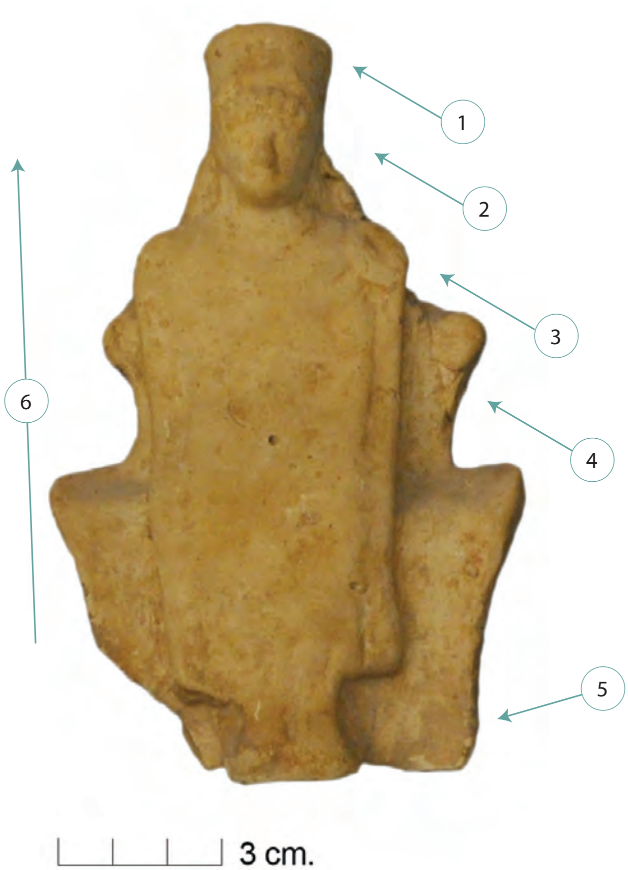

Figure 4 Frontal view of AGS273 (Van Rooijen). AGS273 is a nearly complete 13.9 cm. tall, simple figurine with a short trapezium or block-like shaped flat body. 1: She wears a low polos (hat). 2: A short neck and round face with her hair hanging loose in regular waves at each side. Her facial expression is not very well visible. 3: She wears a straight dress. The pectoral chain, an impressed double line, is attached to her clothing with round clasps. The disc shape is repeated as decorative ending of the throne. The throne/chair consists of a wide bench with a back rest. 4: Her arms are not depicted. 5: Her feet are sticking out and set on a small pedestal. 6: The back is column-shaped and flat. Among some other inclusions, there is a shell fragment on the backside of the seat. A hole in the front middle is probably caused by the spalling of a lime-grain. The colour is 10 YR 7.3, very pale brown

Figure 5 Front and side view of AGS901 (Van Rooijen). AGS901 is a nearly complete 26.8 cm. tall figurine with a flat body and arms. The lower part, with the feet, is broken off. Her posture creates the impression of a sitting figure: the upper body is leaning backwards, and there is a slight bending at the knees. The statuette is not able to stand by itself because of the straight backside and the therefore very thin body. The body is 'abstract' without natural shapes. Femininity is merely indicated by her facial expression and the plurality of her jewellery. The upper arms are very flat, which is hidden by the folds of her garment. They are probably an addition in this type, because they are 'deeper', as an extension of the so-called ependytes, the straight dress. Elbows are absent, but she holds her hands, with bracelets, on her knees. She has an Archaic smiling mouth, small but with thick lips, large eyes, fleshy cheeks and hair in rhizomes. She wears big earrings and a high polos with a discs-in-squares pattern. Pendants in three rows cover her chest. The two upper rows, between the rectangular 'fibulae', consist of seven similar pendants, roundish triangular shaped. The third row consist of eight elongated, pointy pendants. She also wears a tight necklace with a round pendant. The rear side is flat at the top and column-shaped at the bottom. The colour is 7.5YR 7.4 pink. AGS901 is found at the City Sanctuary as well and is dated to the first decade of the 5th century BC by Albertocchi 2004, 16 no. 18

1.2 *From clay to figurine*

Local production could be proved by tracing the provenance and use of clays. Clay samples were collected from nearby Agrigento and tested on workability and shrinkage behaviour. The latter is of high importance because of its effect on new generations in a series of mould-produced figurines. The use of different mixtures of clay would reduce these effects and as such prolongs the usability of these moulds. Such characteristics and practices would not only mark locally made terracottas but possibly distinguish the different workshops of the town as well.[3] After the required clay mixture is prepared, the second step of the coroplast's work, in order to be able to produce a sequence of figurines, is to make a mould after the selected object, the *patrix* or archetype. The use of a deep mould tends to keep the figurine hollow which eases drying and firing. Out of the first mould, the *matrix*, numerous figurines of almost identical shape can be produced in a relatively fast and smooth fashion (fig. 3). During these steps, the results of working with different tools, circumstances, and their effect on the outcome are of specific interest. What does the coroplast need and how do processes interact differently with the materials? The reconstructions included the firing process as well. Specific oxidation and reduction firings and tests with different firing trajectories were, however, not part of the objective of this study. It is clear that the Akragantine figurines are fired more or less at the same temperature, or at least with restricted variation. It is probable that several coroplasts combined their products in the same kiln load because firing must have been the most expensive part of the production process. All objects in the experiment were fired at about 750 degrees Celsius in an oxidation atmosphere. The last part of this investigation concerned the effect of the intensive use of moulds and the production of new generations within the same genealogy. The different versions and the possibilities to alternate the design were as well of interest because a range of varieties within the same series is found archaeologically. Specifically, differences in details of the observed reworked edge, the addition of a seat or the replacement of the face are common features of alternative figurines.

2 The experiment: from clay samples to terracotta statuettes

2.1 *Clay*

Two sorts of raw clay materials, which can be easily found today, were selected as samples from nearby Agrigento (fig. 1).[4] The first clay is from a natural park, *Macalube di Aragona*, where hot volcanic gases bring clay to the surface in a liquefied form, where it can be picked up over a vast area. This clay is very fine, dark grey and turns a light-red colour after firing. The clay works well in its pure form but suffers from uneven drying. The second source is a remarkable natural phenomenon as well: the white mudstone deposits of Scala dei Turchi. This fine, very white marlstone is hardly useable on its own, but suitable to be mixed with the clay from Macalube. The addition of a lime-rich substance facilitates the drying of the resulting clay body. Such a mixture of 75% of 'Macalube' with 25% of 'Scala dei Turchi' results in a very workable clay body that does not stick too much to the surface of the mould, nor does it shrink too much. Its colour turns pinkish beige after firing. By mixing these two clays as well as some silt, shrinkage was reduced from 7% to 5% (table 1). A significant difference with utilising pure clay was that this mixture performed much better during the drying process. The tendency to deform by warping was reduced. Drying became more uniform, due to the open structure of the lime-containing clay body. The lighter tint of the clay might have been one reason to mix clays. About 73% of the Akragantine figurines are pink, very pale brown or reddish yellow[5] and it seems that the original colour was in most cases meant to be seen, though some parts would have been highlighted with red and black paint (e.g. AG1145).

2.2 *Figurines*

The clay should be intensively kneaded with some water to be properly mixed and be brought in a good plastic condition. When the clay is pressed into the mould while it is too dry, cracks appear on the surface. The preparation is laborious because the marl clay needs to be ground. Grinding the marl rock to a very fine fraction is necessary to avoid 'lime-spalling'. Its grains behave like chalk pieces expanding upon firing, causing fractures of the ceramic structure if the size of the grains is bigger than 250 μm. Though it depends on the size and details, it usually takes around 10 minutes to press the clay into the mould. Commonly, the more articulated and thus deeper parts, such as the nose, need to be pressed in separately to make sure that the soft clay will follow all the irregularities of the mould. Therefore, a more detailed mould would require more time and expertise. The face in this respect has to be considered the most difficult part, because even small changes to its details could alter the facial expression. Figurine AGS273 (fig. 4) already had a quite worn face, resulting in even vaguer impressions of the final figurines in new generations. The use of a separate lump of soft clay to form the head mostly causes a line on the chest, if no special precautions were taken to avoid it. The typical chest adornments, sometimes only marked by a line, seem a striking coincidence. It might be that the line caused by the moulding was taken up as an extra accentuation of the adornment on the chest. Or, the other way around, the chest adornments would be perfect to hide this mark of the moulding technique.

The moulds are self-unloading, and after around 40 minutes the object can be taken out. Using this time to fill other moulds, an estimated number of four statuettes could be worked on simultaneously. A deeper relief makes it more difficult to take the figurine out of the mould. When it is still too wet, the heavy clay is vulnerable and can easily break. The latter usually happens in the places where the legs are attached to the body, specifically for the bigger figurines because the angle at the knee is quite sharp. This problem might be the reason that many figurines have evolved as short bodies and just bent slightly, sometimes with bulging knees, to give the impression of sitting. Technologically, a less sharp angle solves this problem: the figurine can be taken out of the mould easier, without risking to break it. After reworking the edges and smoothening the surfaces, the object needs to dry for a couple of days before firing. A longer drying time in the mould would decrease the chance of damage to the figurine but would also make it harder to rework. When the statuette dries in a standing position, it tends to bend a bit due to gravity and as a result it looks downwards. The head and polos (hat) of the bigger figurine are rather heavy to be carried by the thin and at the time of production still flexible clay body (fig. 6). The mould should be dried and eventually cleaned afterwards. Otherwise, clay residues would stick to the next figurine.

Figure 6 Figurine replicas produced during the experiment. The figurine, from the second generation, is taken out of the mould and partly reworked. The too narrow mould causes the damage to the nose and the sides of the head. Small cracks in the clay in the neck show that some force was used to take it off the mould. Note also the sharp lines on the side and on the back caused by reworking with a thin knife. Also visible in the picture is the tendency of the figurine to bend to the front, because the head and polos are heavy and the clay still flexible (Van Rooijen)

2.3 Additions and editions

The figurines from Akragas are made from a single mould, which forms the front side, and, except for some small figurines, they are hollow and open only on the bottom. After the clay is applied in the frontal mould, the back could be made by draping a thin slab of clay over a temporary support on the inside. In order to keep the figurine hollow, ropes and pieces of cloth were successfully used in this experiment (fig. 7). Possibly a bladder of an animal would have generated the desired result. The cylindrical shape of the back in particular is an argument for this suggestion (fig. 5). For a smaller object, such as AGS273, a filling is not necessary. After the front and back of the figurine are put together, the inside could be strengthened by pressing

Figure 7 Figurine AG1141: The imprint of the inside of the back shows straws and fingerprints. At the same time, the elliptical shape is regular. This form strengthens the idea that a piece of cloth or an animal bladder filled with straws was used to hold the slab of clay of the backside of the figurine (Van Rooijen)

additional clay to the seam. On the outside, a rim of clay overlapping the frontal mould could be left in place to form an extra rim or just be cut off at the edge. Both possibilities are known from Akragas (fig. 8). A wide rim around the body would have strengthened the vulnerable parts, such as the neck. To some, this rim might have had a certain appeal and it was reworked straight, in other instances, it has been completely removed. For this reworking, a sharp tool like a thin knife was probably used (fig. 6).

The cutting variations of the extra rim make clear that the backside was a differently worked slab of clay. However, figurine AGS896 (fig. 8) also shows, a figurine with such an extra rim of clay attached to the frontal mould. The softer, more rounded edge indicates that the broad rim along the body and head was part of the frontal moulding and made before the back slab was added. This figurine is part of a group of the same moulding genealogy, of which the rim is worked in different ways.[6] The edge of a figurine with a rim, probably from the same mould genealogy, in the collection of the Allard Pierson Museum, Amsterdam is much more straight and very wide.[7] This rim was cut straight with a tool after front and back were pressed together. Another

Figure 8 AGS896 on the left and AGS899 on the right: Though hard to see on the picture, AGS896 has a slightly protruding line from the right side of the throne over the arm and the lap. This indicates a crack in the mould. The clay had many inclusions, of which some are burned leaving small holes at the surface. This object is also remarkable for its rim of clay, which seems to have overlapped the front mould. The outer edge of the back is cut away next to it. h. 20cm.
In comparison AGS899, from the same genealogy, but without rim. It is probably a younger generation, because it is smaller, but features the same line on the arm and lap. The bigger difference in height is due to the podium AGS896 is set on. The rather coarse clay they are made of is also visible in the rough breaking. The clay of this figurine shows many insertions, among which are shell pieces. h. 16.6cm (Van Rooijen)

Figure 9 Figurine AG 1141: The facial features of this figurine are seen as Ionian influences. The face is round and fleshy with a large nose, slanted eyes, puffy cheeks and a voluptuous mouth curving up. The veil draped over the polos is reminiscent of Ionian influence as well. The backrest of the throne is formed by the rear slap of clay. Though broken off on this figurine, we know that the throne had projecting 'ears' at each side at the top (Van Rooijen)

application of the rim, at least partly, is to shape it into a chair. The chair or throne that is formed from a slab of clay is usually composed of a wider bench, sometimes curving up at the sides, and a backrest with rounded endings (e.g. AG1141, fig. 9)[8]. Smaller and less wide furniture is usually part of the mould. While the figurines from the same genealogy as AGS901 are seated, they are in Akragas depicted without a chair. This omission as part of the reworking would have saved the coroplast quite some time. An additional seat, which was added in the experiment, changes the impression of the object considerably. Probably alternative designs and different techniques were practised side by side. Local habits and maybe even workshops might be distinguished by tracing the different characteristics.

2.4 A comparison with Selinous

The resemblance in both design and technical aspects of production between Selinous and Akragas is striking. Figurines or even moulds are likely to have been exchanged between the cities[9], as well as technical skills. Both settlements developed their own variants and artistic characteristics. One of those is the use of a vent in the terracotta production of Selinous. Such a vent is rather large and placed in the middle of the back, oval in shape and unnecessary for firing, as the base of the figurine is already open. One reason might be that reworking after moulding was preferred when the figurine was not completely dry yet. The vent would have facilitated drying at an earlier state or might have been used to efficiently consolidate the front and back by smoothing the seam on the inside.

Another example of different reworking between Akragas and Selinous is the shape of the throne. In Akragas, as mentioned above, it seems to have been common in this particular series of AGS901 to leave the chair away, while in Selinous artisans used the extra rim as the outline of the statuette as well to make a throne.[10] Some unpublished objects from Selinous originating from the same genealogy as AGS901, have a different curving of the lower part of the throne on the right side. The shape, however, is comparable to other figurines with thrones from Akragas (fig. 8).[11] Coroplasts from Akragas and Selinous might have inspired each other with the design, but could have exchanged technical skills as well. The flexibility of the coroplastic art facilitated the creation of a wide range of designs, even within the set outline of the image of the seated figurine.

2.5 Mould

Designing and constructing a mould deserves more attention than shaping a figurine. The clay should be in a relatively soft and wet condition in order to have all the details from the original pressed in well. For the production of moulds, the untempered Macalube clay seems to be preferable in order to obtain the most detailed result. Another reason not to include the ground clay of Scala dei Turchi here is the risk of lime spalling. The mould is formed by pressing a rather massive clay slab carefully around the front of a statuette. It needs to dry much slower and therefore longer, preferably a couple of hours, before removal. This time is required because the walls are much thicker than those of a figurine. Before firing, it needs to dry for a couple of days to decrease the risk of expanding moisture when the object is fired.[12] The decision to make the moulds of Macalube clay had, however, the disadvantage of an increased shrinkage and turned out to be problematic. During drying the sides tended to bend inwards, narrowing the space (table 2). This defect became apparent when we used the mould to make a figurine. The narrow space was not large enough to remove the head. It caused damage to both the sides of the head and, when moving in a wrong direction, damaged the nose as well (fig. 6). This problem seems to have occurred at Akragantine workshops as well: e.g. AGS899 has a flattened nose and chin.

Shrinkage of moulds and figurines, in both the experiments and the originals, resulted in figurines of the new generation being 11% smaller than figurines of the previous generation. This percentage depends, however, on the sorts of clay and its composition. It might seem marginal, but because a figurine is a three-dimensional object the decrease in volume is well visible. More problematic is the decline in sharpness in the production of new generations. Furthermore, the distortion of the moulds considerably affects the figurines (table 2).

The expression fading out is most noticeable for the face, but other details such as the hands on the lap and jewellery also become increasingly vague in a new generation. Replacing the head seems to have been an option regularly applied in Akragas.[13] Often this occasion would have been taken up to introduce a new sort, like the Ionian face which appears on the AG1141 and is dated in the second half of the 6th century BC (fig. 9)[14]. A newly produced mould was an opportunity for small alterations as well, like the addition of a necklace. Such details could easily be pressed into the freshly shaped mould.[15] The different replacements or changes suggest which parts of the figurine were regarded as most important. Reviewing the alterations, corrections, and additions by Akragantine coroplasts it seems that the face, the chest pendants, and the seated position played a significant role in the meaning and function of the votive as a whole.

3 Conclusions

The result of the tests on local clay mixtures found near Agrigento analysed in this experiment can be described as a process of assembling various positive material characteristics. A combination of Macalube di Aragona clay and a calcareous source, like the marl of Scala dei Turchi, reduces the shrinkage significantly when compared to the result of natural clay. The second outcome of this mixture is the softened colour tone of the fired clay. This colour might have been preferred over the darker more reddish tint of the unmixed clay. Indeed, most of the figurines from Akragas have a soft beige pinkish colour. Such a specific comparable mixture of clays was, therefore, plausibly utilised in the past. The forming of figurines in the moulds, the next step in this experiment, turned out to be relatively straightforward, but only if the clay is prepared well. Cracks or other imperfections can easily be reworked before firing, but the lime-spalling cannot be covered up later. To avoid this problem, a mould of a new generation of figurines was made of natural Macalube di Aragona clay instead. However, uneven drying caused distortion, and the shrinkage remained considerable. In particular, the first effect can have a negative impact on the face. The facial expression is easily damaged and fades in new generations. Reworking other parts of the figurine to sharpen the impression or to add details, such as a chair or fibulae, can be achieved. During the process, the utilisation of different tools was necessary: a round stick to create an evenly flat slab of clay, a small knife for reworking, and something to fill up the figurine to keep it hollow.

These outcomes of the experiment make it possible to recognise the different marks on the figurines, as they are the result of the applied techniques. The hands-on method of research gives us a better understanding of the practical issues the coroplasts had to handle. Below are some observations regarding the technical aspects of the Akragantine figurines.

The technique of moulding figurines is not too complex to apply, it saves time and does not require much creativity, compared to forming figurines by hand. This method, together with the specific nearby availability of high-quality clay raw materials, might explain the high number of objects produced in Akragas. The resulting series of nearly identical objects would only stop when its mould was no longer usable. The experiment showed that forming a new mould, preparing the right clay, and changing the design required specific skills and considerations. The decreasing volume and sharpness, in particular of the face of these ‘new generation’ figurines was problematic. These difficulties might explain the long use of mould-series and the gradual changes in the design of Akragantine figurines, such as the addition of arms. A coroplast would rather change something in a freshly made mould or a figurine than form a complete new figurine by hand to be used as a patrix. AGS901 is a clear example of such a reworking: the arms are comparatively deeper. Such details and additions could be an indication of a change in iconographic preference. Another example is the increasing number of chest pendants. Without any direct incentive, the general appearance of objects did not tend to change drastically. An alternative iconography could depend on the coroplasts' skills or on an occasionally imported figurine that could be used as patrix. One of the most frequent alternations is the replacement of the head. Not only fashion, like the Ionian face, but also fading in new generations, might have been the reason. Weathering because of frequent use of the mould could not be proved: in the experiment the mould was still sharp after 11 figurines had been made with it. New generations, however, had a large impact on the sharpness of the face and other detailed parts.

The moulding technique itself has a conservative effect on the design. However, Akragantine figurines show a great variety in the application of tools and the quality of the artisan's work, as well as details on the design. The different places of origin of these features in combination with high frequencies of local variables indicate that coroplasts were inspired by each other's work, and that moulds figurines or ideas on technique and design were exchanged between workshops of Akragas and Selinous. The creativity of the workshop, however, was angled by the moulding technique.

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The authors want to express their gratitude to the responsibles of the Museo Archeologico Regionale di Agrigento 'Pietro Griffo', in particular to the directors Gabriella Costantino and Gioconda Lamagna, as well as to Donatella Mangione. *Le foto di soggetto archeologico sono tutelate dal Copyright Regione Siciliana – Assessorato Reg. le dei BB. CC. e dell'I. S. – su concessione del "Polo Reg.le di Agrigento - Museo Archeologico "Pietro Griffo" – divieto di duplicazione con qualsiasi mezzo.*

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Notes

1 De Miro 2000 dates the earliest piglet carrying figurines as early as the end of the 6th-beginning of the fifth century BC, but the majority dates around the second half of the 5th century BC. This change in design is then radical, a completely different iconography with the depictions of the adorant instead of, probably, the deity. The typical iconography is a female figure, dressed in loose clothing with many folds, carrying a piglet. These figurines are as well made by using moulds. Sguaitamatti 1984.

2 Cf. resp. Albertocchi 2004, 58 and 16. If no other indication is given, inventory numbers refer to pieces from the Museo Archeologico Regionale "Pietro Griffo" di Agrigento.

3 Next to this experiment and a detailed investigation of the objects, an XRF-test was done on the elemental composition of the clays. These measurements will show to what extent the elemental composition of the clays are identical. The combined results will be part of Gerrie van Rooijen's PhD-thesis at Leiden University, funded by the NWO.

4 Macalube di Aragona, (37° 22' 31.68" N 13° 36' 2.37" E) and Scala dei Turchi (37° 17' 23.88" N 13° 28' 21.58" E) are about 12 km. walking distance from Akragas, respectively to the north and west. Because of the limited amount we could bring we also used some commercial local clay from Agrigento with similar properties as the Macalube di Aragona clay. We believe the rich supply of clay at Macalube di Aragona is still used as a base source today. Commercial clay from Agrigento showed similarity in colour and workability.

5 Description as in the Munsell Color System.

6 Agrigento: AGS281, AGS288, AGS893, AGS894, AGS895, AGS896, AGS897, AGS898 and AGS899.

7 APM01419 from Sicily. Picture and description: https://www.uvaerfgoed.nl/beeldbank/xview?identifier=hdl:11245/3.2331; R.A. Lunsingh Scheurleer, Grieken in het klein, p. 53-4 no. 41 Comparable in both the design and rim reworking of Type BXV from Selinous. See Dewailly 1992, 88 fig. 51. This figurine is another good example of a common practice to compensate the reduced height. Figurines from later generations, smaller in size because of the shrinking of the clay, are elevated on a podium with footstool.

8 Albertocchi 2004 13-14 n. 1 Tav. Ia; De Miro 2000 130 Tav. LXII 34. Cf. Schipporeit 2014, 323-4

9 Albertocchi 2004, 101 n. 78 states that a group of statuettes, to which AGS273 belongs, from Akragas is derived from a series from Selinous, but without the chest pendants. To this group in Akragas belong as well: AG274, AG885, AG886, AG887, AG888, AG889, AG890, AG891. They are all found at the city sanctuary.

10 Cf. SM Pal T1254 from Selinous. See Dewailly 1992 86 fig. 49. AGS899 and AGS896 (fig. 8) strongly resemble figurines of Dewailly type B XV. Dewailly 1992, 86 describes variants (different parts of the rims left) of Type B XV. She states, however, that the backside is made out of a mould as well. The cutting variations of the extra rim make clear that the backside was a differently worked slab of clay. Cf. other Akragantine figurines n. 6.

11 Cf. Albertocchi 2004, 25 no. 105 and no. 108. This type, A VIII, was very popular in Akragas and Selinous and of a total of 417 statuettes, Albertocchi distinguishes 4 generations, the first two from Selinous with 399 figurines, 17 from Akragas and 1 from Ibiza. Albertocchi 2004, 24-7.

12 Though the moulds would be stronger if they were fired on 950-1000° Celsius, the walls would not be porous enough to let moisture through and so unloading would not work well.

13 See discussion on the facial features: Albertocchi 2004, 14.

14 Ionian influences are mentioned by De Miro 2000, 101. The veil draped over the polos, running down on each side of the headgear and face, is a typical Ionian fashion as well. Langlotz and Hirmer 1963, 72 no. 68.

15 A certain workshop seems to have had the tight necklace with one small round pendant as a typical characteristic of its figurines. It is sometimes added to the figurine: pressed in the freshly moulded unfired figurine (AG1157), or to the mould directly (AG1141), probably when the head was replaced. Both figurines have a similar, specific face.

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Gerrie van Rooijen
Loe Jacobs
Dennis Braekmans
Faculty of Archaeology
Leiden University
PO Box 9514
2300 RA Leiden
The Netherlands
g.k.van.rooijen@arch.leidenuniv.nl
l.f.h.c.jacobs@arch.leidenuniv.nl
d.j.g.braekmans@arch.leidenuniv.nl

Natascha Sojc
Universität Augsburg
Klassische Archäologie
Universitätsstraße 10
D - 86159 Augsburg
Germany natascha sojc
natascha.sojc@philhist.uni-augsburg.de

Location preferences of rural settlements in the territory of Venusia: an inductive approach

Anita Casarotto

This paper aims to point out the location preferences underlying the pattern of rural settlements located in the hinterland of the ancient town of Venusia (Southern Italy). An inductive approach is used to systematically analyze differences and similarities in location preferences of different settlement distributions. Specifically, distribution graphs are constructed from and statistical tests are applied on the existing settlement dataset to identify significant correlations (and trends in these correlations) between the settlement positions and several environmental and cultural characteristics of the landscape. These correlations can provide valuable insights into favored or avoided land units for settlement in the Hellenistic and Roman periods (particularly in the 4th – 1st century BC) in the territory of Venusia.

1 Introduction

This analysis explores and describes the location preferences exhibited by distributions of ancient rural settlements. Certain cultural and physical characteristics of the landscape could have influenced the pattern underpinning the empirical settlement evidence recorded by means of field surveys (first-order effects, Orton 2004; Palmisano 2013, 349; see discussion in Stone 1996, 6-27). This paper addresses whether this may indeed be the case for the pattern of ancient settlements in the Hellenistic and Roman colonial landscape of Venusia (Southern Italy). Through an inductive analysis, significant correlations and statistically meaningful trends in patterns are formally pointed out.

It is important to state, however, that the settlement rationale behind the detected location preferences will be investigated thoroughly in another paper (Casarotto *et al.* forthcoming). As a matter of fact, in the above mentioned forthcoming paper the trends in pattern that are identified in the inductive analysis presented here are going to be confronted also with those identified in a previous analysis (Casarotto *et al.* 2016) in which, instead, a deductive approach had been used. This comparison between the results from inductive and deductive analyses will enable us to eventually move from observations of patterns (some of which are described below and some others are reported in Casarotto *et al.* 2016; forthcoming) to interpretations of these patterns. The current paper, however, focuses on a quantitative and systematic description of the data available, and some of their correlations with the landscape.

The relationship between landscape variability and changes in the properties of settlement distributions is the main object of study of locational analysis (Haggett *et al.* 1977; cf. the critical discussion in Barnes 2003). The inductive approach to locational analysis falls under the umbrella of the ecological tradition of studies in human geography. It investigates how people adapt to the environmental conditions of the geographical setting where they live (above all to physical conditions) and if their settlements are located in some predictable way with respect to this environment (see Haggett *et al.* 1977, 1-6 for a description of the two, economic- or ecological-locational traditions of studies in human geography).

This ecological approach has been particularly influential in archaeological predictive modeling (Judge and Sebastian 1988; Kvamme 1990a; van Leusen and Kamermans 2005; Verhagen 2007; De Guio 2015; see criticism in Wheatley 2004). Regional inductive modeling (Kamermans and Wansleeben 1999), also known as data-driven predictive modeling (Wheatley and Gillings 2002, 166), aims to predict the position of archaeological sites in regions were systematic investigations were not conducted. It does this by projecting onto the *terra incognita* the correlations between settlement and environment that were previously detected by means of observations and/or statistical tests in known samples and regions (see the discussion in Kvamme 2006, 2011; for an example see Carrer 2013).

The focus of this paper lies on identifying these correlations for research purposes (Casarotto 2015, 35-38), rather than on predicting new sites in unexplored regions. The area under consideration here was systematically surveyed between 1989 and 2000 (Marchi and Sabbatini 1996; Sabbatini 2001; Marchi 2010; see also Stek 2012). Complete survey coverage of all accessible fields has been carried out and a representative sample of the (visible) surface evidence can be expected to have been successfully recorded. In this paper an explorative, bottom-up analysis is implemented on the available settlement record to point out the ecological zones and the land types within the surveyed sample area that, on the basis of attractive or repulsive properties, may have prompted the already-known settlements to favor or avoid certain locations. Eventually, this inductive location preference analysis will offer the opportunity to gain further understanding of ancient settlement strategies in this surveyed region of Southern Italy (Casarotto *et al.* forthcoming).

2 Data

The hinterland of the ancient town of Venusia was systematically surveyed by an Italian team led by M. L. Marchi and G. Sabbatini, who published in three books precise data about the position, the size and the chronological range of occupation for each site recorded (Marchi and Sabbatini 1996; Sabbatini 2001; Marchi 2010). On the basis of this information sites are organized per size and per period (see table 1 and fig. 1). For the purpose of this paper, the position of these attested archaeological sites was digitalized in GIS using the site distribution maps attached to these books (IGM maps, 1 : 25,000) as a georeferenced base. Only the location of the settlement sites was considered in the presented analysis.

It is important to bear in mind that the size of those settlement sites with multiple phases of occupation (*i.e.* "inherited settlements" in table 1) may have been different in the different phases (*e.g.* for multi-period large sites)[1]. It is difficult to trace, in the field, the chronological development in size of a site simply through the visual inspection of the artifact scatter configuration. For the majority of these inherited sites, surveyors could record only their largest extent.

An inductive analysis was implemented on the settlement samples listed in table 1, which are organized per period and per size. While it must be acknowledged that unpredictable or irretrievable cultural and environmental factors may have

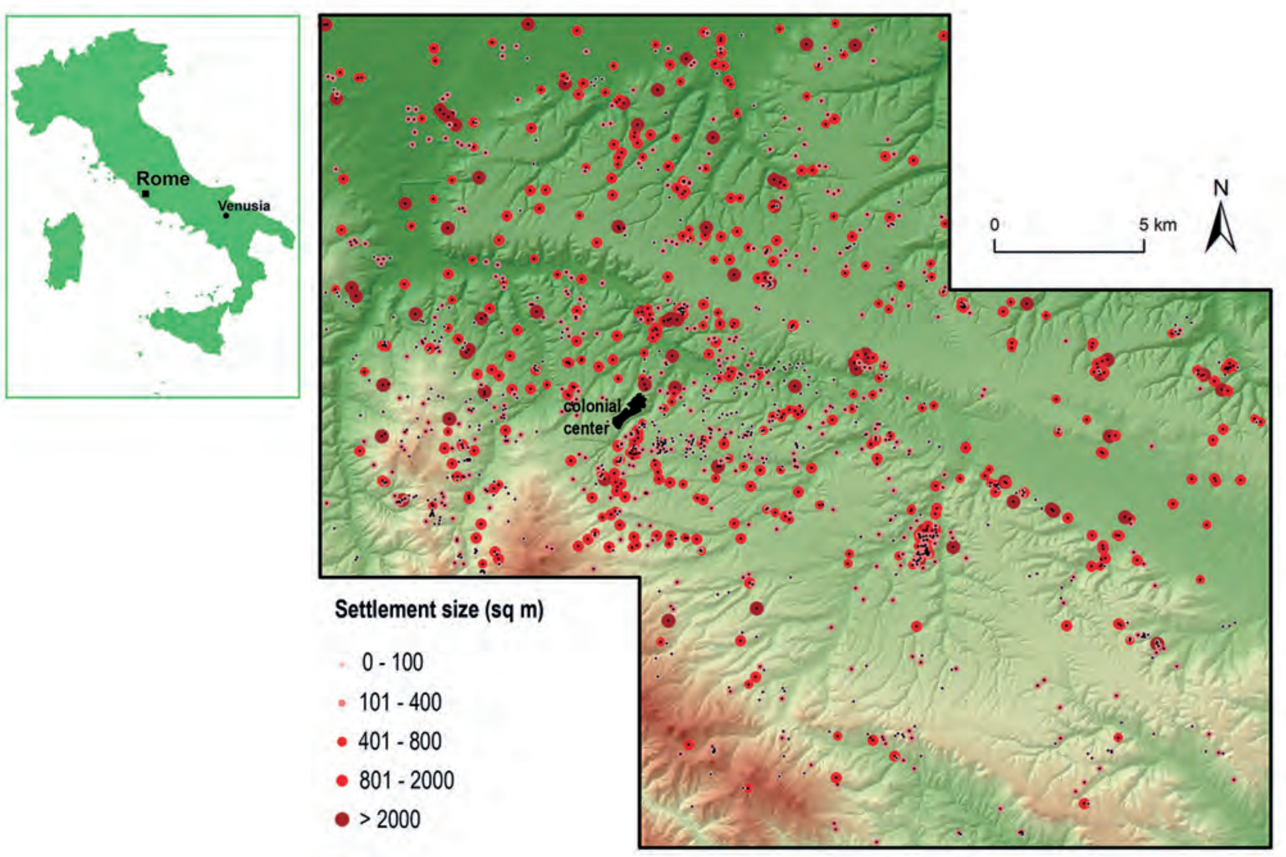


Figure 1 Settlement distribution (pre-Roman to Imperial period settlements). The position of the settlements is indicated by black dots. The extension of the red circles circumscribing these black dots does not match with the scale of the map; they are used here, and in the following figures, only as symbols for the size of these settlements (see legend). The raster base map for this and all subsequent figures is the shaded relief calculated from the 10 m-resolution DEM named TINITALY/01 (Tarquini *et al.* 2007, 2012; Tarquini and Nannipieri 2017) and is combined with an elevation colour palette

influenced (and possibly caused) past location decisions and resulting settlement patterns, only those factors which were retrievable and which could possibly have been influential for settlement purposes in this type of landscape can be analyzed (see below). The aim was to note macro-spatial tendencies in location preferences and to evaluate whether these regional tendencies changed through time.

Particular attention was paid to whether location preferences significantly changed from the pre-colonial to the early Roman colonial period (*i.e.* from the 5th – 4th to the 3rd century BC), the moment when Rome conquered this territory and supposedly revolutionized its rural organization (see discussion in Salmon 1969; Brown 1980; Rathbone 1981, 2008; Celuzza and Regoli 1982; Settis 1984). In order to assess this alleged drastic change in settlement organization, 3rd century BC settlement sites were selected and their location preferences compared with those of previous (and later) phases. In the graphs displayed in figures 3, 5, 7, 9, 11, 13, 15 and 17 the trends in distribution of both the totality of 3rd century BC sites (*i.e.* those sites that continue to exist plus those newly founded in this period) and the newly founded early colonial period sites are reported because, as previously underlined, the aim was to highlight the settlement developments occurred in this phase of occupation.

3 Method

As a first step, the environmental and cultural factors to be analyzed in the inductive analysis were calculated or imported in GIS (mostly using Idrisi GIS, Selva Edition – Eastman 2012, see below). These factors are altitude, slope, aspect, soil, location of dominant positions in the landscape (*i.e.* ridges and peaks), distance from a water source, distance from the city of Venusia, and distance from a road. Secondly, the settlement positions were confronted with these variables to calculate settlement counts that were subsequently converted into settlement percentages for each variable category. From this calculation, settlement distribution graphs were produced. These graphs were used as the main tool to observe and highlight possible trends and changes in the arrangement of settlement samples (figures 3, 5, 7, 9, 11, 13, 15, 17). Finally, statistical tests were applied[2]

Settlement size (sq m)

	0-100	101-400	401-800	801-2000	> 2000	Tot.
Pre-Roman settlements (5th-4th century BC)	100	88	34	45	22	**289**
Early colonial period settlements (3rd century BC)	18	34	9	18	10	**89**
Inherited settlements	7	13	6	6	7	39
New Early colonial period settlements	11	21	3	12	3	50
Republican settlements (3rd - 1st century BC)	168	218	74	109	37	**606**
Inherited settlements	20	21	12	13	10	76
New Republican settlements	148	197	62	96	27	530
Late-Republican - Triumviral settlements (1st century BC - 33 AD)	78	138	64	93	37	**410**
Inherited settlements	22	62	25	51	27	187
New Late Republican-Triumviral settlements	56	76	39	42	10	223
Imperial settlements (1st - 4th/5th century AD)	144	194	78	125	53	**594**
Inherited settlements (see note)	9	8	5	13	4	39
Inherited settlements	34	78	32	72	36	252
New Imperial settlements	101	108	41	40	13	303
Uncertain Pre-Roman-Imperial settlements	19	12	4	7	6	**48**

Table 1 Legacy survey data organized per period and per size. Archaeological sites were identified by teams of three to five surveyors spaced at five to ten m intervals, on a territory of ca. 700 sq km, using a minimum threshold of 5 sherds per sq m (see Marchi and Sabbatini 1996; Sabbatini 2001; Marchi 2010).
Note: These sites are not occupied in the Late Republican-Triumviral period but have a Republican phase of occupation

to further explore these trends and identify possible significant correlations between site distributions and these variables (Hodder and Orton 1976; Shennan 1988; Drennan 2009; Field 2009).

Statistical tests help discriminate between significant and non-significant correlations. It is possible for sites to occur with remarkable frequency in a certain land unit not necessarily because there was an intention in ancient human behavior to preferentially place dwellings there, but simply because this land unit covers a large extent of the territory. Chances to find sites in large regions are expected to be higher than in small regions, and thus the recorded number of sites may actually be statistically not-significant in this case. This is an important observation to bear in mind while analyzing the graphs in figures 3, 5, 7, 9, 11, 13, 15 and 17: peaks in settlement distribution, which indicate high percentages of sites in certain land units, may sometimes be explained by the large area covered by those land units rather than by real location preferences. For this reason, in order to single out location preferences that are more likely to be the result of intentional settlement choices (in other words, significant location preferences), both parametric and nonparametric statistical tests were used[3] (a significance level α of at least 0.05 was selected).

In the presented analysis, the former type of test assesses whether a significant difference may exist between the distribution of various settlement samples, whereas the latter type assesses where this difference emerged more prominently in the landscape. Specifically, parametric tests were used to evaluate whether, for each variable, the mean values of the distributions of periodic-size-site samples significantly differ from one another. For these tests, only continuous variables (*i.e.* variables that are measured along a continuum of numerical values) shall be considered (*e.g.* altitude).

On the other hand, nonparametric tests were performed on categorical variables, which are discrete variables composed of either ranked classes (*i.e.* ordinal variables, *e.g.* distance from the town of Venusia categorized in subsequent distance bands) or qualitative classes (*i.e.* nominal variables, *e.g.* soil categorized in soil units). Nonparametric tests are better suited for behavioral sciences, on account of several advantages: for instance, they are easier to use, they have less conditions (or, in other words, assumptions) to be met (or assumed to hold) in order to be appropriate, they can handle relatively small samples, and allow researchers to make inferences on the strength and, sometimes, also on the direction of the correlation (in other words, they can discriminate between favored and avoided classes/bands/units). They eventually indicate whether a correlation exists and where (in which class/band/unit) this correlation manifests itself. For the reasons specified above, in this paper greater significance is appointed to the results from the nonparametric tests (see also the discussion in Siegel 1956, 18 – 34).

First, a preliminary, explorative analysis was carried out to get a general impression of possible differences in distribution between site samples. The ANOVA and the parametric t-test were used to compare site samples of different periods and sizes[4] (Siegel 1956, 18-20; Drennan 2009, 147-163, Field 2009, 316-394). The one-way ANOVA (*i.e.* analysis of variance with one factor) was applied to assess whether the distribution mean of a group composed by site samples of subsequent periods, with the same size, was similar or not. When a divergence was detected, the t-test was applied to evaluate which pairs of samples may have had a significant difference in distribution mean (example in appendix I).

In order to detect possible differences in frequency distribution, the nonparametric Kolmogorov-Smirnov two-sample test (Siegel 1956, 127 – 136; Shennan 1988, 54 – 61) and the Chi-squared two-sample test (Siegel 1956, 104-116) were also used. They permitted to compare site proportions (of two independent site samples) attested in the variable categories[5].The former test was applied for ordinal variables, the latter for nominal variables.

Confronting the results from these tests with the distribution graphs (figures 3, 5, 7, 9, 11, 13, 15, 17), helped identify those site samples that seemed different from one another in their distribution[6].

Once the presence of possible distribution differences between site samples was assessed, the next question was where, most likely, these differences in distribution manifested themselves in the landscape. As a second step, the nonparametric one-sample Chi-squared (Siegel 1956, 42 – 47; Shennan 1988, 65 – 70), Kolmogorov-Smirnov (Siegel 1956, 47 – 52; Wheatley and Gillings 2002, 136 - 142) and Attwell-Fletcher tests (Attwell and Fletcher 1985; 1987) were used on relative frequencies of sites occurring in discrete variable categories (*i.e.* land types: classes, bands or units) to test for significant location preferences. These tests, especially the former two, are used widely in regional archaeological analysis to assess the degree of preference in site location (for other tests see *e.g.* Shennan 1988, 61 – 64, 114 - 189; Kvamme 1990b; Whatley and Gillings 2002, 136 - 142; Verhagen 2007, 48 - 50). In order to apply them to the data, the variables needed to be first classified into categories, after which the frequency of settlements occurring in each category could be controlled to assess the presence of a preference (or a disfavor) for the land type under study[7]. Subsequently, these preferences were compared to evaluate where precisely (*i.e.* in which land unit) sites of different period and/or size exhibited divergences in distribution (see results in appendix II). The distribution graphs helped locate possible differences in location preferences between samples in this case as well (figures 3, 5, 7, 9, 11, 13, 15, 17).

All these three tests are of the goodness-of-fit type. This means that they are tailored for detecting significant differences between an observed pattern of archaeological sites and an expected one (in other words, a theoretical, referent, random distribution of sites) with respect to certain environmental factors or cultural conditions of the landscape (Kvamme 1990b). The Chi-squared one-sample test (Siegel 1956, 42-47, best suited for nominal variables) only allows identification of whether a difference in frequency distribution exists between the observed and the expected sites but it cannot inform us about which significant correlations underpin the observed pattern (see also Shennan 1988, 74). It simply tells us if, for instance, settlements of a certain period or size are or are not equally located across all soil types (Shennan 1988, 69). The Kolmogorov-Smirnov one-sample test (for ordinal variables) can also pinpoint which land type has the greatest divergence between observed and expected cumulative frequency distributions of sites (Siegel 1956, 47-52). The Attwell-Fletcher test (1985, 1987) provides a very useful indication about the strength and the direction of a relationship in each land type (*i.e.* we can pose questions to our data like "are there significantly more or fewer sites than expected in a certain environmental category (*e.g.* altitude band 301 to 400 m a.s.l.)?"), and allows making statements like "the altitude band from 301 to 400 m a.s.l. is likely to have been significantly favored by small Republican settlements" (examples in appendix I)[8].

The procedure for calculating each variable is illustrated below, along with the significant correlations detected by means of distribution graphs and statistical tests (Results sections).

4 Altitude, Slope and Aspect

The basic topographic characteristics of a landscape can be described in terms of altitude, slope, and aspect conditions. These variables can be easily extracted from a digital elevation model (DEM). In this case, the 10-m resolution DEM named TINITALY/01 was used for such a calculation (Tarquini *et al*. 2007, 2012; Tarquini and Nannipieri 2017)[9]. As a second step altitude, slope, and aspect variables were classified into bands or classes (figs 2, 3, 4, 5, 6 and 7).

Altitude, slope, and aspect conditions may have an impact on both settlement and agriculture: for instance, south-facing slopes receive a good level of sunlight and are less exposed to winds, which could ease cultivation. On the contrary, more extreme elevation and slope conditions were likely avoided for settlement and cultivation purposes in the past due to the difficulty in living in and farming on these locations (see also Goodchild 2007, 123 – 140).

4.1 Results

Site samples generally have a quite similar distribution with respect to slope and aspect variables and do not exhibit significant correlations with them (figures 5 and 7). On the contrary, clear significant correlations in distribution could be pointed out for the altitude variable (fig. 3). Both pre-Roman and early colonial period settlements exhibit a positive correlation (more sites than expected) with the 4th altitude band (401 – 500 m a.s.l) and a negative correlation (fewer sites than expected) with the 1st band (138.6 – 200 m a.s.l) (see results in appendix II). The Republican and Late Republican (LR) - Triumviral settlements tend, instead, to be preferentially located in the 3rd altitude band (301-400 m a.s.l).

As regards size site samples, the highest variability in location preferences is exhibited by the smallest site categories (0-100 and 101-400 sq m settlements), that have the most typical and diverging distribution in the different periods with respect to altitude and slope values. This is evident if we look at the various graphs of the periodic-size-site samples (figures 3 and 5). Interestingly, for elevation and slope factors also the t-test and the Kolmogorov-Smirnov two-sample test pointed out significant differences in distribution between small pre-Roman settlements and small Republican settlements, and between small Republican settlements and small Imperial settlements (see results in appendix II).

According to the Attwell-Fletcher test results (see appendix II), indeed, the small pre-Roman settlements display a significant preference for the 4th and 5th altitude band and a refusal for the 1st band, small Republican settlements have a preference for the 3rd altitude band, and small Imperial settlements have a preference for the 5th band and a refusal for the 1st band. Similarities, instead, were exhibited by small pre-Roman settlements and small early colonial period settlements, small early colonial period settlements and Republican settlements, small Republican settlements and small LR-Triumviral settlements, and small LR-Triumviral settlements and small Imperial settlements. As regards medium and large sites, there are similarities between pre-Roman, early colonial period, and Republican settlements, and also between Republican and LR-Triumviral settlements. The one-sample tests detected only one clear correlation, namely with the large Imperial settlements (and probably also with the large LR-Triumviral settlements) that exhibited a preference for the 1st altitude band (138.6 - 200 m a.s.l).

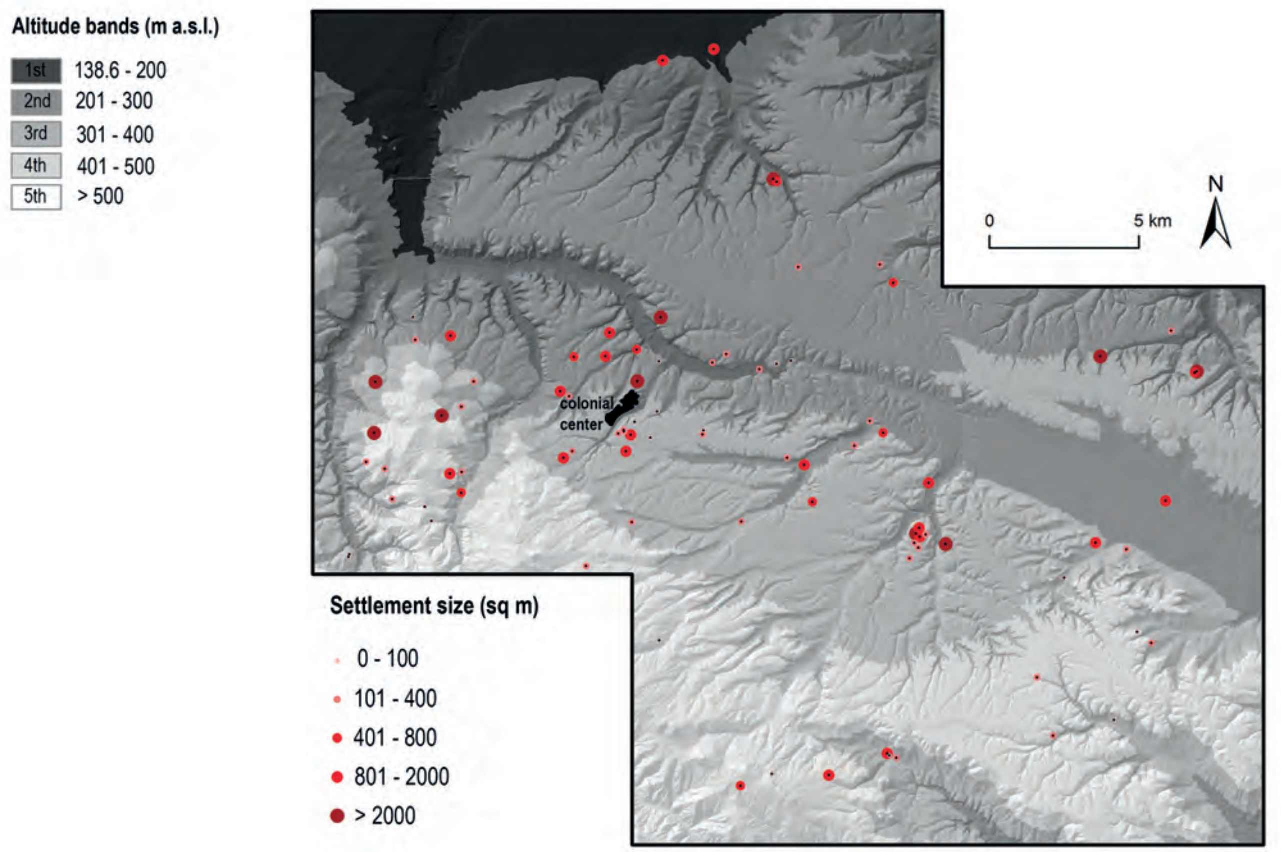
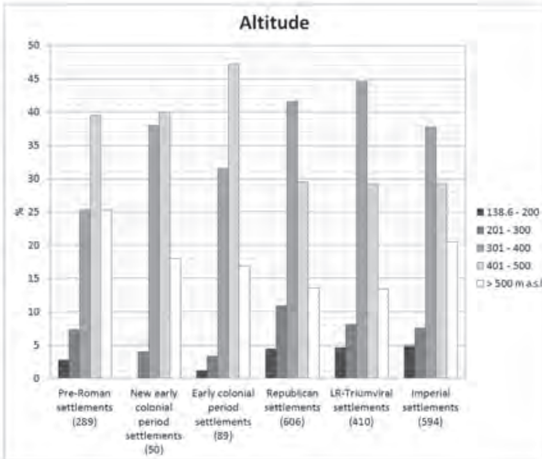


Figure 2 Altitude variable (based on the 10 m-resolution DEM named TINITALY/01, Tarquini *et al.* 2007, 2012; Tarquini and Nannipieri 2017) categorized in elevation bands and distribution of the early colonial period settlements



Altitude band		Area (sq m)	%
1st	138.6 - 200	42809500	6.2
2nd	201 - 300	78911100	11.3
3rd	301 - 400	236098000	34.0
4th	401 - 500	179970600	25.9
5th	> 500 m a.s.l.	157493000	22.7
	Tot.	695282200	100

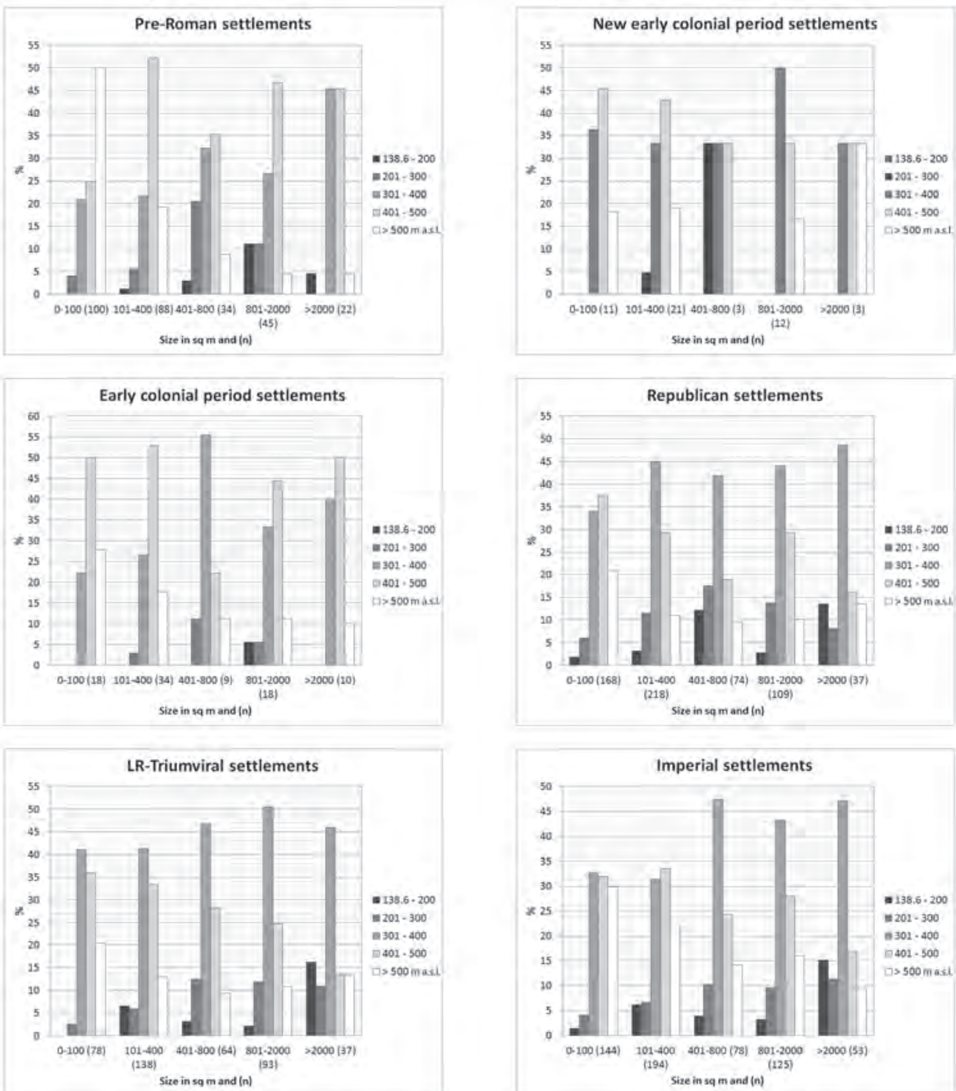


Figure 3 Settlement percentages with respect to altitude bands. In brackets, total number of settlements per sample (n)

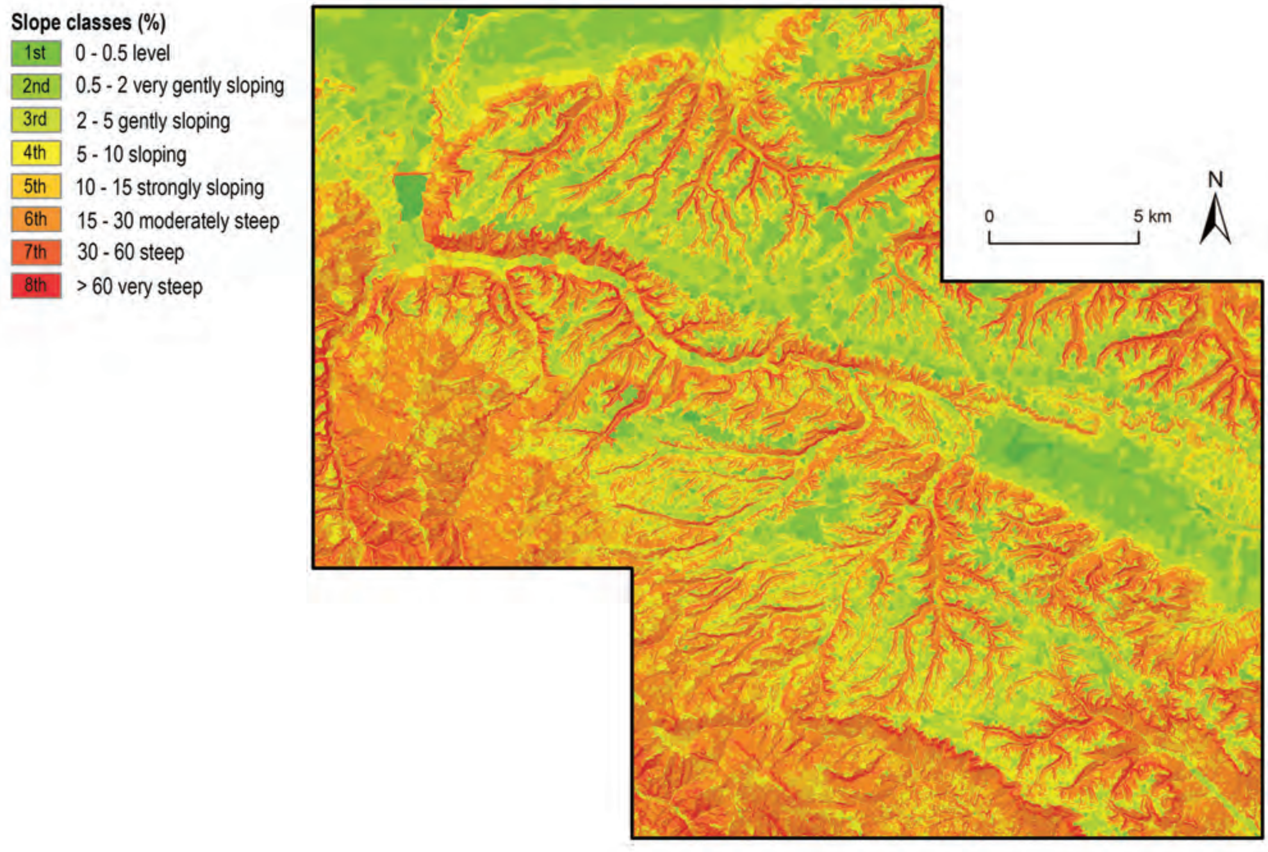
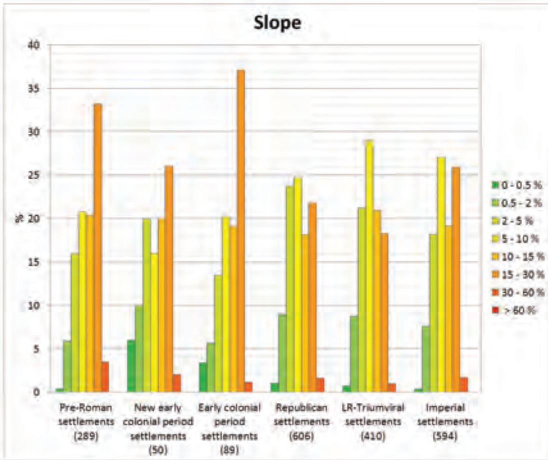


Figure 4 Slope variable (calculated from the 10 m-resolution DEM named TINITALY/01, Tarquini *et al.* 2007, 2012; Tarquini and Nannipieri 2017) categorized in classes. The categorization in slope classes is based on FAO 2006 (p. 12)



Slope class		Area (sq m)	%
1st	0 - 0.5 %	3679400	0.53
2nd	0.5 - 2 %	79234200	11.40
3rd	2 - 5 %	130012400	18.70
4th	5 - 10 %	121022700	17.41
5th	10 - 15 %	107931100	15.52
6th	15 - 30 %	201213300	28.94
7th	30 - 60 %	49488800	7.12
8th	> 60 %	2700300	0.39
Tot.		695282200	100

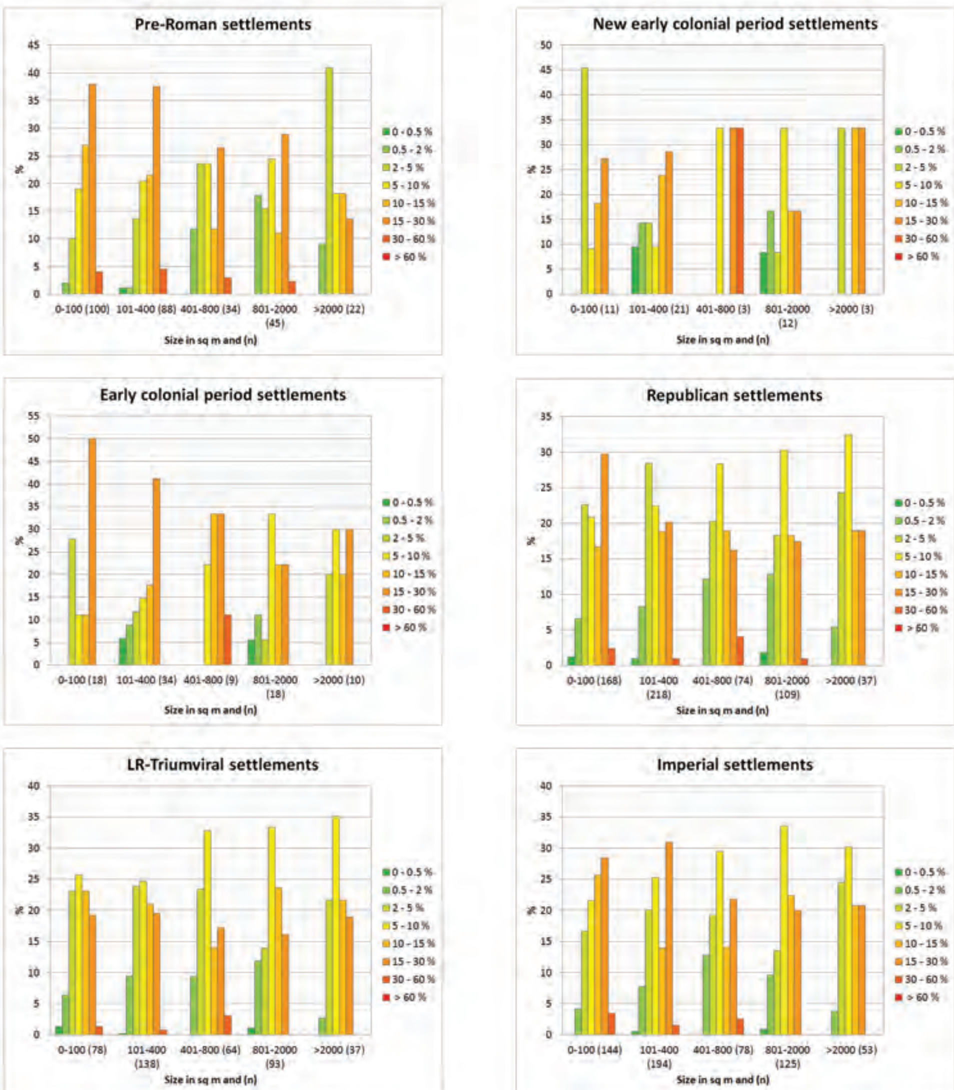


Figure 5 Settlement percentages with respect to slope classes. In brackets, total number of settlements per sample (n)

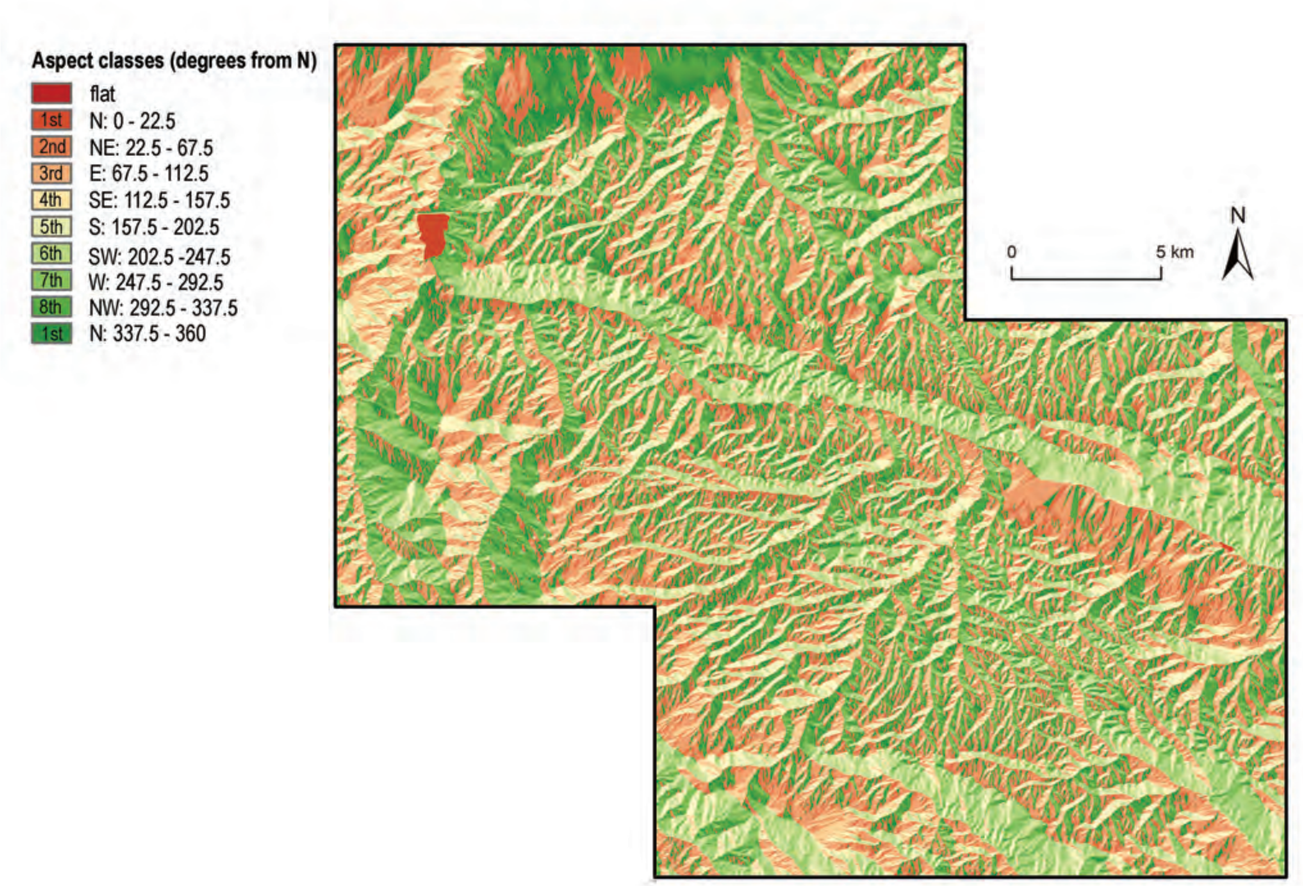
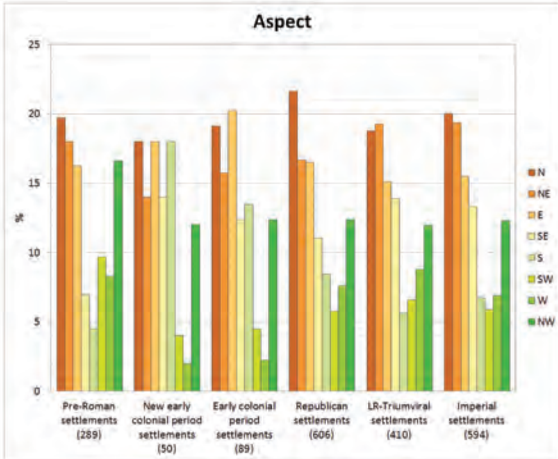


Figure 6 Aspect variable (calculated from the 10 m-resolution DEM named TINITALY/01, Tarquini *et al.* 2007, 2012; Tarquini and Nannipieri 2017) categorized in classes. The categorization in aspect classes is based on ESRI 2014



Aspect class		Area (sq m)	%
	Flat	63400	0.01
1st	N	143747900	20.67
2nd	NE	112804900	16.22
3rd	E	84013500	12.08
4th	SE	74520900	10.72
5th	S	60661100	8.72
6th	SW	55319500	7.96
7th	W	64981400	9.35
8th	NW	99169600	14.26
Tot.		695282200	100

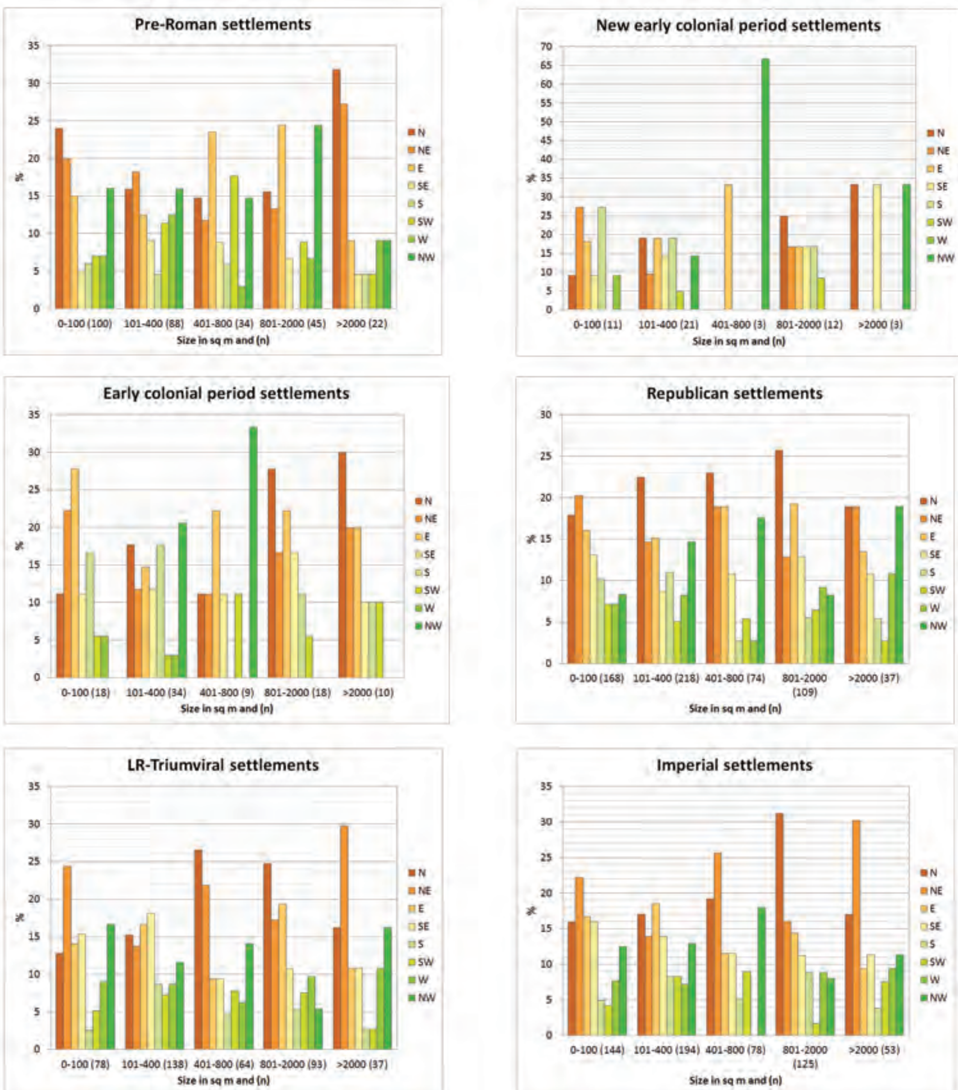


Figure 7 Settlement percentages with respect to aspect classes. In brackets, total number of settlements per sample (n)

5 Soil

Topographic, geological, and pedological information is extremely useful for distinguishing the types of land units characterizing a landscape. This information can be acquired from a soil map and its legend. The soil map of the Regione Basilicata (1 : 250,000)[10] was used for such a purpose (fig. 8)[11]. This soil map provides a very good description of the macro-regional geomorphological units characterizing this landscape. The land units outlined in table 2 were controlled to see whether correlations between settlement distributions and soil/geomorphological conditions may have existed, and if these correlations changed over time (fig. 9). It is important to underline, however, that the present natural conditions and the present distribution (and qualities) of soil types may, of course, be different to those which existed in the past. As a matter of fact, erosion and deposition processes that occurred after the abandonment of settlements, along with modern anthropic transformations, may have altered the appearance and the properties of the Hellenistic and Roman landscape (Judson 1963; Vita-Finzi 1969; Potter 1976; Sevink 1985; Bintliff 1992; Allen *et al.* 2002; Lefèvre *et al.* 2010; Casarotto *et al.* 2017).

According to conventional views on Roman settlement and economy, fertile and easily workable soils were particularly attractive for settlement and related agricultural activities in Roman times (see the discussion in White 1970; Dyson 1978; Celuzza and Regoli 1982; Settis 1984; Garnsey 1988, 49; Rathbone 1981, 2008; Goodchild and Witcher 2010; Witcher 2016; but see also the discussion in Boserup 1981, 63 – 80). Favorable soils may have been those rich in volcanic minerals and nutrients developing in alluvial plains, in gentle and wide middle-height plateaus, or in low, gently sloping hills. The former situation is represented, for instance, by land unit 14.1; the second condition is represented by unit 14.2 and the latter situation by unit 9.2 (see table 2 and fig. 8).

5.1 Results

A significant correlation with the most fertile soils of this landscape is exhibited by the LR-Triumviral and Imperial settlements (respectively with unit 14.2 and 9.2). This does not seem to be the case for the early colonial and Republican settlements that, instead, concentrate on less-conducive sandy conglomeratic soils (unit 11.1). It is also interesting to note that the totality of pre-Roman settlements exhibits a preference for unit 6.3 and 6.4 corresponding to the mountainous and hilly areas of the landscape.

As underlined for altitude, slope and aspect, for the soil variable the smallest site samples (0-100 and 101-400 sq m settlements) are also characterized by the highest number of significant differences between periods. Interestingly, small Imperial settlements have a significant preference for unit 9.2 whereas small pre-Roman settlements have a preference for unit 6.3. On the other hand, small Republican settlements have a pattern which seems very similar to the LR-Triumviral one (fig. 9). In addition to that, the Attwell-Fletcher test indicates a correlation for the large pre-Roman settlements that have a preference for unit 14.3.

6 Location of dominant positions in the landscape

Beside landscape exploitation, the visual control over the surrounding territory, or over other settlements, could also have been a strategic factor for the survival and success of a settlement system. Dominant positions in the landscape may thus have been appealing points for certain types of settlement sites. Ridges and peaks, therefore, can be expected to have attracted settlement interests at certain historical periods (figs 10 and 11). The ridge and peak environmental condition was calculated from the TINITALY/01 DEM (Tarquini *et al.* 2007, 2012; Tarquini and Nannipieri 2017) in LandSerf GIS (Wood 2009) through a geomorphological modeling of the relief (‘feature extraction’ tool)[12]. Only those

Table 2 Soil units. This is a basic classification based on the information provided by the legend of the soil map of Regione Basilicata. For more detailed descriptions of soils and soil properties see http://www.basilicatanet.it/suoli/carta2.htm ; http://www.basilicatanet.it/suoli/province.htm. For these land units a qualitative evaluation of the suitability for general agricultural purposes (*i.e.* plant growth) is proposed (see last column). The productive potential (*e.g.* low, medium, high) of each land unit is established on the basis of two important qualities of the soil (see also Vink 1975, 196 – 208), namely fertility (here depending on the availability of nutrients and minerals, and the drainage status of the soil) and workability (here depending on slope and stoniness qualities, White 1970; Frayn 1979; Spurr 1986). In principle, abundance of plant nutrients and minerals along with a good drainage are typical of fertile soils; flat to gently sloping surfaces with scarce presence of stones are typical of easily workable soils. The land qualities from which fertility and workability are inferred (cf. supra) have been estimated on the basis of the information provided in Vink 1975, Kamermans 2000, FAO 2014, and in the legend of the soil map. In addition to that, for several of these units the land qualities related to workability could also be assessed directly, in the field, during recent archaeological field surveys, in which surveyors recorded systematically both slope and stoniness conditions of the fields (LERC survey campaigns 2013 – 2016, see Pelgrom *et al.* 2014, Pelgrom and Tetteroo 2015; https://landscapesofearlyromancolonization.com/)

Soil unit	Area (sq km)	%	Landscape type	Topography	Geology	Soil type WRB 98	Modern land use	Fertility	Workability with basic tools	Suitability for agriculture
6.3	13.2	1.9	Mountains	Moderately steep to very steep	Quartz sandstones with thin layers of clay rocks	Eutric Cambisols / Endogleyi-Luvic Phaeozems	Mainly forest	Medium/ Low	Low	Low
6.4	6.7	1	Mountains	Gently sloping to steep	Sandstones and marls	Eutric Cambisols	Forest and pasture	Medium	Medium	Medium
7.3	67.3	9.7	Hills	Undulating	Clayey slate rocks and marls	Luvi-Vertic Phaeozems / Calcaric Regosols	Arable	Medium/ Low	Medium	Medium/Low
7.5	7.4	1.1	Surfaces connected the hills with the alluvial landscape	Flat to gently sloping	Clayey marls	Luvi-Calcic Kastanozems	Arable	Medium	Medium	Medium
9.2	15.8	2.3	Hills	Gently sloping to moderately steep	Pyroclastic colluvial deposits	Luvic Phaeozems / Eutric Cambisols / Dystri-Andic Cambisols	Mainly viticulture and olive orchards alternate to forest and pasture	High	Medium	Medium/High
11.1	280.0	40.2	High plateaus (ancient Pleistocene surfaces)	Flat to gently sloping	Sands and Pleistocene conglomeratic deposits	Luvi-Vertic Kastanozems / Luvic Kastanozems/ Calcic Vertisols	Arable	Medium	Medium/Low	Medium/Low
11.2	136.0	19.5	Slopes of the higher plateaus	Gently sloping to steep	Sands and Pleistocene conglomeratic deposits	Luvic Kastanozems / Eutric Cambisols / Calcari-Arenic Regosols	Arable	Medium/ Low	Low	Low
12.1	23.3	3.4	Hills	Undulating	Clayey and silty marine deposits, mainly marls	Hyposodic Vertisols / Luvi-Vertic Kastanozems	Arable	Medium	Medium	Medium
14.1	29.0	4.2	Alluvial plain	Flat	Fluvio-lacustrine deposits (with pyroclastic material)	Pelli-Calcic Vertisols	Arable	High	High	High
14.2	61.5	8.8	Low plateaus (fluvio-lacustrine terrace)	Flat	Fluvio-lacustrine deposits (with pyroclastic material)	Luvi-Vertic Phaeozems / Calcic Vertisols	Arable and pasture	High	High	High
14.3	8.9	1.3	Surfaces connected the plateaus with the alluvial landscape	Flat to gently sloping	Alluvial deposits and colluvial deposits with clayey and sandy granulometry	Eutri-Vertic Cambisols	Arable	Medium	High	Medium/High
14.4	2.5	0.4	Alluvial terraced conoids	Flat to gently sloping	Sandy and clayey deposits	Calcic Luvisols	Arable	High	High	High
14.5	9.7	1.4	Alluvial terraces	Flat to gently sloping	Sandy, clayey and silty deposits	Petric Calcisols / Eutri-Fluvic Cambisols	Arable	Medium	Medium	Medium
14.6	15.4	2.2	Alluvial terraces	Flat to gently sloping	Higher clayey and silty deposits, lower sandy and gravelly deposits	Luvic Phaeozems / Haplic Calcisols / Eutric Vertisols	Arable	Medium	High	Medium/High
14.7	19.1	2.7	Valley floors	Flat	Sandy and stony deposits	Eutri-Fluvic Cambisols / Calcaric Phaeozems / Calcari-Arenic Regosols	Arable	Medium/ Low	Medium	Medium

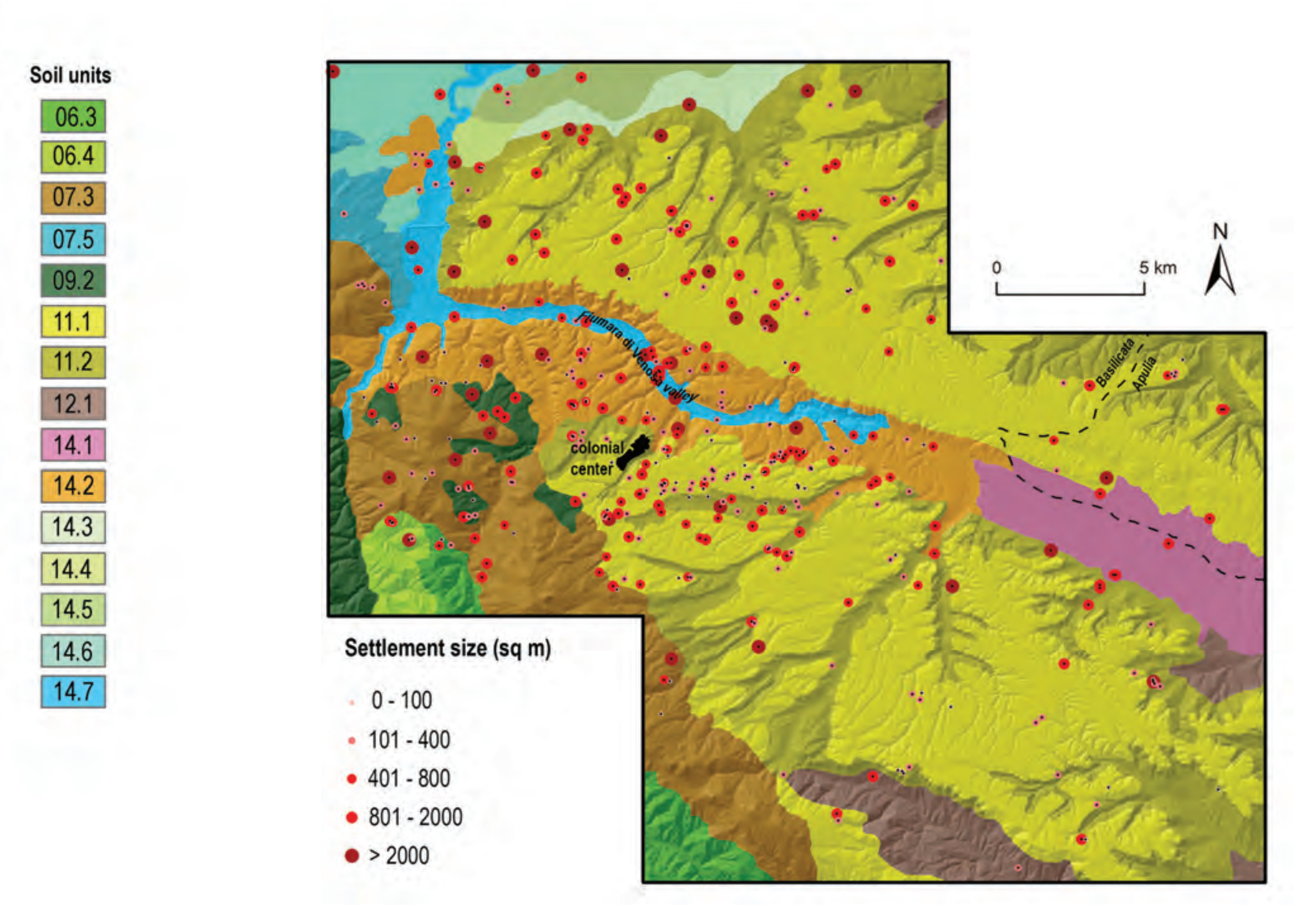
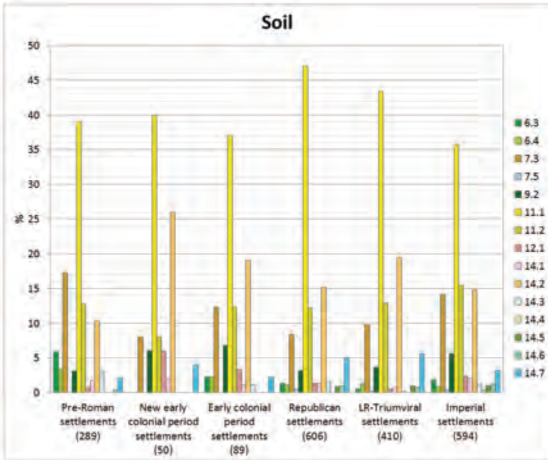


Figure 8 Soil variable classified in units and distribution of the LR-Triumviral settlements. The base map for the territory within the administrative borders of the Basilicata region is the soil map of the Regione Basilicata (1: 250, 000) (Ufficio Produzioni Vegetali e Silvicoltura Produttiva - Dipartimento Agricoltura, Sviluppo Rurale, Economia Montana - Regione Basilicata). Outside this territory soil properties were reconstructed; for further information see notes 10 and 11 of this paper



Soil unit	Area (sq m)	%
6.3	13156400	1.89
6.4	6690000	0.96
7.3	67255200	9.67
7.5	7361700	1.06
9.2	15808800	2.27
11.1	279720100	40.23
11.2	135817200	19.53
12.1	23297100	3.35
14.1	28993500	4.17
14.2	61494600	8.84
14.3	8919300	1.28
14.4	2542200	0.37
14.5	9745700	1.40
14.6	15408200	2.22
14.7	19072200	2.74
Tot.	695282200	100

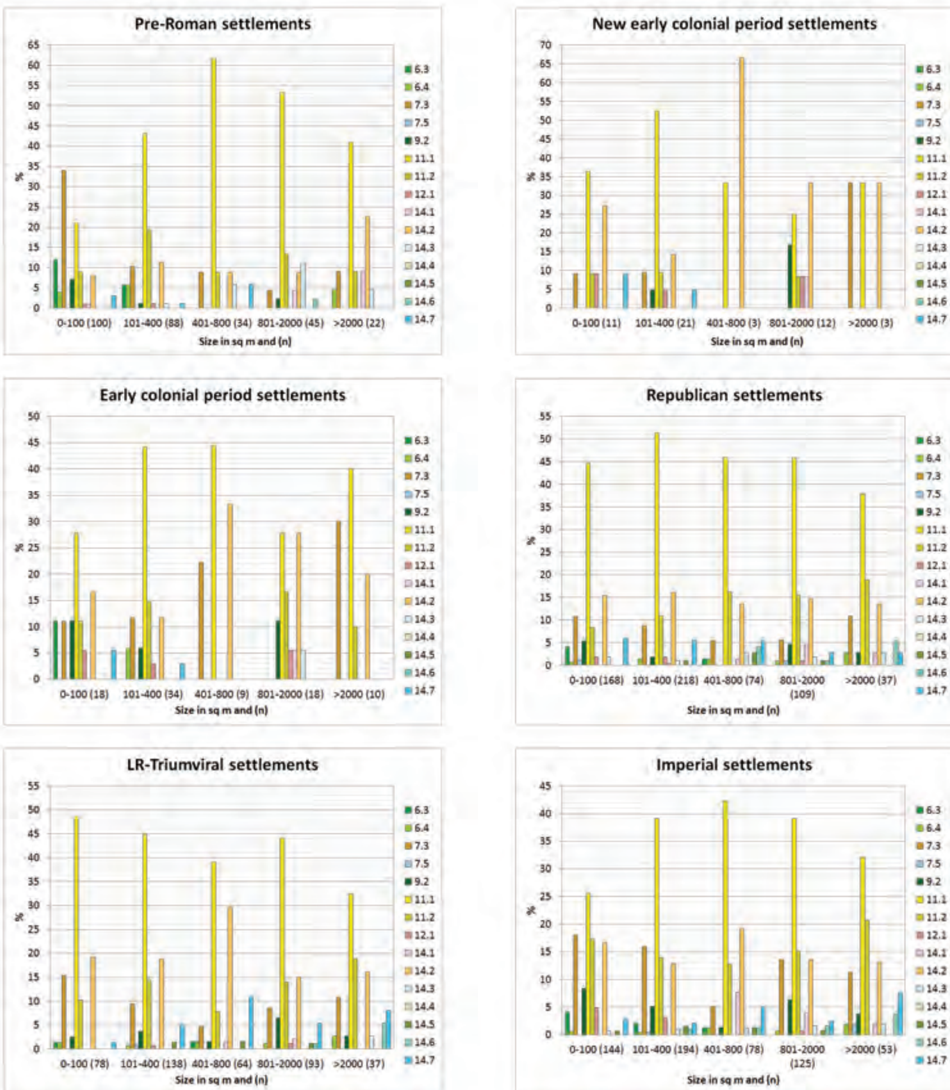


Figure 9 Settlement percentages with respect to soil units. In brackets, total number of settlements per sample (n)

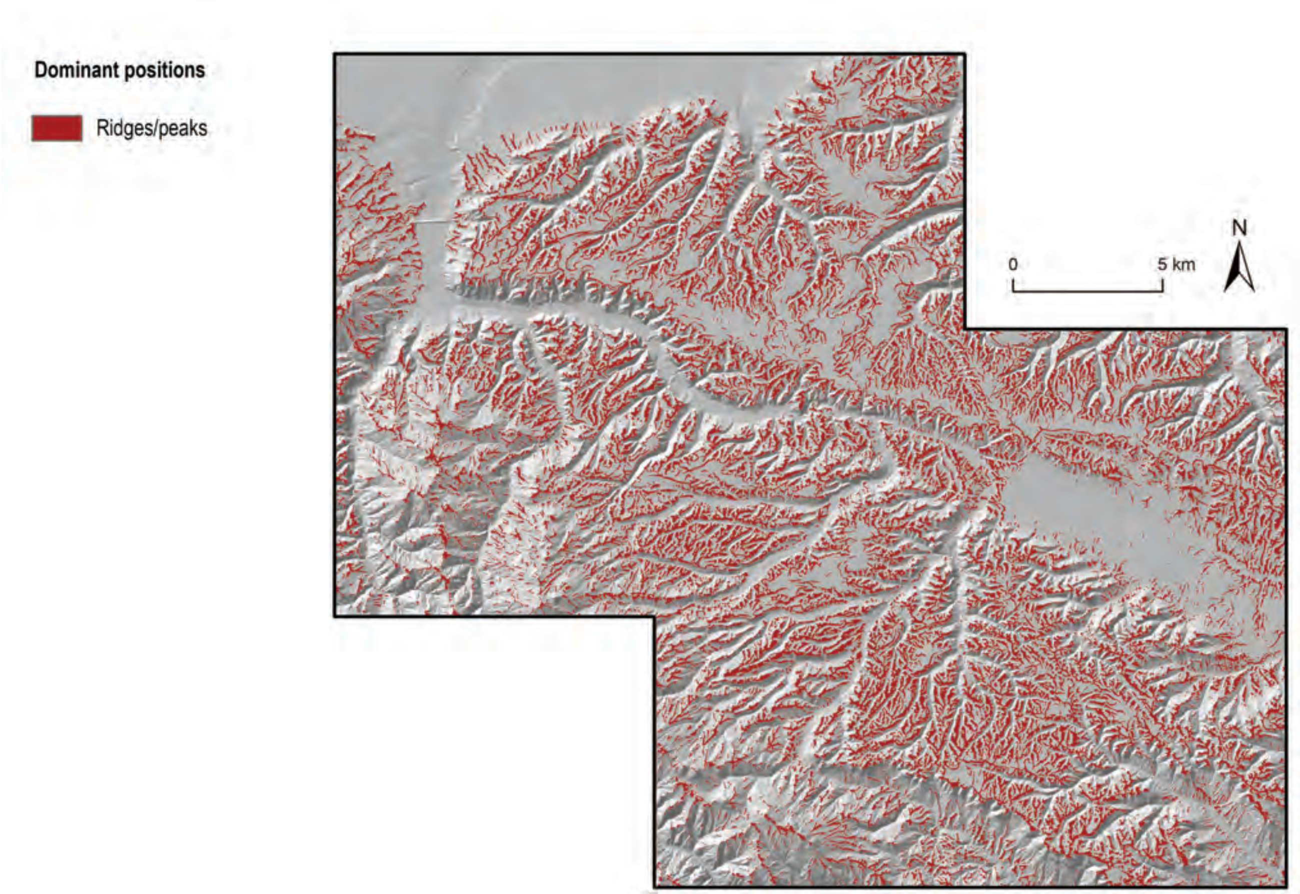
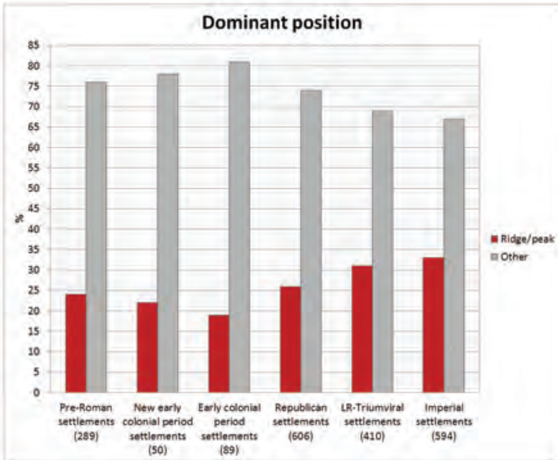


Figure 10 Location of dominant positions in the landscape (calculated from the 10 m-resolution DEM named TINITALY/01, Tarquini *et al.* 2007, 2012; Tarquini and Nannipieri 2017)



Dominant position	Area (sq m)	%
Ridge/Peak	129836500	18.67
Other	565445700	81.33
Tot.	695282200	100

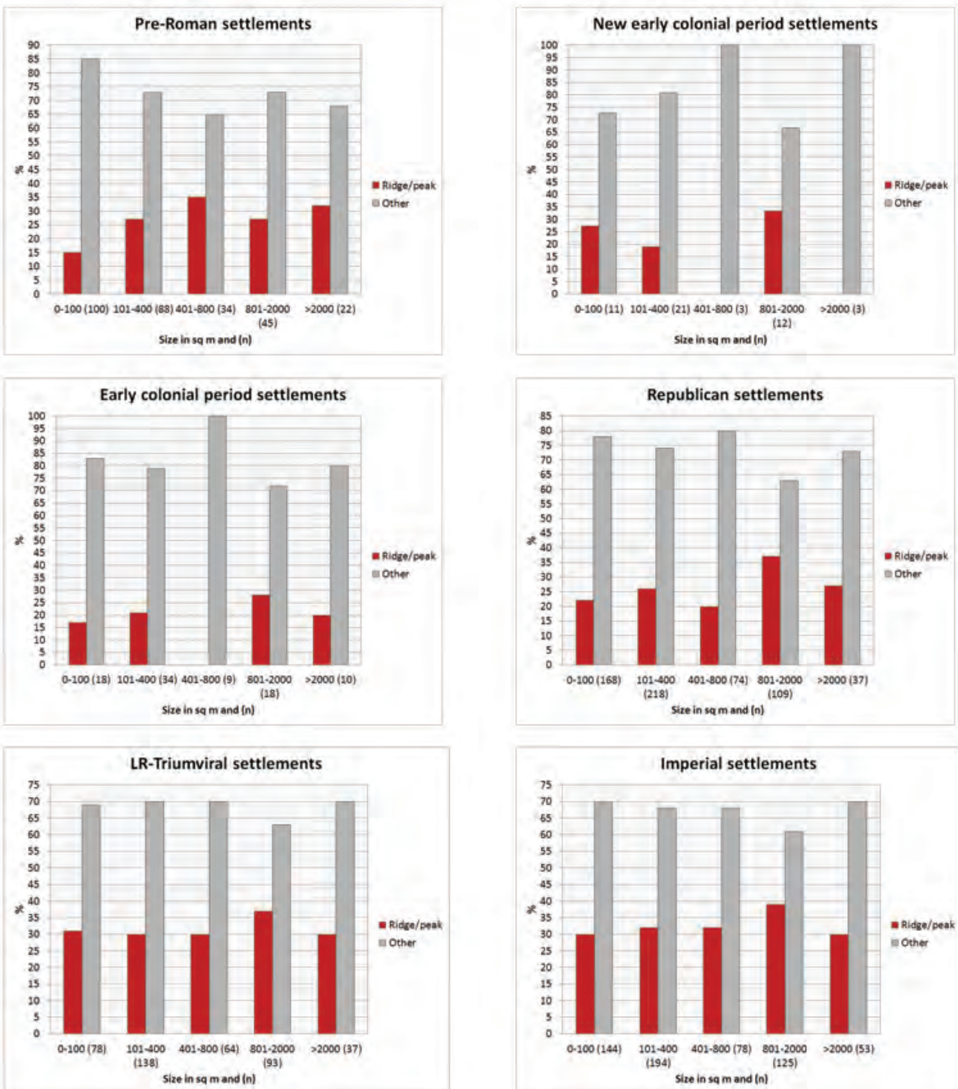


Figure 11 Settlement percentages with respect to dominant positions of the landscape. In brackets, total number of settlements per sample (n)

ridges and peaks located above the valley floors (higher positions) and in planar topographical locations were considered in the analysis. The aim was to assess whether there was a significant element of choice for dominant land marks in the location of settlements.

6.1 Results

There is a tendency for pre-Roman, Republican, LR-Triumviral, and Imperial settlements to be located on peaks or ridges. This preference is also exhibited by several size site samples and, interestingly, by all Imperial size site samples but the largest. The largest settlements (> 2000 sq. m) of all historical periods considered here do not seem to be attracted by such locations (for a possible explanation see Casarotto *et al.* forthcoming).

7 Distance from water

Access to water is probably the most important pragmatic need of humans, both for their own survival and for the carrying out of agricultural activities. A regular supply is required in any type of economy, but the extent of the demand can be different, and dependent on demographic and economic conditions. As a general rule, constant flow-rate rivers and perennial springs are expected to attract settlements.

The specific case of Venusia is quite exceptional with respect to water availability (Marchi and Sabbatini 1996, 115). The territory was well served, with *fiumare* (small rivers), streams, water springs, and starting from the Triumviral period, also with an aqueduct (Salvatore 1984, 38; Marchi and Sabbatini 1996, 47; Capano 1999). The main rivers and main streams were extracted from the shapefile of the hydrological system of Regione Basilicata[13]. The perennial springs were digitalized in ArcGIS 10.2.2 from the IGM maps (1:25,000)[14]. These two layers were then merged and the variable representing the Euclidean distance from water was carved up into bands of 200 m (figs 12 and 13). It is worth noting that the present-day river system was considered in this analysis: it is evident that this may differ from the past situation. However, the typical geomorphology of this landscape consisting of deep, incised valleys and interposing large plateaus would have probably allowed river migrations within these quite narrow valleys. In consequence, their current position was considered indicative for the periods under consideration.

The probable route of the aqueduct is reported in photos and in a map dating to 1883 (Venosa, Archivio Comunale) (see Salvatore 1984, 38; Rosa *et al.* 2016)[15]. This important element for water supply functioned both for diverting water to the city and possibly also to the surrounding fields for irrigation. Therefore, the position of the *castellum aquae*, where the water transported by the aqueduct was collected and then distributed, may have influenced the position of arable fields close to the city and the building structures related to them from the Augustan age onwards (Marchi and Salvatore 1997, 47 – 49). Therefore, its location was taken into account when the distribution of the LR-Triumviral and Imperial settlement samples was analyzed.

7.1 Results

There is high homogeneity in settlement distributions with respect to distance from water sources. As a general trend, sites tend to be located at a certain distance to rivers and streams (possibly due to the high risk of flooding at the nearby locations) but close enough to reach them easily. Settlements seem to avoid the farthest distance bands and to favor, instead, the second distance band (201 to 400 m from a water source). If we look at the size site samples per period (see results tables in appendix II), a significant association with water is displayed by the smallest Republican settlements (0-100 sq m) and by the small pre-Roman settlements (101-400 sq m) that significantly favor the 2nd distance band and avoid the more distant ones.

8 Distance from the town and from major roads

The town of Venusia may have functioned as an important market place for local and regional exchange of products yielded by the surrounding rural territory. In addition to that, the colonial center provided the rural population with defensive, administrative, ritual, and political facilities. On the other hand, rural settlements played a crucial role for the survival of the city itself since they supplied it with food, bulk products and basic materials (see discussion in Vogel *et al.* 2016). The consumption center, thus, may have been an important attractor for productive location and settlement in Roman times. Connecting routes are another important cultural attractor for settlements (see for instance De Neeve 1984, 25), both for human movement and for the transport of goods from the countryside to the markets and the other way around. However, differently from the position of the colonial central place (*i.e.* town) which is known, road route reconstructions are problematic, as is the issue of dating and reuse of roads over different periods.

In this analysis all major roads arguably in use during the Roman period are considered, connecting the countryside to the town of Venusia (reconstructions are provided in Buck 1971; 1981; Vinson 1972; 1979; Salvatore 1984, 17 - 21; Marchi and Sabbatini 1996, 123 - 127; Sabbatini 2001, 78 - 80; Marchi 2010, 281 – 285 with further references), and whether they influenced the position of settlements in this period was analyzed. The variable representing the Euclidean distance from the town was carved up into bands of 2 km, whereas the distance from major roads was divided up into Euclidean bands of 200 m (figs 14, 15, 16 and 17).

8.1 Results

These two cultural variables have the highest number of significant correlations with settlement distributions and thus seem to be the most influential in settlement location preferences in Roman times. This is especially true for the distance from the colonial center. As a rule, all sites from the early colonial to the Imperial period have a preference for the closest distance bands from the town, and significantly fewer sites are located far from it (see also Marchi and Sabbatini 1996, 112 – 114; Casarotto *et al.* 2016). The opposite is true for the pre-Roman period settlements, which are located quite distant from the town and do not favor the territory close to it.

It is important to note that the Imperial settlements are more homogeneously distributed across the survey sample area than the other previous Roman period settlements (see also Marchi and Sabbatini 1996, 117 – 123; Sabbatini 2001, 72 – 75; Marchi 2004, 139). In addition to that, other differences and similarities amongst Roman period sites with respect to the distance to the town and roads can be pointed out if we look at the various size site samples per period (figures 15 and 17).

For instance, as regards the distance to town, the small Imperial sites (0-100 and 101-400 sq m) differ in distribution from the small early colonial, Republican, and LR-Triumviral sites (which are, instead, more similarly distributed). The early colonial, Republican, and LR-Triumviral sites remarkably favor the 1st band from the town (0 to 2 km, already noted by Marchi and Sabbatini 1996, 112 - 113; Marchi 2004, 133). Significantly fewer small Republican sites are attested in the more distant bands, but this is not the case for small LR-Triumviral and Imperial sites. As regards the largest sites (> 800 sq m), the Republican and LR-Triumviral sites are similar in their distribution whereas the largest Imperial sites (> 800 sq m) seem more homogeneously distributed across the territory with a preference for the 3rd distance band (4 to 6 km, size category 801 – 2000 sq m).

With regard to the variable representing the Euclidean distance from a known (Roman) road, the Imperial sites seem to be the least interested in staying close to a road. They are, indeed, more homogeneously scattered than the Republican and LR-Triumviral sites with respect to the distance to roads. Significant differences in distribution also exist between size site samples, specifically between small Republican and small Imperial sites, and between small LR-Triumviral and small Imperial sites. As regards pre-Roman settlements, they seem to be less interested in staying close to these roads but a preference is attested for the 3rd distance band (401 – 600 m), especially for the size category 101 – 400 sq. m.

9 Summary of the results

This inductive location preference analysis offered the opportunity to systematically and formally assess patterns in location preferences of diachronic and hierarchical settlement distributions. It was noted that settlement distributions of different periods favor or avoid similar slope, aspect, and water distance conditions: the flat and gently sloping locations are not particularly favored (for a similar conclusion in another Roman landscape see also Goodchild 2007, 131) but at the steepest slopes low site density is always attested. There is no preferential orientation in settlement locations, neither per size nor per period. Moreover, as a general trend the totalities of sites per period avoid locations farther away from water sources and prefer, instead, the closest ones (in particular the 2nd distance band). Interestingly, this preference for the 2nd distance band (201- 400 m from a water source) is significantly displayed also by two size site samples: the smallest Republican settlements (0-100 sq m) and the small pre-Roman settlements (101-400 sq m). However, due to many similarities in distribution, it can be concluded that the slope, aspect, and water distance factors do not provide significant indication for drastic changes in settlement location preferences from the pre-Roman to the Imperial period.

A different situation is exhibited by the altitude and soil variables. Settlements of different periods cluster in different ecological parts of the landscape, which can be outlined on the basis of elevation, soil, and geomorphological conditions. Pre-Roman settlements favor the hills and mountain west of the town of Venusia (at quite high altitudes); early colonial period settlements prefer the hills west of the town as well, but also the conglomeratic plateaus in the central part of the survey sample area, especially those located in front of the urban center; Republican and LR-Triumviral settlements tend to concentrate on the conglomeratic plateaus surrounding the urban center as well, but also much farther, north / north-east of it on the conglomeratic plateaus located at the other side of the *Fiumara di Venosa* valley (corresponding to soil unit 11.1 and the 3rd altitude band). Differently from the Republican settlements, however, the LR-Triumviral sites also exhibit a preference for more productive types of soil. Lastly, Imperial settlements are clearly more widely and homogeneously distributed across the survey sample area than ever before, with a preference for the most fertile soils of this territory.

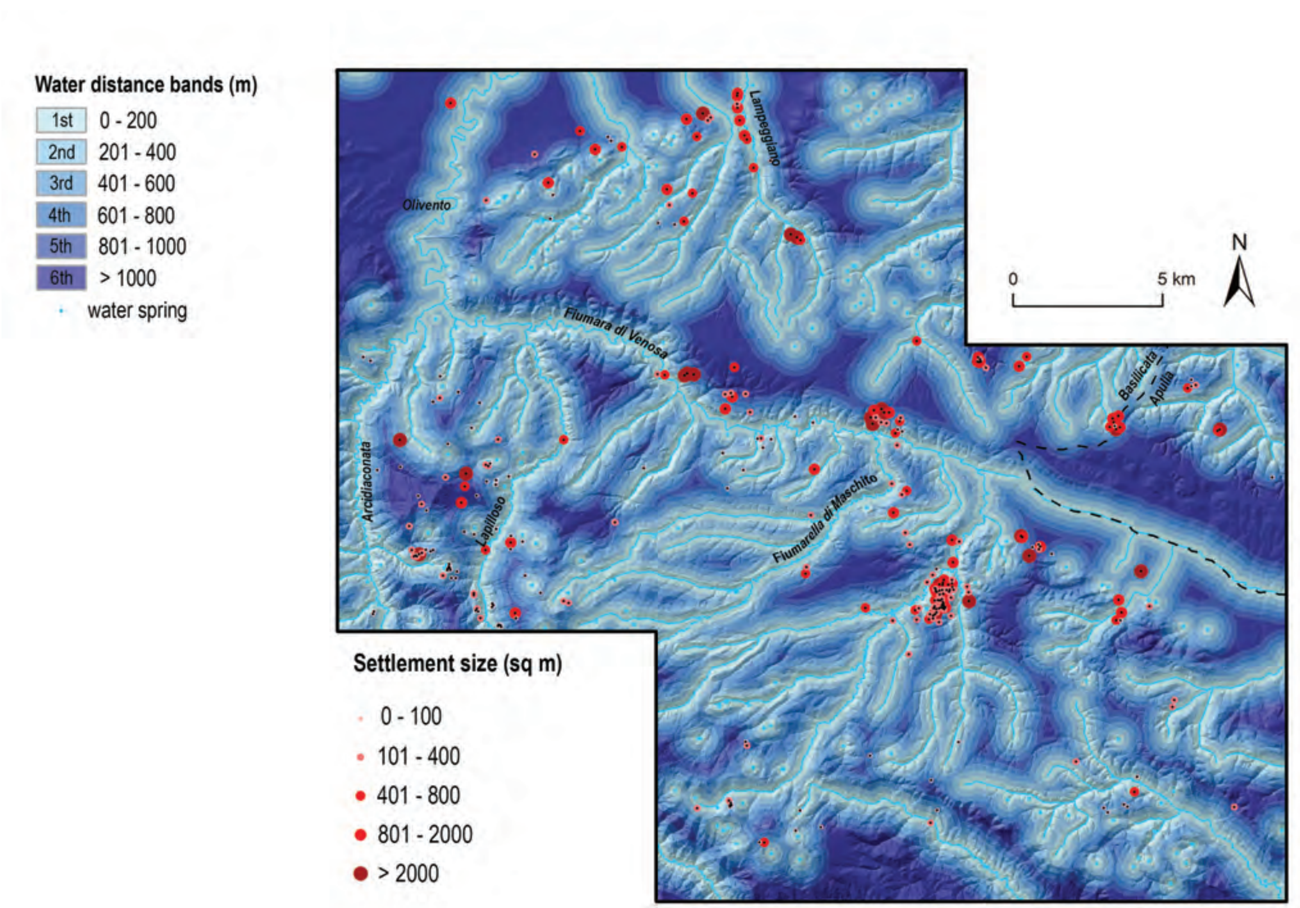
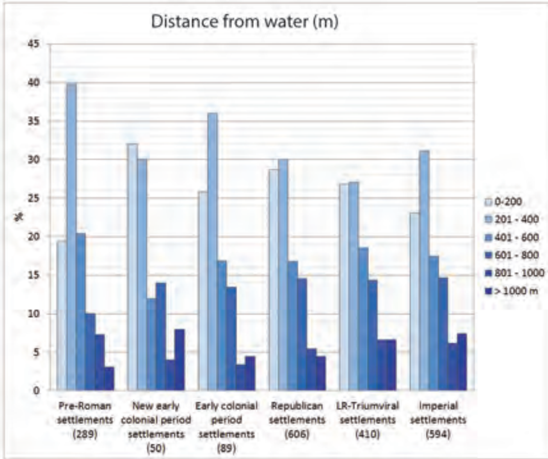


Figure 12 Distance from water sources classified in bands and distribution of pre-Roman settlements



Water band		Area (sq m)	%
1st	0-200 m	175648200	25.26
2nd	201 - 400 m	164570200	23.67
3rd	401 - 600 m	127113900	18.28
4th	601 - 800 m	89448700	12.87
5th	801 - 1000 m	56637100	8.15
6th	> 1000 m	81864100	11.77
	Tot.	695282200	100

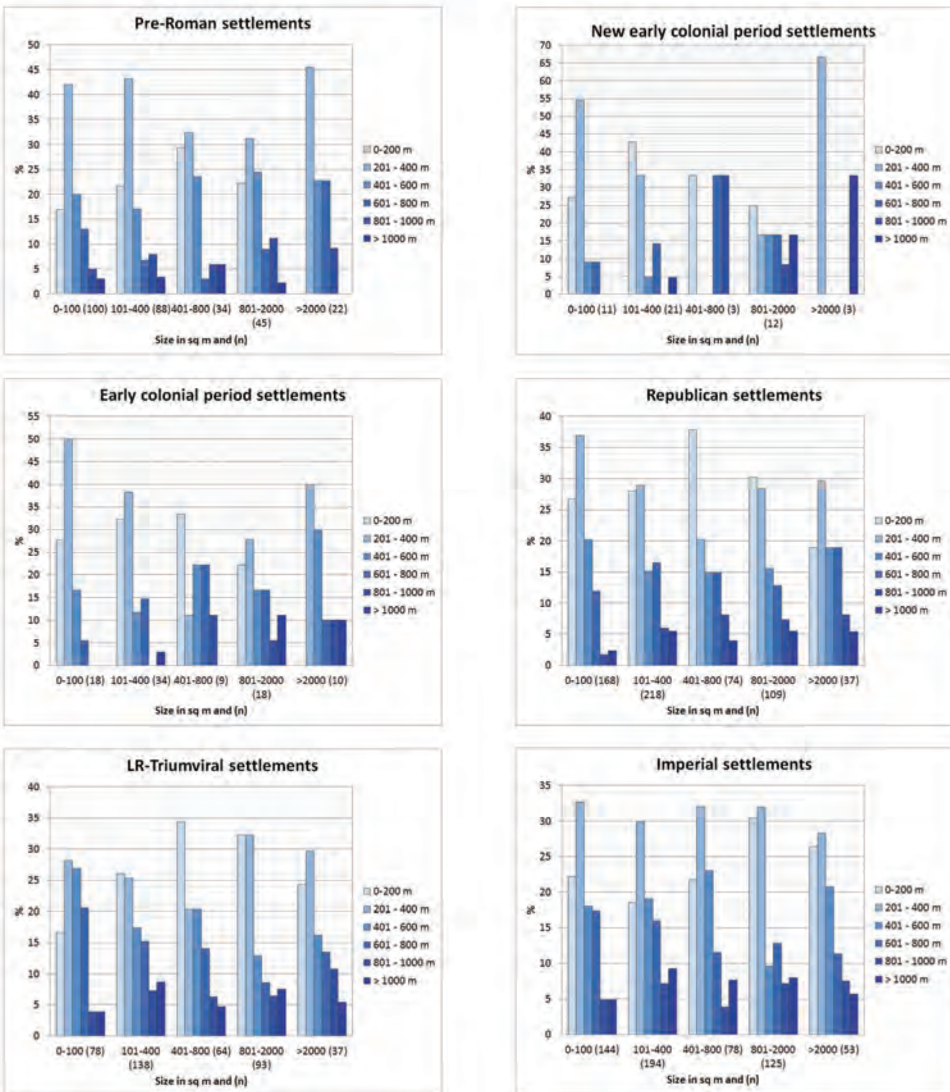


Figure 13 Settlement percentages in progressive distance bands from water sources. In brackets, total number of settlements per sample (n)

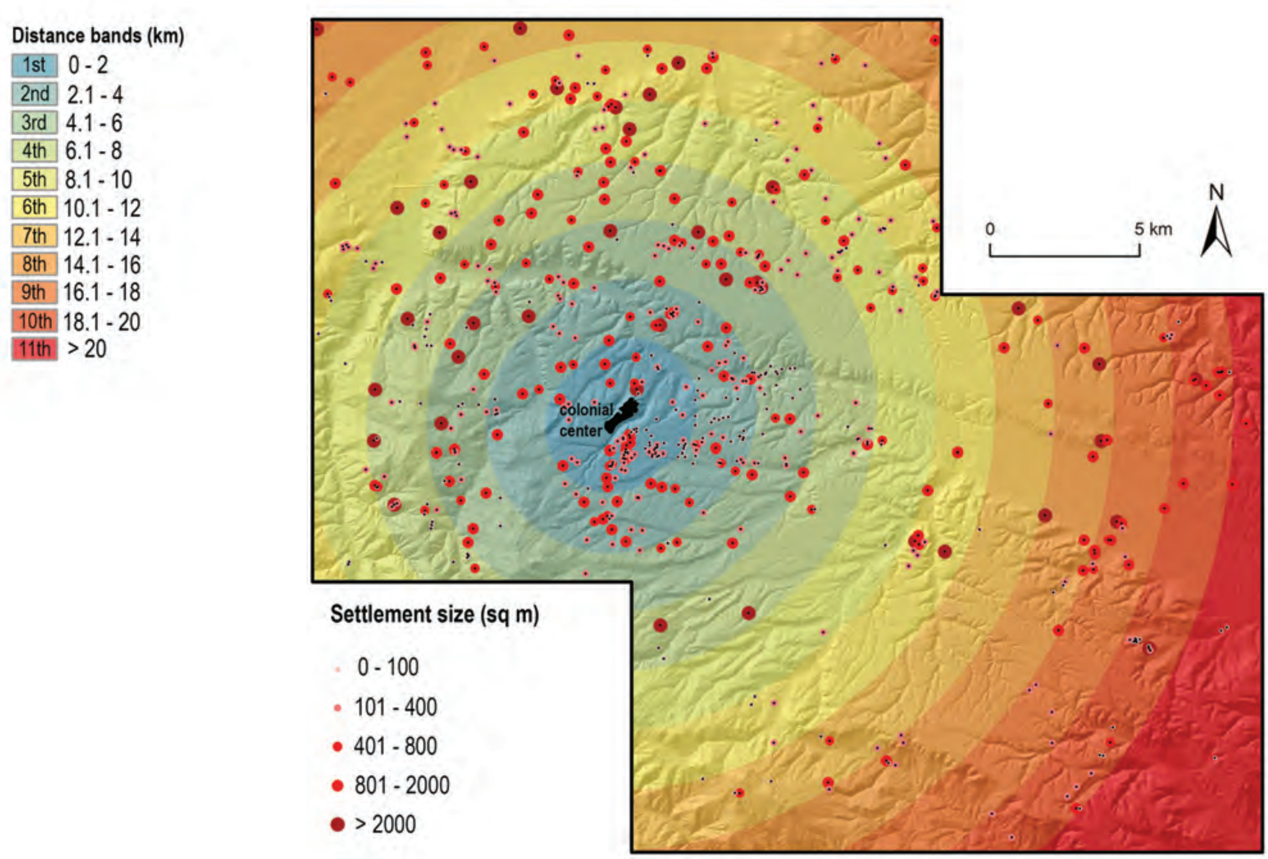
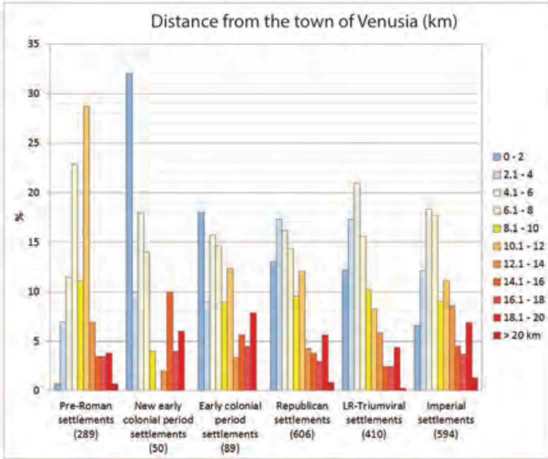


Figure 14 Distance from the town classified in bands and distribution of Republican settlements



Distance band		Area (sq m)	%
1st	0 - 2	20050700	2.88
2nd	2.1 - 4	44602500	6.42
3rd	4.1 - 6	66629100	9.58
4th	6.1 - 8	82483500	11.86
5th	8.1 - 10	99370200	14.29
6th	10.1 - 12	97895100	14.08
7th	12.1 - 14	88587200	12.74
8th	14.1 - 16	60777500	8.74
9th	16.1 - 18	43986300	6.33
10th	18.1 - 20	41855200	6.02
11th	> 20 km	49044900	7.05
Tot.		695282200	100

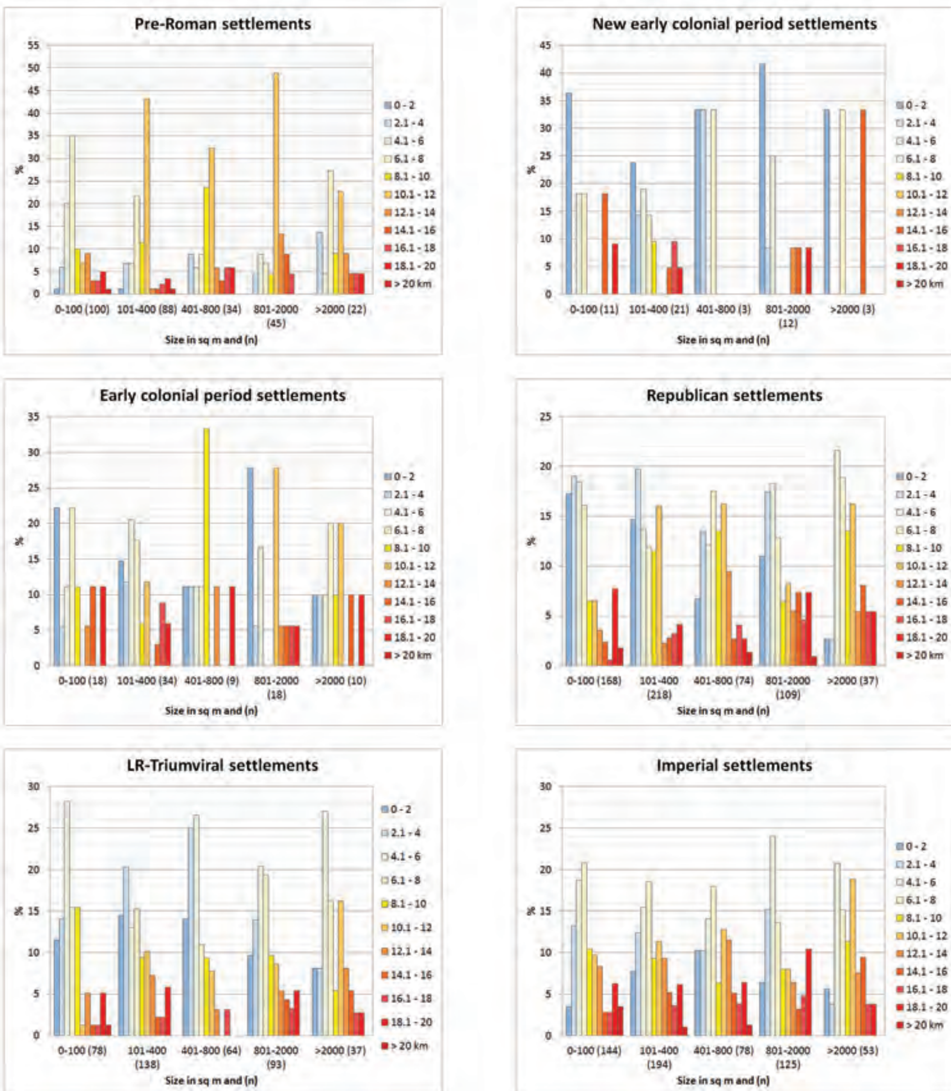


Figure 15 Settlement percentages in progressive distance bands from the town of Venusia. In brackets, total number of settlements per sample (n)

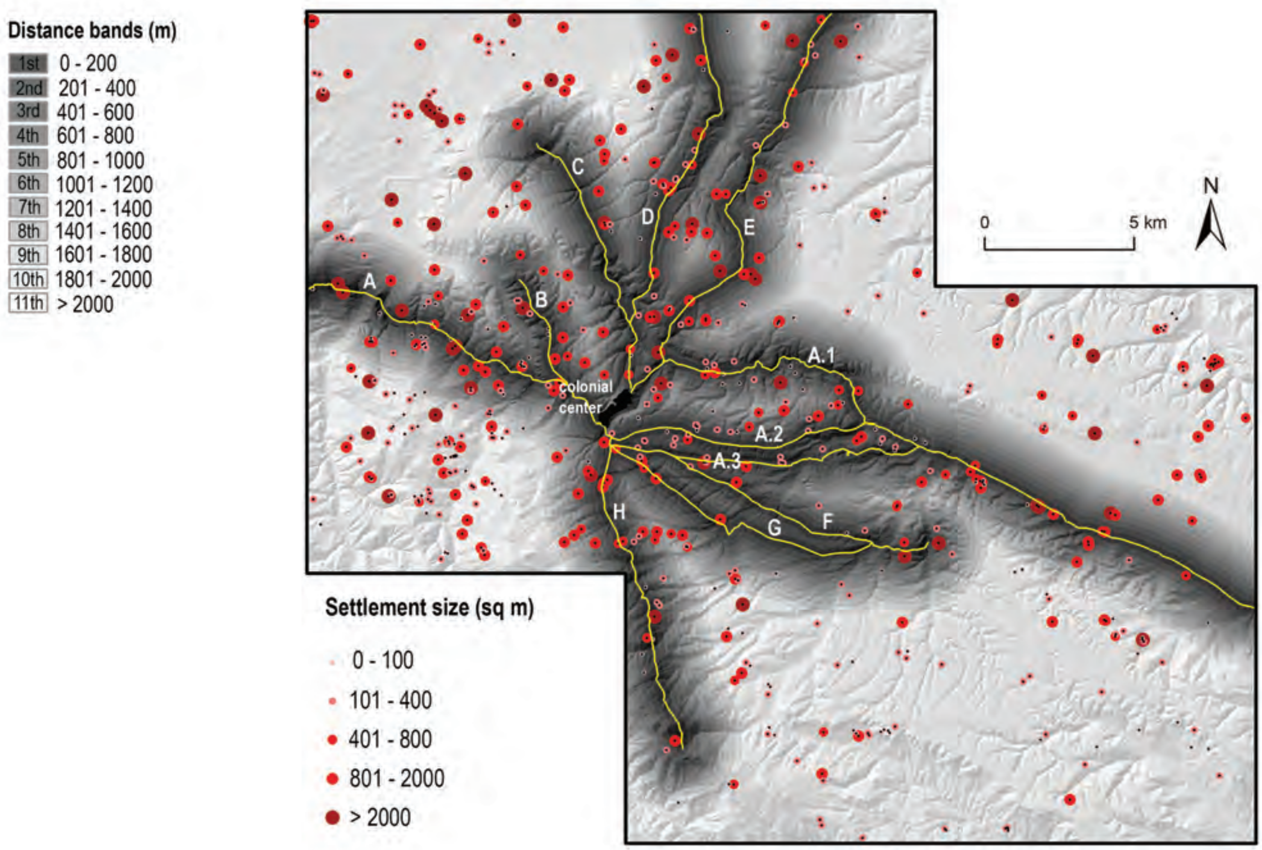
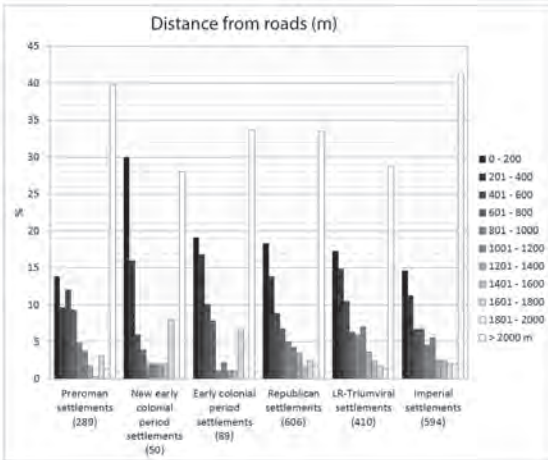


Figure 16 Distance from (Roman) roads classified in bands and distribution of Imperial settlements. The routes have been digitalized on the basis of the information and maps reported in Salvatore 1984 (pp. 17 – 21), Marchi and Sabbatini 1996 (pp. 125 – 127), Sabbatini 2001 (pp. 78 – 80) and Marchi 2010 (pp. 279 – 285). A: Via Appia; A.1: alternative route of the Via Appia (Marchi and Sabbatini 1996, 125); A.2: segment of the Via Appia (Marchi and Sabbatini 1996, 125 – 127, see also Marchi 2010, 279 – 285) ; A.3: segment of the Via Appia (Vinson 1979; Marchi, Sabbatini 1996, 125 – 127); B: Via Venusia – Herdonias (Salvatore 1984: 17 – 21; Marchi and Sabbatini 1996, 125 – 127); C: Via Venusia – Forentum (Marchi and Sabbatini 1996, 125 – 127); D: road parallel to the Lampeggiano river (Sabbatini 2001: 78 – 80); E: via Venusia – Canusium (Sabbatini 2001, 78 – 80). F and G: via Venusia – Bantia (Buck 1981; Marchi and Sabbatini 1996, 125 – 127); H: via Herculia (Buck 1971; Marchi and Sabbatini 1996, 125 – 127)



Distance band		Area (sq m)	%
1st	0 - 200	51136700	7.35
2nd	201 - 400	46892800	6.74
3rd	401 - 600	40638300	5.84
4th	601 - 800	37719400	5.43
5th	801 - 1000	34711500	4.99
6th	1001 - 1200	31034200	4.46
7th	1201 - 1400	27170200	3.91
8th	1401 - 1600	23640300	3.40
9th	1601 - 1800	21404100	3.08
10th	1801 - 2000	20094000	2.89
11th	> 2000 m	360840700	51.90
	Tot.	695282200	100

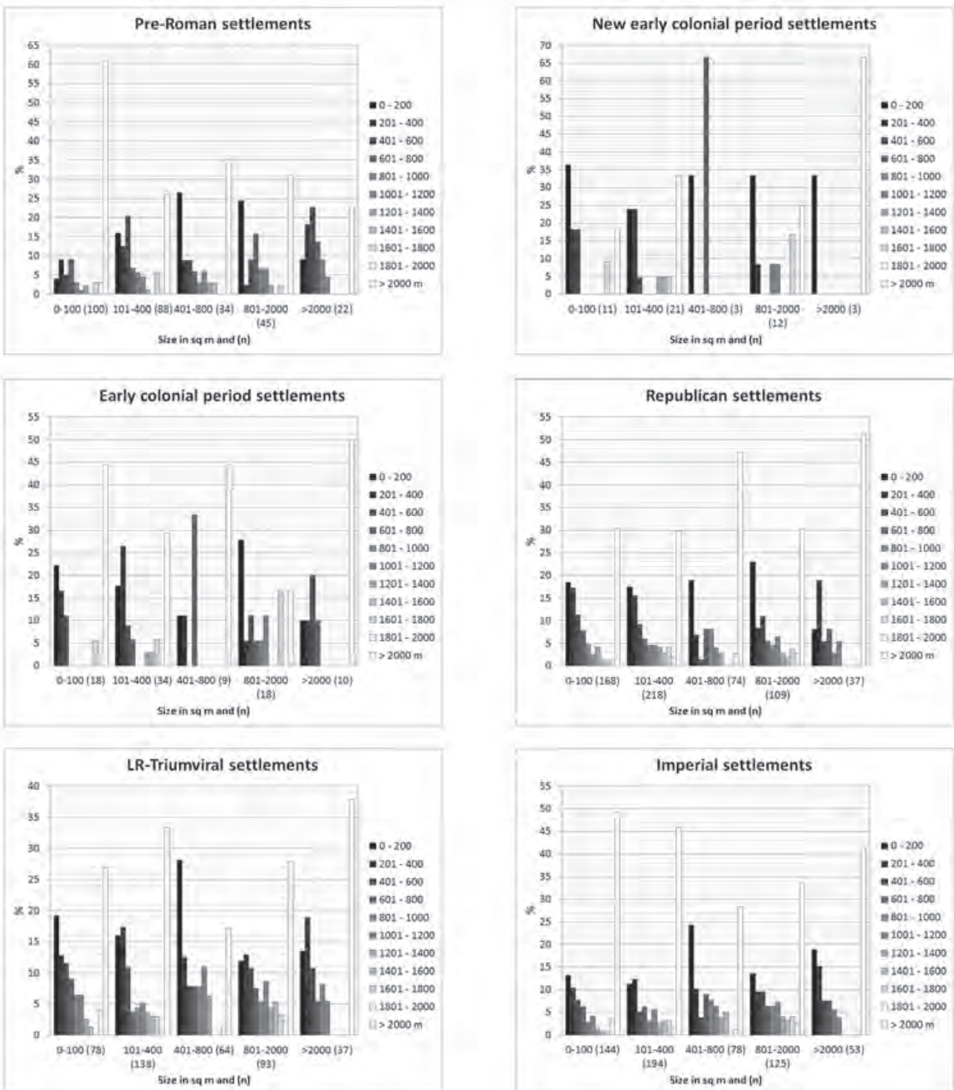


Figure 17 Settlement percentages in progressive distance bands from the (Roman) roads. In brackets, total number of settlements per sample (n)

We have seen that the pre-Roman and early colonial period settlement configurations often display similar location preferences and patterns with respect to the natural environment. The only clear difference in location preferences is cultural, and regards the way in which these settlements are located with respect to the town of Venusia (see Marchi 1991; Marchi and Sabbatini 1996, 47-48; Marchi 2000, 231; Marchi 2010, 249).

Early colonial period settlements also exhibit similarities with the larger sample of Republican settlements. This, of course, could depend on the fact that the early colonial settlement sample (3rd century BC) is not an independent sample but has been extracted from the Republican settlement sample (3rd – 1st century BC). It is likely that other early colonial period settlements are still incorporated in the Republican sample: as a matter of fact, those sites lacking diagnostic 3rd century BC archaeological material could be dated only to a broader chronological range (namely, the Republican period) (see also the discussion in Marchi and Sabbatini 1996, 111 footnote 129). Eventually, this may contribute in enhancing the similarity between surely-datable early colonial and generally-datable Republican settlements.

We also encountered similarities in location preferences between Republican and LR-Triumviral settlements and between LR-Triumviral and Imperial settlements. For instance, Republican and LR-Triumviral settlements are preferentially located in the 3rd altitude band and seem to preferentially gravitate towards the urban center or a road. However, differently from Republican settlements, the LR-Triumviral and Imperial settlements are both significantly attracted by fertile soils. The distance to town and roads is an important element in location choices in these periods too, but, especially for the Imperial period, clearly to a lesser extent than before.

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Notes

1 This may also be the case for those settlements founded in a certain period and attesting discontinuous occupation in later phases as well. Their recorded size may be indicative of these later phases rather than of the phase concerned. The role played by occupation phases prior to the pre-Roman period on size recording was not taken into account.

2 Performed in Excel 2010. The Attwell-Fletcher test was run in DOS.

3 In some cases the type of data used did not meet the conditions associated with the tests (*e.g.* the assumption of normality in the distribution of data considered in the ANOVA and t-test). These trends were subsequently compared with the distributions represented in the graphs to test whether similar trends were also displayed in these graphs. In a second step, during the interpretation of the results, untrustworthy trends and/or correlations will be discarded and the reliable ones will be pondered more thoroughly, taking into account possible limitations (Casarotto *et al.* forthcoming).

4 As for the impossibility to disentangle, for each phase, the actual extension of the inherited sites (see Data section of this paper), the statistical analysis was not performed on the inherited samples with large size categories (*i.e.* 401-800, 801-2000 and > 2000 sq m). Therefore, as regards the inherited sites, only the distribution of the smallest size categories (*i.e.* 0-100 and 101-400 sq m settlements) is analyzed with these tests. This is because, if we assume that the artifact scatter size provides reliable indication of the actual settlement size (see the discussion in *e.g.*, Dyson 1978; Potter 1979; Lloyd and Barker 1981; Fentress 2000; Given 2004), in these cases, the small size of such settlements should be expected not to have significantly changed from a period to the subsequent one.

5 Specifically, by means of these tests the frequency distribution of a periodic-size-site sample (*e.g.* pre-Roman 0-100 sq m settlements) and the frequency distribution of new settlements established in the subsequent phase and having the same size category (*e.g.* new Republican 0-100 sq m settlements) were analyzed.

6 However, these tests did not allow us to ascertain what precisely these differences or similarities are (for other limitations see also note 3 of this paper).

7 It is possible that the method chosen for the classification of the variables in categories does not correspond with the ancient perception of the landscape topography (Verhagen 2002, 202-203). The definition given here of what constituted, for instance, a gentle slope might not correspond with how people in the past perceived a slope to be gentle. Therefore, it cannot be totally excluded that significant preferences may have escaped detection because the reclassification method used in this analysis does not entirely accord with ancient judgments on the landscape suitability for settlement.

8 When conducting inference statistic, it is always advisable to use at least two different tests of significance. This was done also in this analysis. As previously stated, the Chi-squared test was implemented for the nominal variables, the Kolmogorov-Smirnov test for the ordinal variables, and the Attwell-Fletcher test for both types of variables. Only when the results from both tests concur on the presence or absence of a correlation can we be confident about the existence of a significant relationship (or absence of a relationship) between site distribution and the landscape variable under consideration. It is important to note, however, that the Chi-squared and the Kolmogorov-Smirnov tests have some limitations – which mainly depend on the size of the sample – and it is advisable not to apply them when required conditions are not met. As a matter of fact the Kolmogorov-Smirnov test should be used only with samples having more than 40 elements (Shennan 1988, 55; Wheatley and Gillings 2002, 140) and the Chi-squared test should not be used when more than 20% of the frequencies expected in each variable category are less than five sites or when at least one expected frequency is smaller than one (Siegel 1956, 46; see also Shennan 1988, 69). Moreover, in case of dichotomous variables (*e.g.* location of dominant positions) the Chi-squared test should be used only when the frequency of sites expected is higher than five in both dichotomous categories (*ibid.*).

9 Permission for download and use of this elevation dataset was released in May and June 2014, see http://tinitaly.pi.ingv.it/

10 Ufficio Produzioni Vegetali e Silvicoltura Produttiva – Dipartimento Agricoltura, Sviluppo Rurale, Economia Montana – Regione Basilicata. Data and legend can be found here: http://www.basilicatanet.it/suoli/index.htm (credits: http://www.basilicatanet.it/suoli/credits.htm) and in the catalogue of the Geoportale della Basilicata: http://rsdi.regione.basilicata.it/Catalogo/srv/ita/search?hl=ita. The shapefile of the soil map of Basilicata was kindly provided to the author by Regione Basilicata in May 2013.

11 The outmost west corner of the survey sample area belongs to the Apulia Region. The soil information for this small zone was inferred by the author on the basis of physiographic and geological conditions. The geological maps of this area (Carta Geologica d'Italia 1: 500,000 - Geoportale Nazionale - Ministero dell'Ambiente e della Tutela del Territorio e del Mare, and Carta Geologica d'Italia 1: 100,000 – Foglio 188, Servizio Geologico d'Italia) were controlled to map the soil units in this zone: since the geomorphological and geological characteristics of this area are the same of adjacent known soil units (*i.e.* 11.1, 11.2 and 14.1; see also Carta Geologica d'Italia 1: 100,000 – Foglio 175 and 187, Servizio Geologico d'Italia), this small portion of the survey area was classified accordingly, using these known soil units (see Figure 8).

12 The parameters applied for the reclassification of the landscape in geomorphological classes were: kernel window 9x9; distance decay 1; slope tolerance 7; curvature tolerance 0.1. See Wood (2009, 81 - 87) for more details on the procedure.

13 This data was kindly provided to the author by the Regione Basilicata in June 2013. Data concerning the hydrography can be found in the catalogue of the Geoportale della Basilicata: http://rsdi.regione.basilicata.it/Catalogo/srv/ita/search?hl=ita For the territory outside Basilicata, rivers and main streams were digitalized manually on the basis of topographic maps.

14 WMS server available through the Geoportale Nazionale: http://www.pcn.minambiente.it/

15 An exhibition on ancient water management systems was recently held at Venosa (Rosa *et al.* 2016).

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Anita Casarotto
Faculty of Archaeology
Leiden University
PO Box 9514
2300 RA Leiden
The Netherlands
a.casarotto@arch.leidenuniv.nl

Appendix I

Here, one example of the results obtained for each statistical test is offered. Significant differences and/or correlations are highlighted in red, whereas absence of differences and/or correlations is highlighted in green.

1. Assessing differences in settlement distributions

a. ANOVA and t-tests: by using these tests in this example it is explored whether the distribution of pre-Roman 801 – 2000 sq m settlements is significantly different from the distribution of Republican 801 – 2000 sq m settlements with respect to the distance from the town of Venusia. As displayed in the tables below, there seems to be a significant difference between two groups of settlements: *i.e.* pre-Roman and new Republican settlements, and pre-Roman and Republican settlements ($\alpha = 0.05$).

	Distance from the town of Venusia (m)		
n	**Pre-Roman settlements**	**New Republican settlements**	**Republican settlements**
1	11114.2	11368.3	11114.2
2	10932.7	15748.5	11368.3
3	11377.4	12028.1	11776.1
4	11776.1	7698.84	15748.5
5	12163.5	9472	12028.1
6	12241.5	6345.47	7698.84
7	8716.25	5486.93	9472
8	13490.3	4026.51	6345.47
9	10256.9	5411.12	5486.93
10	9624.6	5515.89	4026.51
11	5697.87	6265.99	5411.12
12	4537.15	12372.7	5515.89
13	5904.05	9900.07	6265.99
14	16273.2	10592.8	13490.3
15	16058	12113.9	12372.7
16	13049.5	8630.98	9900.07
17	12393.1	8419.06	10592.8
18	11034.4	7957.42	10256.9
19	11090.8	7304.42	9624.6
20	11093.3	6725.21	12113.9
21	12354.9	7041.77	8630.98
22	15381.7	7509.7	8419.06
23	15185.9	7420.55	7957.42
24	15206.3	8327.71	7304.42
25	15405.2	7363.97	6725.21
26	7743.95	6954.28	7041.77
27	7258.35	4288.89	7509.7
28	3020.55	5257.09	7420.55
29	2586.52	5849.62	8327.71
30	5125.44	4384.27	7363.97

	Distance from the town of Venusia (m)		
n	**Pre-Roman settlements**	**New Republican settlements**	**Republican settlements**
31	7977.63	2934.93	6954.28
32	10113.4	5098.28	4288.89
33	10360.3	3606.12	5257.09
34	10491.4	7950.37	5849.62
35	10586.2	5550.23	4384.27
36	10290.8	5958.14	2934.93
37	10316	14359.4	5697.87
38	10129.3	13794.9	5098.28
39	10203.2	19875.7	3606.12
40	10238.9	15949.3	4537.15
41	10458.6	15912.8	7950.37
42	10469.3	16102.7	5550.23
43	10576.6	17304.1	5958.14
44	10729.4	15626.1	14359.4
45	10662.9	10853.3	13794.9
46		16495.7	19875.7
47		16716.1	15949.3
48		18014.8	15912.8
49		20144.5	16058
50		18514.2	16102.7
51		15807.2	17304.1
52		15389.3	15626.1
53		12431.5	10853.3
54		15114.9	16495.7
55		19109.1	16716.1
56		19597.6	18014.8
57		19517.7	20144.5
58		19658.6	18514.2
59		19541.7	15807.2
60		2065.84	15389.3

Distance from the town of Venusia (m)			
n	Pre-Roman settlements	New Republican settlements	Republican settlements
61		2564.7	12431.5
62		3106.01	15114.9
63		3180.22	19109.1
64		3877.69	19597.6
65		1420.56	19517.7
66		2371.24	19658.6
67		1712.83	19541.7
68		560	2065.84
69		526.972	2564.7
70		612.699	3106.01
71		687.968	3180.22
72		652.993	3877.69
73		731.095	3020.55
74		966.488	1420.56
75		2912.47	2371.24
76		7816.55	1712.83
77		5950.6	560
78		5877.25	526.972
79		4399.06	612.699
80		1475.74	687.968
81		1856.91	652.993
82		2443.93	731.095
83		1761.82	966.488
84		2269.74	2912.47
85		2870.05	5125.44

Distance from the town of Venusia (m)			
n	Pre-Roman settlements	New Republican settlements	Republican settlements
86		3200.25	7816.55
87		3645.85	5950.6
88		5444.24	5877.25
89		3893.44	4399.06
90		3020.35	1475.74
91		2462.19	1856.91
92		6846.76	2443.93
93		8814.65	1761.82
94		5925.96	2269.74
95		5502.45	2870.05
96		2130.38	3200.25
97			3645.85
98			5444.24
99			10113.4
100			10316
101			10458.6
102			3893.44
103			3020.35
104			2462.19
105			6846.76
106			8814.65
107			5925.96
108			5502.45
109			2130.38

SUMMARY

Samples	Count	Sum	Average	Variance
Pre-Roman settlements	45	471697.56	10482.168	10107288
New Republican settlements	96	770269.275	8023.63828	34107923
Republican settlements	109	891858.385	8182.18702	31756273

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Samples	209286932.8	2	104643466	3.632917	0.027862	3.032361
Within Samples	7114650838	247	28804254.4			
Total	7323937770	249				

t-Test	Pre-Roman settlements	New Republican settlements
Mean	10482.168	8023.638281
Variance	10107288.02	34107923.31
Observations	45	96
Pooled Variance	26510599.91	
Hypothesized Mean Difference	0	
df	139	
t Stat	2.643005103	
P(T<=t) one-tail	0.004580305	
t Critical one-tail	1.655889868	
a: P(T<=t) two-tail	0.009160609	
b: P(T<=t) two-tail (Bonferroni's correction)	0.016666667	
t Critical two-tail	1.977177724	
If a< b, significant difference exists	TRUE	

t-Test	Pre-Roman settlements	Republican settlements
Mean	10482.168	8182.187018
Variance	10107288.02	31756272.68
Observations	45	109
Pooled Variance	25489461.33	
Hypothesized Mean Difference	0	
df	152	
t Stat	2.57100583	
P(T<=t) one-tail	0.005550097	
t Critical one-tail	1.654940175	
a: P(T<=t) two-tail	0.011100195	
b: P(T<=t) two-tail (Bonferroni's correction)	0.016666667	
t Critical two-tail	1.975693928	
If a< b, significant difference exists	TRUE	

t-Test	New Republican settlements	Republican settlements
Mean	8023.638281	8182.187018
Variance	34107923.31	31756272.68
Observations	96	109
Pooled Variance	32856798.84	
Hypothesized Mean Difference	0	
df	203	
t Stat	-0.197615997	
P(T<=t) one-tail	0.421771627	

t-Test	New Republican settlements	Republican settlements
t Critical one-tail	1.65239446	
a: P(T<=t) two-tail	0.843543254	
b: P(T<=t) two-tail (Bonferroni's correction)	0.016666667	
t Critical two-tail	1.971718848	
If a< b, significant difference exists	FALSE	

b. Kolmogorov-Smirnov two-sample test: by using this test in this example it is assessed whether the distribution across variable categories (in this case, subsequent distance bands from the town of Venusia) of pre-Roman 801-2000 sq m settlements significantly differs from the distribution of new Republican 801-2000 sq m settlements.

Kolmogorov-Smirnov test. Critical value 0.246 (α = 0.05)

Distance band from the town of Venusia	Pre-Roman settlements	Proportion of pre-Roman settlements	Cumulative proportion of pre-Roman settlements (a)	New Republican settlements	Proportion of New Republican settlements	Cumulative proportion of new Republican settlements (b)	Difference = |a - b|
0-2 km	0	0	0	12	0.125	0.125	0.125
2.1-4 km	2	0.044	0.044	18	0.188	0.313	0.268
4.1-6 km	4	0.089	0.133	17	0.177	0.490	0.356
6.1-8 km	3	0.067	0.200	14	0.146	0.635	0.435
8.1-10 km	2	0.044	0.244	6	0.063	0.698	0.453
10.1-12 km	22	0.489	0.733	3	0.031	0.729	0.004
12.1-14 km	6	0.133	0.867	5	0.052	0.781	0.085
14.1-16 km	4	0.089	0.956	8	0.083	0.865	0.091
16.1-18 km	2	0.044	1	4	0.042	0.906	0.094
18.1-20 km	0	0	1	8	0.083	0.990	0.010
> 20 km	0	0	1	1	0.010	1	0
Tot.	45	1		96	1		

c. Chi-squared two-sample test: by using this test in this example it is assessed whether the distribution across variable categories (in this case, soil types) of pre-Roman 101-400 sq m settlements significantly differs from the distribution of new Republican 101-400 sq m settlements. A very small p value (in this case, p = 0.00027) indicates that a significant difference exists. In this case (df = 11 ; α = 0.001) the critical value to reject the null hypothesis of no difference between the two samples is 31.26 (see Siegel 1956: 249). However, it should be noted that in this example there are many expected frequencies of sites below five; the Chi-squared test might not be the most appropriate method to be used in this case (see Siegel 1956, 110).

Soil unit	Pre-Roman settlements (O_β)	New Republican settlements (O_γ)	Totality	Expected Pre-Roman settlements (E_β)	$(O_\beta-E_\beta)^2/E_\beta$	Expected New Republican settlements (E_γ)	$(O_\gamma-E_\gamma)^2/E_\gamma$
14.2	10	33	43	13.277	0.809	29.723	0.361
14.3	1	1	2	0.618	0.237	1.382	0.106
9.2	1	3	4	1.235	0.045	2.765	0.020
7.3	9	17	26	8.028	0.118	17.972	0.053
11.1	38	105	143	44.154	0.858	98.846	0.383
6.3	5	0	5	1.544	7.737	3.456	3.456
14.5	0	2	2	0.618	0.618	1.382	0.276
14.1	0	1	1	0.309	0.309	0.691	0.138
12.1	1	4	5	1.544	0.192	3.456	0.086
11.2	17	19	36	11.116	3.115	24.884	1.391
14.7	1	12	13	4.014	2.263	8.986	1.011
6.4	5	0	5	1.544	7.737	3.456	3.456
Tot.	88	197	285	88	24.036	197	10.737
						Chi-square = 34.773	

2. ASSESSING CORRELATIONS BETWEEN FACTORS AND SETTLEMENT DISTRIBUTIONS: THE ONE-SAMPLE CHI-SQUARED, KOLMOGOROV-SMIRNOV, AND ATTWELL-FLETCHER TESTS

By applying either the Chi-squared (for nominal variables) or the Kolmogorov-Smirnov test (for ordinal variables), it is possible to assess whether there are significant differences between the frequency distribution of observed and expected settlements with respect to certain landscape factors. In the first example (a), the chi-squared test is used to assess whether Imperial settlements are equally distributed across the various soil types. This does not seem to be the case ($p < 0.001$); subsequently, the Attwell-Fletcher test is used to point out possible correlations with soil types. In the second example (b), we focus instead on the Republican 0-100 sq m settlements and on how these settlements are placed with respect to a water source. First the Kolmogorov-Smirnov test is used to assess whether a divergence exists from equality in distribution with respect to water distance bands and subsequently, the Attwell-Fletcher test is applied to highlight both favored and avoided distance bands to water.

a. Chi-squared and Attwell-Fletcher tests

Chi-squared test. Critical value 23.68 (df = 14 ; α = 0.05)

Soil unit	Area (sq m)	%	Observed settlements (O)	Expected settlements (E)	(O - E)²/E
14.4	2542200	0.366	2	2.172	0.014
14.6	15408200	2.216	7	13.164	2.886
14.2	61494600	8.845	88	52.537	23.939
14.3	8919300	1.283	7	7.620	0.050
9.2	15808800	2.274	33	13.506	28.137
7.3	67255200	9.673	84	57.458	12.261
11.1	279720100	40.231	212	238.973	3.044

Chi-squared test. Critical value 23.68 (df = 14 ; α = 0.05)

Soil unit	Area (sq m)	%	Observed settlements (O)	Expected settlements (E)	(O - E)²/E
6.3	13156400	1.892	11	11.240	0.005
14.5	9745700	1.402	6	8.326	0.650
14.1	28993500	4.170	12	24.770	6.583
12.1	23297100	3.351	14	19.903	1.751
11.2	135817200	19.534	92	116.033	4.978
7.5	7361700	1.059	2	6.289	2.925
14.7	19072200	2.743	19	16.294	0.449
6.4	6690000	0.962	5	5.715	0.090
Tot.	695282200	100	594	594	Chi-square = 87.762

Attwell-Fletcher test

number of settlements = 594 ; number of simulations = 200

Soil unit	N of settlements	Expected proportion	Observed proportion	Category weight	More sites than expected	Fewer sites than expected
14.4	2	0.00	0.00	0.06		
14.6	7	0.02	0.01	0.04		
14.2	88	0.09	0.15	0.11		
14.3	7	0.01	0.01	0.06		
9.2	33	0.02	0.06	0.16		
7.3	84	0.10	0.14	0.10		
11.1	212	0.40	0.36	0.06		
6.3	11	0.02	0.02	0.07		
14.5	6	0.01	0.01	0.05		
14.1	12	0.04	0.02	0.03		
12.1	14	0.03	0.02	0.05		
11.2	92	0.19	0.15	0.05		
7.5	2	0.01	0.00	0.02		
14.7	19	0.03	0.03	0.08		
6.4	5	0.01	0.01	0.06		

95th percentile = 0.14 +- 0.007 ; 5th percentile = 0.00 +- 0.000

b. Kolmogorov-Smirnov and Attwell-Fletcher tests

Kolmogorov-Smirnov test. Critical value: 0.105 (α = 0.05)

Water distance band	Area (sq m)	Proportion of area	Expected Cumulative proportion (E)	N of settlements	Proportion of settlements	Observed Cumulative proportion (O)	Difference = |E - O|
0 – 200 m	175648200	0.253	0.253	45	0.268	0.268	0.015
201 – 400 m	164570200	0.237	0.489	62	0.369	0.637	0.148
401 – 600 m	127113900	0.183	0.672	34	0.202	0.839	0.167
601 – 800 m	89448700	0.129	0.801	20	0.119	0.958	0.158
801 – 1000 m	56637100	0.081	0.882	3	0.018	0.976	0.094
> 1000 m	81864100	0.118	1	4	0.024	1	0
Tot.	695282200			168			

Attwell-Fletcher test

number of settlements = 168 ; number of simulations = 200

Water distance band	N of settlements	Expected proportion	Observed proportion	Category weight	More sites than expected	Fewer sites than expected
0 – 200 m	45	0.25	0.27	0.21		
201 – 400 m	62	0.24	0.37	0.31		
401 – 600 m	34	0.18	0.20	0.22		
601 – 800 m	20	0.13	0.12	0.18		
801 – 1000 m	3	0.08	0.02	0.04		
> 1000 m	4	0.12	0.02	0.04		

95th percentile = 0.25 +- 0.002 ; 5th percentile = 0.09 +- 0.008

Appendix II

The tables below report the results of the statistical analysis. Significant differences and/or correlations are highlighted in red, whereas absence of differences (*i.e.* presence of similarity) and/or correlations is highlighted in green.

For the one-sample tests, the yellow fields indicate that only one out of two tests detected a correlation. The symbol "+" indicates more sites than expected (positive correlation), whereas "-" indicates that fewer sites than expected are located in a certain land unit (negative correlation). Positive and negative correlations are separated by a semicolon. The ordinal numbers indicate the classes/bands/units where the correlations occur (see also the correspondent Figures).

1. ANOVA and t-tests

Pre-Roman and early colonial period settlement comparison	**ANOVA and t-tests**					
0-100 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
Pre-Roman vs. inherited pre-Roman settlements						
Pre-Roman vs. new early colonial period settlements						
Pre-Roman vs. early colonial period settlements						
Inherited pre-Roman vs. new early colonial period settlements						
Inherited pre-Roman vs. early colonial period settlements						
New early colonial period settlements vs. early colonial period settlements						
101-400 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
Pre-Roman vs. inherited pre-Roman settlements						
Pre-Roman vs. new early colonial period settlements						
Pre-Roman vs. early colonial period settlements						
Inherited pre-Roman vs. new early colonial period settlements						
Inherited pre-Roman vs. early colonial period settlements						
New early colonial period settlements vs. early colonial period settlements						
401-800 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
Pre-Roman vs. new early colonial period settlements						
Pre-Roman vs. early colonial period settlements						
New early colonial period settlements vs. early colonial period settlements						
801-2000 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
Pre-Roman vs. new early colonial period settlements						
Pre-Roman vs. early colonial period settlements						
New early colonial period settlements vs. early colonial period settlements						
> 2000 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
Pre-Roman vs. new early colonial period settlements						
Pre-Roman vs. early colonial period settlements						
New early colonial period settlements vs. early colonial period settlements						

Pre-Roman and Republican settlement comparison	**ANOVA and t-tests**					
0-100 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
Pre-Roman vs. inherited pre-Roman settlements						
Pre-Roman vs. new Republican settlements						
Pre-Roman vs. Republican settlements						
Inherited pre-Roman vs. new Republican settlements						
Inherited pre-Roman vs. Republican settlements						
New Republican vs. Republican settlements						
101-400 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
Pre-Roman vs. inherited pre-Roman settlements						
Pre-Roman vs. new Republican settlements						
Pre-Roman vs. Republican settlements						
Inherited pre-Roman vs. new Republican settlements						
Inherited pre-Roman vs. Republican settlements						
New Republican vs. Republican settlements						
401-800 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
Pre-Roman vs. new Republican settlements						
Pre-Roman vs. Republican settlements						
New Republican vs. Republican settlements						
801-2000 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
Pre-Roman vs. new Republican settlements						
Pre-Roman vs. Republican settlements						
New Republican vs. Republican settlements						
> 2000 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
Pre-Roman vs. new Republican settlements						
Pre-Roman vs. Republican settlements						
New Republican vs. Republican settlements						

Republican and LR-Triumviral settlement comparison	**ANOVA and t-tests**					
0-100 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
Republican vs. inherited Republican settlements						
Republican vs. new Republican settlements						
Republican vs. LR-Triumviral settlements						
Republican vs. new LR-Triumviral settlements						
Inherited Republican vs. new Republican settlements						
Inherited Republican vs. new LR-Triumviral settlements						
Inherited Republican vs. LR-Triumviral settlements						
New Republican vs. New LR-Triumviral settlements						
New Republican vs. LR-Triumviral settlements						
New LR-Triumviral vs. LR-Triumviral settlements						

Republican and LR-Triumviral settlement comparison	ANOVA and t-tests					
101-400 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
Republican vs. inherited Republican settlements						
Republican vs. new Republican settlements						
Republican vs. LR-Triumviral settlements						
Republican vs. new LR-Triumviral settlements						
Inherited Republican vs. new Republican settlements						
Inherited Republican vs. new LR-Triumviral settlements						
Inherited Republican vs. LR-Triumviral settlements						
New Republican vs. New LR-Triumviral settlements						
New Republican vs. LR-Triumviral settlements						
New LR-Triumviral vs. LR-Triumviral settlements						
401-800 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
Republican vs. new Republican settlements						
Republican vs. LR-Triumviral settlements						
Republican vs. new LR-Triumviral settlements						
New Republican vs. new LR-Triumviral settlements						
New Republican vs. LR-Triumviral settlements						
New LR-Triumviral vs. LR-Triumviral settlements						
801-2000 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
Republican vs. new Republican settlements						
Republican vs. LR-Triumviral settlements						
Republican vs. new LR-Triumviral settlements						
New Republican vs. new LR-Triumviral settlements						
New Republican vs. LR-Triumviral settlements						
New LR-Triumviral vs. LR-Triumviral settlements						
> 2000 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
Republican vs. new Republican settlements						
Republican vs. LR-Triumviral settlements						
Republican vs. new LR-Triumviral settlements						
New Republican vs. new LR-Triumviral settlements						
New Republican vs. LR-Triumviral settlements						
New LR-Triumviral vs. LR-Triumviral settlements						

Republican and Imperial settlement comparison	ANOVA and t-tests					
0-100 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
Imperial vs. Inherited Republican settlements						
Imperial vs. new Imperial settlements						
Imperial vs. Republican settlements						
Imperial vs. new Republican settlements						
Inherited Republican vs. new Republican settlements						
Inherited Republican vs. new LR-Triumviral settlements						
Inherited Republican vs. Republican settlements						
New Imperial vs. new Republican settlements						
New Imperial vs. Republican settlements						
New Imperial vs. Imperial settlements						
101-400 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
Imperial vs. Inherited Republican settlements						
Imperial vs. new Imperial settlements						
Imperial vs. Republican settlements						
Imperial vs. new Republican settlements						
Inherited Republican vs. new Republican settlements						
Inherited Republican vs. new LR-Triumviral settlements						
Inherited Republican vs. Republican settlements						
New Imperial vs. new Republican settlements						
New Imperial vs. Republican settlements						
New Imperial vs. Imperial settlements						
401-800 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
Imperial vs. new Imperial settlements						
Imperial vs. Republican settlements						
Imperial vs. new Republican settlements						
New Imperial vs. new Republican settlements						
New Imperial vs. Republican settlements						
New Imperial vs. Imperial settlements						
801-2000 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
Imperial vs. new Imperial settlements						
Imperial vs. Republican settlements						
Imperial vs. new Republican settlements						
New Imperial vs. new Republican settlements						
New Imperial vs. Republican settlements						
New Imperial vs. Imperial settlements						
> 2000 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
Imperial vs. new Imperial settlements						
Imperial vs. Republican settlements						

Republican and Imperial settlement comparison	**ANOVA and t-tests**
Imperial vs. new Republican settlements	
New Imperial vs. new Republican settlements	
New Imperial vs. Republican settlements	
New Imperial vs. Imperial settlements	

LR-Triumviral and Imperial settlement comparison	**ANOVA and t-tests**					
0-100 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
LR-Triumviral vs. inherited LR-Triumviral settlements						
LR-Triumviral vs. new LR-Triumviral settlements						
LR-Triumviral vs. Imperial settlements						
LR-Triumviral vs. new Imperial settlements						
Inherited LR-Triumviral vs. new LR-Triumviral settlements						
Inherited LR-Triumviral vs. new Imperial settlements						
Inherited LR-Triumviral vs. Imperial settlements						
New LR-Triumviral vs. new Imperial settlements						
New LR-Triumviral vs. Imperial settlements						
New Imperial vs. Imperial settlements						
101-400 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
LR-Triumviral vs. inherited LR-Triumviral settlements						
LR-Triumviral vs. new LR-Triumviral settlements						
LR-Triumviral vs. Imperial settlements						
LR-Triumviral vs. new Imperial settlements						
Inherited LR-Triumviral vs. new LR-Triumviral settlements						
Inherited LR-Triumviral vs. new Imperial settlements						
Inherited LR-Triumviral vs. Imperial settlements						
New LR-Triumviral vs. new Imperial settlements						
New LR-Triumviral vs. Imperial settlements						
New Imperial vs. Imperial settlements						
401-800 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
LR-Triumviral vs. new LR-Triumviral settlements						
LR-Triumviral vs. Imperial settlements						
LR-Triumviral vs. new Imperial settlements						
New LR-Triumviral vs. new Imperial settlements						
New LR-Triumviral vs. Imperial settlements						
New Imperial vs. Imperial settlements						
801-2000 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
LR-Triumviral vs. new LR-Triumviral settlements						
LR-Triumviral vs. Imperial settlements						

LR-Triumviral and Imperial settlement comparison	ANOVA and t-tests					
LR-Triumviral vs. new Imperial settlements						
New LR-Triumviral vs. new Imperial settlements						
New LR-Triumviral vs. Imperial settlements						
New Imperial vs. Imperial settlements						
> 2000 sq m settlement samples	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**
LR-Triumviral vs. new LR-Triumviral settlements						
LR-Triumviral vs. Imperial settlements						
LR-Triumviral vs. new Imperial settlements						
New LR-Triumviral vs. new Imperial settlements						
New LR-Triumviral vs. Imperial settlements						
New Imperial vs. Imperial settlements						

2. Kolmogorov-Smirnov and Chi-squared two-sample tests

	Kolmogorov-Smirnov test						Chi-squared test	
Pre-Roman and early colonial settlement comparison	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**	**Soil**	**Ridges/ Peaks**
0-100 sq m settlement samples								
Pre-Roman vs. new early colonial period settlements								
101-400 sq m settlement samples								
Pre-Roman vs. new early colonial period settlements								
401-800 sq m settlement samples								
Pre-Roman vs. new early colonial period settlements								
801-2000 sq m settlement samples								
Pre-Roman vs. new early colonial period settlements								
> 2000 sq m settlement samples								
Pre-Roman vs. new early colonial settlements								

	Kolmogorov-Smirnov test						Chi-squared test	
Pre-Roman and Republican settlement comparison	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**	**Soil**	**Ridges/ Peaks**
0-100 sq m settlement samples								
Pre-Roman vs. new Republican settlements								
101-400 sq m settlement samples								
Pre-Roman vs. new Republican settlements								
401-800 sq m settlement samples								
Pre-Roman vs. new Republican settlements								
801-2000 sq m settlement samples								
Pre-Roman vs. new Republican settlements								
> 2000 sq m settlement samples								
Pre-Roman vs. new Republican settlements								

	Kolmogorov-Smirnov test						Chi-squared test	
Republican and LR-Triumviral settlement comparison	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**	**Soil**	**Ridges/ Peaks**
0-100 sq m settlement samples								
Republican vs. new LR-Triumviral settlements								
101-400 sq m settlement samples								
Republican vs. new LR-Triumviral settlements								
401-800 sq m settlement samples								
Republican vs. new LR-Triumviral settlements								
801-2000 sq m settlement samples								
Republican vs. new LR-Triumviral settlements								
> 2000 sq m settlement samples								
Republican vs. new LR-Triumviral settlements								

	Kolmogorov-Smirnov test						Chi-squared test	
Republican and Imperial settlement comparison	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**	**Soil**	**Ridges/ Peaks**
0-100 sq m settlement samples								
Republican vs. new Imperial settlements								
101-400 sq m settlement samples								
Republican vs. new Imperial settlements								
401-800 sq m settlement samples								
Republican vs. new Imperial settlements								
801-2000 sq m settlement samples								
Republican vs. new Imperial settlements								
> 2000 sq m settlement samples								
Republican vs. new Imperial settlements								

	Kolmogorov-Smirnov test						Chi-squared test	
LR-Triumviral and Imperial settlement comparison	**Altitude**	**Slope**	**Aspect**	**Water**	**Town**	**Roads**	**Soil**	**Ridges/ Peaks**
0-100 sq m settlement samples								
LR-Triumviral vs. new Imperial settlements								
101-400 sq m settlement samples								
LR-Triumviral vs. new Imperial settlements								
401-800 sq m settlement samples								
LR-Triumviral vs. new Imperial settlements								
801-2000 sq m settlement samples								
LR-Triumviral vs. new Imperial settlements								
> 2000 sq m settlement samples								
LR-Triumviral vs. new Imperial settlements								

3. One-sample Chi-squared, Kolmogorov-Smirnov and Attwell-Fletcher tests

Pre-Roman settlements	0-100 sq m	101-400 sq m	401-800 sq m	801-2000 sq m	>2000 sq m	Totality
Altitude	+ 5th ; - 1st	+ 4th ; - 1st				+ 4th ; - 1st
Slope						
Aspect						
Soil	+ unit 6.3	+ unit 6.4	+ unit 14.3	+ unit 14.3		+ units 6.3, 6.4
Ridges/Peaks						+ on ridges/ peaks
Water	+ 2nd ; - 6th	+ 2nd ; - 6th				+ 2nd ; - 6th
Town	+ 3rd , 4th	+ 6th		+ 6th		+ 4th , 6th; - 1st , 11th
Roads		+ 3rd				+ 3rd ; - 8th

Early colonial-period settlements	0-100 sq m	101-400 sq m	401-800 sq m	801-2000 sq m	>2000 sq m	Totality
Altitude	+ 4th	+ 4th				+ 4th ; - 1st
Slope		+ 1st				+ 1st
Aspect						- 7th
Soil						
Ridges/Peaks						
Water	+ 2nd	- 5th				+ 2nd
Town	+ 1st	+ 1st		+ 1st		+ 1st
Roads			+ 4th			

Republican settlements	0-100 sq m	101-400 sq m	401-800 sq m	801-2000 sq m	>2000 sq m	Totality
Altitude	+ 4th ; - 1st	+ 3rd				+ 3rd ; - 5th
Slope						
Aspect						
Soil						
Ridges/Peaks				+ on ridges/ peaks		+ on ridges/ peaks
Water	+ 2nd ; - 5th , 6th	- 6th				+ 2nd ; - 5th , 6th
Town	+ 1st , 2nd ; - 7th–9th, 11th	+ 1st , 2nd ; - 7th, 8th, 11th		+ 1st , 2nd		+ 1st , 2nd ; - 7th–9th, 11th
Roads	+ 1st , 2nd			+ 1st		+ 1st , 2nd ; - 8th

LR-Triumviral settlements	0-100 sq m	101-400 sq m	401-800 sq m	801-2000 sq m	>2000 sq m	Totality
Altitude	+ 4th ; - 1st			+ 3rd	+ 1st	+ 3rd
Slope						
Aspect						
Soil						+ unit 14.2
Ridges/Peaks		+ on ridges/ peaks		+ on ridges/ peaks		+ on ridges/ peaks
Water						- 6th
Town	+ 1st, 3rd	+ 1st, 2nd	+ 1st, 2nd	+ 1st		+ 1st–3rd ; - 6th–9th, 11th
Roads		+ 2nd				+ 1st, 2nd

Imperial settlements	0-100 sq m	101-400 sq m	401-800 sq m	801-2000 sq m	>2000 sq m	Totality
Altitude	+ 5th ; - 1st				+ 1st	
Slope						
Aspect						
Soil	+ unit 9.2					+ unit 9.2
Ridges/Peaks	+ on ridges/ peaks	+ on ridges/ peaks	+ on ridges/ peaks	+ on ridges/ peaks		+ on ridges/ peaks
Water	- 6th					+ 2nd ; - 6th
Town	+ 2nd	+ 1st ; - 11th	+ 1st	+ 3rd		+ 1st–3rd ; - 8th, 11th
Roads						+ 1st

Enigmatic (?) friezes on Praenestine *cistae*

L. Bouke van der Meer

This article offers an explanation for fourteen hitherto not (fully) understood, engraved main friezes on the bodies of Praenestine cistae *showing apparently unrelated mythical scenes or figures. It considers important iconographic details, and uses visual comparanda and ancient literary sources. It will appear that engravers connected scenes or figures with a common ground. Association played an important role in their choice.*

According to G. Bordenache Battaglia and A. Emiliozzi, editors of the corpus of Praenestine *cistae* (ca. 350-300/280 BC), many engraved main friezes on the bodies of these bronze toiletries boxes are generic (*Ciste* I.1; I.2), enigmatic or presenting misunderstood Greek or local myths unknown to us today. Generic scenes show several figures, often in a statue-like, paratactic, non-narrative, decorative composition. If inscriptions are present, they do not always label the figures with the correct name, which, at first sight, suggests misunderstanding (*Ciste* I.2, 296; Franchi De Bellis 2005, 162-163; Krauskopf 1993, 257-258). This article attempts to explain the content of some unexplained friezes. In the following the numbers of *cistae* correspond to the catalogue numbers of the corpus.

The an-epigraphic frieze of *cista* 6 (fig. 1) in Berlin has never been explained completely (*Ciste* I, 55-56). Does it depict a meaningless series of figures? First a short description. It depicts from left to right: a frontal nude man with a mantle draped around his right arm and a frontal nude woman leaning on a pillar and looking to right, a semi-dressed woman turned to left, seated on a base or altar and extending her right hand, a frontal nude man leaning on his spear, a nude woman with a mantle draped over her right upper arm holding an inverted arrow in her left hand, running to left, a nude man lifting over his left shoulder a woman with a mantle draped around her left hand and moving to right, a frontal nude woman with a mantle which covers her head and back, leaning on a pillar, two frontal men, both with a mantle draped around their left arms, of whom the one on the right bears a baldric crossing his chest and a long spear in his left hand, and a nude female figure with spread wings holding a hammer in her right hand and nailing a boar's head on a palm-tree. Behind her stands a

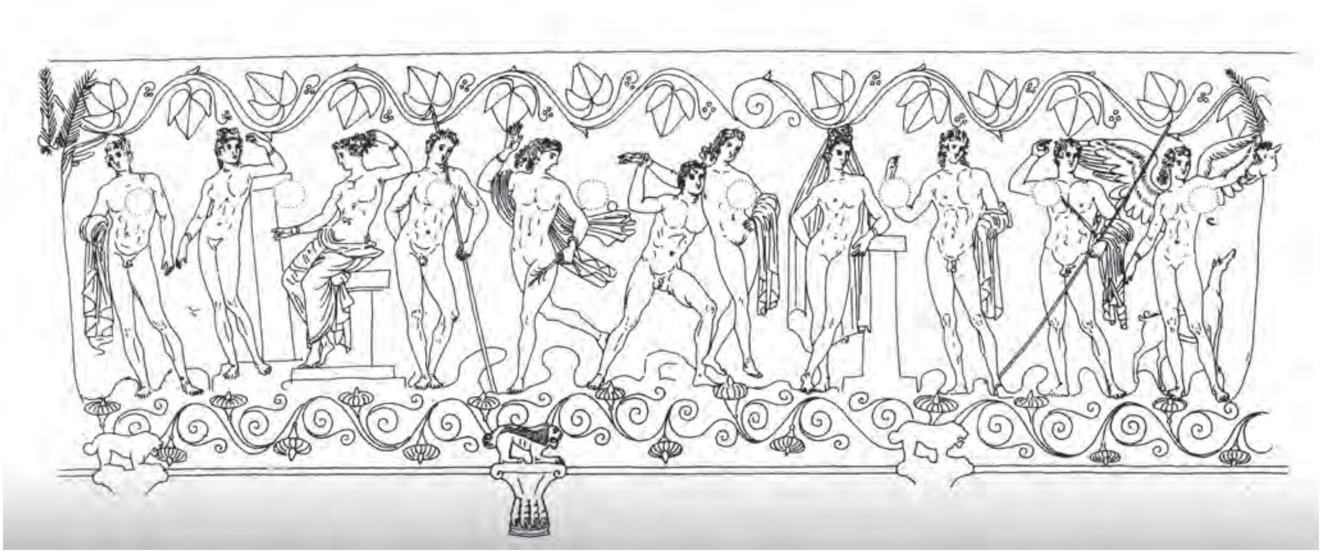

Figure 1 *Cista* 6 (from *Ciste* I.1)

Figure 2 Lost Etruscan mirror (from *ES* 78)

dog. Bordenache Battaglia compares the latter woman with Nike on Syracusan silver coins of king Agathokles (310-304 BC) where she nails armor on a bare tree trunk with a hammer in her right hand and a nail in her raised left hand. On the coins, however, Nike is bare to the hips, her wings hang down and the trunk is not the rest of a palm-tree. The palm-tree on the *cista* refers to victory. Sportsmen in the Greek and Roman world could receive a palm branch as prize. Since inscriptions on Praenestine *cistae* and mirrors are written in Latin or local Latin, I call the winged woman Victoria. The dog next to her played a role in hunting. Important for the identification of the mythological context is a famous inscribed Etruscan mirror from Perugia showing Adonis (inscription *Atunis* lost) and *Tu*[*ran*] (Aphrodite) on the left and *Meliacr* (Meleagros) and *Atlenta* (Atalanta) on the right (*ES* 176; Van der Meer 1995, 224-227, fig. 106). Between the love pairs stands a nude *Aθrpa* (Atropos: the Inevitable), one of the three Moirai who nails a boar's head on an invisible object. Her mantle is draped over her left upper arm. Like Nike on the coins she is semi-dressed and like Victoria on the *cista* her wings are spread. The function of *Athrpa* is twofold: she alludes to the death of the boar and of two male hunters. Both Adonis and Meleager die respectively directly and indirectly in a boar hunt. In the myth of the Calydonian boar victory plays a role as Meleager kills the boar. As he gave its hide to his love Atalanta instead of to his mother's brothers, both he and Atalanta are likely to be present in the frieze. Bordenache Battaglia tentatively interprets the spear bearer just to the left of Victoria as Meleager and the man lifting a woman as an undefined abductor. The spear bearer, however, is not accompanied by a woman. Therefore, the pair to the right of the tree is rather representing representing Meleager and Atalanta. In addition, as the two men to the left of Victoria are rendered in the same attitude, with the same gestures and the same position of the mantles, they probably represent the Dioscuri, who, according to ancient written sources, assisted Meleager during the hunt (Ovid, *Metamorphoses* 8.269- 546; Pseudo-Apollodorus 1.66; Pausanias 8.45.6; Pseudo-Hyginus, *Fabulae* 172-174). They are also present in other *cista* friezes, though mostly with a horse. The veiled woman has a perfect parallel on a lost Praenestine mirror (ca. 330-300 BC), formerly in Munich (fig. 2; *ES* 78; *LIMC* II, s.v. Apollo/Apulu 81). It represents from right to left: Apollo seated on a stool and playing cithara, Diana, frontally rendered, standing in a relaxed way, dressed and holding her spear downward, and Latona seated with the mantle drawn over her head and back. The latter is dressed in the same way as the veiled woman on the *cista* (cf. Latona in *cista* frieze 70). The female figure with the arrow to the left of the abduction scene must be Diana. One of Artemis' epithets is *iocheaira* ('shooting arrows'), mentioned in Homer's description of the Calydonian boar hunt (*Iliad* 9.538). The woman with the arrow cannot be Atalanta fleeing for Meleager's uncles as she does not carry the boar's head and skin. In addition, the uncles are absent too. The abduction probably depicts Apollo lifting up Meleager's future wife, Cleopatra, daughter of Idas and Marpessa (Homer, *Iliad* 9.559-561). These identifications show that, in this case, the juxtaposition of scenes can be explained by family relations. Therefore, it is not accidental that Latona turns her attention to her sons, the Dioscuri. Finally, the semi-dressed woman seated on a base or altar may be Venus. Atalanta probably makes the gesture of *aposkopein*: she looks at the goddess of love. The latter extends her right hand, probably approving Meleager's falling in love with Atalanta. If my identifications are correct, the nude spear bearer behind Venus may be her partner, Mars. Why does the woman with the arrow, Diana, flee away? She punished the Aetolians by sending a giant boar because Meleager's father, king Oeneus, had sacrificed the yearly firstlings to all gods except to her. So the killing of the boar must have frustrated her. Menichetti does not identify the figures but holds that the frieze illustrates the *paideia* of men in view of the abduction, the presence of athletes (the two men to the left of Victoria) and hunting (probably related to Meleager) and it shows the *paideia* of women because of their beauty and seduction (Menichetti 1995, 72). He suggests that the seated lady fashions her hair with her left hand. However, there is no man to seduce. In addition, as we have seen, the two men are the Dioscuri assisting Meleager, not as athletes but as hunters as one of them holds a spear.

Interestingly, Atalanta is also present on the inscribed *cista* frieze 9 (fig. 3; *Ciste* I, 64-65). Facing a semi-dressed *Alixentr*[*os*] (Alexandros; Paris) who holds a laurel branch in his left hand, his left foot on a rock (like a haruspex, see Van der Meer 1995, 83-85, 89, 97-100) and offers a twig with his right hand, next to a basin which receives water from a lion head spout, there are three, nearly nude women: *Ateleta* (Atalanta) arranging her hair with her left hand, a woman labeled *Alsir* leaning against an altar or base, and *Felena* (Helena) whose name is written on the column pillar behind her. The attitude of *Ateleta* and *Alsir* slightly resembles the just identified Atalanta and Venus on the Berlin *cista*. Interestingly, Pliny (*N.H.* 35.17-18) mentions an old wall painting showing Atalanta and Helena, both nude: *Insula enim absoluta erat pictura etiam in Italia. exstant certe hodieque antiquiores urbe picturae Ardeae in aedibus sacris, quibus equidem nullas aeque miror, tam longo aevo durantes in orbitate tecti veluti recentes. similiter Lanivi, ubi Atalante et Helena comminus pictae sunt nudae ab eodem artifice, utraque excellentissima forma, sed altera ut virgo, ne ruinis quidem templi concussae. Gaius princeps tollere eas conatus est libidine accensus, si tectorii natura permisisset*. 'But already, in fact, had the art of painting been perfectly developed in Italy. At all events, there are extant in the temples at Ardea, at this day, paintings of greater antiquity than Rome itself; in which, in my opinion, nothing is more marvellous, than that they should have remained so long unprotected by a roof, and yet preserving their freshness. At Lanuvium, where Atalanta and Helen, close together, nude, are painted by the same artist, they are both of the greatest beauty, the former (*altera*, see below) being evidently the figure of a virgin, and they still remain uninjured, though the temple is in ruins. The (emperor) Caius (Caligula), inflamed with lustfulness, attempted to have them removed, but the nature of the plaster would not admit of it'(translation by J. Bostol *et al*., 1855, online). Pliny's text is interesting as it may imply that the painter left a signature. In addition, it may mean that Praenestine engravers found inspiration in monumental paintings or copies of them. E. Moormann (2011, 17) presumes that Atalanta and Helena were painted on separate panels though Pliny only states that they were painted on plaster. He also holds that Atalanta was depicted as an athlete. In view of Atalanta's prominent place on *cista* 9 this seems unlikely: she rather is a successful huntress. *Alsir* is a name with an unusual ending, maybe without parallel (*LIMC* I, s.v. Altria/Alsir (B.M. Giannattasio Alloero; in Umbrian *arsir* means (anyone) other). The engraver replaced the three goddesses of the Judgement of *Alixentros* by three women two of whom are mythical. The figures in the left part of the frieze are interrelated too. *Crisida* (Chryseis) holding a cup or *cantharus* and a bearded *Aiax* (Aias) holding spear and shield, both turned to right, stand between two mounted, armed women dressed in short vests, *Casentra* (written from right to left; Kassandra) and *Oinumama*. As A. Franchi De Bellis points out, the name looks like the Latin compositum *unimammae* (Titian., *ap. Isid*. 9, 2, 64; Auct., *Itin. Alex*. 41; Jul. Val., *Rer. Gest. Alex*. 3, 50) and *Unomammiam* (Plautus, *Curc*. 445), 'with one breast', which is perhaps comparable with Greek *a-mazos,* 'without a breast.' In addition, the *pelta* of *Oinumama* is a frequent attribute of Amazons. *Casentra*, however, holds a *scutum*. Neither of the women shows one bare breast like Amazons in Greek art. The horses, both decorated with rosettes, move in opposite directions. Under the left horse there are a *scutum* and a dog, under the right one a hungry mouse and a frog. *Oinumama* is facing a nude man with a *chlamys* whose hat hangs down from his neck. The inscription behind him reads: *Ạḷses*. A pillar decorated with a standing and a hanging branch stands between them. Also from the pillar beside *Felena* hangs a long branch. Kassandra, Chryseis, Aias and Amazons all play a role in the Trojan War. Agamemnon returns his beautiful war captive Chryseis to her father Chryses, priest of Apollo, threatening to take a female slave from Achilles, Aias (!), or Odysseus as compensation (Homer, *Iliad* 1.138-139). *Casentra* is depicted as an Amazon, probably because of her courage. She is shown with her back turned to *Aiax*, probably as an allusion to her awful future fate: she will be raped by Aiax. It is, however, not certain if Aias, son of Oileus or Aias, the son of Telamon, is meant. Amazons guided by queen Penthesileia assisted Priam, king of Troy, against the Greeks (*Aethiopis*, fr. 1 Allen; Arctinus, *Amazonis*). Enigmatic is the inscription *Ạḷses* behind the man, who stands in front of *Crisida*, *Aiax* and *Oinumama*. The vegetal decoration of the pillars, the rosette decoration on the horses[1], and the cup in Crisida's hand intended for a drink or libation suggest a lucky *post mortem* situation like the scene in the lower part of the famous, inscribed Etruscan *Epiur* mirror (*ES* 181) where *Elinai* (Helena; enthroned) and *Aχmenrun* (Agamemnon; standing) shake hands in the presence of *Aivas* (Aias) and *Elaχsantre* (Alexandros) crowned by *Mean* (a Victoria-like goddess), *Menle* (Menelaos) holding a

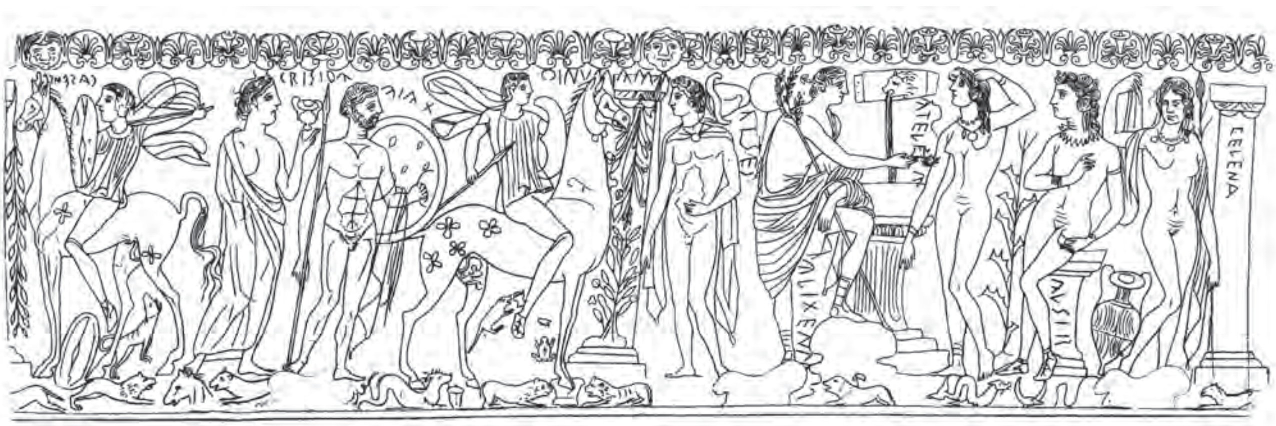

Figure 3 *Cista* 9 (from *Ciste* I.1)

libation cup and *Lasa θimrae,* a minor love goddess here probably associated with the Trojan Apollo Thymbraios. The scene is probably located on Leuke, an Elysian island in the Black Sea (Brendel 1978, 369-370, fig. 286. Van der Meer 1995, 92-97, fig. 38). *Ạḷses* in the *cista* frieze may derive from Greek *alsos* ('sacred grove'). The change from Greek -*os* to Latin -*es* is attetested by a Praenestine inscription reading Greek Amykos as *Amyces*. The word *alses* may refer to a grove in the underworld in view of the Medusa head in the upper border decoration, just above the pillar and the man with the *chlamys*. The place of Medusa's head is not unique. On the famous, inscribed *cista* 5 Cerberus in the decorative upper border sits right above the young *Mars* who, cared for by *Menerva* and about to be crowned by a large *Victoria* and a tiny one, is seated above a *dolium* with flames or a boiling liquid (wine?). If the *dolium* is an *orca*, it may symbolize Orcus, the Roman underworld (*Ciste* I,1, 50-54. Van der Meer 1988, 127). *Alses* may be a noun like *leces* (Latin *leges*: 'Laws') on a tag which hangs on a nail on the column on *cista* 45 (Franchi De Bellis 2005, 163). On *cista* 9 the branches on the pillars and the presence of a mouse and a frog also suggest a peaceful *alsos*-like netherworld. Aiax, son of Telamon, in the underworld is also present on a Praenestine mirror presenting Thetis, here labelled *Telis* (as the poet Ennius did later), giving Achilles's armour to *Aiax* in an act of posthumous justice (*ES* V 120; Adam 1980, 22 no. 4; Franchi De Bellis 2005, 85-88 (cites Varro's quotation of Ennius). According to De Angelis (2015, 96) Aiax substitutes Achilles which is unlikely in view of Alcumena's presence). The setting is, as F. Coarelli suggests, the underworld since *Alcumena* (Alkmene) became the wife of Rhadamanthys, a judge of the dead, when she married for the second time (Coarelli, in *RMR* 1977, 275-276 no. 420, fig. 20). The interpretation is supported by the inscribed frieze of *cista* 101 (fig. 4) probably featuring *Aiax* in the netherworld too (Franchi De Bellis 2005, 148-159). The frieze depicts from left to right, between columns: a nude young man labelled *Micos* (from Greek *mikkos* which means *mikros* ('little')) keeping two horses on reins, *Aciles* (Achilles) looking back to them and getting a helmet from *Victoria*, *Fercles* (Herakles), *Diesptr* (Diespater/Diespiter; Jupiter), *Iuno*, *Mircurios* (Mercurius) holding the balance of *psychostasia*, an almost nude man labelled *Iacor* (Iakchos? (Dionysos); Franchi De Bellis 2005, 158-159), holding a spear and bringing his hand to his mouth in amazement, and *Aiax* getting a helmet from *Iventus (Iuventus)*, the personification of Youth. At first sight, the presence of *Diesptr* and *Iuno* suggests that the weighing of the souls takes place in the Olympic sphere before or during a battle. As, however, both *Aciles* and *Aiax* are depicted as men who respectively receive victory and youth, they are more likely in a post-war, posthumous situation. That would explain why *Mircurios'* empty scales are in balance.

Let us return now to the inscribed *cista* 45 (fig. 5). According to O.J. Brendel (1978, 359), its frieze does not tell a story. It shows from left to right: a satyr labelled *Silanus* who holds a *patera* and dances with a nude maenad, next to them is a semi-dressed woman labelled *Doxa* ('Glory') holding a dove, a frontal, dressed woman labelled *Ladumeda* holding a stag on a rein and leaning on a bearded herm, *Aiax Ilios* with a spear, holding two horses on reins in front of an Ionic column with a tag inscribed *leces* ('Laws'), a nude man viewed from behind, *Soresios* with himation, sheath and two spears, semi-dressed *Acmemeno* (Agamemnon) leaning on a base, two horse heads in a window, *Istor* a man in a short chiton and in a thoughtful pose, and *Lavis*, a dressed woman.

Bordenache Battaglia compares *cista* 45 with the an-epigraphic *cista* 82 because both friezes have the same decorative borders (*Ciste* I.1, 148-149). From left to right she identifies on *cista* 82 (fig. 6): Aiax with a horse, Achilles

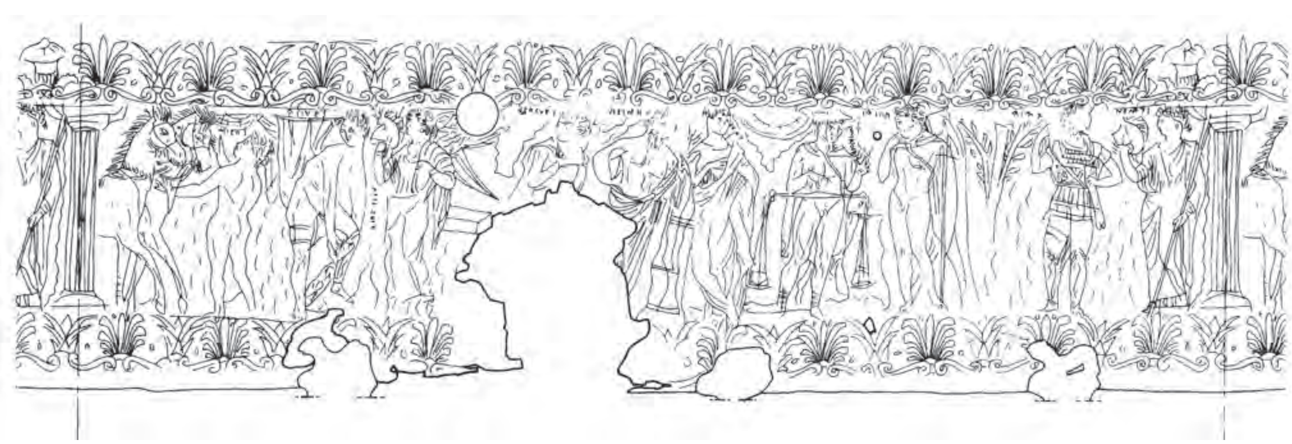

Figure 4 *Cista* 101 (from *Ciste* I.2)

mourning with his back turned to Iphigenia who denudes herself exposing her willingness to be sacrificed to Diana (cf. Eur., *Iph. in Aulis* 1397 ('I give my body to Hellas'). [*H*]*elena* denudes herself in the same manner as Iphigenia on *cista* 83; see below) by Calchas and a male assistant, who both wear a stippled dress and a Phrygian hat, a dog, a half open window showing a woman within, Agamemnon in almost the same pose as *Acmemeno* on *cista* 45, a frontal, nude spear bearer (Menelaus?), and a Dionysiac group consisting of a dancing nude man, a seated, flute playing silen, a woman upholding a mirror, and a panther. Bordenache Battaglia identifies *Soresios* on *cista* 45 as Achilles on *cista* 82, as both men hold two spears and are viewed from behind.

According to I. Krauskopf (1993, 252), the right part of the frieze refers to the chariot race in honour of the dead Patroclus. Key to her interpretation is Homer, *Iliad* 23, 486: *istoora d'Atreiden Agamnona theiomen amphoo*. 'Let us both (Idomeneus and Aias) choose Atreus' son Agamemnon as judge.' Idomeneus quarrelled with Aias, son of Oileus (*Iliad* 23, 485-488; *Aiax Ilios* on the *cista*), about the question which of their chariots were in the lead. The Praenestine engraver did not understand the word *istoor*; so he labelled the person behind *Acmemeno* as *Istor*. *Istor* was, according to Krauskopf, Idomeneus in the original model. She tentatively presumes that *leces* is a writing error for *lebes*, a prize for the winner. *Lavis* from Greek *Lais*, a frequent name of *hetairai*, is one of the female slaves, who are destined for

Figure 5 *Cista* 45 (from *Ciste* I.1)

Figure 6 *Cista* 82 (from *Ciste* I.2)

the winner (*Iliad* 23, 261). Krauskopf does no explain the identity of *Soresios*. The rest of the frieze shows stock figures. A weak spot in her interpretation is the absence of a chariot and a *lebes*. In addition, she does not explain why the heads of the figures, including that of *Ladumeda*, are turned to left, toward *Doxa*.

According to Menichetti (1995, 118-119), the frieze does not tell a story but shows the fate of heroes 'in an afterworld sphere.' *Aiax Ilios*, a kind of *eques*, is a symbol of *virtus*. *Leces* ('Laws') in connection with *Istor* ('Judge; Umpire') are essential for the *paideia* of men. *Ladumeda* is Laomedeia, one of the Nereids (Hes., *Theog.* 257) who gave new armor to Achilles. *Silanus* and the maenad allude to the *paideia* of women. This interpretation is not convincing as it does not explain the connections between the Greek heroes of the Trojan War.

Franchi De Bellis (2005, 160-164) comments on the inscriptions without explaining the whole frieze. Following E. Peruzzi she holds that *Soresios* is the paretymologic name of the sometimes young or androgynous rendered seer Teiresias, who had connections with (a man) Laios (cf. *Lavis*) and (a woman) Historis (cf. *Istor*). The change of sexes is due to confusion or misunderstanding. *Soresios* is compared with Latin *sero*, *sors*, and *sorex* (a priest who strings the *sortes* (lots)). Teiresias, however, has no role in the Iphigenia myth.

G. Colonna (2007 [2009], 127-128) holds that *Soresios* is the Latin version of Etruscan *Śuri-sie ('that (man) of Suri,' a deity comparable with the oracular and underworld god Apollo Soranus), another name for the seer Calchas who had to slaughter Iphigenia. Iphigenia, here labelled *Ladumeda*, probably to be compared to Laomedia, widow of Protosilaus, being an excellent example of conjugal love, and *Aiax Ilios* are famous judged from the presence of nearby *Doxa* ('Glory'). The inscription *leces* ('Laws') alludes to the violation of human laws by Agamemnon because of his order to sacrifice Iphigenia and it alludes to *Aiax Ilios* because of his raping of Cassandra. *Istor* ('Witness') is Aegisthus planning a murder in the same attitude as Medea does in a Pompeian wall-painting (*LIMC* VI, s.v. Medea 8). *Lavis* is Clytaemnestra who murdered Agamemnon (here labelled *Acmemeno*) or Lais, name of famous *hetairai*, symbol of adulterous love. The erotic, dancing group (*Silanus* and maenad) on the left is a positive counterpoint to the murderous lovers (Aegisthus and Clytemnestra) on the right. The horses in the window may be those of Agamemnon. Colonna's interpretation also has some weak spots. *Soresios* is an armed young man, who is not compatible with the old Calchas. As Bordenache Battaglia already noted, he probably is Achilles. *Ladumeda* is Diana rather than Iphigenia as she holds the rein of a stag.

In my view, the *cista* frieze combines the prelude and aftermath of the Sacrifice of Iphigenia. *Ladumeda* may be another name for Diana though Laodameia ('Leader of the folk') is not testified as epithet of Artemis. Euripides in his tragedy *Iphigenia Aulidensis*, however, frequently calls her *anassa* ('mistress'). I presume that *Ladumeda* derives from *Latoneda ('Daughter of Latona'), that is Diana. The name can be compared with *Crisida* which derives from the accusative of Greek Chyseis. The engraver, however, interpreted the name as a nominative, meaning 'Daughter of Chryses.' The n > m shift in *Latoneda > Ladumeda is also visible in *Diama* on *cista* 5. *Soresios* is another name for Achilles. If the name refers to Śuri/Soranus, it may hint at Achilles' foretold death: he will be killed by Paris and Apollo (Homer, *Iliad* 22.359-360). The dance of *Silanus* and maenad illustrates the happy ending of the tragedy. Core figure is *Doxa*, personifying the Glory of Iphigenia, as the latter, willing to die for Hellas, says in Euripides' tragedy (1397-1399): *didoomi sooma toumon Helladi. thuet', ekportheite Troian. tauta gar mnèmeia mou dia makrou, kai paides houtoi kai gamoi kai dox'emè*. 'I give my body to Hellas. Sacrifice it, destroy Troy! This is my enduring monument, my children, my marriage and my glory.' As *Lavis* is fully dressed, she does not look like a *hetaira*; she may have been Clytaemnestra in the original model. Her alternative name may hint at her future adultery. The fact that the pertaining lid of the *cista* shows a silen labelled *Ebrios* ('drunken') seated between a silen with a krater and a maenad with a whip both riding *kètè*, does not mean that the figures of the main frieze are situated in an afterlife situation too. The windows in the friezes of *cistae* 45 and 82 show that they were indirectly inspired by paintings of South Italian red-figure vases with tragic and comic scenes (Schauenburg 1972; 1973).

In Bordenache Battaglia's view also enigmatic is the inscribed *cista* frieze 83 (fig. 7), though she notes that most names are related to the Trojan cycle. She suggests that the engraver may have seen *cista* 82 as [*H*]*elena* is disrobing like Iphigenia (*Ciste* I.2, 277-280). The frieze shows from left to right: a bearded semi-dressed man labelled *Tondrus* (probably Tyndareus) with a dog, a dressed man (damaged), a window of lattice-work, a young man labelled *Seciolucus* holding on rein a horse which is turned to right, *Creisita* (Chryseis) and [-]*elena* (*Felena* or *Helena*) flanking a basin under a lion's head spout, *Aciles* (Achilles) with spear holding on rein a horse which is turned to left, a nude man, labelled *Simos*, greeting him, carrying two yokes ending in bird heads with an oil flask and a purse on his shoulder, and a frontally rendered, nude young man, with *chlamys* and spear, labelled *Orestes*. Between him and *Tondrus* stands a tree. Menichetti (1995, 67-68), led by his *paideia* theory, presumes that ‘the female beauty (of *Creisita* and *Helena*) leads to victory’ and that Achilles is an example of male *virtus*. Franchi De Bellis does not explain the meaning of the frieze but points out that Simos is a Greek slave name, and suggests that the name *Seciolucus* is a composite one, perhaps a previously unattested Praenestine *nomen gentilicium*. If she is right, the engraver wanted to compare a local horseman with *Aciles*. That may explain the symmetrical position of their horses. *Aucena* on *cista* lid 9 is a parallel if she is a local woman. In that case the engraver wished to compare or associate her with *Venus* (Franchi De Bellis 2005, 173-174). Of course, *Creisita* and *Helena* are not only beauties but also the cause of grave conflicts that did not lead to female victories. *Tondrus* may have been placed at the far left and *Orestes* at the far right of the frieze as Tyndareus accused Orestes for having killed his mother, Clytaemnestra (Eur., *Orestes* 491-541; 915). Evidently, the rather symmetrical composition invites the viewer to compare the figures on the left with those on the right. The frieze seems to allude to the prelude and the aftermath of the Trojan War.

The inscribed frieze of *cista* 66 (fig. 8) depicts, according to Bordenache Battaglia, ‘a quiet flow of divine images with the right names, not united by a particular action’(*Ciste* I.2,

Figure 7 *Cista* 83 (from *Ciste* I.2)

Figure 8 *Cista* 66 (from *Ciste* I.2)

66). It shows from left to right: a standing, dressed woman, probably Juno, a seated, semi-dressed [*Dies*]*pater* with scepter, [*Dia*[*n*]*a*] talking to Diespater, rendered like a huntress with cross-belt and spear standing in front of a spotted hind, *Porlou*[*ces*] (Polydeukes/Pollux) and *Castor,* both with *chlamys*, *pileus* (set off), spear and horse, a dressed woman with a twig walking to right, ...? (gap in the frieze), [*Vi*[*c*]*toria*] accompanied by a dog and holding a rectangular object in her left hand, and a bearded *Silanos* (Doric Greek Silanos), carrying a wineskin on his shoulder and dragging with him a dead goat. Menichetti (2005, 103-104) does not explain the frieze but, following Bordenache Battaglia, he presumes that the object in Victoria's hand is a rectangular *cista* like the unique *cista* 100. It is 'an allusion to a victorious omen which leads to a matrimonial aspect.' The object, however, has not the same form; it is a small box. It may be a jewelry case or *arca* containing *sortes* (lots). In the latter case, Victoria, to judge from her inclined head, is reading the omens. The frieze probably combines parts or excerpts of a more extensive model. The presence of *Diana*, the Dioscuri and *Victoria* with a dog (as in *cista* frieze 6) may refer to the Calydonian boar hunt. *Silanos* may allude to a happy ending, like the dancing *Silanus* and maenad on *cista* 45. His attributes, a wine bag on *cista* 66 and a *patera* on *cista* 45 (to play *kottabos*) were used during Dionysiac symposia.

The partly inscribed *cista* frieze 27 (fig. 9) depicts from left to right: Pollux (without inscription), meeting *Castor*, both with spear and horse, *Pater.poimilionum* ('Father of the pygmies/dwarfs'), with disordered hair, a rough beard and a large penis, a lion hide as *chlamys*, holding a *falx* and a club, turned to left, Minerva with an aegis without Medusa head, holding lance and shield, a pillar on a base, a dressed winged female figure, probably Victoria, seated on a base or chest which is rendered in perspective, a mother and two nude boys who carry a plate and an oval *cista* toward a frontal, nude man with *himation* who makes an imperious gesture with his raised right hand in the direction of Minerva. The Dioscuri and the Father of the pygmies show *kunodesmè*, i.e. the foreheads of their penises bound with a leather thong. Bordenache Battaglia holds that all figures are generic, 'only chosen from a decorative perspective' (*Ciste* I.1, 108-10; for pygmies, see Harari 2004). According to Menichetti (1995, 79, 102-103) the mother with children and the nude man are married, their children bringing offerings to Minerva. The left part of the frieze refers to male *paideia* (athletics), and the right part to female *paideia* (marriage). Franchi De Bellis holds that the name *Poimilio* does not directly derive from Greek Pygmalion. However, she derives the Latin word *pumilio* ('dwarf') from *poimilio*. Both scenes, in my view, have comical elements: the Father of the Dwarfs is depicted as an athlete with the attributes of Hercules or Theseus (club) and of Priapus or Silvanus (*falx*) and the children who carry offerings are walking in the wrong direction. The nude man tries to correct their behavior by pointing to Minerva. Victoria may have a double function, alluding to the success of athletes, and to Minerva who protects the Dioscuri and children.

The left part of *cista* frieze 85 (fig. 10) depicts a woman with a pitcher and Tyro holding a bucket on a line to draw water from a well. The latter recognizes her sons, Neleus and Pelias, from the *skaphè*, a trough or baking mould with the

Figure 9 *Cista* 27 (from *Ciste* I.1)

signs of *anagnorismos*. According to Bordenache Battaglia, the right part of the frieze shows stock figures (*Ciste* I.2, 284-285. Menichetti 1995, 79-80. Gilotta 2002, 78 n. 131). From left to right there are a man wrapped in a mantle which covers his head, accompanied by a beast of prey, a dressed woman leaning on an altar, three young man, nude apart from their *himatia*, the first extending his right arm to the left, the second and third holding a spear, the latter, rendered in dorsal view, outstretching his right arm to the right. The mantled man and the woman at the altar, however, are not stock figures. The man may be Poseidon who watches, unseen, the meeting between Tyro and her sons like *flere* (*numen*) on an inscribed Etruscan mirror from Perugia in a very similar recognition scene. Above the well mouth *flere* arises as a male within an undulating frame that may refer to the deity of water, Nethuns (Neptunus; Van der Meer 1995, 175, fig. 83). The altar scene is explained by what happened after the recognition, Pelias killing Sidèro, Tyro's cruel stepmother who had taken refuge in the sanctuary of Hera. If my interpretation is correct, the man to the right of the altar is Pelias whose imperative gesture may hint at his avenging of his mother's humiliation.

Cista frieze 91 (fig. 11) is unexplained so far (*Ciste* I.2, 297-299. Menichetti 1995, 101). Core of the scene is a semi-dressed, young man with scepter seated on a throne, looking back to a bearded man who hands over a letter to a woman who is draped in a mantle covering her head. The group may refer to the myth of Bellerophon. Stheneboea, wife of Proetus, king of Argos, tried in vain to seduce the exile and guest Bellerophon. After his refusal the queen

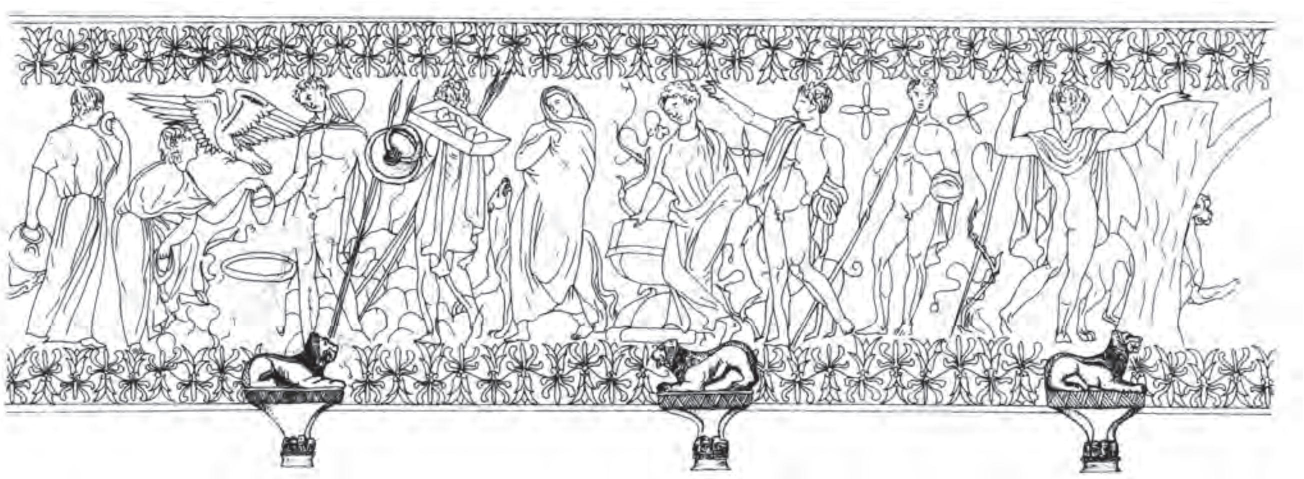

Figure 10 *Cista* 85 (from *Ciste* I.2)

Figure 11 *Cista* 91 (from *Ciste* I.2)

accused him of having raped her. Proetus sent him with a sealed letter to Iobates, king of Lycia, with an order to kill him. In theory, the bearded man with the letter could be Proetus showing the letter to his wife. However, after having slain the Chimaera Bellerophon got half of Iobates' kingdom (Homer, *Iliad* 6.152-205), which may explain why he sits on a throne, holding a scepter. If correct, Iobates shows the letter or explains its content to one of his daughters, who will become the wife of Bellerophon. It explains why the woman is veiled. She may be visible on a Campanian red-figure krater from Capua, dated to ca. 350-330 BC, depicting Iobates, in Phrygian dress, holding a scepter, seated on a stool, and reading the diptych. Bellerophon stands in front of him accompanied by Pegasus. Behind Iobates probably stands his daughter who is veiled here too (A.D. Trendall, *LCS* 415 no. 360, pl. 167.5 (Winterthur, inv. 364)). Both are frightened by the content of the letter. In the *cista* frieze Pegasus is missing. The man facing the throne in Oriental stippled dress, leaning on a stick, however, may be refer to Lycia.

Cista frieze 117 (fig. 12) depicts gods, warriors and women. U. Liepmann gives an excellent description but does not explain the meaning of the frieze (*Ciste* I.2, 397-414). Some details, however, contain clues for an interpretation. The center shows a young man seated on a throne which stands on a base decorated with undulating lines. He places his hand on the shoulder of a nude boy who stands with a whip in front of him. The whip may hint at Achilles as a future famous horseman. The waves may symbolize the sea. In that case Achilles may stand in front of his father Peleus, husband of Thetis, goddess of the sea. The quickly moving winged female on the left may be Thetis fastening with both hands Achilles' new armor to his body (cf. Thetis on *cistae* 55, 69 and 106). That would explain the presence of the winged male figure behind the throne. He wears a loincloth and a tight cap with a knob that looks like a *pileus*; he holds an axe-like hammer and nail in his left hand. He may be Hephaistos who, asked by his daughter Thetis, made new weaponry for Achilles (*Iliad* 18.457-616). His wings are unique but four Attic black-figure vases depict him with winged feet and two Attic red-figure *kylikes* (ca. 510 BC) show him respectively seated on a winged chariot and on a chariot with winged wheels (*LIMC* IV, s.v. Hephaistos 3-44; for a possible winged Vulcanus with *pileus* on a pillar from Nijmegen, see Panhuysen 2002)). Though on the *cista* he wears, like Vulcan, a loincloth instead of the usual *exomis* (*LIMC*, s.v. Hephaistos 4) the working garb characterizes him as an artisan as can be inferred from *cista* frieze 12 showing a butcher and cooks, all males, working in the open air. Homer (*Iliad* 18.615-616) says that Thetis 'swooped like a falcon, from snow-topped Olympus, bearing Hephaestus' gleaming gift,' which explains the rush of the winged woman. Behind her stands Apollo with arrow and laurel branch. He caused the death of Patroclus (Homer, *Iliad* 18.453-456). In the right part of the frieze only Heracles can be identified thanks to his club and lion-skin. He is about to receive a libation from a dressed man holding a *patera*. It seems that the engraver added some Olympic gods to key moments of Achilles' life. The frieze may be one of the few where the protagonist appears twice which may point to a cyclic model like e.g. the two level frieze of the golden relief cover of a *gorytus* from Nikopolis, dated to the fourth century BC, which depicts Achilles three or four times. The *paideia* scene in the left corner of the upper frieze vaguely reminds us of the throne scene: Achilles as a nude boy stands on a rock learning how to use the bow from a man, not the centaur Chiron, who is sitting opposite him (*LIMC* I, s.v. Achilles 182).

Figure 12 *Cista* 117 (from *Ciste* I.2)

Cista frieze 76 (fig. 13) depicts Perseus, whose head is touched by Minerva as holds up the head of Medusa, and Peleus wrestling with Thetis who tries to escape him by changing herself into a lion and a *kètos*. Both heroes never appear together in a mythological context. The frieze, however, shows frightened figures: in the left part a boy clinging to his mother, and in the right part a draped woman spreading out her hands. So, the engraver's choice of the themes probably stems from amazement about two miraculous events.

As in the other *cista* friezes discussed (9, 83 and probably 106) comparison plays an important role. Repetition of motifs may indicate that an engraver was inspired by his association of different themes. The well known *cista* frieze 69 depicts the Judgment of Paris (Alexander), Laius' Abduction of Chrysippus, and a bearded warrior, maybe Laius again but older, consulting Apollo in Delphi. The themes are different; so why are they combined? Since Paris and Apollo are seated on the same type of stool (*diphros*), the engraver probably wished to compare two decision makers. This is corroborated by the laurel branch of *Alixentr*(*os*) (Alexandros/Paris) in *cista* frieze 9 who judges three female beauties near a basin (*labrum*): *Ateleta*, *Alsir*, and *Felena* (mentioned above). The laurel is a frequent attribute of Apollo (see *cistae* 5 and 69). Repeated on *cista* 69 is the motif of libation. Amor and Apollo both hold a *patera* in their right hand. Menichetti's suggestion (1995, 73) that Apollo's *patera* holds *sortes* is incorrect as these were preserved in an *arca*.

Another type of comparison is visible in *cista* frieze 52, which shows a nude Hercules with a raised club holding a staggering winged horse, probably Arion, and a nude man, probably Bellerophon, holding the staggering Pegasus on a rein. Both horses move into opposite directions. The lion under the left horse refers to Hercules. An Ionic column stands between them. The heroes do not occur in a same mythological context, but the rather symmetric composition betrays the engraver's interest in fantastic horses. The semi-dressed winged Victoria-like man who looks back to Jupiter and Juno probably indicates the future success of both heroes. A comical addition is the head of a silen peeping from behind a rock.

Problematic is *cista* frieze 4. In the left part stands a couple in an intimate pose. The woman, holding a scepter, is veiled which indicates her married status. The man wears an Oriental dress and holds a sheath with sword in his left hand. Menichetti (1995, 104-105), following Bordenache Battaglia, presumes that they are Venus and Adonis. However, Adonis is almost never armed in visual representations. In view of his dress he must be Paris. So the woman is Helen. The man approaching them leading a horse is not one of the Dioscuri as Menichetti suggests but Paris' attendant. In the right part Jupiter with scepter, in front of an altar, and Diana accompanied by her sacred deer are approaching Dionysus (with *thyrsus*) who is seated on rocks. The link between both scenes may be that, according to ancient authors, both Dionysus and Paris were known as *gynaimanès* ('crazy about women'; *Homeric Hymn* 1.17 (1 D.8 West). Homer, *Iliad* 3.39 and 13.769). Why Jupiter and Diana visit Dionysus, however, does not become clear.

Conclusion

Cista friezes may have a generic meaning. However, my analysis of compositions, symmetry, groups, figures, drapery,

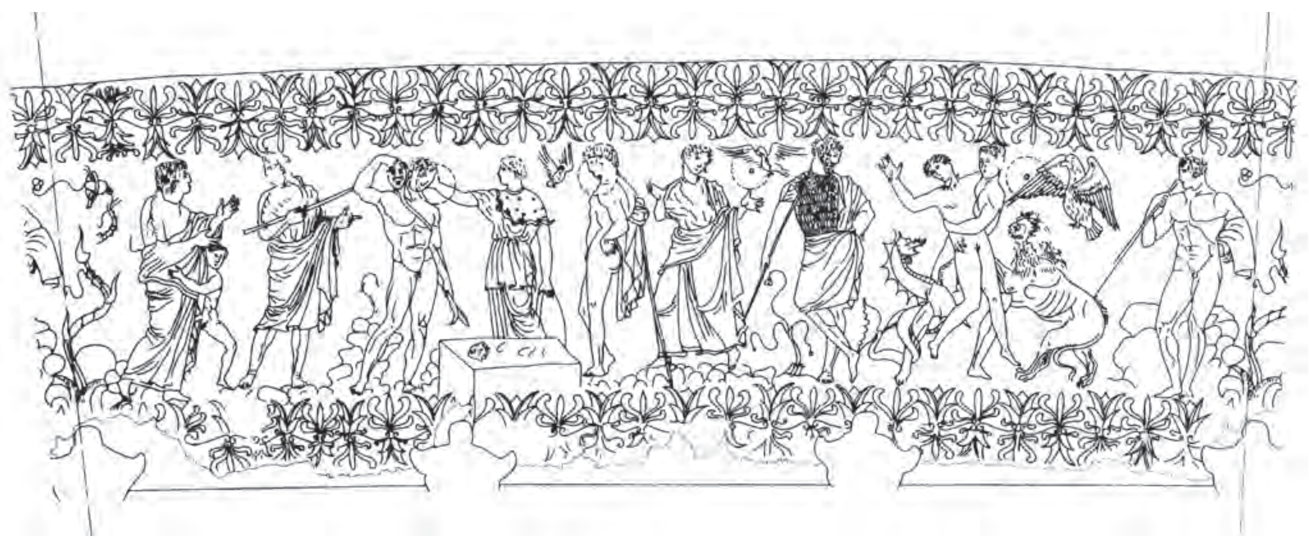

Figure 13 *Cista* 76 (from *Ciste* I.2)

attributes, movements, gestures, repeated motifs, and inscriptions may have shown that some of these friezes were meaningful to the engravers. They saw common features in the contents of different mythical scenes or different mythical figures and therefore connected these in one frieze. Associations are: family ties (Meleager), Trojan themes and figures (some in the netherworld), happy endings (Iphigenia, Bellerophon), comparison of beautiful women (Chryseis and Helen), comical elements (*Pater poimilionum*), and terrifying events (Perseus with Medusa's head; Thetis' metamorphoses). If the engravers discussed the choice of subjects with their commissioners, which seems likely, the latter understood the coherence and deeper meaning of friezes that, at first sight, are less transparent to us.

Notes

1 On the lid showing *Venus* and *Aucena* both riding a *triga*, rosettes are also visible on the horses of *Aucena*. The latter may be a Vesper-like, female deity as the two snakes under the chariot refer to the night or the underworld. Franchi De Bellis (2005, 173-4), however, holds that the name refers to a lady of the local gens *Aucenna or *Augenna. Anyhow, Aucena is not a man as G. Camporeale suggests (*LIMC*, sv. Aucena) because she wears under-arm bracelet. Apart from Eros/Amor, men on *cistae* and mirrors may wear a bracelet around the upper arm but not around the under-arm.

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L. Bouke van der Meer
Faculty of Archaeology
Leiden University
Post Box 9514
2300 RA Leiden
l.b.van.der.meer@arch.leidenuniv.nl

Visualizing antiquity before the digital age: early and late modern reconstructions of Greek and Roman cityscapes

Chiara Piccoli

In recent years, the creation of computer-based archaeological reconstructions has become increasingly widespread. The attempt to visually "reconstruct" relics of ancient architecture, however, is not a novelty of the digital age. Although little research has been done so far in this direction, taking an historical perspective on reconstructions of archaeological evidence over the centuries offers some reflections on the use and legacy of modern 3D visualizations in archaeology. This contribution discusses a selection of archaeological reconstructions (both drawings and 3D physical models) of Roman and Greek cities in the early and late modern period, focussing especially on the motivations, the aims and the methods that guided such endeavours. By doing so, it will shed light on how much the reconstructed past was in fact the result of a re-elaboration of present needs, thoughts and beliefs. Moreover, it will trace the path towards the formation of a scientific method of archaeological inquiry, which includes the elaboration of ways to assess the reliability of the reconstruction.

1 Introduction

Over the centuries, ancient buildings in ruin have excited the imagination of viewers. Their being fragmentary has triggered artists' creativity and often caused the fabrication of legends to explain their existence. Depending on the sentiment of the beholder, ruins have become a symbol of the transience of life or of the desperate attempt to survive from the oblivion of time.[1] Even more imbued with meanings that transcend their physical appearance has been the creation of reconstruction drawings of these past relics of architecture. These visual restorations are the expressions of the mind-set and cultural milieu of their creators, which offers us a vivid documentation of the way in which the past was understood, perceived and represented at the time of their realization. As much as the archaeological evidence that they depict, reconstruction drawings also are historical products, as they are the result of the combination of several factors that need to be contextualized to ensure their correct reception.[2] Such factors include the state of the knowledge on the evidence represented, the drawing and survey techniques available at the moment of their creation, and the background and cultural milieu of both the reconstruction maker and the viewer.[3]

As this paper will show, this type of information is crucial in order to be able to appreciate reconstruction drawings and plaster models as important sources of documentation not only about the subjects they depict, but more importantly about who made them, and the historical period in which they were produced.[4] One may consider how naïve and fictitious some early reconstruction drawings appear nowadays since a deeper knowledge of the archaeological site under investigation has been acquired, or how outdated some of the first digital visualizations look to the eye of the present-day viewer whose expectations are high in terms of engagement, realism and interaction. Often, reconstruction drawings or images of plaster models are still being used nowadays in presentations and articles without citing the author and the correct period in which they were made, thus leading to the transmission of obsolete ideas, or to the underestimation of works that were instead ahead of their time. Little research has been done so far on this type of visual representations, although they are valuable sources of information for the history of archaeological research.[5] Every drawing entails in fact a process of interpretation of reality, since, as well expressed by the art historian Sir Ernst Gombrich, a drawing "is not a faithful record of a visual experience but the faithful construction of a relational model (…). The form of a representation cannot be divorced from its purpose and the requirements of the society in which the given visual language gains currency".[6]

In the next sections, I shall present a selection of archaeological reconstructions depicting Roman and Greek cities and buildings in Europe from the 15th to the 20th century.[7] I will briefly sketch the historical framework in which such representations have been created to provide the contextual information to assess their aims and their novelty. The case studies presented will offer an insight into the variety of functions that reconstructions have fulfilled within the period taken into consideration, which provides the basis for a reflection on the use, purpose and legacy of computer-aided 3D models that have nowadays become ubiquitous in the archaeological domain. This paper will shed light on the purpose and use of reconstructions, showing the role of reconstruction drawings as functional aids to stir emotional responses, and to support political agendas before being used as a means to present historical information. Moreover, this overview will serve to investigate the path towards the formation of a scientific method of archaeological inquiry, which includes the introduction of personal observations of the extant remains as an integral part of research, the development of a critical appraisal of earlier sources and the elaboration of ways to assess the reliability of the reconstruction.

2 The 14th and 15th centuries

In the 14th century, works describing antiquities rarely used visual representations to integrate or explain the text. One of the early examples of drawings included in a manuscript is to be found in the autograph copy of the *Historia Imperialis* by the antiquarian and historian from Verona, Giovanni de Matociis (or Mansionario), who started to work on it from about 1310. On the side of some pages, he drew a number of coins and a schematic representation of a Roman circus.[8] Although Giovanni could have easily inspected directly the architecture of a Roman circus by looking at the specimen still standing in his hometown (the famous Arena of Verona), thus comparing and integrating the textual sources with his personal observations, he relied completely on the encyclopaedia of Isidore of Seville as the primary source for his historical account (Weiss 1969, 23). As will be discussed in the course of this paper, the reverence for classical authors and the related general preference for textual documents - seen as more authoritative than knowledge gained by first-hand experience - will be longtime companions of antiquarian studies.

Most of the examples that I will mention in this section relate not surprisingly to Rome since this city has attracted many humanists that were fascinated by Roman ruins and were trying to preserve the memory of its still obscure ancient past. The humanists' engagement with architectural theory shaped a renewed interest for Roman buildings, which were studied to derive rules of construction, as exemplified by Leon Battista Alberti's *De Re Aedificatoria* (Stinger 1998, 66). During this period, the approaches of the antiquarians drawing and reconstructing ancient ruins greatly vary: some of them tried to critically look at earlier sources and treated sceptically the medieval *Memorabilia* and previous accounts that explained with mythical legends the origins of cities.[9] Generally, however, the interpretations and reconstruction drawings of this period were still mostly based on reproducing the content of earlier textual sources and on creating fantastic explanations and depictions arising from the fascination for these otherwise inexplicable monumental buildings. The Colosseum was for example thought to have been the biggest temple of Rome dedicated to Jupiter and its original shape was reconstructed as being surmounted by a golden dome with a golden statue on top (Günther 1997, 382).[10]

Rome had severely declined during the ten years' exile of Pope Eugenius IV (1383-1447), who had been forced to leave his episcopal see to escape from the unfavourable political situation in the city. Any visitor coming to Rome in those years could witness a striking contrast between the monumental ancient ruins and the humble 15th century dwellings. In a letter dated March 1443 and addressed to Giovanni de' Medici, Alberto degli Alberti gives us a testimony of this situation, writing that contemporary masonry houses were many but in bad condition, while actually the nicest things to see in Rome were the ruins.[11]

Among the scholars that lamented the deplorable state of the eternal city, the name of the Italian humanist Flavio Biondo (1388-1463) stands out for his innovative approach to antiquities. In his *Roma Instaurata* (1444-46), Biondo assembled his first-hand observations on the ancient topography of Rome with the information that he took from ancient texts such as Pliny, Tacitus, Livy and Suetonius. Although his account is not exempt from errors, Biondo treated ancient texts, medieval sources and hagiographical accounts with a critical approach (Günther 1997, 384). Biondo's aim was to collect enough sources for an antiquarian reconstruction of Rome, in order to better inform his contemporaries, who were showing great ignorance about what the city had been like. As appears clear in the preface of the *Roma Instaurata*,[12] the interest of Biondo was however not much focused on the ruins as historical artefacts, but rather on their contribution in a programme of renewing 15th century Rome, with Pope Eugenius IV playing the principal role as its initiator. As McCahill pointed out, through his texts Biondo was indeed "determined to remind his readers, including Eugenius, that Rome's ancient grandeur is not an irrevocably distant reality but something that has been revived before and can be revived again" (McCahill 2009, 191).

The reconstruction of Rome that Biondo presents is textual, there being no maps or drawings that accompany the verbal descriptions. To find drawings of ancient Rome during the Quattrocento, one has to turn to the *Collectio Antiquitatum* by the Paduan doctor and antiquarian Giovanni Marcanova (1410/18-1467). Several manuscripts of the *Collectio* survive, the earliest being dated to 1465 and kept at the Estense library in Modena.[13] The text, which included copies of Latin and Greek inscriptions, was composed by Marcanova, while the visual representations of ancient monuments and places of ancient Rome have been identified as copies of the drawings of Cyriac of Ancona (1391-about 1455), which were reinterpreted by the painter Marco Zoppo.

This manuscript, defined as "the most lavishly illustrated antiquarian manuscript produced in the Renaissance" (Trippe 2010, 767-99), contains in fact 18 drawings depicting reconstructed views of ancient Rome and everyday life scenes in the city. Such drawings include, for example, the city gate with towers guarded by armed soldiers, the Monte Testaccio with broken fragments of urns on the ground, the Forum crowded by sellers and buyers and with a circular temple in the centre, the Arch of Titus during a triumph, the Diocletian's Baths, and scenes of sacrifices and games, all populated by people in 15th century clothing.[14]

The *Collectio* has received contrasting reviews from contemporary and modern scholars (Trippe 2010, 767), and although most have dismissed it as a production with low archaeological value, others have tried to contextualize this work within the spirit of the time in which it was produced. As Hülsen noted in his 1907 publication, which discussed the drawings in the *Collectio* for the first time, the reconstructed architecture is a mixture of ancient, Medieval, Renaissance and imaginary elements. Some drawings, in fact, seem to be derived from observations on the spot (such as the equestrian statue of the Emperor Marcus Aurelius, which is reproduced in accurate detail), while others are made by enlarging decorations on cinerary urns (such as in the depiction of the *Vivarium*), or inspired by the contemporary architecture of Bologna, the city in which the *Collectio* was written (Hülsen 1907). For example, the temple in the Forum, which has a circular plan instead of the more common rectangular one, is indicative both of the early state of the knowledge on Roman architecture, but also of the preference for circular shapes in sacred architecture during the Renaissance, as exemplified by the theories and works of Leon Battista Alberti (Hülsen 1907, 38). As usual for any depiction of antiquity during this period, these drawings had no intention to reproduce an archaeologically accurate reality; their aim was instead evocative, according to the humanist spirit of "recollection" that used images as a means to trigger the memories of the viewers, related to a specific place or experience (Trippe 2010). As Mitchell observed, "antiquity was in fact becoming an ideal of life, rather than an object of inquiry." (Mitchell 1960, 478).

The contribution of Cyriac of Ancona (1391-about 1455) to the study of antiquities deserves to be explored further as his first-hand recording of Greek and Roman buildings earned him the title of father of modern classical archaeology (Bodnar and Foss 2003, ix). Contrary to his contemporaries, who had gained acquaintance with the subject by consulting books in libraries, Cyriac travelled extensively in Greece and Italy, where he recorded and drew in his notes several ancient monuments that he had personally seen. Cyriac was in fact accustomed to travel since an early age, when he used to accompany his uncle, a merchant, in his trade; later on in his life, he became one of the diplomats of Pope Eugenius IV, which took him to several countries, thus allowing him to visit remote places and monuments. Cyriac's first encounter with ancient ruins had been the arch of Trajan in his home town, which, according to Weiss, "made him realize more and more that what still remained of the ancient world was doomed to perish sooner or later, and that it was therefore his imperative duty to try to rescue, or at any rate record, its relics for posterity before it was too late." (Weiss 1969, 138). According to Ashmole, although the drawing style of Cyriac is not sophisticated, he paid great attention to reproducing the reliefs or monuments he saw with accurate detail (Ashmole 1959, 25-6). Probably some of Cyriac's most famous drawings are those that depict Hadrian's temple in Cyzicus, which represent an important documentation of this monument that he could visit in 1431 and that would have been almost completely destroyed by 1444 for its intensive use as a quarry (Burrel 2002/03, 36).

Besides drawing extant remains, Cyriac drew also reconstructions of the buildings that he recorded. While his documentation drawings are considered fairly accurate, his reconstructions were on the other hand imaginative, giving again confirmation of the fascination that surrounded ancient ruins and the commonly shared intention of reconstructing them "not to deceive, but as a light-hearted fantasy" (Ashmole 1959, 27). Unfortunately, Cyriac's autograph manuscripts have not survived, his Commentaries probably being lost in a fire that burned down the library of Alessandro and Costanzo Sforza in Pesaro where they were kept. Cyriac's notes and drawings have been transmitted in excerpts and copies in other manuscripts, thus leading to problems of their attribution to Cyriac or to some other draughtsmen (Ashmole 1959, 28). In some cases, however, the copies still give us an idea about the type of reconstructions that Cyriac would have drawn, as in the case of the reconstruction of the Mausoleum of Hadrian (present-day Castel Sant'Angelo). The image of the reconstructed building appears on the folio 63r of the *Liber Monumentorum Romanae Urbis et Aliorum Locorum*[15] that was published at the end of the 15th century and compiled by Bartolomeus Fontius (1445-1513), an important Florentine humanist (fig. 1).[16]

In other cases, imaginative reconstructions were created on purpose, the lack of a critical approach in analysing texts in this and later periods ensuring their fortune for several centuries. One of the most famous fabricators of stories of this time is the Dominican Annius of Viterbo (1432?-1502), who published a collection of passages of ancient chronicles and documents (*Antiquities* or *Commentaria*, 1498), which retraced the colonization of Europe to Noah and his grandchildren after the Flood. These texts, to which Annius added his erudite commentaries citing authoritative sources, were skilfully invented by him to reconstruct the history of the Etruscans and ultimately to prove the historical importance of his home town Viterbo as the oldest city in Europe (see Weiss 1969, 125-6 and Hiatt 2004, 10-1).[17] This work will be published in several editions and will have a great influence on European historiography of the 15th and 16th century, as it provided suitable stories to legitimate the national monarchies that were growing in Spain, France and England.[18] The fortune of Annius' stories is due not only to the fact that they presented Europeans with "what they wanted to hear about their past" (Allen 1949, 114 cited in Stephens 2004, S203), but also that they were convincingly written mimicking the techniques and format of historical scholarship and philology, which immediately evoked scholarly respect (Stephens 2004, S216-7).

Other texts that Annius forged are collected in the *Auctores Vetustissimi* printed in Rome in 1489. Among them, there is the *De Aureo Saeculo et de Origine Urbis Romae eiusque Descriptione* that Annius claimed was written by Quintus Fabius Pictor, a 3rd century BC Roman historiographer whose works have not survived. The chronicle describes the early urban development of Rome, described as having the shape of a bow, with the Tiber river as its rope, and highlights the Etruscan contribution to the early development of the city. In one of the editions, a large woodcut view was inserted which represents the city in this way, surrounded by walls in a typically medieval fashion, and features the "Vicus Tuscus", Viterbo, in a prominent location close to the city (fig. 2). This urban configuration of Rome, which was instrumental in Annius' celebration of Viterbo, was still taken as authentic into the 18th century (Weiss 1969, 94).

As the examples discussed in this section show, in this century illustrations of ancient ruins and reconstruction drawings were used sparsely and, when they were inserted, there was no intention or interest to create a historically accurate representation. Generally, antiquarians found satisfaction in an approach to the past based on describing, collecting and comparing ancient relics, where no analytical attempts were made to view the archaeological remains in an historical perspective (Stinger 1998, 69). Contributions such

Figure 1 Reconstruction of the Mausoleum of Hadrian, copy from a drawing by Cyriac of Ancona contained in the Codex Ashmolensis, Bodleian Library, fol. 63r (digital copy available at http://bodley30.bodley.ox.ac.uk:8180/luna/servlet, last accessed March 2017)

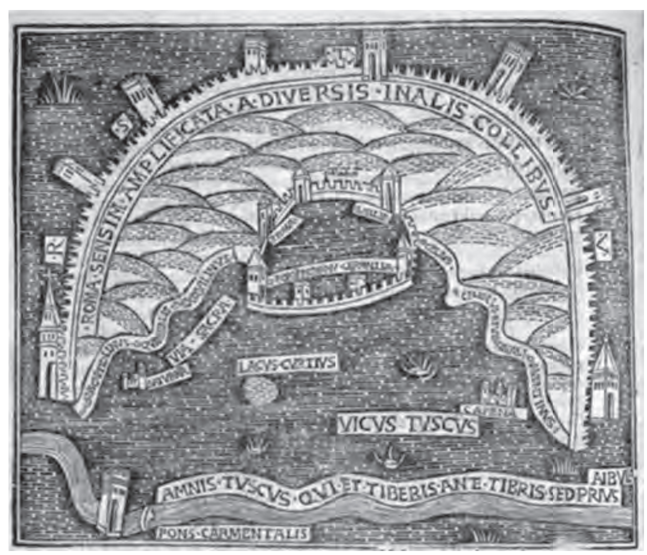

Figure 2 The large woodcut view of Archaic Rome in Annius of Viterbo's *Auctores Vetustissimi* (Rome: Eucharius Silber, 1498) (modified after http://www.brynmawr.edu/library/exhibits/antiquity/use4c.htm, last accessed March 2017)

as Flavio Biondo's and Cyriac of Ancona's stand out for their innovative approach, which included a critical view of previous scholarship and personal surveys. However, this changing attitude does not translate into a different approach towards visual reconstructions. In fact, if present, these drawings are generally an exercise of fantasy, expressing the fascination for the relicts of ancient buildings and a means of recollecting memories, in which contemporary elements are mixed together, without any attempt at historical veracity. In some cases, as shown by Biondo's *Roma Instaurata*, and by Annius' forgeries, furthermore, antiquities and reconstructions become instruments for political propaganda, a metaphor of a past grandeur that could be revived, or threads to weave deceiving narratives of local pride.

3 The 16th century

During the Renaissance, a new approach towards urban design and planning was developed. While until Medieval times there was the tendency to build a new construction by reusing an existing one, Renaissance architects and commissioners were more prone to razing the old buildings to the ground and using the stones to construct new ones (Weiss 1969, 99). This situation had a great impact on the urban appearance of Rome, which started to comply more and more with the Popes' agenda of using architecture to create a visually strong impression of their power. Construction works caused accidental discoveries of ancient buildings and sculptures. Especially these latter excited Renaissance antiquarians and led to the production of copies or triggered their imagination in creating tentative restorations of the fragmentary sculptures to their original entirety (Barkan 1999, 119–69). This combination of factors prompted an increased interest for antiquities, along with growing complaints by antiquaries against the unscrupulous destruction of ancient buildings and the call for more efforts to document and reconstruct these quickly disappearing testimonies of the past. "Roma quanta fuit ipsa ruina docet" (how great Rome was, it's very ruins tell), a phrase that was written on a drawing depicting the ruins of the Septizodium attributed either to the Dutch painter Maarten van Heemskerck or to Herman Posthumus, is the maxim that best summarizes the attitudes towards ancient ruins in this period.[19]

During the 16th century, the amount of visual representations that were used to integrate textual descriptions progressively increases. When antiquarians based their works on classical texts and earlier accounts, a verbal description would be the easiest and most suitable way to transmit this knowledge. However, as was evident already with works such as Cyriac of Ancona's, when a greater attention was paid to the extant remains and their documentation, the use of drawings became the most appropriate technique to record the material evidence that had been personally inspected. This trend of including more visual material in publications as a reflection of an increased reliance on personal observations can be noticed also in other fields such as natural history and the hard sciences (Stenhouse 2012, 248). Telling examples are the richly illustrated *De Humani Corporis Fabrica* (1543) by the Belgian Andreas Vesalius (1514-1564) in the field of human anatomy, and the *De Historia Stirpium Commentarii Insignes* (1542) by Leonhart Fuchs (1501-1566) in the field of botany. This latter is especially interesting since it breaks with the traditional representations of plants that are found in earlier herbal books and presents instead drawings (made by Albrecht Meyer) based on first hand observations of the plants and seeds that Fuchs had acquired.

Fuchs' attitude matches a change of approach in an increasing number of contemporary historians and antiquarians, who dedicated their efforts to survey ancient architectural remains and to provide related documentation based on their personal examination. In Britain, the contribution of William Camden (1551-1623) stands out as a milestone in European antiquarian studies.[20] His *Britannia*, which was published for the first time in 1586 and would be revised and enlarged in the following editions until the 19th century, contained his observations and his study of the material he collected during his journeys in Great Britain and Ireland. This topographic work is well situated within the late 16th century and 17th century English Renaissance, in which the study of history underwent a revolution in methodology and scope and contributed significantly to the formation of the "Englishness" typical of the Elizabethan age (Richardson 2004, 108-23, esp. 112 and 120). This autoptic approach to antiquities will become more widespread in the course of the 17th century, promoted by the development of a new scientific method that encouraged empirical research over reliance on the authority of Classical authors.

Regarding Roman antiquities, a noteworthy work of the early decades of this century is the *De Nola*, compiled by the physician Ambrogio Leone (1458-1525), friend to the publisher Aldo Manuzio and to Erasmus of Rotterdam. In this work, published in 1514 in Venice, Leone combines the themes of the *descriptio Urbis* and the *laudatio Urbis*, which are typical of humanistic culture, aiming to praise his hometown Nola, near Naples, that he had to leave. Among the engravings that Leone included in the text, we find a reconstruction of Nola in Classical times (fig. 3), which represents the first archaeological plan of a city outside Rome that is known to us (Weiss 1969, 129). In line with the cartographic tradition that depicted Rome as a circular town,[21] the drawing represents Roman Nola as having a circular plan, extending much beyond the town in Leone's

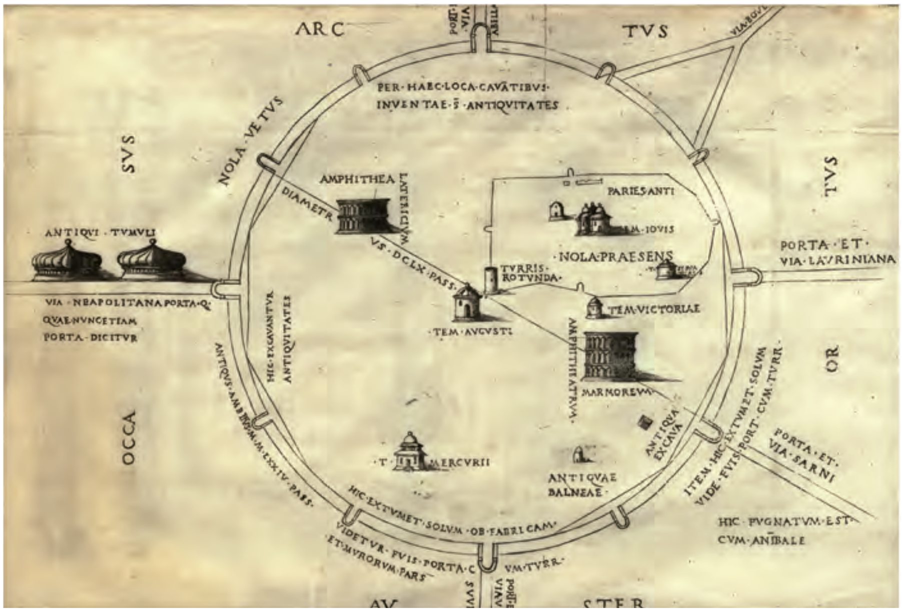

Figure 3 Map of ancient Nola (engraved by Girolamo Micetto) in the *De Nola* by Ambrogio Leone (copy from the John Adams Library at Boston Public Library digitised by Internet archive and available at https://archive.org/details/denolaopusculumd00leon, last accessed March 2017)

time and surrounded by a fortification with twelve regularly spaced gates. A temple of Augustus stands in the middle of the circle, on the same axis as two amphitheatres, one of marble and one of brick. Leone describes the buildings of which the ruins were still visible at his time, providing fanciful reconstructions for the extant remains, again in line with the traditional way of depicting Roman monuments at that time.[22] Noteworthy, moreover, is the effort to contextualize Nola in its territory ("De Agro Nolano" is discussed in the first chapter of the book and mapped in an engraving), although the fact that this work is mainly based on inscriptions and ancient texts led Leone to suggest various wrong identifications in attempting to relate ancient names with modern topography.

Around the same years, a project of a much larger scale was designed by the painter and architect Raphael (1483-1520). Pope Leo X (1475-1521), son of Lorenzo the Magnificent, had in fact commissioned him to prepare the first visual reconstruction of Rome in antiquity, which had to be created from measuring and recording the ancient buildings. Although Raphael died before having completed his plan, a surviving letter that he and his friend, the humanist Baldassarre Castiglione, wrote to the Pope in 1519 gives an insight about his view on antiquities, on their destruction, and on the method that he was applying to complete the project.[23] In this letter, Raphael blames the time, the Vandals, the Goths, but more than these, he holds the predecessors of Pope Leo X accountable for the destruction of the ancient buildings in Rome, since they allowed the pillage of ancient temples and sculptures to produce mortar for the construction of new buildings.[24] He says that he has been measuring with great care the ancient buildings, reading "good writers" (Vitruvius among others) and comparing the ancient texts with the structures, which gave him a good knowledge of ancient architecture.[25] Moreover, he is convinced that he can unerringly relate the ruins to their original shape, by integrating the missing information with the knowledge of the still standing examples.[26] A long section of the letter is filled with the description of the instruments that he intended to use in order to precisely measure and draw sections and perspective views of the buildings, and gives specific indications on how to operate them (Golzio 1936, 87-92). Raphael's attitude is characteristic of this period in which scholars never doubted their capability of reconstructing ancient remains without making mistakes ("infallibilmente", unerringly, to use Raphael's words). Until this period, the reliance on ancient authoritative authors, the collection of several sources, and personal surveys among the ruins were deemed enough to provide an accurate reconstruction of ancient ruins. This approach will start to be put into question in the 17th century, when the scientific methods of Galileo and Descartes spread a new awareness that started to influence also the study of antiquities, and scholars became more conscious of all the unknowns that had to be catered for through conjectures.

Some of the artists that were part of Raphael's circle attempted to finish his project, but the results were not comparable to the extent of Raphael's vision. Among the works that were published with this intention, there were the *Antiquitates Urbis* (1527) by Andrea Fulvio, who used to accompany Raphael in his surveys and showed him the buildings in ruins that were worthy to be documented, and the *Antiquae Urbis Romae cum Regionibus Simulachrum* (1527) by Marco Fabio Calvo, who had translated Vitruvius' *De Architectura* for him. Calvo's book contains a brief text and a series of woodcuts depicting, among others, views of Rome's ancient plan, regions and landmarks, which are randomly mapped and imaginatively reconstructed. The drawings show the urban development of the city, changing its plan in different geometric shapes: a square with four gates when it was founded by Romulus, an octagon under Servius Tullius, a circle divided in sixteen regions with a matching number of portals under Augustus, and a larger urban fabric cut by the Tiber in Pliny's time (fig. 4).[27] Calvo was inspired by the descriptions of classical authors, such as Livy, Dionysius of Halicarnassus, Pliny the Elder, and Vitruvius, and by the images of buildings appearing on Imperial coins, but he drew also on Late Antique land-survey treatises such as the 6th century *Codex Arcerianus*, depicting Roman military colonies as geometrically planned settlements (Jacks 1990, 459).

Later scholarship has judged negatively Calvo's imaginative reconstructions, which were labelled "une barbarie incroyable!" at the end of the 19th century (Muentz 1880, 306-7, cited in Jacks 1990, 463), and more recently "so naive as to be little more valuable than the plan invented by Annius of Viterbo" (Weiss 1969, 96-7). Similarly to the reconstructions in Marcanova's *Collectio*, these drawings are surely not historically accurate representations of Roman architecture and city planning, but as Jacks has shown they offer instead a great testimony of both the attitude towards Classical antiquities that permeated the Renaissance, and of the state of the knowledge in this domain by scholars of the time (Jacks 1990). Calvo's reconstructions are indeed a blend of his interpretations of both archaeological evidence and the current architecture "all'antica", which had found new forms of expression reinterpreting classical authors and monuments (Jacks 1990, 474).

In this period, a critical appraisal of earlier and contemporary works starts to be more common in the antiquarians' publications. Inconsistencies and inaccuracies in epigraphic transcriptions and monuments' identifications were found in the works previously written (for example by Fulvio and Flavio) and denounced by a number of scholars. Among them was the architect Pirro Ligorio, who was born in Naples in about 1513 and moved to Rome some twenty years later. He was in charge of several construction works in Rome and, after the death of Michelangelo, was appointed supervisor of the works at St. Peter's for a short period. In 1549, Cardinal Ippolito d'Este gave him the responsibility to carry out some excavations at Hadrian's villa at Tivoli.[28] His interest in antiquities led to the publication in 1553 of his *Libro delle Antichità di Roma*,[29] which was composed of two treatises, one where he described the chief antiquities of Rome focusing on circuses, theatres and amphitheatres, and the other (the *Paradosse*) where he contradicted some of the identifications that previous scholars had suggested.[30] Ligorio, who was also trained as a painter, drew several reconstruction drawings of the structures that he had included in the book.

In the *Paradosse*, he points out that his predecessors have made many mistakes in their interpretations and identifications, like people who walk blindly and stumble into false impressions because they have not spent sufficient time in making acquaintance with the words of the ancient authors.[31] Particularly interesting for our purposes is Ligorio's exposition of his method of investigation. His conclusions were largely based on his surveys in which he carefully observed and measured the remains, integrated them with what he knew from classical authors, and compared them with similar structures that were still standing. The section describing the Circus Flaminius is particularly telling about Ligorio's purpose and methods: his aims were to keep the memory of antiquities alive and to satisfy those that were interested in them; to do so, he says to have tried "with every possible care" to show the original shape of the circus by studying and measuring each portion of the surviving structure and comparing them with what other authors have written about Roman circuses. Later on, Ligorio explained that often he had to make use of "conjectures" to integrate the parts that were missing, in order to visually reconstruct the building in its original shape. These integrations, however, were always based on comparisons with other structures, and on the opinions that he exchanged with other scholars.[32] For this reason, Ligorio hopes for the good disposition of his readers, since he underlines that he has been the first person who has undertaken such a cumbersome work.[33] Ligorio's studies led him to complete Raphael's project forty years after its conception: in 1561 he drew a map of Rome that the brothers Michele e Francesco Tramezzino published in six sheets in 1561 with the name *Antiquae Urbis Imago Accuratissime ex Vetusteis Monumenteis Formata*.[34]

Another antiquarian that would leave his mark on this century was the Augustinian Onofrio Panvinio (1529-1568), who became librarian of Cardinal Alessandro Farnese and

Figure 4 Reconstruction drawings of Rome in Fabio Calvo's Antiquae Urbis Romae cum Regionibus Simulachrum. Top: Romulus' square city, bottom: Rome in Pliny's time (digitised copy available at http://arachne.uni-koeln.de/books/FabioCalvo1532, last accessed March 2017)

had at his disposal the vast collection of books of the Vatican Library for consultation. Cardinal Farnese had involved Panvinio in his plans to decorate his Villa Caprarola, near Viterbo, with iconographic motifs, which triggered his interest in visual representations of ancient monuments and scenes (Stenhouse 2012, 244). In fact, Panvinio became very famous for his knowledge of antiquities and published in 1571 the *De Triumpho Commentarius*, a description of how triumphs were celebrated in ancient Rome, with illustrations that depicted reconstruction drawings of the processions. Panvinio underlined the accuracy of his work ("monumentis accuratissima descriptio") and cited extant remains, coins and ancient authors among the sources that he used (Stenhouse 2012, 241).

Another work of Panvinio which provides insights in his methods and in his aims is the *De Ludis Circensibus Libri II*, which was printed posthumously in Venice in 1600. In these volumes, Panvinio inserted a number of drawings (made by the French architect Étienne Dupérac) of coins, reliefs, and several reconstructions depicting, among others, the Circus Maximus, a scene of a sacrifice and a *naumachia*, which he drew based on extant remains and coins. Moreover, Panvinio included what he defined a "very accurate" map of ancient Rome,[35] which was largely based on Ligorio's (Bajard 1992, 579).[36] The chapter of the first book, which relates to the Circus of St. Sebastianus on the Via Appia, gives us a glimpse of Panvinio's target audience and purpose for including visual representations in his text: he writes in fact that he included the topography of the circus, a reconstruction and a drawing of the current state of the ruins in the two plates depicting the circus, in order to increase the understanding of the building and "to follow his habit of satisfying the interest of eager scholars, who are passionate about Roman antiquities".[37]

As one might expect, antiquarians, architects and artists looked at the ruins and created reconstructions with different purposes in mind. While antiquarians were progressively sharpening their intellectual tools of scientific inquiry, artists were more engaged in creating powerful and appealing scenes that responded to the current fascination for the past, paying little attention to the archaeological documentation. This perception of the past is visible in the set of imaginative drawings depicting the Seven Wonders of the World plus the Colosseum in ruin made by the already mentioned Dutch painter Maarten van Heemskerck and printed by the Dutch publisher and engraver Philip Galle in 1572. These drawings show the artistic intention to create an imaginative interpretation of ancient monuments. The reconstruction of the temple of Artemis in Ephesos, for example, far from being an archaeologically accurate attempt, is inspired by the canon of Renaissance architecture (fig. 5).

Architects, on the other hand, were interested in studying ancient architecture for the knowledge that they could gain about ancient construction techniques and proportions, which they could then apply to their contemporary projects. During the Renaissance, in fact, ancient architecture was seen as a source of inspiration and comparison for the creation of modern pieces (Curran 2012, 37). This last purpose is well expressed in the preface of the *Livre des Edifices Antiques Romains* (1584), a collection of reconstruction drawings of several buildings in Rome written by the French architect Jacques Androuet du Cerceau, the founder of an important family of artists.[38] In Cerceau's intention, the book could be useful to those that are curious about antiquities and even more to the architects that could be inspired by them.[39]

Over this period, illustrations start progressively to be seen as pleasant additions to texts and publishers pushed for their insertion in books to embellish them and make them more appealing to buyers. Some scholars were however very cautious about which illustrations they wanted to insert in their books, such as the Dutch philologist and antiquarian Justus Lipsius (1547-1606), who applied the same philological approach he used to interpret and reconstruct texts to the study of ancient ruins. Lipsius stayed in Rome from 1568 to 1570 where he worked as secretary to Cardinal Antoine Perrenot de Granvelle and "diligently sought out many libraries, statues, inscriptions, coins, and whatever was relevant to the understanding of antiquity" (Papy 2004, 103). He walked in Rome, admiring and making notes of the ruins with the company and guide of the historian and antiquarian Fulvio Orsini, who had built up a vast knowledge of Roman

Figure 5 The imaginative reconstruction drawing of the temple of Artemis in Ephesos (1572) by the Dutch painter Maarten van Heemskerck (source: https://commons.wikimedia.org/wiki/File:Temple_of_Artemis.jpg)

history together with a collection of antiquities and a well-furnished library (Papy 2004, 104-5).

A passage of Lipsius' second edition of the *Poliorceticωn sive de Machinis, Tormentis, Telis Libri Quinque* (1599), in which reconstruction drawings of *ballistae* were inserted to better convey the textual explanation on the functioning and appearance of this Roman weapon, is particularly interesting for our purpose to investigate the role and development of reconstruction drawings over the centuries. The reason why visual representations are important in Lipsius's view is clearly expressed in a dialogue with his friend Dominicus Lampsonius that he reports in the *Poliorceticωn*: "Lamps.: Forgive me, Lipsius, but we shall accomplish little, if you present information about these machines to the ears only. Lips.: What can we do further? Lamps.: You should present it to the eyes as well. These can understand and judge more quickly at a single glance, than the ears can after much listening."[40] Lipsius, however, was a severe judge of the accuracy of the illustrations that he included in his texts, to the point that in the opening of the second edition of his *Saturnalium Sermonum Libri Duo* (1585) he alerts the reader that he did not agree with the insertion of the illustrations that were included by the publisher. Likewise, in another passage of the second book, he notes that the drawing of the gladiatorial games contained some invented elements that are the product of artistic license and not historical truth.[41] The "veritas" that Lipsius advocates in his illustrations corresponds however to the state of knowledge of his time, with the result that anachronisms can be found, such as the presence of typically Medieval walls protecting the Boeotian city of Plataea depicted under siege in one of the illustrations of the *Poliorceticωn* (fig. 6).

Figure 6 Reconstruction drawing of the siege of Plataea in Justus Lipsius' *Poliorceticωn* (1596), 66 (copy digitized by Google books)

As this overview has showed, in this period scholars had not yet developed what could be called a scientific method in modern terms and their approaches towards the study of antiquities and the making of reconstruction drawings of ruins greatly vary in relation to their personality, interests and background. There are however some elements that emerge as common shared values among scholars, which include a more marked reliance on personal surveys, and hence on primary sources, a more critical approach towards previous scholarship, a conscious use of conjectural integrations based on comparisons and exchange with peers, and a more defined idea about the role of reconstruction drawings in explaining and clarifying concepts otherwise difficult to grasp. These considerations contribute to a reassessment of the antiquarians' approaches to antiquities in line with recent scholarship which has aimed to re-contextualize them in their historical and cultural period.[42] The traditional rendering of antiquarian endeavours as amateurish and unscientific has been in large part overemphasized and generalized to underline the contrast with the scientific and modern approach of the developing discipline of archaeology in the 19th century (Marchand 2007, 248-85). In this view, antiquarianism was therefore dismissed as a "wrong-turning on the pathway to archaeological enlightenment" (Murray 2007, 14).[43] As the next section will further confirm, antiquarian production of the 16th and 17th century should not be discarded as naïve, as it in fact sets the basis for the revolution of the historical method that will impact modern day archaeology. Its analysis in fact enriches the discussion about the roots and methodologies of this discipline.

4 The 17th century

In the 17th century wars, pestilences and famine invested Europe. Especially devastating was the Thirty Years' War (1618-1648) which ended with the peace of Westphalia, but had long term repercussions on the social and political balance of the European powers. Against this background, the cultural panorama was very dynamic and the conceptual and practical developments, which were maturing in the last decades of the previous century, consolidated. Philosophers such as Francis Bacon (1561-1626), Thomas Hobbes (1588-1679), René Descartes (1596-1650), and Benedict Spinoza (1632-77) all contributed to create a vibrant intellectual scene; science made important advances thanks to the observations and theories by Galileo Galilei (1564-1642), Johannes Kepler (1571-1630), Blaise Pascal (1623-1662), and Isaac Newton (1642-1727); art and architecture flourished in the Baroque style with the achievements of artists and architects such as Caravaggio (1571-1610), Gian Lorenzo Bernini (1598-1680), and Francesco Borromini (1599-1667).

During this period, a new way of researching is conceived, which originated primarily from relying on empirical observation and on the use of reason, as expressed in the ideas and writings of Bacon, Galileo and Descartes. In 1637, Descartes published his *Discours de la Méthode* where he explained his view on the method that he thought necessary to be applied to study and research. The key elements were a rational and critical approach towards traditionally accepted knowledge: everything had to be doubted, while the only certainty was the existence of the being who conceives the doubt, which is summarized in his famous proposition "cogito ergo sum": I think, therefore I am. Empiricism and rationalism promoted the development of a scientific method based on original observations and first-hand experience, and on a deductive reasoning to reach knowledge. Especially towards the end of the century, these principles would start to impact more profoundly also the study of antiquities, by reinforcing the emphasis on the self-inspection of ruins and on a critical approach towards tradition, both in the form of Classical authors and of previous generations of scholars.

The interest in antiquities and the collection of small finds, coins and inscriptions continued to rise in the course of this century. The antiquary became a figure which was enough defined to be satirised in 1628 in the collection of characters by the British bishop John Earle as a man "that hath that unnaturall disease to bee enamour'd of old age, and wrinckles, and loves all things, (as Dutchmen doe cheese) the better for being mouldy and worme–eatern".[44] In his caricature, Earle presents the antiquarian as a great admirer of past relics, which he seeks, inspects and collects with much passion, to the point that he disdains all his contemporary products, even printed books which "he contemnes, as a novelty of this latter age".[45]

In Italy, the fascination for Rome continued to inspire antiquarian works, one of the most famous being the *Antiquae Urbis Splendor* by Giacomo Lauro. Lauro, born most likely in Rome at an unknown date in the second half of the 16th century, started to work on the *Antiquae Urbis Splendor* probably around 1586. The four volumes came out between 1610 and 1628, after which they were reprinted in several editions until the very end of the 17th century. As the title promises, Lauro's aim was not to create an accurate reconstruction of Rome; instead, he wanted to represent the glory and splendour of the ancient city, which he conveys through a series of reconstruction drawings of monuments and views of ancient Rome and nearby places of interest, such as Portus, the ancient harbour of Ostia. These representations were appreciated by artists such as Bernini and Borromini as models and source of inspiration (Del Pesco 1984, 418-9; Di Calisto 2005), and were popular among travellers and visitors that came to Rome, serving as a sort of tourist guide. In the 1625 edition, in fact, descriptions of the represented buildings in Italian, German and French were added to the original Latin text to make this work more appealing for a broader audience.[46] The editions published in 1637 and 1641, moreover, were sponsored by the Swiss Guard Hans Gross (under the pseudonym of Giovanni Alto), who was working in his spare time as a tourist guide in Rome.

As we can gather from Alto's dedication to the reader, 17th century tourists, especially German and French, wanted to better understand the buildings in ruins and to have some visual souvenirs to take home. Lauro's reconstruction drawings were therefore meant to serve this very purpose by providing those visiting Rome with a visual memory of the monuments they saw, that they could show to relatives and friends at home. Gross is himself portrayed in one of the drawings, while he is showing the *Meta Sudans* between the Colosseum and the Arch of Constantine to a group of German nobles (fig. 7). The explanatory text under this drawing well illustrates the idea that these encounters with the distant past held an educational value. They were perceived not only as an honest and recreational way to spend the time, but also as an opportunity to reflect upon the "vicissitudes of all things, on how now lies what previously had flourished."[47]

The dedication to the reader at the beginning of the volume and the explanations of the drawings give us also an indication of the method and sources that had been used to create such representations: accurate recording of the extant remains that were compared to the buildings engraved in medals, marbles and metals, ancient writers (most notably Vitruvius, Varro, Livy, Suetonius), and modern authors such

Figure 7 Drawing of the Meta Sudans in Lauro's *Antiquae Urbis Splendor*. On the left, Hans Gross with a group of German tourists (Savannah College of Art and Design Digital Collections)

as Ligorio,[48] Dupérac, Biondo, Marliani, Fulvio, Panvinio and Lipsius.[49] It must be noted, however, that Lauro was mainly an engraver and had little knowledge of architecture. He therefore relied much on the visual models that were known at the time, supplying with coherent fantastic elements the missing pieces in his reconstructions (Del Pesco 1984, 426).

As previously noted, the expertise of the drawing-maker has a great influence on the drawing method, the choices about which elements to draw and the final aim of the work. This difference is clearly visible when comparing the reconstructions included in Lauro's work, which were mainly aimed at tourists visiting Rome, with the drawings made by the French architect Antoine Babuty Desgodetz (1653–1728) and published in *Les Edifices Antiques de Rome: Dessinés et Mesurés Très Exactement* (1682), which were meant instead to create a reliable documentation of the buildings for French architects interested in Roman architecture. Desgodetz's treatise, which remained a reference work on Roman antiquities in the following century, is organized in chapters, each one describing one monument (mainly temples, arches, and theatres) that was illustrated with plans, sections, details, and reconstruction drawings. The reconstruction drawings are purely geometric and report accurately the measurements of each part of the structures. Buildings are drawn either from the front or from one side, without a perspective view or any attempt to insert vegetation or people, to make them more engaging to the viewers as Lauro had done in his drawings.

The predominance of works on Roman antiquities in the previous paragraphs is a reflection not only of the prevalent interest of antiquarians and tourists in the 17th century, but also of the options of travellers in that period. Greek antiquities were in fact more challenging to visit, as the Ottoman conquest of Greece in the 15th century had closed the frontiers of the empire, making Greece difficult to enter from this period onwards. Cyriac of Ancona was indeed one of the last travellers that could freely move in Greece, at least until 1687 when the Venetians invaded Greece and took possession of Athens even if only for a short period. In the meantime, sparse information over Greek antiquities was coming from diplomats, traders or missionaries who came back also with some ancient artefacts (Sánchez Hernández 2010, 11).

The political situation in Greece has had an impact also on the state of the scholarship on Greek antiquities. The isolation of Greece and the reduced accessibility of its monuments made the books on this subject an appealing reading for both scholars and non-specialists. Given the difficulty to reach the country, publications on Greek antiquities were mainly based on descriptions offered in ancient sources, such as the 2nd century AD Greek traveller Pausanias. For example, the Dutch Johannes Meursius (1579-1639), professor of Greek and History in Leiden in the second decade of the 17th century, wrote his *Athenae Atticae* (1624) without having ever visited Athens, but by relying on the material he found in the well-furnished Leiden University library.[50] The inaccessibility of Greek antiquities made moreover possible the circulations of unverified information and allowed publications such as Guillet de la Gulletière's book *Athènes Ancienne et Nouvelle* (Paris, 1674) that were not substantiated by any personal encounter with the ruins described and reconstructed. Although the frontispiece of the second edition of this book (1675) promises that the treatise was "augmentée en plusieurs endroits, sur les memoires de l'auteur", de la Gulletière, historiographer of the Royal Academy at Paris, had never been to Greece himself and had based his work on Meursius' and on the information that he could access because of his appointment at the Royal Academy. The book contained a map of ancient Athens that was completely fanciful. De la Gulletière's forgery was disproved some years later when the French doctor Jacob Spon wrote the accounts of his journeys in his *Voyage de l'Italie, de Dalmatie, de Grèce et du Levant* (1678) and was able to prove the unreliability of Guillet's map and correct also some of the inaccuracies and errors in Meursius' text (Sánchez Hernández 2010, 11).

At the turn of the century, the signs of a changing approach towards the study of antiquities can be seen in the work of the Florentine antiquarian Filippo Buonarroti (1661-1733). In 1698 Buonarroti published his *Osservazioni Istoriche Sopra Alcuni Medaglioni Antichi* ("historical observations over some ancient medallions"), a treatise on the coins and medals from the collection of Cardinal Gasparo di Carpegna, which he illustrated with several drawings of his study material. Although this iconographic work does not contain any reconstructions, it is worth mentioning since it is quite telling on a changed perception towards the study of antiquities that will become more marked in the 18th century.[51] In the preface of his work, Buonarroti confesses the many doubts that he felt in studying this material, insomuch as to define his treatise a "stodgy collection of doubts, instead of one of certain and digested observations".[52] Casting doubt on his observations is quite remarkable and stands out from the prevalent approach of antiquarians claiming to present "accuratissimae descriptiones" of the documented and reconstructed antiquities. Buonarroti explains the reasons for his doubts, saying that the study of antiquities greatly differs from any other, and requires a more complex method of investigation. Its premise was a sincere confession that one does not know what ancient painters and sculptors have had in their minds ("il confessar sinceramente di non sapere tuttociò che ha potuto venir' in capo a tanti pittori e scultori antichi"),[53] and the acknowledgment of the challenging task that is set out for a scholar studying antiquities, facing the difficulty to identify the correct information among the many previous works on this topic instead of simply reporting what others had written before, thus behaving "like sheep that leave a closed space, one following the others".[54]

5 THE 18TH CENTURY

The beginning of the systematic excavations at Herculaneum in 1738 is traditionally taken as the starting date of the discipline of Classical archaeology. In previous years, excavations had been carried out on the Aventine (1705), on the Domus Flavia on the Palatine (1720) and on the graves along the Via Appia (1726) directed by the antiquarian from Verona Francesco Bianchini.[55] These, and the excavations that started in 1748 in Pompeii,[56] gave a great impetus to a widespread interest in Roman antiquities in the 18th century that was nourished by young savants visiting the ruins during their *Grand Tour*.[57] Even the models and vocabulary of the French Revolution came from the classics, and Rome, Greece and Egypt were seen as the cradle of civilisation (Díaz-Andreu 2007, 67-78). Illustrations were by now seen as an integral part in the study of antiquities, as confirmed by the words of the British antiquarian William Stukeley (1687-1765), who stated that "without drawing or designing the Study of Antiquities or any other Science is lame and imperfect".[58]

The new discoveries created an even more pronounced need to document and represent the monuments and their decorations in their context, with a visual language that was appropriate for presenting them to the public (Barbanera 2010, 33-4). The first musea of antiquities started to be established growing out the antiquarians' private collections and opened to visitors, the first being the Capitoline Museums in Rome (1733) that was followed by other similar initiatives all over Europe, such as the British Museum (1759) and the Louvre (1792) (Díaz-Andreu 2007, 46-7). After the mid-18th century, an interest for landscape started to increase, encouraged by the ideas on nature by Jean-Jacques Rousseau (Dubbini 2002). This new way of looking at landscape was of great importance for the contextualization of ancient buildings, that started to be seen not in isolation any more, but as part of their surroundings.

Works on antiquities started to be systematically collected in larger publications such as the *Thesaurus Antiquitatum*. At the turn of the 17th century, the famous *Thesaurus Antiquitatum Romanarum* (Utrecht/Leiden, 1694-1699) edited by the German scholar Johannes Georgius Graevius in twelve volumes and the *Thesaurus Antiquitatum Graecarum* (Leiden, 1697-1702) by the Dutch Jacobus Gronovius appeared in print in The Netherlands.[59] The aim of these collections was to reprint and make available to a wider audience works that had been previously published or that were difficult to access. However, the works that were published or republished in these years varied greatly in terms of the accuracy and reliability of the material presented. In one of the 1712 issues of the *Giornale de' Letterati d'Italia*, an important Italian literary journal founded in 1710, an article by the intellectuals Pietro Caterino Zeno, Scipione Maffei, and Giusto Fontanini criticized the fact that many histories of Italian cities were still being published even though they were not based on historical documentation but on myths and legends (Gallo 2007, 111-2).[60]

In the second half of the century, in Germany Johann Winckelmann published his *Geschichte der Kunst des Alterthums* (1764) where he considered ancient artistic productions from the point of view of their style to establish their chronology and not only from the point of view of their iconographic motifs, as was the prevalent approach in the circles of antiquarians.[61] Winckelmann is considered the founding father of art history and had a great impact on the development of German Hellenism with his studies on Greek art. The German scholar, in fact, sustained the superiority of Greek art over Roman, which he saw as always attempted to imitate the Greek original,[62] and was one of the leading intellectuals who saw the roots of European identity in Greece (Morris 2006, 258). The influence of Winkelmann's writings impacted in various degrees on the study of antiquities in the other European countries. In Italy, for example, his contribution was not absorbed much by Italian antiquarians, not only because of the linguistic barrier posed by reading the German text, but also for the diffidence of erudite circles towards a foreigner's opinion (Gallo 1999, 841).

In France, the Comte de Caylus (1692-1765) stands out among his contemporary antiquarians.[63] The mutual antipathy with Diderot and with the "Encyclopédistes", caused not least by Caylus' aristocratic lineage, resulted in a sort of *damnatio memoriae* of Caylus in France (Fumaroli 2007, 168).[64] From the 19th century onwards, however, several studies have reassessed his contribution to the development of a scientific method, to the point that he has been paired with Winkelmann as a founder of Classical archaeology (Gran-Aymerich 2001, 40).[65] His most important work, the *Recueil d'Antiquités Égyptiennes, Étrusques, Grecques et Romaines*, was published in six volumes and a supplement between 1752 and 1767, and contained explanations and drawings of the materials that he personally owned and inspected. De Caylus' reliance on the comparative method allowed him to go beyond the taxonomies that had been established by Classical authors (e.g. Varro), thus contributing to the elaboration of the typological method based on his observations and comparisons between the artefacts that were part of his large collection (Warin 2011).

On the other side of the English Channel, the comprehensive *History of the Decline and Fall of the Roman Empire*, written by the historian Edward Gibbon (1737-1794) and published in six volumes between 1776 and 1788, will influence the historical method of the 19th century for its reliance on primary sources and will become a reference work on the subject for following generations (Momigliano 1954, 450-63).

In Italy, one of the most controversial figures of this period, not least for his reconstruction drawings, is Giovanni Battista Piranesi (1720-1778), a troubled and restless architect who was fascinated by Roman architecture. Like the architects of the previous century, he was convinced that ancient buildings should be the starting point for the modern architect to "reshape the good taste in architecture, which was twisted by the barbarian coarse and ill-fated way of construction".[66] Some of the publications of the archaeologist Bianchini were the starting point for the composition of Piranesi's *Antichità Romane*, a treatise on Roman antiquities that he published in 1756. In the preface of this work in four volumes, he stated clearly the purpose of this publication in trying to preserve the memory of the ancient buildings of Rome with his prints: "And since I've seen that the remains of the ancient buildings of Rome, that are scattered in gardens and other cultivated fields, are decreasing in number day after day, either because of the harm committed by time, or for the greed of their owners who are surreptitiously digging them up to sell their parts to construct new buildings,

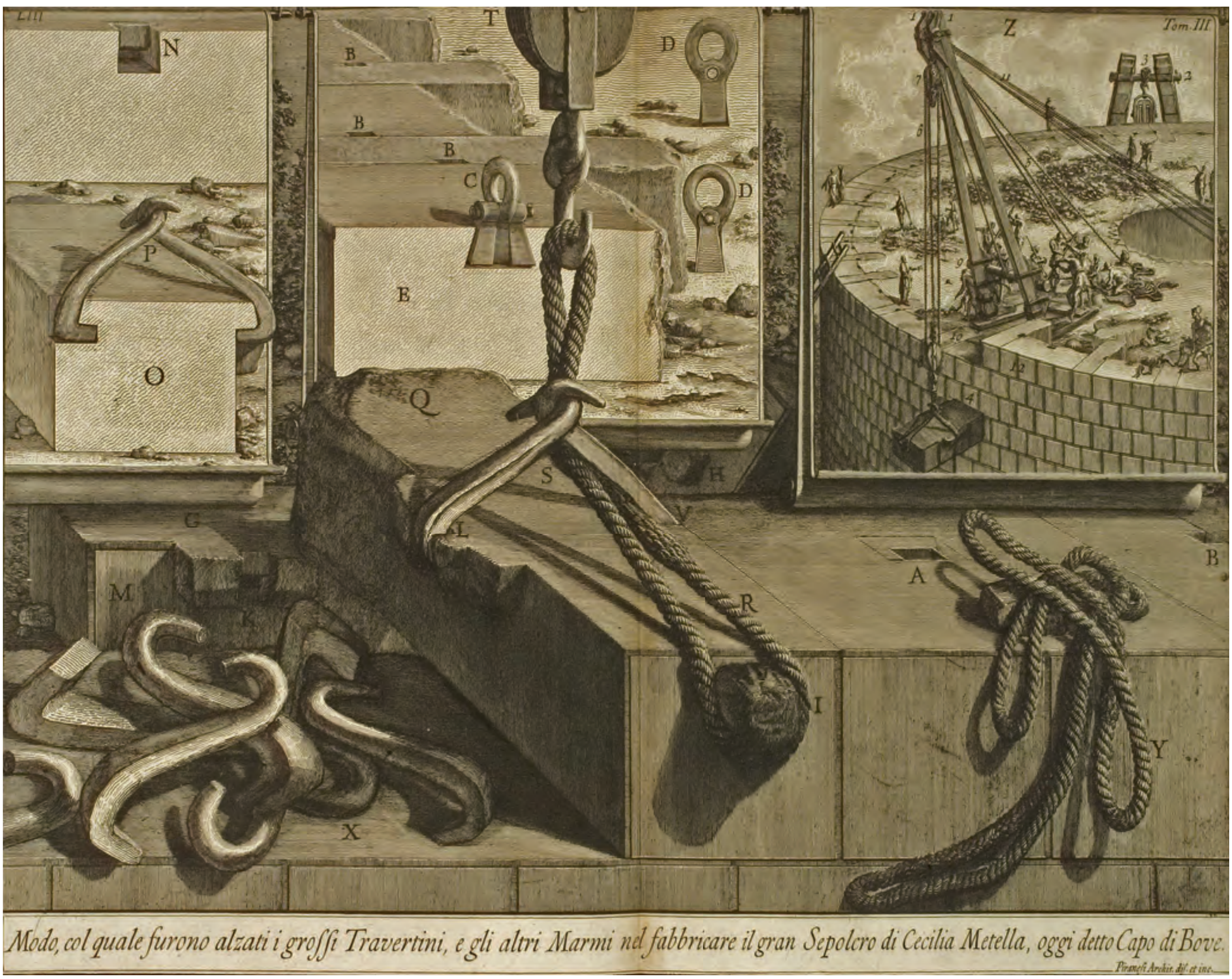

Figure 8 Piranesi's drawing of the construction technique adopted for the funerary monument of Caecilia Metella, in *Le Antichità Romane: Divisa in Quattro Tomi: Contenente gli Avanzi de' Monvmenti Sepolcrali di Roma e dell'Agro Romano*, vol. III, pl. LIII (digitized by Google books)

I decided to preserve them by means of my prints."[67] In the same preface, Piranesi complained that he could not rely much on modern works on Roman antiquities since they contained many mistakes, to be attributed either to the fact that their authors did not carefully inspect the ruins, or to their ignorance of architecture, or to the fact that they did not have a complete plan of Rome (such as the famous one that Giovan Battista Nolli had worked on between 1741 and 1743 and was published in 1748, see Leto 2013). For this reason, Piranesi had to turn to ancient authors, analysing them and comparing them with the extant remains that he carefully recorded.

Piranesi has received much attention with publications and exhibitions devoted to him and to his unusual approach to architecture and antiquities. His style of drawing is characteristic and his interest for ancient building techniques is clear in his publications, in which he supplied etchings representing sections and details of buildings that aimed to illustrate ancient construction methods (fig. 8). The composition style that he adopted in many of his drawings was meant to collate all the different sources that he drew on to create the reconstructions, resulting in what Nixon has called "multi-dimensional images" (Nixon 2002, 476). In these drawings, Piranesi took into consideration all the elements that compose a structure, such as its foundation, the elevation and its construction technique, contrary to the traditional view which focussed primarily on decoration (Barbanera 2010, 35).

His reconstructions, however, have puzzled contemporary and modern scholars for their mixture of archaeology and invention, their purpose being difficult to grasp. Piranesi possessed in fact a great knowledge of Roman architecture, that he acquired with personal observations of the buildings and by reading modern and ancient authors that he combined with his skills in architectural design; yet, he introduced many elements from his own imagination that made his reconstruction drawings to be discarded by many as mere imaginative depictions. An example of his approach is his reconstruction of the Campus Martius in Rome, titled *Ichnographia Campi Martii Antiquae Urbis*, which he published in 1762. In the dedication to the Scottish architect Robert Adam, Piranesi explains his concerns about the reception of this work, especially the fact that his work could be seen as imaginative and false, while he had taken some creative license, likewise, he observed, had ancient architects.[68] This plan seems therefore a conscious attempt to break the rules of architecture and therefore should not be considered as a mere visionary reconstruction; instead, according to Aureli, it needs to be contextualized within the recurrent theme of the "instauratio Urbis", the ruins of ancient Rome being used as symbols to convey a message of renovation (Aureli 2011, 92).[69]

In the late 18th century, a Greek revival movement started to grow out of the interest in ancient Greek architecture. In Britain, The Society of Dilettanti, which was founded in London around 1734, contributed to make known the deplorable state of ancient monuments in Greece and financed studies and publications on the subject. Notable outcomes of the Society were the surveys of Athenian architecture by the artist James Stuart and the architect Nicholas Revett between 1751 and 1754, who produced accurate drawings of monuments that are now lost. The four volumes resulting from their work were published between 1762 and 1816 under the title of *The Antiquities of Athens* and will influence the taste for architectural classicism during the late 18th and 19th centuries (Stiebing 1993, 121).

Greece had become the subject of romantic and idealised writings by many scholars and men of letters, as testified to by works such as the *Voyage Pittoresque de la Grèce* (1782) by the French ambassador to the Ottoman Empire and scholar of Greek antiquities Marie-Gabriel-Florent-Auguste de Choiseul-Gouffier (1752-1817).[70] In this collection of his impressions gathered during his travels, he included numerous reconstruction drawings of the monuments he had seen, such as a reconstructed view of the ancient town of Assos on the coast of Asia Minor (fig. 9), aiming at conveying "a faint idea" of the original cityscape. Interestingly, he legitimates his attempts at reconstructions of architecture by making a parallel between the visual reconstruction of ancient monuments and the philologist's restoration of a corrupted ancient text,[71] an analogy that will be used again in recent years to call indeed for a "new philology" of 3D digital reconstructions, a requirement to ensure the correct assessment of computer-based reconstructions by the academic community (Frischer *et al.* 2002, 7-18).

Figure 9 Restored view of Assos, in de Choiseul 1809, pl. 10

In this period, the separation between the rigorous and archaeologically accurate documentation and a more visionary and artistic way of depicting antiquities starts to become increasingly evident and will become more pronounced from the second half of the 19th century. Piranesi's style of creating composite images remained quite unique and was followed up only for the illustrations of the "voyages pittoresques", a genre that became popular at the end of the 18th century to describe journeys in thus far unknown destinations.[72] The archaeological documentation, on the other hand, became more and more specialized, in a drawing style that aimed to accurately record the evidence and to establish some standard methods to distinguish between documentation and interpretation, and this will become more evident in the course of the 19th century.

6 The 19th and 20th centuries

In the 19th century, archaeology started to gain the status of an academic discipline and was introduced into universities. The world's first professor of archaeology was Caspar Reuvens appointed at the University of Leiden (The Netherlands) in 1818. By the mid-19th century, ten chairs of archaeology existed in Germany and one in France, while in 1851 the first chair was established in Great Britain by John Disney at the University of Cambridge (Leach 2007, 35-9). France and Germany were also the first countries to establish their schools in Athens: the École française in 1846 and the Deutsches Archäologisches Institut in 1874. Italy was struggling to become a truly united country after 1861 and, despite individual bright examples such as Giuseppe Fiorelli, Italian archaeology was lacking experienced personnel able to be in charge of the developing institutions for the new born state.[73] The first professor of "archaeology and art history" in this country was the Austrian archaeologist Emanuel Löwy, who was appointed in Rome in 1891.[74]

In the first decades of this century, the stratigraphic principle established in geology was introduced into archaeology. Although stratigraphic excavation would still be far from being the standard field methodology, a considerable change is noticeable in the excavation practise in the closing decades of the 19th century. In the 1870s, the German scholar Alexander Conze started the large scale and meticulous excavations at Samothrace, which were published in a report that for the first time included photographs; the German Archaeological Institute commenced the excavations at Olympia, under the directorship of Ernst Curtius, paying great attention to small finds and stratigraphic information (Stiebing 1993, 138; Fagan 2016, 92). In Britain, Pitt Rivers' careful excavations at his Cranborne Chase estate in Dorset between 1880 and 1900 set the methodological standard for the following generations.[75] Outside the academic environment, local antiquities societies, museums and journals grew exponentially, mirroring the increased participation of the middle class in the study of antiquities (Marchand 2007, 255).

The fascination for classical literature and Greek and Roman antiquities inspired and promoted narratives of national identity (Murray 2002, 238).[76] In Greece, the revolts that had begun in 1821 against the Ottomans fuelled sentiments of Romantic Nationalism in the other European countries. These feelings and calls for action are well embodied by the poem "Hellas" composed by Percy Bysshe Shelley in 1821, in which he urges the British people to support the Greek War of Independence writing that "We are all Greeks".[77] The independence obtained led to the formation of the new state, which was rooted in the ancient Greek past, and measures were taken (such as the creation of the Greek Archaeological Society in 1837) to protect the Greek heritage that had already been looted and appropriated by other European countries.[78] As Hamilakis and Yialouri have shown, Greek classical antiquity played a crucial role in the formation of the new state and has been used throughout Greek history as symbolic capital that could be exchanged in the negotiation for power and as an authoritative source that has been used to legitimate or resist a regime (Hamilakis and Yialouri 1996, 117-29).

In Victorian Britain (1837-1901), Latin and Greek held a predominant role in the curriculum at elite schools and universities (see Goldhill 2011), with Homer being considered an inspirational and relaxing reading (Wood 1999, 178), and the study of Roman Empire being seen in the light of the politics of colonial consolidation of the British Empire. Mythological and historical scenes and atmospheric views of ancient Rome and Greek landscapes appear in the works of several painters, such as William Turner's "Ancient Rome" exhibited in 1839 (Thomas 2008, 89-90), and in the many paintings by the Dutch Sir Lawrence Alma Tadema (1836-1912).[79] In this context, illustrations of ancient monumental architecture took a different route than the drawings of finds, as the latter was increasingly employed by archaeologists to create artefacts' typologies (Lewuillon 2002, 226).

Roman and Greek architecture continued to be used as training material for young European architects. During the 19th century, numerous French architects came to Rome and visited Greece leaving many drawings of ruins and reconstructions of the monuments. The "Prix de Rome", a scholarship established in the 17th century and opened to architects in the early 18th, gave in fact the possibility for many French students to spend some years in Rome, applying their skills to study ancient sculptures and monuments (see Cassanelli *et al*. 2002). One of these architects was Augustin-Nicolas Caristie (1783-1862), who won the prize in 1813. After he came back to France he was in charge of the restoration of the Roman arch at Orange which he published in his *Notice sur l'État Actuel de l'Arc d'Orange et des Théâtres Antiques d'Orange et d'Arles* (1839) and his *Monuments Antiques à Orange: Arc de Triomphe et Théâtre* (1856) (Sturgis 1905, 455). Later on, others won the prize such as Constant Moyaux (1835-1911) in 1861, Julien Guadet in 1864 and Louise Noguet in 1865, all of them engaging in creating reconstruction watercolors of monuments in Rome, especially in the Forum. To Greece, instead, went Albert Tournaire (1862-1958), who participated in the excavations at Delphi and in 1894 created a restored drawing of the complex of the sanctuary of Apollo, by merging the extant remains that he had surveyed with the information from ancient texts (Ragon 1995, 57).

Among the British scholars who travelled in Greece and Italy in this period, one of the most famous is the London architect Charles Robert Cockerell (1788-1863), who spent over seven years in his *Grand Tour* around Greece and then Italy studying ancient architecture and participating in excavations. He then applied his taste for classical architecture to design buildings such as the offices of the Bank of England in different cities. Moreover, he expressed his interest for Greek and Roman buildings in several reconstruction drawings, such as of the city of Athens, the Parthenon, the Roman fora and the houses at Pompeii (Richardson 2001, 79). His restored views were used in other publications, such as his view of Athens (fig. 10) which is included in the second volume of H. W. Williams, *Selected Views in Greece* (1829).

In this period, archaeologically informed reconstructions and art productions depicting imaginative scenes of the past developed in increasingly different directions. Scholars in fact started to pay more attention to the choices they made in the reconstruction drawings to be inserted in their publications, thus offering more elements to the reader to assess the reliability of their illustrations, a topic which has

Figure 10 Restored view of Athens by C. R. Cockerell in Williams 1829

generated discussion among scholars dealing with reconstructions in the digital age (see e.g. Miller and Richards 1995; Ryan 1996; Forte 2000; Denard 2012). An early example of an attempt to make the reconstruction drawings "intellectually transparent" comes from the British scholar Sir William Gell (1777-1836). In his *De Pompeiana* (1819) that he wrote in collaboration with the British architect John Peter Gandy (1787-1850), several reconstruction drawings are presented, that were accompanied by explanations to facilitate the reader in understanding the choices made in the restorations. In the preface, the method that was used to create the drawings is elucidated, which consisted of using the "camera lucida", a device which helped in rendering the correct perspective in the drawings. Each plate is preceded by an introduction that discusses the drawings and the accuracy of the elements that were inserted. For example, for plate XIX (fig. 11), the authors state that "The gateway is restored in the simplest manner possible, but the biga over it is imaginary. Of the walls there can be no question. The pedestal supporting a statue on the left undoubtedly was built for that purpose; but it possibly might have been an equestrian or other group since the plan of the pedestal is not square. The statue is from one found in the city. (...) As a general observation, it may be marked that in this view everything beneath the horizontal line is certain; above it, only partly so" (Gell and Gandy 1852, 98).

In some cases, the drawing of the reconstruction was juxtaposed to the one of the extant remains, as in the case of plate XXIX representing the restored atrium of the house of Sallust, since by comparing the two "it will be seen how far the restoration is authorised" (Gell and Gandy 1852, 125). Moreover, the text updates the reconstructions when some new discovery would shed new light on the section of the city that was drawn. This is for example the case of the restored view of the temple of Jupiter, where the textual explanation specifies that "The part to the right had perhaps a second order, as two sizes of columns are found upon the spot; but this restoration was imagined before the excavation had fully laid open the part beyond the building marked 3" (Gell and Gandy 1852, 168).

Figure 11 Reconstruction of one of the city gates of Pompeii (Gell and Gandy 1852, pl. XIX)

During the 19th and 20th century, illustrations depicting reconstructions of ancient buildings and sites started to be increasingly made either by archaeologists themselves, or by draughtsmen and architect participating in excavations and being actively engaged in discussions with the archaeologists, in order to visualize the most plausible reconstruction hypotheses in their drawings. One of them was the Dutch Piet de Jong (1887-1967), who is considered "one of the best-known, most distinctive, and most influential archaeological illustrators of the 20th century" (Papadopoulos 2007, 2). By the first decades of the 20th century, he was involved in several projects: he worked with Arthur Evans and the British School to make reconstructions of the Palace at Knossos and with Carl Blegen and the American School at Athens for the reconstruction of the Palace at Pylos, and participated for several years in the American excavations in the Athenian Agora. His numerous watercolors, depicting reconstruction of objects, wall paintings and buildings, have had a great influence on shaping the image of Aegean prehistory and Classical archaeology. The level of detail and quality in the drawings made these works of art in themselves, as stated by Rachel Hood: "The archaeologists asked for a restoration of the pictures and patterns on the pottery or a reconstruction of an architectural moulding. What they got were works of art" (cited in Papadopoulos 2007, 17). All the scholars that he worked with held a high opinion about him, Blegen for example remembered him as "(...) our artist, whose constructive imagination recreated and brought to vivid perception the lingering aura of the Royal Mycenaean rulers who dwelt in this palace" (cited in Papadopoulos 2007, 13).

In the same period, in Italy, the archaeologist Giuseppe Gatteschi (1862-1935) was working on a series of reconstruction drawings of ancient Rome. The research related to this study took up thirty-four years of his life (1890-1924) and its publication in 1924 was endorsed by great archaeologists of the time, such as Rodolfo Lanciani (1847-1929).[80] Unlike de Jong, Gatteschi is not well known and sparse information on his life can be derived from his publications. Gatteschi based his reconstructions on a variety of sources (ancient authors, coins, the Severan marble plan *Forma Urbis Romae*, works of Renaissance architects), on his own personal observations of the buildings, and on the new archaeological discoveries that were made at that time.[81] He tried to recreate lively scenes of the ancient urban way of living by inserting drawings of people occupied in everyday activities in his reconstructions. Gatteschi embarked in this work aiming to preserve the memory of the ruins that he was seeing quickly disappearing after the major urban renovation that Rome was undergoing in that period. As Raphael before him, he complained that Rome had been destroyed not so much by the weather, earthquakes and Barbarian invasions, but rather by men, and especially by the 16th century Popes.[82]

Gatteschi wanted to provide the reader with enough information about the reliability of his reconstructions. For this reason, his method was to supply each reconstructed view of ancient Rome with a photograph of the current state of the corresponding place taken from the same perspective of the reconstruction. In this way, one could immediately catch the correspondence between the two and be convinced of his accurate study.[83] Moreover, likewise Lauro's *Antiquae Urbis Splendor*, each drawing is accompanied by a short textual explanation in Latin, Italian, French and German discussing the sources that were used for the reconstruction (fig. 12).

In the course of the 20th century, reconstruction drawings have been used copiously as illustrations in books and exhibitions to convey a more immediate impression of the everyday life in the ancient world. Examples of influential publications that employed such drawings in the 20th century are Wycherley's *How the Greeks Built Cities* (1949), Paul McEndrick's *The Greek Stone Speak* (1962) and Peter Connolly's and Hazel Dodge's *The Ancient City, Life in Classical Athens and Rome* (1998). A good example of an artist who was able to inject his artistic flair to archaeologically informed reconstructions, was the Englishman Alan Sorrell (1904-1974).[84] He studied art in England and won in 1928 a Prix de Rome scholarship that allowed him to get acquaintance with antiquities and archaeologists in Rome. Sorrell's unique style has fascinated and inspired generations of archaeologists. Although Sorrell was always keen on describing himself as an artist and not as an archaeologist, his drawings helped to trigger new research questions that the archaeologists that he collaborated with had not thought about before. In a preparatory sketch of the temple area at Caerwent, Wales, one could see his drawing method based on a gridded canvas that allowed him to maintain the correct proportions and perspectives and the presence of many annotations and questions about the rendering of the scene that he wanted to discuss with the excavators.[85] For example, Sorrell wonders about the most likely vegetation cover on the background of the scene and of the temple's courtyard, and makes inquiries on the correct locations of architectural elements (Catling 2013, 32-39). Other drawings bear traces of the extensive correspondence he engaged with archaeologists to clarify his uncertainties and suggest the inclusion of details in a rigorous and collaborative reconstruction process (Perry and Johnson 2014).

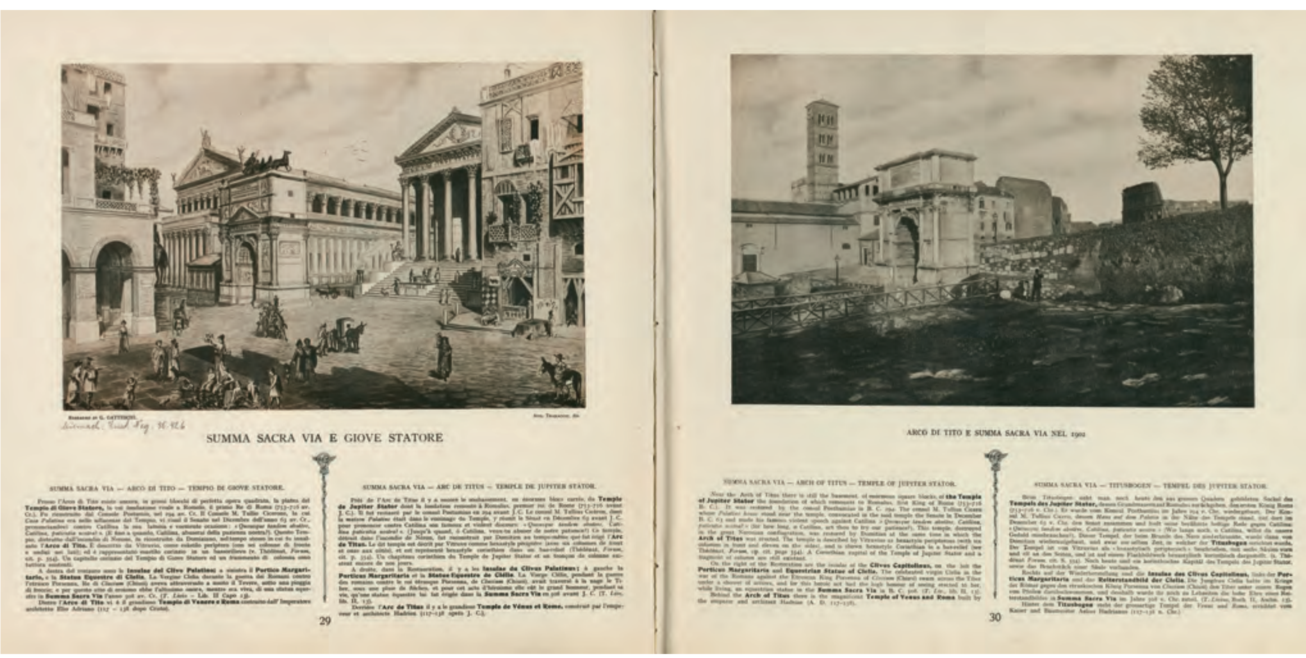

Figure 12 Gatteschi's reconstruction and photograph of the area of the Via Sacra and the Temple of Jupiter Stator (Gatteschi 1924, 29-30)

In the 19th century, physical models also started to be employed as a means to display the extant remains or the reconstruction hypotheses for an archaeological site. One of the earliest three-dimensional models of Italian antiquities is the one of Pompeii that was made in the late 19th - early 20th century. This model had a troubled history and was on display again in the early 1990s at the Archaeological Museum of Naples after restoration work that tried to save this delicate and dusty piece (Sampaolo 1993, 89-91). The streets were made of plywood, while the walls were of cork that was incised to create the different brickworks such as *opus reticolatum* and *incertum*. The frescoes are reproduced on the walls by using at first a base of plaster, and later on decorated paper that was used also for the floors. The vaults and ceilings were made in separate pieces so that it was possible to lift them to inspect the interior of the buildings (Sampaolo 1993). The model was of great importance for scholars, since, as the German archaeologist Johannes Overbeck pointed out, it recorded the ancient city, and allowed an overview of the excavations that could not be achieved with the panorama photographs that were available at that time (cited in Sampaolo 1993, 85). It is, however, even more important nowadays because, notwithstanding the ravages of time, the model keeps the record of *insulae* and decorations that are now lost, either destroyed during the wars or decayed from negligence.

Several 3D physical models have been created to represent the city of Rome in Imperial times. The first attempt to create a three-dimensional reconstruction of this city was made by the sculptor Giuseppe Marcelliani between 1904 and 1911.[86] This monochromatic model, known as the *Restitutio Urbis* (or "La Roma di Coccio", since clay is the material that is made of), aimed to show Rome in the 4th century AD. The result, however, should be considered more as an artistic product than a reliable attempt to create a volumetric reproduction of the ancient urban layout. Marcelliani's artistic background played in fact a relevant role in the realization of the project, which shows little archaeological knowledge of ancient Roman topography and landscape and is mainly based on fantasy (Giuliani 2007, 261; Ciancio-Rossetto 1990, 11-15).

In the same period, the French architect Paul Bigot created his "Le plan de Rome", a 75 m² model presenting again the city at the time of the emperor Constantine. The model was first displayed during the 1911 exhibition celebrating the fiftieth anniversary of the unification of Italy (Pasqualini 2006, 631).[87] In order to facilitate the assembling of his model, Bigot divided it into 102 modules that could be easily combined together as pieces of a puzzle. The French architect started to work on this project in 1904 and continued to modify it until his death in 1942, conducting in the meantime research on Roman architecture and city planning (Royo 1992; Royo 2006). During this period, the urban layout of Rome went through major changes and many archaeological discoveries were made that shed new light on the urban development of the ancient city. For this reason, Bigot devised a workflow that allowed him to quickly update the model when new information needed to be included. He therefore based his work pipeline on the creation of sketched mock-ups made of clay that could be revised several times before being finally plaster casted (Giuliani 2007, 261). Bigot paid also much attention to colours, that nowadays have mostly faded away, and to the contrast that the architecture in travertine and marble would create against the surrounding green vegetation (Bigot 1942, 6 cited in Royo 1992, 596). Moreover, it seems that Bigot had installed several projectors around the model emitting various colours to recreate the effect of light in Rome during different day and night times (Royo 1992, 596).

A different celebration, the bi-millenary of Augustus' birthday in 1937, was the occasion to create another plaster-model of Rome, made by the Italian architect Italo Gismondi. The model was displayed during the "Mostra Augustea della Romanità", an exhibition that Mussolini wanted in order to stress the connection both between the magnificent ancient Rome and the new one that he intended to create, and between Augustus and himself.[88] Gismondi, as previously Bigot, based his model on the fragments of the "Forma Urbis" that Rodolfo Lanciani had published in 1901 and that reported all the major buildings of ancient Rome that were known at the time of its creation at the beginning of the 3rd century AD. The model was made on a 1:250 scale and it extends over a surface of about 200 m², filling up an entire room of the *Museo della Civiltà Romana* in Rome. While the plaster-model of Rome is Gismondi's best known achievement, he actually created many reconstruction drawings of ancient buildings and other plaster-models, representing for example Hadrian's Villa at Tivoli (Ten 2007, 277-80), the complex of Claudius' and Trajan's harbours, and the ancient city of Ostia, the last two being currently on display at the Museo della Via Ostiense – Porta S. Paolo in Rome (Pellegrino 2007, 275-6).

Gismondi looked at the ancient structures with the technical eye of an architect, looking especially to materials and construction techniques, but as the archaeologist Giuseppe Lugli has pointed out "he combined a knowledge of the archaeological material which is remarkable for a technician" (Filippi 2007, 15). It is interesting to analyse the methodology that Gismondi applied to the creation of his model of Rome, to see how the Roman architect dealt with challenges that also the modern 3D model-maker is confronted with.[89] The first challenge that Gismondi had to overcome was the necessity of reconstructing the entire city, although many of its parts were not archaeologically documented. This situation called for solving two problems, the first one was to find a way to relatively quickly fill in the empty areas with buildings, and the second one was to distinguish the buildings archaeologically attested from those that were inserted only to create a plausible view of the ancient city. To tackle the first problem, Gismondi created two categories of Roman building types, the *insula* and the *domus*, dividing each of them in three subtypes, thus obtaining six basic types that he could then arrange randomly to generate variety in the urban layout (Tschudi 2012, 391). To solve the second problem, he chose to create buildings with different levels of detail, by moulding only a volumetric outline for the building for which little or nothing was known and adding more details to those that were archaeologically documented. As Tschudi noted, "these two different approaches to architectural 'unknowns' may be seen to mark a transition from a historicist model of ancient Rome to a modernist one" (Tschudi. 2012, 391).

In 1951, Gismondi's plaster model of Rome was used in Mervyn LeRoy's cinematographic adaptation of *Quo Vadis: A Narrative of the Time of Nero*, the epic historical novel by the polish writer Henryk Sienkiewicz (1895). Ironically, the model that was originally commissioned for the 1937 exhibition aiming to connect Mussolini's and Augustus' Rome was now used in the scene where Nero illustrates to his court his megalomaniac project for the new Rome he had envisioned (Wyke 1997, 140-1). The novel was rendered as a movie adaptation on five different occasions (the Italian silent movies in 1912 and 1925, the Hollywood blockbuster in 1951, the miniseries for Italian television in 1985 and the Polish version in 2001), each of them giving prominence to and interpreting in different ways the various themes of the story such as politics, ethnicity and religion.[90] For example, in the adaptation released in 1951, the aftermath of WWII, the American audience could easily grasp the reference to Hitler and the Nazi's persecution of the Jews in Nero's madness, his destructive effects on Rome and the persecutions against the Christians (Scodel and Bettenworth 2009, 93-7; see also Skwara 2013, 166).[91] The Polish version of the novel focused instead on different aspects (such as the more explicit allusions to Poland and to the pontificate of Pope John Paul II), associating Nero's rule to the communist regime and Saint Peter to the Polish Pope (Scodel and Bettenworth 2009, 97).

Quo Vadis' movies are just an example of how the image of the reconstructed ancient world that has been elaborated and transmitted in movies has always been permeated by contemporary ideas and messages. In recent years, film historians have started to look at historical movies as powerful agents that shaped and popularized a historical narrative of the past, which represented and addressed the needs of the contemporary society (Wyke 1997, 8-13). At the beginning of the 20th century, some indeed considered cinema as the new frontier to teach history and reconstruct the past in a way that could surpass in accuracy and capability of engagement any previous attempt (Wyke 1997, 9). As Wyke has shown, Roman virtues, such as military courage, the Emperors' vices and the rise of Christianity opposed by the cruel Roman Empire have been deployed as recurrent themes in an extensive filmography to support different narratives, including nationalism, imperialism or opposition to tyrannical regimes (Wyke 1997, 14-33, esp. 20). In the early years of the introduction of cinema, for example, movies provided the collective experience needed to foster feelings of national identity in the United States and in Italy, two countries struggling to create an internal cohesion. For example, the Italian cinematographic production of *Scipione l'Africano* in 1937, sustained by copious financing by the Fascist regime, was infused with colonial ideology. This movie aimed to contribute to the creation of the ideal Fascist Italy that had to be "wise, strong, disciplined and imperial", and resurrect the "immortal spirit of Rome", as envisioned by Mussolini in his speech for the celebration of the foundation of Rome on the 21 April 1922.[92]

The dominant Hollywood style of historical movies that was popular until the 1950's and is well expressed by the colossal productions such as *Ben-Hur* (1959) and *Spartacus* (1960) knew a rapid debacle in the course of the 1960's, culminated in the bankruptcy of the 20th Century Fox caused by the costs that the movie studio had to sustain for *Cleopatra* (1963), the most expensive production of the time, which did not return the expected revenues (Wyke 1997, 184). During the 1960's, the audience could not identify any more with the clichéd characters and themes that had been proposed until that time in these rather standardized productions (Wyke 1997, 184-5). In striking contrast with the visual language that characterized Hollywood historical movies, European filmography adopted other schemes and narratives. The change in taste and the different image of the past that is projected in movies in the late 1960's and early 1970's is well represented by Fellini's *Satyricon* (1969), where alien and desecrating Roman characters played in the fragmented narrative that wanted to render in this way "the potsherds, crumbs and dust of a vanished world" (Fellini 1978, 17 cited in Wyke 1997, 189).

7 Conclusion

The purpose of this paper was to contextualize the reconstructions of Greco-Roman cities within their historical framework by discussing a selection of case studies from the 15th to the 20th century. Specifically, with this study I aimed to contribute to the still rare studies on the creation and reception of visual reconstructions of antiquities, which add interpretative keys to explore the complex relationship between ancient and modern cultures. The case studies here discussed have demonstrated the richness of clues in visual reconstructions, which, taken their often questioned archaeological reliability aside, contribute to the interpretation of the historical context in which they were created. In fact, the act of visually representing a reconstruction hypothesis always entails a (more or less conscious) process of selection, interpretation and cultural appropriation. Any type of reconstruction of antiquities, be it a drawing, a plaster model or a cinematographic adaptation, lends itself to express and legitimate present ideas and needs, and contributes to shaping the contemporary traditional view of the past.

The ways in which humanists, antiquarians, architects, artists and film makers have looked at the past and the message they wanted to express with their renditions have varied considerably. For the humanist historian Biondo, the ancient restored monuments were instrumental to support the papal plans of the architectural renovation of Rome; Annius of Viterbo's forgeries contributed to emphasise the importance of his hometown; antiquarians such as Lauro wanted to convey a suggestive impression of ancient Rome that could still transmit the ancient glory of the city and be popular among visitors who came from across the Alps; Gismondi's plaster model visually and physically brought back the magnificence of Imperial Rome that Mussolini wanted to connect to; and finally, the cinematographic images of Rome mirrored contemporary political, ideological and social issues. The attention to this topic is still relevant today, as the selection of specific elements of the past for substantiating a cultural narrative or an ideological discourse can still be seen in how archaeological objects are represented and how the notion of heritage is constructed, as shown by recent research in the field of heritage studies (Watson and Waterton 2010, 84-97; Hamilakis 2016).

The attempt to preserve the vanishing traces of an ancient past that could still hold meaning for the present has always been one of the triggers for surveying and drawing material remains. Many scholars over the centuries have complained about the critical condition of ancient ruins, that have been constantly spoiled not only by time and weather, but also by pillages, commerce, negligence, and indifference. This is well exemplified by the city of Rome, first the capital of the Roman empire and then of the Catholic church, that, soon after the decline of the Roman empire, became a quarry of marble for the construction and embellishment of new buildings and a "warehouse of ancient sculpture" (Weiss 1969, 8). Reconstructions, therefore, have become also a valuable source of information on the state of knowledge of the time of their creation and also a visual memory of structures that nowadays are lost, such as the drawings of Cyriac of Ancona or the plaster model of Pompeii remind us.

When the interest for antiquities started to extend beyond the limited audience of antiquarian circles, a second reason to prepare reconstruction drawings was to present what the ancient buildings looked like to visitors and to engage them in a more popular and approachable vision of antiquities. This was the purpose of the 17th century Swiss Guard Giovanni Alto, but also, more close to us, of the many drawings that were commissioned to Piet de Jong and Alan Sorrel to be displayed in musea. Finally, architects have been accustomed to prepare reconstructions of ancient buildings as part of their training, to understand how buildings were constructed and to gain the skills that would allow them to apply ancient construction techniques in their contemporary architectural projects. This is a recurrent theme in the work of Leon Battista Alberti, in Piranesi's engravings and in the European architects that came to Rome and then created many buildings in their own countries following classical taste.

Besides exploring the different functions of reconstructions over the centuries, the examples discussed have allowed us to follow the development of a scientific methodology to deal with historical sources and archaeological remains. By starting to question the reverence for the authority of the written word, antiquarians began to adopt an empirical approach based on first hand observations and personal surveys as the principal way to gather information. The direct study of the extant remains, starting with Biondo, Cyriac of Ancona and Ligorio, also had a clear impact on the way in which antiquities were represented, as the textual descriptions that had been well suited to replicate the information found in ancient authors fell short in conveying the physicality of the ruins, thus paving the way for an increasing use of visual representations. A further methodological turning point is represented by the growing awareness of the uncertainty related to any reconstruction of antiquities, as expressed by Buonarroti, and the associated inclusion of explicit information about the reliability of the reconstructed parts, as well exemplified by Gell's and Gatteschi's works.

Finally, this overview of reconstruction drawings and plaster models contributes to putting modern computer-based visualizations into an historical perspective. Similarly to their analogue counterparts, also digital reconstructions are knowledge representations. This parallel emphasizes the importance of being explicit about the original data, the comparative material, and the line of interpretation underlying the creation process. In fact, this information enables other researchers to evaluate the scholarly value of the digital reconstruction, and can serve as a starting point for future research – even in case digital formats have become obsolete, or current modelling methods have been replaced with more advanced techniques. Recent initiatives have contributed to the development of standards for computer-based visualizations in archaeology.[93] However, a survey analysing papers presented at major conferences in 2012 has shown that only a very small percentage of published articles on this subject (1% of 686 papers) included methods to integrate metadata and to validate their results (Cerato and Pescarin 2013, 290). Moreover, while the transition to a different *medium* has changed the visual appearance of digital reconstructions into more sophisticated and realistic renderings, the new possibilities of analysis and simulation offered by 3D modelling have so far been recognized and explored only by a few researchers (e.g. Earl and Wheatley 2002; Frischer and Dakouri-Hild 2008; Hermon 2008; Hermon and Nikodem 2008; Paliou 2014; Landeschi *et al*. 2015; Piccoli 2016; Piccoli, in preparation). Only when the intellectual transparency and the analytical potential of 3D reconstructions will be more broadly addressed, they will become an integral part of archaeological research.

Notes

1 For an overview of the fascination for ruins and their use in literature see e.g. Woodward 2001. For the tension between old and new and the consideration of the past as an artefact of the present, see Lowenthal 1985.

2 Cf. Favro 1999, 366; Smiles and Moser 2005, 6.

3 See in this respect Favro 1999, 366.

4 The decoding of such symbolic values as elements specific of a certain period and cultural milieu belongs to the field of perception studies and has been treated extensively in art history, starting with the pioneering works by Erwin Panofsky (Panofsky 1939). In this regard, see also the works by Pierre Bourdieu, who identifies art perception as a mediate deciphering operation (e.g. Bourdieu 1984, especially Chapter 8 – Outline of a Sociological Theory of Art Perception).

5 Piggott was the first scholar who started to critically analyse the history of archaeological illustrations (1965; 1978). In more recent years, Moser has delved deeply into the subject of archaeological representations and their reflections of cultural conceptions and political or nationalistic agendas (Moser 1992; 1998; 2001; 2012; 2014; 2015); Perry has critically analysed the relationship between archaeologists and images (Perry 2009a; 2009b; 2013), stressing the deductive power of reconstructions for example for gaining information about the behaviour and habitat of prehistoric animals (Perry 2013, esp. 293).

6 Cited in Piggott 1978, 7.

7 The scope of this paper has been limited to Greek and Roman cities in Europe. There are obviously several other instances that show how the past has been "re-constructed" over the centuries in different ways in compliance with the current cultural and political contexts. Examples include other cities (e.g. Babylon, to which the Louvre has dedicated an exhibition in 2008, see http://www.louvre.fr/en/expositions/babylon, last accessed March 2017), archaeological structures (e.g. Stonehenge, to which the travelling exhibition "Stonehenge belongs to you and me" has been dedicated, see Bender 1998; Hodgson 2004, 140-74) and countries (e.g. Egypt, see Moser 2015).

8 A digital image of this page is available at https://www.ibiblio.org/expo/vatican.exhibit/exhibit/b-archeology/images/arch01.jpg (last accessed March 2017).

9 See for example Elia Caprioli's *Chronica de rebus Brixianorum ad Senatum Populumque Brixianum (*1505) where he refuses to explain the origins of his hometown Brescia with the tradition that connected them with the myths of Hercules.

10 A similar representation of the Colosseum is to be found in a depiction of the city of Rome that appears in an illuminated 15th century copy of the poem *Dittamondo* by the 14th century Florentine poet Fazio degli Uberti (1305?-1367) describing in its verses an imagined journey around the world (Fazio degli Uberti, Il Dittamondo, avec le commentaire d' Andrea Morena da Lodi, 1447, [Paris, BnF, MSS italien 81], fol. 18r.). See http://gallica.bnf.fr/ark:/12148/btv1b8426808j/f41.image (last accessed March 2017) for a copy digitized by the Bibliothèque National de France.

11 "Le case moderne, cioè in muratura, sono molte ma guaste; il bello di Roma sono le rovine..", cited in Günther 1997, 380.

12 From the preface of *Roma Instaurata* dedicated to Pope Eugenius IV, predecessor of Nicholas V: "Urbis Romae rerum dominae ruinarum potius quam aedificiorum quae nunc cernuntur noticiam pro viribus innovare Eugeni pontifex sanctissimi multa suadent mihi. Sed illud maxime impellit quod tanta fuit praeteritorum diu saeculorum hominibus studiorum humanitatis ignoratio: ut quum pauca singulis in urbis ipsius aedificiorum partibus, quae olim fuerint, non ab imperita solum moltitudine, sed ab his etiam qui doctrina cultiores sunt sciantur: tum multa ac pene omnia falsis et barbaris appellationibus inquinata vel potius infamata cernamus. Unde brevi futurum apparet ut Roma ingeniorum parens, virtutum alumna, celebritatis specimen, laudis et gloriae columen, ac omnium quae universus orbis ubique habet bonarum rerum seminarium in suis obscurata structuris maiorem celebritatis et famae iacturam faciat; quam in rebus pridem factam ac potentia videamus".

Excerpt from the preface of Roma Instaurata dedicated to Pope Eugenius IV, predecessor of Nicholas V (based on the translation in Warwick 2016, 94, modified by the author): "Most holy Pope Eugenius, many things persuade me to renew as much as I could the fame of the ruins - more than of the buildings that still can be recognized - of the city of Rome, the mistress of things, but this one thing compelled me the most: there has been so much ignorance of the study of the humanities in previous generations that, since few of the structures of this very city which once existed are understood in their single parts not only by the inexperienced multitude but also by those who are more learned with respect to doctrine, we then see many, nearly all things fouled, or rather defamed, by false and barbarous names. (…) The return of your pontificate onto its seat confirmed our resolution to write, a return so useful and necessary for its conservation that it is evident that, being already destroyed by calamity and decline, it would be completely lost if you had been absent another ten years. Not only do you nurture Romans with the presence of your accompanying curia, a thing which has always benefited the opulence of the city, but also in many locations you restore and remake fallen, misshapen buildings at the greatest cost. (…) As I owe everything I have to your holiness, why shouldn't I strive to renew Rome with the literary monuments of my small talent likewise you do with the labor of stone workers or carpenters. The renewed account of the works of the Roman Popes who came before you is added to this restoration of our city, which would suit the sanctity of your merit and especially increase your glory (...)."

13 Estense Ms. Lat. 992. Other copies are known, such as the earlier Bern codex (MS. B42) held at the Stadt- und Universitätsbibliothek and the Garrett MS. 158 held at Princeton University Library. While the former has no illustrations, the latter begins with 15 full page drawings with the same representations as the Estense manuscript. A digitized copy of the Garrett manuscript is available at *libweb5.princeton.edu/visual_materials/garrett/garrett_ms_158.final.pdf (last accessed March 2017).*

14 A digitized copy of the manuscript held at Princeton University Library and containing these drawings is available at http://libweb5.princeton.edu/visual_materials/garrett/garrett_ms_158.final.pdf (last accessed March 2017).

15 Codex Ashmolensis, MS. Lat. misc. d. 85, kept at the Bodleian Library.

16 On this text, see Saxl 1940/41, 19-46, who contextualized it within the role that Roman inscriptions played in the 15th century political panorama. For the contacts between Fontius and Cyriac of Ancona, see Saxl 1940/41, 29-37.

17 One of the 16th century detractors of Annius, the Archbishop of Tarragona Antonio Augustín, reports a story according to which Annius, after the discovery of some inscriptions that he had forged and buried in a vineyard in the vicinity of Viterbo, claimed that they matched with a passage in one of his books, confirming that there lay the oldest temple in the world and proving that Viterbo had been founded by Isis and Osiris (Stephens 2004, S207).

18 For the reception of Annius' *Antiquities* and its outreach among European scholars, see Stephens 2013, 277-89; Stephens 2004, S201–S223. The influence of Annius' work on Spanish historiography has been investigated in Caballero López 2002, 101-120.

19 The coinage of this sentence has been attributed to Francesco Albertini, who wrote it in his *Opusculum de Mirabilibus Novae et Veteris Urbis Romae* (Rome, 1510); after its use for the Septizodium's drawing, the sentence appears again on the frontispiece of Sebastiano Serlio's *Third Book on Architecture* (1544). See Curran 2012, 37. For a contextualization of the first generation of Dutch artists who travelled to Rome in the 1530's such as Herman Posthumus, Lambert Sustris and Maarten van Heemskerck, see Dacos 2004.

20 See chaper III 'William Camden and the *Britannia*' in Piggott 1978, 33-55.

21 For the fashion of depicting Rome with a circular or ellipsoidal plan, see Cesarano 2011, 69.

22 Cf. below Fabio Calvo's plans of Rome. For an analysis of the *De Nola* and its legacy, see Cesarano 2011.

23 A transcription of the letter is published in Golzio 1936, 78-92. For the surviving manuscripts and a translation of the letter in English, see Hart and Hicks 2006, 177-92.

24 "Ma perchè ci doleremo noi de' Gotti, de' Vandalli et d'altri perfidi inimici del nome latino, se quelli che, come padri et tutori dovevano difendere queste povere reliquie di Roma, essi medesimi hanno atteso con ogni studio lungamente a distrugerle et a spegnerle?" (Golzio 1936, 82-3).

25 "Onde essendo io stato assai studioso di queste tali antiquitati, et havendo posto non piccola cura in cercarle minutamente et in misurarle con diligentia, e leggendo di continuo di buoni auctori et conferendo l'opere con le loro scripture, penso aver conseguito qualche notitia di quell'antiqua architettura." (Golzio 1936, 82).

26 "(...) Havendomi Vostra Santità comandato che io ponessi in disegno Roma anticha, quanto cognoscier si può per quello, che oggi dì si vede, con gli edificii, che di sè dimostrano tali reliquie, che per vero argumento si possono infallibilmente ridurre nel termine proprio come stavano, facendo quelli membri, che sono in tutto ruinati nè si veggono punto, corrispondenti a quelli che restano in piedi e che si veggono." (Golzio 1936, 84).

27 For a detailed discussion on each of Calvo's drawings see Jacks 1990, 453-81.

28 For a biography of Pirro Ligorio see Coffin 2004.

29 Full title: *Libro di M. Pyrrho Ligori Napolitano, delle Antichità di Roma, nel quale si tratta de' Circi, Theatri, & Anfitheatri, con le Paradosse del medesimo auttore, quai confutano la commune opinione sopra varii luoghi della città di Roma, Venice: Michele Tramezzino, 1553.*

30 This work, as we learn from the preface that was written by the editor Michele Tramezzino, was dedicated to Ippolito d'Este and was meant to be just an extract of a much greater undertaking that Ligorio was carrying out, namely a treatise in 40 volumes on the antiquities of Rome. Tramezzino and Ligorio hoped that the Cardinal was willing to sponsor and finance the work, but this ambitious project was never accomplished, see Daly Davis 2008, 5-6.

31 *Paradosse*, 25v: "(...) ne con la diligenza, che si ricerca leggendo & essaminado le parole, e i sentimenti de gli antichi scrittori , ne' quali si conserva anchor viva in buona parte la memoria di Roma; ma andando à guisa di ciechi, & quando in una, & quando in un'altra falsa apparenza inciampando, sono caduti infiniti, & grandissimi errori.

32 *Libro di M. Pyrrho Ligori Napolitano, delle Antichità di Roma*, 18r: "Desiderando io à tutto mio potere di rinfrescare, & di conservare la memoria delle cose antiche, & insieme di sodisfare à quelli, che d'esse si dilettano, mi sono con ogni possibile cura, & diligentia sforzato, & ingegnato, tra gli altri nobili edificij di dimostare anco la pianta intiera di questo Circo; & per ciò fare sono

andato non senza grandissima fatica ricercando minutamente ogni luogo, & parte di esso; non lasciando pezzo alcuno di muro, per minimo che fusse, senza vederlo, & considerarlo sottilissimamente, accompagnandovi sempre la lettione di quelli auttori, che hanno scritto de i Circi alcuna cosa piu particolare; & valendomi bene spesso della coniettura, dove le ruine, che poche sono, mancavano; & pigliando l'essempio de gli altri Circi, che sono più intieri in quelle parti, che in questo erano affatto ruinate; & in somma il tutto di parte in parte conferendo, & communicando con huomini non meno per dottrina, che per giudicio rari, & eccellenti. Tanto che tra per li vestigij, & per l'auttorità, & per le conietture, & per gli essempij, & per le consulte, ne habbiamo alla fine ritratta la presente forma."

33 *Libro di M. Pyrrho Ligori Napolitano, delle Antichità di Roma*, 18v: "Se però alla bontà loro parerà, che io lo meriti, essendo stato il primo che mi sono messo à tanto pericolo, accertandoli che ne havrò loro obligo grande, & che non mi sarà mai discaro l'imparare da chi ne sa più di me."

34 A reprint of the 1561 original can be viewed online in the digital collections of the British School at Rome http://www.bsrdigitalcollections.it/details.aspx?ID=3&ST=BS (last accessed March 2017).

35 Titled "Antiquae Urbis Romae Imago accuratissime ex vetustis monumentis formata".

36 Panvinio and Ligorio shared in fact a publisher (which made the engravings that Ligorio had used for his work accessible also to Panvinio) and also the collaboration with Dupérac (Stenhouse 2012, 246-7).

37 "Haec ut facilius intelligantur , & morem meum sequar in satisfaciendo avidis antiquitatum studiosis Romanarum rerum, duabus tabellis huius Circi topographiam, delineationem, & post ruinam quomodo nunc cernitur adiunxi." *De Ludis Circensibus Libri II*, 55-6.

38 For a contextualization of the Du Cerceau family see Blomfield 1911, 140-156.

39 "(...) qui pourra servir à ceux qui sont curieux de l'antiquité, & encore plus (à mon jugement) à ceux qui sont maistres en l'Architecture, lesquels y pourront trouver plusieurs beaux traits & enrichissements pour aider leurs inventions." *Livre des Edifices Antiques Romains* (1584), letter of dedication.

40 Lipsius, *Poliorceticωn*, I, cap. 6 (p. 37) translated by J. Papy (Papy 2004, 116).

41 "Insere figuram in qua tu, Lector, scito quaedam à pictore esse ad rem subiiciendam oculis, non à veritate. ut ostiolum ante Editorem, gradus in arenam: quia revera per alios interiores aditus delati gladij & arma in Orchestram.", J. Lipsius 1585. *Saturnalium Sermonum Libri Duo* II, cap. XIX (p. 150).

42 The first work that positioned antiquarians in their historical and cultural context is the essay 'Ancient History and the Antiquarian' by A. Momigliano, which was presented as a paper at the Warburg Institute in 1949 and reprinted twice (in 1955 and 1966) after its first publication in the *Journal of the Warburg and Courtauld Institutes* in 1950. This essay has been influential in setting the framework for the understanding of the relationship between antiquarians and ancient history, and of the development of a historical method. A recent re-contextualization of Momigliano's work is given in Miller 2007. Another important contribution to the field has been given by Piggott 1976, which focusses on the history of antiquarian studies in England and Scotland from the 16th to the 17th centuries. Recent re-assessments of the antiquarian contributions are given by Sweet 2004, Murray 2007, 14-21, and Murray 2014, 189-201.

43 Murray focuses in particular on the construction of British prehistory during the 16th and 17th centuries, discussing what he defines the 'interactionist methodology' that antiquarians adopted to reconcile new sources of information, such as ruins, coins and inscriptions with 'authorities' such as the Bible and the *historiae* of Classical authors such as Tacitus (Murray 2014, 189-201; Murray 2007, 14-9).

44 Excerpt from section n. 7 ("The Antiquary") of John Earle' *Microsmographie* (1628).

45 This tension between those who sustained the supremacy of the ancients and those who instead considered the inventions of modern times as the proof of the cultural superiority of their age is a recurrent theme in the Renaissance thought, starting with Petrarca (Boruchoff 2012, 133-164; Fumaroli 2001, 7-220). In 17th century France, this debate peaked with the so called "Querelle des Anciens et des Modernes", a dispute initiated within the Académie française among scholars sustaining opposing views of artistic inspiration and models. The "casus belli" was the reading of the poem Le Siècle de Louis le Grand that Charles Perrault had composed in 1698 for the King, in which the French author compared the "siècle de Louis" with that of the Emperor Augustus, stating that the ancients are "men like us" ("La belle Antiquité fut toujours vénérable,/ Mais je ne crus jamais qu'elle fut adorable./ Je vois les Anciens, sans plier les genoux./ Ils sont grands, il est vrai, mais hommes comme nous;/ Et l'on peut comparer, sans craindre d'être injuste,/ Le siècle de Louis au beau siècle d'Auguste (…)" cited in Mortier 1982, 51). This view represents the feelings of the "Modernes", who praised the accomplishments of their contemporary artists under Louis XIV, as opposed to the "Classiques", who instead considered Greek and Roman achievements as unparalleled and therefore promoted imitation as the only way to replicate the artistic perfection of the Classical works. This opposition was however not only limited to literature, but was the expression of different political orientations as discussed in Fumaroli 2001, 167-8.

46 For an analysis of this work, its context and its dedications, see Del Pesco 1984.

47 "Vides hic praeterea Ioannem Grossum Heluetium pro more suo nobilibus Germanis antiquitates ostendentem Romanas, cuius ipsi ut etiam nobiles Galli, sunt inspectores curiosissimi et merito quidem, nam præter quam quod decet honestos uiros huiusmodi honesta occupatio ad ponendum tempus utiliter et cum voluptate interim dum alij illud impendunt pecuniasque profundunt in res cum honestate pugnantes et in plurima mala quae secum solet afferre otium malorum omnium origo, proficiunt etiam hac cognitione ad cognoscendam rerum omnium uicissitudinem quomodo plurima nunc iaceant quae olim floruerunt, adde quod multum facit haec cognitio antiquitatis ad intelligendos et interpretandos profanos auctores."

48 In the explanation related to the reconstruction drawing of Portus, the ancient harbour of Ostia, Lauro in fact stated that the

depiction was taken from the description of Ligorio, from antiquities, medals and from ancient and modern authors: "(...) come in questa descrizione si vede, cavata da quella di Pirro Ligorio, delle antichità, e medaglie, e da gl'Autori antichi, e moderni."

49 Transcription of the dedication to the reader opening the 1641 edition: "Gio. Ridolfo Alto / Svizzero a chi leggerà / La città di Roma, si come, per la vastità dell'Imperio non ebbe mai altro popolo, o Natione, che l'agguagliasse, così ha lanciato nelle sue Rovine sì alti vestigi dell'antica maestà, e grandezza, che è forza, da' soli avanzi, che se ne veggono, (tutto che le reliquie miserabili del tempo, e dell'hostilità de' Barbari) ammirarla per Capo del Mondo, e trionfatrice dell Universo, E perchè essendo questi monumenti, non solamente venerati; ma con estraordinaria curiosità, e diligenza da tutte le genti continuamente ricercati; poichè (spinte dal rimbombo della Fama) sin da gli ultimi confini della Terra, qua si trasferiscono a posta per vederli, e contemplarli dappresso: nè essendo poi lor possibile descriverne, ritornati alle lor case, così esattamente le maraviglie, che, & essi, e gli ascoltanti ne restino pienamente sodisfatti.; ho voluto servire in quella parte al godimento universale, rappresentandole nuovamente in queste carte delineate al naturale dalla dotta mano di Giacomo Lauro; e da penne sublimi vivamente descritte in varie lingue; Opera veramente di grandissima spesa, e fatica; già che per darle la perfettione, che si poteva maggiore, oltre all'essersi esattissimamente ricercate le piante delle Antichità nelle macerie stesse; & investigate le forme vere delle fabbriche, nelle Medaglie, Bassi rilievi, Marmi, Metalli, & altre cose tali de' secoli passati, si sono anche rivoltati con sommo studio gli Autori più celebri, e rinomati, come Pollione Vitruvio, M. Varrone, Tito Livio, Svetonio, Tacito, l'uno, e l'altro Plinio, Plutarco, Dione, Appiano Alessandrino, Diodoro Siciliano, Herodiano, Dionisio Alicarnaseo, Ammiano Marcellino, Sesto Rufo, Giulio Capitolino, Elio, Lampridio, Flavio Vopisco, Elio Spartiano, Flavio Eutropio, Flavio Gioseffo: & oltre a questi Giovanni Zonara, Gio. Boemo, Fenestella, Pomponio Leto, Andrea Alciato, il Biondo, l'Albertino, il Boccaccio, Guido Pancirolo, Alessandro de Alessandri, Gugiielmo di Choul, il Marliano, & il Fauno, e L. Mauro, Andrea Fulvio, Carlo Sigonio, Honofrio Panvinio, il Lipsio, e tutti gli altri finalmente, da' quali si poteva aver notitia, sì degli edificij notabili publici, e privati, come delle Attioni Sacre, Civili, e Militari de' Romani, più degne di memoria; che sono state per colmo aggiunte, parimenti delineate al vivo in questo Libro. Ricevi (amico Lettore) queste fatiche, qualunque sieno: e pascendo in esse la tua virtuosa curiosità, gradisci l'animo di coloro, e mio, che per servire in uno stesso tempo all'utilità, e dilettatione commune, ci siamo volentieri adoperati in metterle insieme e pubblicarle; riputandoci non indegni della tua affettione, se non per altro, per havere impiegato le nostre industrie nel rappresentarti, quasi in maestosissimo Teatro, quelle cose, che sono state sempre l'oggetto della maraviglia, lo stupor de' secoli, e 'l miracolo del mondo: E vivi contento."

50 For Meursius' scholarship and his contacts with several scholars who sent him materials, see Sánchez Hernández 2010, 9-11.

51 Gallo defines this treatise as the "manifesto of a new antiquarianism" that was influenced by the establishment in 1657 of the Accademia del Cimento, a Florentine scientific society that followed Galileo and his experimental method, and by the Newtonian approach (Gallo 1999, 828). In Buonarroti's reasoning one can also recognize the influence of "Cartesian doubt", Descartes' method of investigating the truth by starting with the assumption that the only certainty is uncertainty.

52 "(...) Indigesta collezione di dubbi, che d'osservazioni certe, ben digerite, & esaminate."

53 "(...) Benchè io sappia, che per contentare il gusto presente, ci volevano altre cose che queste, messe giù senz'ordine e alla rinfusa, e con tal' incertezza e dubbio della mia opinione e sentimento, che meriteranno forse d'esser'avute piuttosto per un'indigesta raccolta di dubbi, che d'osservazioni certe, ben digerite, & esaminate. Egli è ben vero però, che in quanto a questa seconda parte, io ci sono caduto volontariamente, sperandone anche l'approvazione di tutti coloro, i quali faranno riflessione, che lo studio dell'antichità e dell'erudizioni è differente da molti altri, ne' quali non pare che in rigor di metodo si ricerchi, che l'adattare le conclusioni a quel solo principio, da cui dependono; dovecchè in questo non si può sperare di seguitare un metodo così semplice; posciachè vi sono, per così dire, infiniti principii, e le conietture dipendono da favole, istorie, riti, & altre cose divise e disparate fra di loro: e conseguentemente dovrà giudicarli per effetto d'una certa cognizione delle forze dell'arte, il confessar sinceramente di non sapere (per pigliare un esempio da una sola parte, che potrebbe sembrare la più facile) tuttociò che ha potuto venir'in capo a tanti pittori e scultori antichi, i quali ci hanno lasciato i monumenti dell'opere loro, circa l'aggiungere, & ancora mutar'affatto i simboli, & i suggetti delle favole e delle Deità", Buonarroti 1698, ii-iii.

54 "E se veruna scienza ha bisogno d'un sì fatto preparamento d'intelletto e cautela, lo studio dell'erudizione e dell'antichità è quello che ne ha una necessità particolare, non solo per le cagioni addotte, ma ancora per il gran numero degli scrittori, e per la varietà delle opinioni che ci sono; onde è molto difficile in una strada tanto frequentata da ogni sorta di ingegni seguitare le vestigie, che conducono alla verità, e non piuttosto, a guisa delle pecorelle che escon dal chiuso, E ciò che fa la prima e l'altre fanno, quelle che vanno a finire in falsità e menzogne (…).", Buonarroti 1698, v.

55 Bianchini is remembered as an important name in the dawn of archaeology as a scientific discipline for his scrupulous method that he applied during the excavation and in the process of publication of the results (Gallo 1999, 833).

56 See e.g. the published excavations diaries by Francesco and Pietro La Vega in Pagano 1997.

57 The *Grand Tour* started to include also sites in South of Italy, such as Paestum, which was properly "rediscovered" only during this century (Villani 2011, 85-98).

58 From the first minute-book of the Society of Antiquaries of London in 1717, of which William Stukeley was first Secretary, cited in Piggott 1978, 7.

59 For the third, less successful, *Thesaurus* on Italian antiquities published by the Leiden publisher Pieter van der Aa between 1704 and 1725 see Piccoli 2013, 61-82.

60 In this regard, it must be noted that the lack of a firm criterion of selection for the works to be inserted in these *Thesauri* depended in some cases purely on the publishers' wish to create huge collections to attract more buyers. This situation is documented for the compilation of the *Thesaurus Antiquitatum et Historiarum Italiae* (Leiden, 1704-1723), which caused disagreements between the publisher Pieter van der Aa and the editor Pieter Burmann (see Piccoli 2013, 6).

61 For Roman antiquarians, see Gallo 1999, 840.

62 As he stated: "A statue by an ancient Roman hand will always stand in the same relationship to a Greek original in the way that Virgil's Dido with her retinue, compared with Diana among the Oreiades, relates to Homer's Nausicaa, which the former attempted to imitate" (cited in Carter 2013, 32).

63 For a discussion of his contributions see Fumaroli 2007, 154-83; Cronk and Peeters 2004.

64 For an analysis on Caylus' relationship with Diderot see Massau 2004, 45-57.

65 Miller actually sustains that in fact de Caylus was a "much better historian" than Winckelmann (Miller 2007, 35).

66 "E la semplice esteriore osservazione degli avanzi delle antiche magnificenze di Roma è bastata a riformare negli ultimi tempi l'idea del buon gusto dell'Architettura, depravato per l'innanzi dalle rozze e infelici maniere de' Barbari (…)." Preface of the *Antichità Romane* (Rome, 1756).

67 "(...) E vedendo io, che gli avanzi delle antiche fabbriche di Roma, sparsi in gran parte per gli orti ed altri luoghi coltivati, vengono a diminuirsi di giorno in giorno o per l'ingiuria de' tempi, o per l'avarizia de' possessori, che con barbara licenza gli vanno clandestinamente atterrando, per venderne i frantumi all'uso degli edifizi moderni; mi sono avvisato di conservarli col mezzo delle stampe (...)."

68 G. B. Piranesi, preface of the *Ichnographia*, Rome, 1762: "I am rather afraid that some parts of the Campus which I describe should seem figments of the imagination and not based on any evidence: certainly if anyone compares them with the architectural theory of the ancients, he will see that they differ greatly from it and are actually closer to the usage of our own times. But before anyone accuses me of falsehood, he should, I beg, examine the ancient [Marble] plan of the city (…), he should examine the villas of Latium and that of Hadrian at Tivoli, the baths, the tombs and other ruins outside the Porta Capena and he will find that the ancients transgressed the strict rules of architecture just as much as the moderns. Perhaps it is inevitable and a general rule that the arts on reaching a peak should decline, or perhaps it is part of human nature to demand some license in creative expression as in other things which we sometimes criticise in buildings of our times."

69 On "Il Campo Marzio", see also Dixon 2005, 115-132.

70 For de Choiseul's biography see Barbier 2010.

71 "J'ai osé (...) relever ces belles ruines, recomposer ces édifices, et essayer d'en donner une faible idée. Qu'on daigne juger avec indulgence ce travail, ou, si l'on veut, ce jeu d'une imagination qui, rétrogradant de quelques siècles, se plaît à voir ce qui n'est plus, et admet la fiction à se présenter à la place de la réalité que l'on regrette. C'est la première fois que je me suis permis de montrer ainsi de simples souvenirs, de restaurer des édifices, ainsi qu'on se hasarde à restaurer des statues, ou à rétablir le texte des manuscrits. Ce n'est que tenter pour l'architecture, ce que d'autres ont fait pour Quinte-Curce, et pour Salluste: et pourquoi m'interdirait-on de redresser les colonnes d'un temple abattu, lorsqu'on pardonne aux efforts du savant qui n'a pas tremblé de se mesurer avec Tacite?" (de Choiseul 1809, 87).

72 See for example the illustrations by Jean-Laurent-Pierre Hoüel in his *Voyage Pittoresque des Isles de Sicile, de Malte et de Lipari, ou l'on Traite des Antiquites qui s'y Trouvent Encore; des Principaux Phenomenes que la Nature y Offre; du Costume des Habitans, & de Quelques Usages* (2 vols., 1782 and 1784) that Nixon considers "the most bold of Piranesi's imitators" (Nixon 2002, 476). Hoüel shares the same attitude towards illustrations as Piranesi and he synthesizes it by stating in the preface of his work: "J'affirme mes dessins par mes écrits, et je confirme mes écrits par mes dessins" (cited in Nixon 2002, 478).

73 For the Italian situation after unification and the methodological debate between a philological/academic and a more practical approach to archaeology, see Barbanera 2000.

74 Chairs of archaeology had existed in Italian university before the unification, such as the one in Naples where Giuseppe Fiorelli was professor from 1861 (Barbanera 2000, 47).

75 Regarding Pitt Rivers and his legacy, Mortimer Wheeler stated: "Between 1880 and 1900 General Pitt Rivers in Cranborne Chase had brought archaeological digging and recording to a remarkable degree of perfection, and had presented his methods and results meticulously in several imposing volumes. Then what? Nothing. Nobody paid the slightest attention to the old man. One of his assistants had even proceed to dig up a lake-village much as Schliemann had dug up Troy or St. John Hope Silchester: like potatoes" (Wheeler 1958, 55 cited by Lucas 2001, 36). The reality of the facts seems more nuanced than what appears from Wheeler's strong statement as recently pointed out by G. Lucas, as Rivers' methodology was received and applied in other contexts (see Lucas 2001, 36ff).

76 Italy for its historical developments represents a different case as elucidated by Barbanera 2000, 42-4.

77 For a contextualization of this work, see Findlay 1993, 281-6.

78 However, it must be noted that Greek intellectual circles in Greece started to react against the pillages of Greek antiquities already before independence, founding for example the Society of the Friends of the Muses in Athens in 1813, but stronger reactions took place only after 1821, see Díaz-Andreu 2007, 46 and 82-6.

79 For a discussion on the classicizing painters of this period, see Wood 1999, esp. chapter 14 and 15 (176-221).

80 See also Capodiferro (ed.) 2006.

81 This information is found in the preface of Gatteschi's publication (1924) written by Orazio Marucchi.

82 See the introduction in Gatteschi 1924.

83 "Il Gatteschi, nel presentare agli studiosi i Restauri di questi gloriosi monumenti ha adottato il metodo assai razionale di mettere a confronto con i suoi disegni di restauro le fotografie dello stato attuale, cioè dello stato in cui presentemente si trovano gli avanzi di quei monumenti stessi fra i moderni edifizi; onde se ne veda a colpo d'occhio la corrispondenza. E chiunque potrà persuadersi che i suoi restauri non sono il prodotto di una fervida immaginazione come alcuni ideati da altri, ma che hanno la loro base nello studio accurato di tutto ciò che può sapersi intorno alla vera forma di ogni singolo monumento." Preface of Gatteschi 1924.

84 An exhibition of Sorrel's works was held at Sir John Soane's Museum in London from 25 Oct. 2013 to 25 Jan. 2014. For a biography and discussion of his works, Llewellyn and Sorrell 2013.

85 The drawing is reproduced in Catling 2013, 37.

86 An earlier three-dimensional representation of some key monuments of Rome (among others, the triumphal arches of Titus, Septimius Severus and Constantine which are now lost) is the fountain called "la Rometta" made by Pirro Ligorio in the gardens of the Villa d'Este. This scenographic monument had a symbolic meaning and embodied in three dimensions Ligorio's interest for Roman antiquities (see Madonna 1991).

87 The model has been restored and kept at the University of Caen; recently it underwent a process of digitization and a virtual visit has been created, see Fleury and Madeleine 2010, 67-75.

88 The "Istituto Luce" recorded a propaganda video that presented the exhibition, which is available online at http://www.youtube.com/watch?v=cneYAemeNqU (last accessed March 2017).

89 For a detailed explanation on how Gismondi organized his work through preparatory sketches and drawings, see Giuliani 2007, 261-5.

90 The five adaptations have been analysed in Scodel and Bettenworth 2009.

91 As Skwara notes, the 1951 version of the movie was received very differently by the Polish audience, which could see it only in the 1980's and could relate less to the allusions suggested in the movie (Skwara 2013, 167-8).

92 Transcript of Mussolini's speech published in his newspaper *Il popolo d'Italia*, cited in Wyke 1997, 21.

93 See e.g. the London Charter (http://www.londoncharter.org/) and the Seville Principles (http://smartheritage.com/seville-principles/seville-principles, last accessed March 2017).

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Chiara Piccoli
Faculty of Archaeology
Leiden University
PO Box 9514
2300 RA Leiden
The Netherlands
c.b.m.piccoli@arch.leidenuniv.nl

Socio-economic status and plant remains: Maastricht (the Netherlands) 1875-1930

Corrie Bakels and Robine Groen-Houchin

Excavation of an old quarter of the Dutch town Maastricht offered the opportunity to analyze social differences in the botanical contents of cesspits. The study concerns households of high, middle, and lower class during the period 1875-1930. Only the quality of the flour and the presence of dried flowers seem indicative of status. The absence of other markers of social differentiation can possibly be attributed to the disappearance of diversity in food habits due to the influence of food educationalists at the end of the 19th century.

1 Introduction

Differences in the socio-economic status of people can manifest themselves, among other things, in their food choice (Jobse-van Putten 1996; Hupkes *et al*. 2000) As the saying goes: "tell me what you eat, and I will tell you what you are". The study of this aspect of life in the past can be undertaken using four sources: oral history, written documents, illustrations, and archaeological remains. The current study deals with archaeological remains, specifically plant remains.

Plants supply an important part of human food. Their remains are most commonly preserved in a charred, waterlogged or mineralized state. This is not the first study to investigate a possible link between socio-economic status and plant remains. In the following a few are mentioned.

De Hingh and Bakels (1996) studied an early medieval aristocratic manor and its peasant village in Northern France. No differences could be detected, and the explanation offered was that the spatial and economic separation between lord and peasant regarding food consumption was not yet wide enough.

Paap (1984) tried to find social differences in material from Amsterdam (the Netherlands), ranging from the 13th to the 18th century, however he had too few samples to make solid conclusions.

Van Haaster (2003) succeeded. He linked botanical material and the height of taxes (known from written sources) in the case of households dating to the 14th to 17th century in the town 's-Hertogenbosch (the Netherlands), and observed noteworthy differences.

A study of post-medieval material excavated in Vlissingen-Scheldekwartier (the Netherlands), however, failed to reveal socio-economic differences, although these were expected on the basis of other archaeological remains (Claeys *et al*. 2010).

Also, a thorough study of late medieval and early historical finds from Lübeck (Germany) showed that remains can even lead to false conclusions. Historical research revealed that what looked rich was, on the contrary, not high status at all. The remains found were parts of old clothes and left-overs from the table of the rich, which had been donated to the poor and ended up in a poor-man's asylum (Stephan 1978; Van Haaster 1989).

The study presented here was conducted in 2006-2007 and concerns a later period than the periods considered in the publications mentioned above, namely 1875-1930. The material was collected during a large-scale excavation in Maastricht, a town in the utmost south of the Netherlands (fig.1). The locality is called Marktmaas. An area between the river Meuse (Maas in Dutch) and the market place had to make way for a new development started in 2003. The excavation was ordered by the Municipality of Maastricht and executed by the archaeological firm Becker & Van de Graaf under supervision of E. Hoven. E.P.G. Wetzels had the final supervision on the part of the town.

The range of periods uncovered comprised the Roman period up till and including the Modern Period. The youngest traces date from just before 1930. In that year an old quarter of the town was pulled down to make way for the drive towards a new bridge over the river Meuse, the Wilhelminabrug. It is this part that had to undergo a new redevelopment, thereby triggering the excavation.

During the excavation samples for archaeobotanical research were collected from all levels. They were subsequently analysed in the archaeobotanical laboratory of the Faculty of Archaeology, Leiden University, the Netherlands and duly reported on (Bakels 2007). However, the youngest samples were subjected to a more intensive research than the kind required by the La Valletta regulations. The reason was the existence of a report on the social status of the people that inhabited the quarter before it

Figure 1 The location of Maastricht (a); the present centre of the town (b) with indication of the area depicted in c, 1 = Wilhelminabrug, 2= Markt; location of the blocks depicted in fig. 2 with the Drieëmmerstraat (R. des 3 seaux) and Kwadevliegenstraat (R. de la vache volante, a mistake in the French translation), map published by Leiter Nypels, Maastricht, in 1850 (c)

was demolished in 1930. This very valuable report by C. Meys and S. Wolfs (2003) deals with the inhabitants, development and use of the individual houses during the period 1875-1930.

The households knew different levels of socio-economic status. An extra 'bonus' was that the quarter still had cesspits. Although Maastricht is one of the first towns in the Netherlands to start with sewage systems, in 1851(comm. Nederlands Water Museum 2014) the old quarter was not yet connected. This fact allowed the study of the correlation between plant remains and social status as it has been presented in the abovementioned report. It was the subject of the MSc thesis of the second author (Houchin 2007).

2 Material and Methods

Before its demolition in 1930 the old quarter consisted of the blocks Markt, Kwadevliegenstraat- Drieëmmerstraat and Langs de Maas (fig. 2). According to Meys and Wolfs they could be classified into three categories: large-scale enterprises, middle class enterprises and dwelling-houses. The large-scale enterprises were situated in Langs de Maas. The buildings were used mainly for working, but the owners lived there as well. The middle class enterprises were to be found in the block Markt including the building Kwadevliegenstraat 22 which was attached to Markt 45. The buildings were in use as butcher's shop, bakery, pub and cinema. For a short time a firm making nails was established there as well. The shops were on the ground-floor. The owner lived at the floor above, but rooms were also let to higher personnel such as book-keepers.

The state of prosperity of the blocks Langs de Maas and Markt is reported to be good. This is not the case for the block in between, the block Kwadevliegenstraat-Drieëmmerstraat. These houses were pure dwelling-houses, inhabited by a large number of people. They were small, even by the standards of the time, and poorly thought of. Some were even considered uninhabitable, but the scarcity of houses was such that they were still lived in. Their inhabitants were factory-workers, day-labourers and artisans not working at home.

In the following the block Langs de Maas (LdM) is designated as block 1, the block Kwadevliegenstraat-Drieëmmerstraat (KV and DE) as block 2, and Markt as block 3 (fig 2).

The excavation revealed a large number of features that were designated as cesspit, possible cesspit, cess cellar etc. By scrupulous and time-consuming analysis of the original excavation plans 64 cesspits with a reliable set of information could be selected. As the terrain was inhabited for a long period and the dwellings rebuilt several times, not all of these cesspits belonged to the period under study. From those that had the right date some had to be left out because it was not sufficiently clear to which block they had belonged. Moreover it became apparent that only one Langs de Maas establishment(LdM 34) and one block 3 house (KV 22) still had functioning cesspits in the period required.

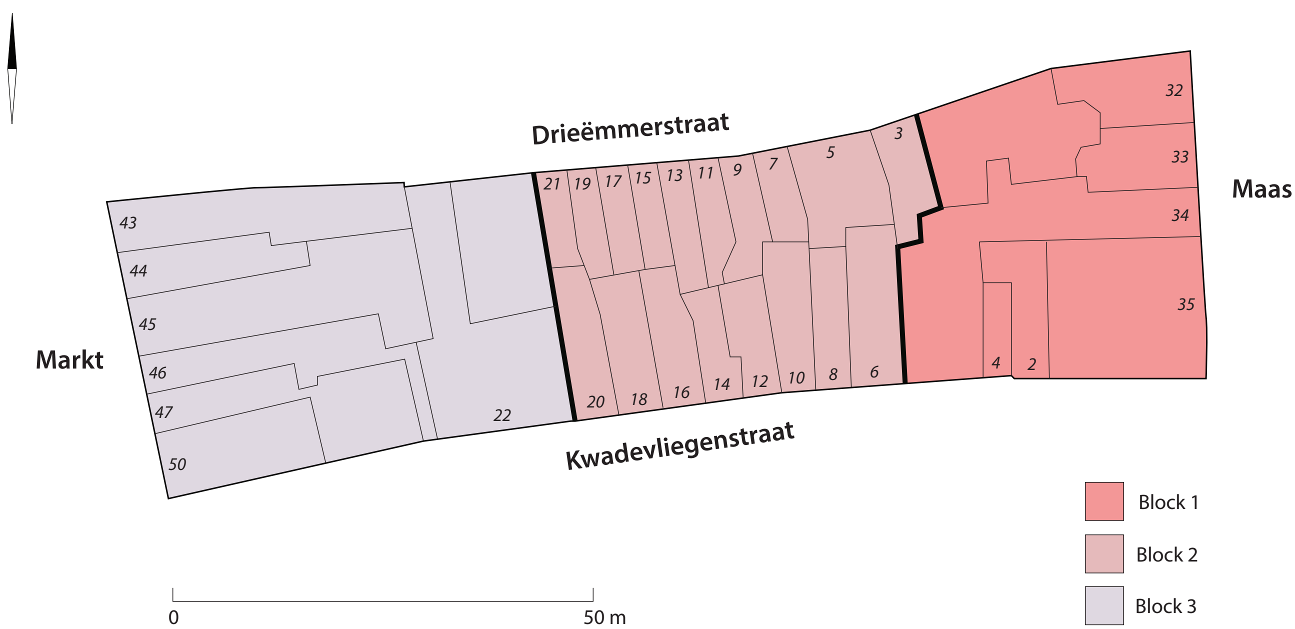

Figure 2 The three blocks. Drawing after Meys and Wolfs 2003

In the end there were ten cesspits left that met the requirements for analysis.

The dating is based on the identification of the pottery found in the fill by E. Hoven.

In the next stage of the work one litre of fill was sieved under gently running tapwater over a stack of sieves with meshes of 2.0, 1.0, 0.5 and 0.25 mm. The residues were sorted under a microscope and the plants remains identified and counted. Most remains were preserved by waterlogging, but charred and mineralised remains were found as well.

The fill of four cesspits was also subjected to pollen analysis. Because of the time-consuming work not all ten cesspits could be analysed during the time allotted to the writing of a MSc thesis. The samples were treated in the usual way with KOH, HCl, specific gravity separation 2.0 and acetolysis. The purpose of the pollen analysis was to look for food plants that are better detected by their pollen than by their macro remains. Therefore, no standard pollen count was executed, but only plant taxa noted.

The resulting data were subjected to four kinds of analysis, three qualitative and one quantitative.

The first approach was to sort the species/taxa into a category as ‘possible marker of status’. This was done without looking at the source of the samples. Criteria were:

– imported product, i.e. plant that could not have been produced in the surroundings of Maastricht. High status.
– plant difficult to cultivate because requiring much care. High status.
– plant relatively new to the Netherlands as food plant. Possibly high status.
– plant rarely found though this cannot be ascribed to problems with taphonomy. Possibly high status.
– ornamental plant. High status.
– plant that is known to have been ‘poor man’s food’. Low status.
– plant that is used in a handicraft. Although it is difficult to link this criterium with high or low, it may shed light on the kind of inhabitants.

The search was supplemented with an analysis of the arable weeds present in the cesspits. Such weeds may point to the import of cereals or other food plants from distant regions (Manders 1993). Crops grown in the neighbourhood of Maastricht are infested by another kind of weed vegetation than crops produced in, for instant, Central France or Poland.

The second approach was a simple qualitative analysis of the number of species in the cesspits to arrive at an impression of the variety in the waste.

The third approach went further and used Correspondence Analysis, Detrended Correspondence Analysis and Principal Component Analysis. Two kinds of data were entered: a set with all species and a second with only species that might be indicators of high status.

The fourth approach was a quantitative analysis of the plant remains in relation to a provenance from blocks 1, 2 or 3.

3 Results

Ninety-five species were retrieved as macro remains of which 38 belong to cultivated plants (see for a list the Appendix). Thirty two plants are arable field weeds. Most of the remainder has a provenance from grasslands and forest edges.

The pollen add more species of which chervil (*Anthriscus cerefolium*), cloves (*Eugenia*), mistletoe (*Viscum*), lilac (*Syringa*) and maize (*Zea mays*) may be of importance to the study presented here.

3.1 The occurrence of plants possibly indicative of status

Table 1 presents the results of the first kind of approach. Species entered as possibly indicative of high status are the imported products rice (*Oryza sativa*), chilli pepper (*Capsicum annuum*), fig (*Ficus carica*), date (*Phoenix dactylifera*), grape (*Vitis vinifera*) and clove (*Eugenia*). Although fig trees are able to grow in sheltered places, they rarely provide edible fruit and their presence in or around Maastricht at the time is unlikely except perhaps for one or two trees in gardens. Grapes can be produced in the neighbourhood, but they were not likely to be cultivated locally at the time. The vineyards in the region had long been abandoned (Van de Venne 1948). If there were any vines still growing in gardens the fresh grapes they produced were luxury fruit anyhow. As clove was detected by its pollen and not all cesspits were investigated in this way its contribution to the investigation may be biased.

Products that require special attention can also be indicative of high status food. Melon is such a plant that needs special care. It is very difficult to grow in the open and the fruits are generally produced under glass. Rosemary (*Rosmarinus officinale*) is scarcely represented in Dutch cesspits (RADAR 2010). The herb is mentioned in historical recipes and the plant was cultivated in the Netherlands in a commercial way since the16th century, but had to be taken inside during winter (Sangers 1952). New to the Netherlands as a regular food plant is tomato (*Solanum lycopersicum*) (fig. 3). Although the plant was already known in the 16th century (Dodoens 1554) it started as an ornamental plant. In the 17th century the fruit was sometimes pickled, but its true appreciation as a vegetable came only at the end of the 19th century. At the turn of the century tomatoes were commercially grown under glass, at first mainly for export to England. Dutch people were reluctant to adopt the fruit as it

Markt-Maas										
House	LdM34	LdM34	DE9	KV14	DE15	KV10	KV8	KV14	KV22	KV22
Block	1	1	2	2	2	2	2	2	3	3
Presumably high status										
Rice	-	-	-	5	-	-	-	-	-	-
Tomato	-	-	-	-	-	-	15	-	-	-
Date	-	-	-	-	-	-	1	-	-	-
Fig	3	39	13	10	1	1500	250	-	-	865
Melon	-	-	-	-	-	-	3	-	-	-
Grape	1	17	7	8	-	15	17	-	-	123
Chilli pepper	-	-	-	-	-	-	2	-	-	-
Clove	-	+	-	-	-	+	-	-	-	-
Rosemary	-	-	2	4	-	-	1	-	-	-
Asphodel	-	-	-	-	-	1	-	-	-	-
Chinese lantern	-	-	-	1	-	4	-	-	-	-
Lilac	-	-	-	-	-	+	-	-	-	-
Presumably low status										
Buckwheat	-	-	652	251	-	-	1	2	-	3
Rye	1	1		1	5	-	2	3	-	-
Technical use										
Weld	2	-	-	-	1	-	-	-	-	-
Teasel	-	-	1	-	-	-	-	-	-	-
Hemp	-	-	-	1	-	1	2	-	-	-
Hop	-	-	-	2	-	-	-	-	-	1

Table 1 Possible indicator species of status and their occurrence in the cesspits

was considered to be poisonous. Only by hours of simmering the poison was thought to become neutralized. Tomato soup was therefore one of the first dishes to appear on the table (Houchin 2010). Its adoption as part of daily meals was to a large extent the result of the food education policy en vogue at the turn of the century. The first recipe for the general public appeared in 1901 (Wittop Koning 1901).

As ornamental plants asphodel (*Asphodelus* spec.) (fig. 4), Chinese lantern (*Physalis alkekenki*) and lilac (*Syringa*) are entered. For lilac the same warning should be given as for the cloves.

A plant possibly to be associated with a craft is weld (*Reseda luteola*), which is used for dyeing. The same may apply to teasel (*Dipsacus fullonum*), grown in the past for raising the nap on woollen cloth, though the heads are also appreciated as component in bunches of dried flowers. Other plants belonging to the non-food category are hemp (*Cannabis sativa*) and hop (*Humulus lupulus*).

Two staple foods, rye (*Secale cereale*) and buckwheat (*Fagopyrum esculentum*), are generally considered low status, certainly in the period 1875-1930 (Voskuil 1983). Rich people preferred wheat.

Table 1 shows that this kind of analysis does not reveal obvious differences between blocks 1, 2 and 3. Only ornamental plants seem to be restricted to the dwelling houses.

The analysis of the weeds revealed only members of plant communities commonly found in the region. No imports of, for instance, cereals could be detected. Some species regularly occurring in the cesspits may be mentioned though, because at present they are very rare and figure on the Red List of Endangered Species. One is corn cockle (*Agrostemma*

Figure 3 Seeds of tomato, length 4 mm. Photo R. Groen-Houchin

Figure 4 Seed of asphodel, length 3.9 mm. Photo R. Groen-Houchin

githago) that is found as entire seeds but more often found fragmented by grinding. Obviously the poisonous seeds were part of the flour and ingested by man. The second Red List species is rye-brome (*Bromus secalinus*). Corn cockle and rye-brome have become near extinct as a result of the intensive cleaning of sowing grain. The third species to be mentioned is venus' looking-glass (*Legousia speculum-veneris*), which has become rare for unknown reason (Weeda *et al*. 1991).

3.2 Number of species

Figure 5 displays the number of species per cesspit. Three of the four expected 'high status' households (blocks 1 and 3) show a relative low number of species, but one from KV22 shows a number that matches the number that is found in five out of the six 'low status' households (block 2). The lowest number belongs to a household in block 2. There seems to be a trend that high status inhabitants leave behind less species in their cesspits than low status inhabitants do, although the difference in not absolute. If the list of species is reduced to plants that are consumed or otherwise used by the inhabitants the trend is the same (fig. 5).

3.3 Correspondence and Principal component analysis

The analysis of the complete set of plants found as macro remains did not result in the detection of any kind of separate clusters. The scatterplots appear as one single mixed-up cloud.

An analysis in which the entries were reduced to nine plants that are not very common in Dutch cesspits and may therefore throw light on a possible high status i.e. asphodel, date, chilli pepper, Chinese lantern, fennel, melon, rice, rosemary and tomato revealed no distinction between the blocks either.

3.4 *Composition of the plant remains per block*

Figure 6 depicts the share of the classes cereals-buckwheat (i.e. the flour-producing staple crops), vegetables, herbs and condiments, fresh fruit, dried fruit, plants with possible technical use, ornamental plants and wild plants in the three blocks based on the presence of species found, as absolute numbers are more subject to chance than presence. The reason that fruit was divided into two classes, fresh and dried, is that the picture presented in table 1 shows that fig and grape appear everywhere and may have been consumed as dried fruit. The third species in this category is date.

Block 1, the larger enterprises, is characterized by the simplest waste and the lowest load of wild plants. Mainly remains of cereals and fruit were found.

The inhabitants of block 2, the dwelling-houses, left far more wild plant species and the diversity in the category not cereal, fruit or wild herb shows the highest diversity of all the blocks.

The picture of block 3, the shops and middle class inhabitants, shows a pattern that holds the middle ground between block 1 and block 2. Remarkably, ornamental plants were only found in block 2. Teasel is entered as ornamental.

Figure 7 presents the pattern when only food plants are considered. Again, block 1 has the fewest number of species, block 2 the highest, whilst block 3 is in the middle. However, the shares of the classes are quite similar in all the blocks.

4 Discussion and conclusion

The first result is that the cesspits belonging to the small dwelling houses with the many inhabitants of block 2 left in general the largest variety in plants. Block 1, the large enterprises with resident owners left the narrowest range and block 3 with its middle-class inhabitants is somewhere in between, but inclines towards block 2. An important difference is due to the share of wild plants. Most of these are weeds from agricultural fields or gardens (Appendix). Many of their seeds are highly fragmented which can be explained by their having been milled together with cereals, thus ending up as a component of flour. Possibly the inhabitants of block 2 consumed bread and the like prepared from flour of a lesser quality than the inhabitants of blocks 1 and 3.

When the food component within the plant remains is considered no striking difference is observed. All inhabitants consumed fresh fruit, for instance. If there is a difference it is within the category vegetables, herbs and condiments, but

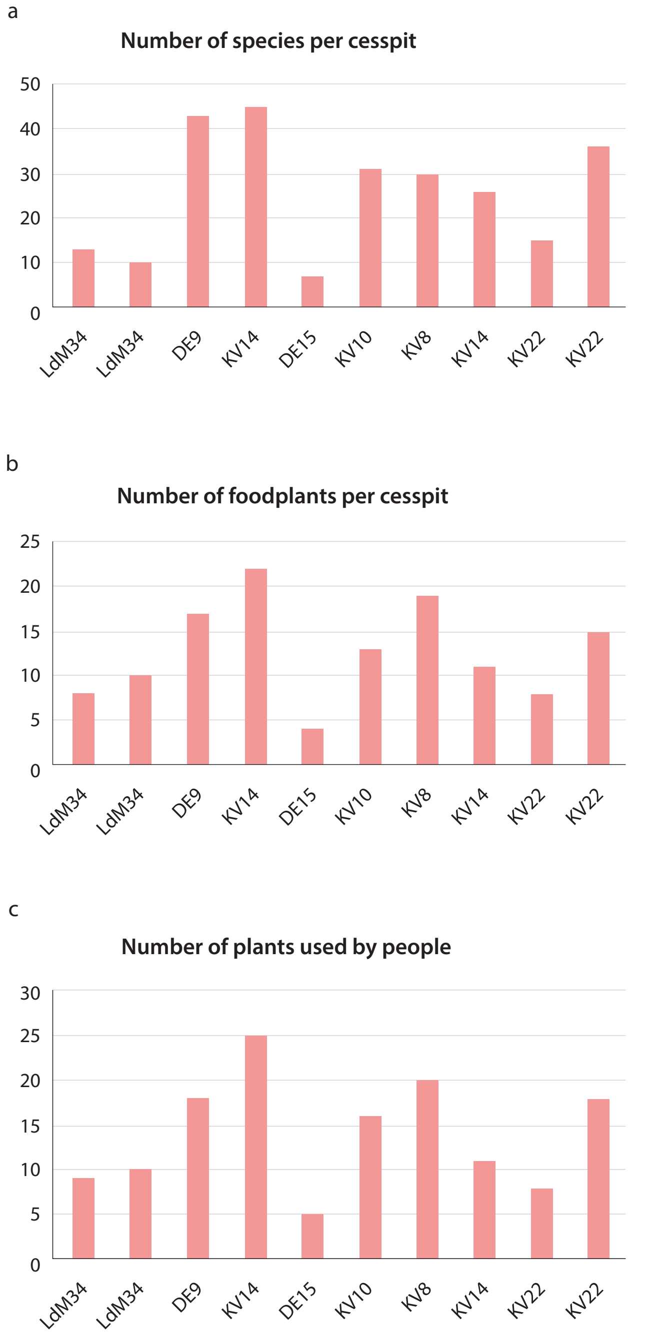

Figure 5 Number of species per cesspit

before the conclusion is drawn that the wealthier people from block 1 ate less vegetables it should be noted that precisely this plant category is hard to detect, because leaves, stems and bulbs are almost never preserved.

Plants that may have held a luxury status, as explained above, are also found in block 2. Of the two cereals, rye and buckwheat, that are supposed to indicate lower status, rye is found in all three blocks. Buckwheat, however, is absent in the cesspits of block 1.

In the non-food sector plants with technical use, no differences are observed. The species involved are weld, hemp, and hop. Weld is only present in blocks 1 and 3, but this is insufficient information to conclude that the inhabitants of these houses were concerned with the dying of textiles. Although weld was a common source of dye in the past, it was hardly so in the period 1875-1930, when the use of synthetic dyes was the common practice. The plant should probably have been classed as a weed. Hemp seed is found only in block 2. It was possibly used as human food or medicine, but was more commonly used as bird feed. The uses of hop seed are less clear. Hop is usually associated with beer, but that does not apply to the seed. Teasel is considered in the MarktMaas case to have been more ornamental than technical.

The last category is the category ornamental plants which is only present in the cesspits of block 2. Two of these plants, Chinese lantern and teasel are appreciated in a dried state. Bunches of dried plants were common features in the houses of the time, especially as *kroedwusj*, a ritual assemblage of seven plants with a distinct meaning: two cereals, two medicinal plants (milfoil, *Achillea millefolium* and tansy, *Tanacetum vulgare*) and three species to avert damage by lightning and thunderstorms, (wormwood, *Artemisia* spec., hemp agrimony *Eupatorium cannabinum* and a branch with leaf of walnut, comm. Botanische Tuin Kerkrade 2015). The bunch was refreshed each year and such plants may turn up in cesspits. However Chinese lantern and teasel are never part of these ritual bunches and therefore they are considered as truly ornamental. Components of the *kroedwusj* were looked for in the remains, but not

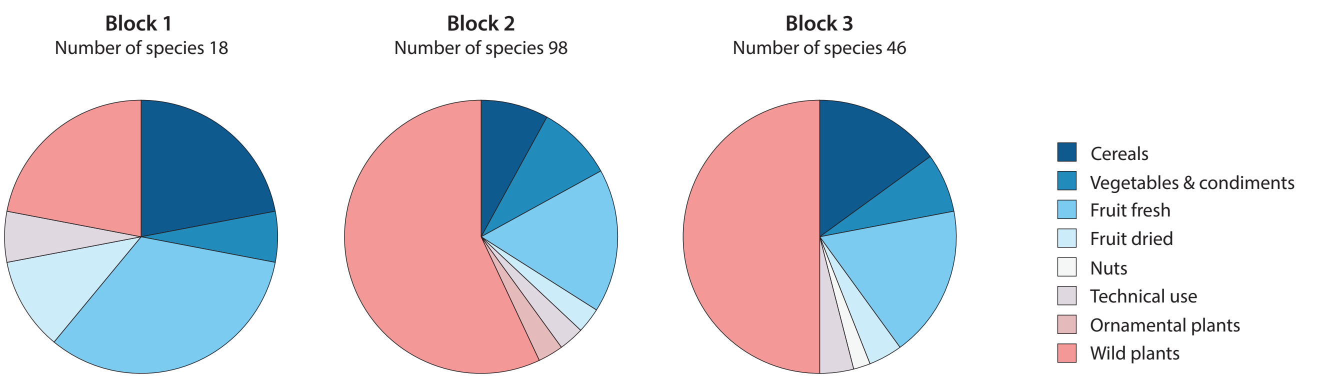

Figure 6 Composition of the plant remains per block

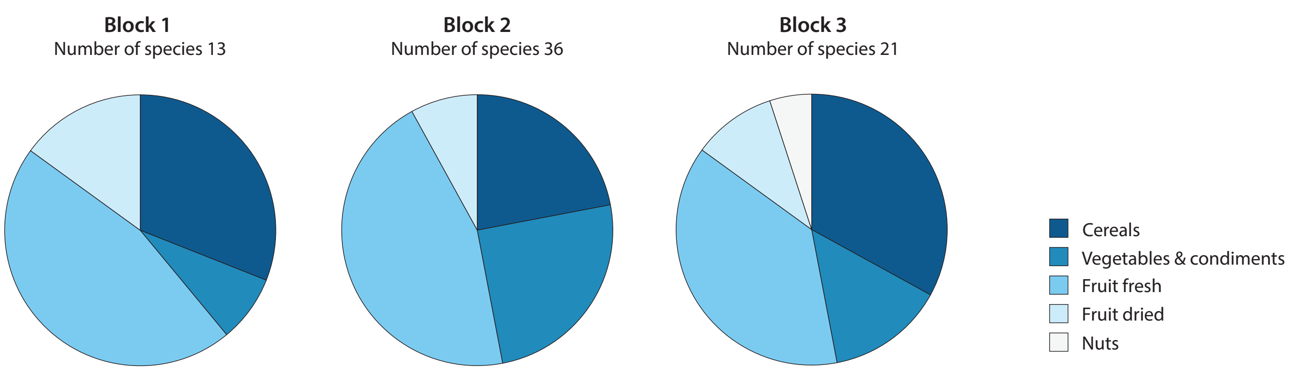

Figure 7 Composition of the remains of food plants per block

sufficiently positively identified, which is not very surprising as four of them concern flowers and one a leafed branch.

The final result of the analysis is that the differences between the poorer people of block 2 and the richer people of blocks 1 and 3 lies in the quality of the flour, the consumption of buckwheat and the presence of ornamental plants. However, these differences should be looked at with caution, because the research comprises only one establishment in both block 1 and block 3, though with two cesspits each. A check is provided by a cesspit at Maastricht-Grote Staat 37-41 (Van Haaster 2012). The fill of this cesspit is dated by ceramics of which the majority dates back to the period 1830-1860, but some material is younger, namely first quarter of the 20th century. The inhabitants had a high social status. Macro remains from cereals and buckwheat were absent, but pollen analysis revealed wheat (the majority), rye, oats, possibly barley, and buckwheat. This result shows that next to rye, buckwheat could be present in high status households as well. At first sight the presence of so-called low-status cereal looks strange. A possible explanation is that they were part of the meals of the servants. But in the case of rye at all events this conclusion is false. From written sources it is known that the upper class of Southern Limburg, the Dutch region in which the town of Maastricht is situated, regularly consumed rye-bread (Jobse-van Putten 1996, 298; Voskuil 1983). Therefore it is an oversimplification to call rye, and possibly also buckwheat, part of a poor man's diet. Although another source of buckwheat may be the technical use of its chaff as isolation material in walls (Kok and Kuijper 2001), such use leaves mainly macro remains and these are absent in the high status cesspit of Maastricht-Grote Staat, therefore this explanation of buckwheat presence is less likely.

On the other side of the cereal spectrum rice is found. Because rice is an imported product, not produced in the country by the local farmers, it may be considered 'high status'. Although rice does appear on the menu for less affluent people, its consumption was restricted to festive occasions such as weddings (Jobse-van Putten 1996, 374). Indeed, in his analysis of 's-Hertogenbosch Van Haaster (2003) detected rice only in high status environments. However, in Maastricht-Marktmaas rice was found in a low status context. The 's-Hertogenbosch study ends with 17th century society. Things may have changed in the course of time, and what was high status in the past need not be high status in a much later period, although these shifts are not always apparent in oral and written history. Jobse-van Putten (1996, p. 375) writes that rice was especially uncommon in Limburg. The same applies to a product like dates, found in another low-status cesspit. It is not very probable that the remains of festivities would be found twice.

The warning against a false interpretation of the near-absence of vegetables, herbs and condiments in block 1 is supported by the Maastricht-Grote Staat cesspit. This cesspit revealed seven species belonging to this category, six of them herbs/condiments and one true vegetable, purslane (*Portulaca oleracea*) (Van Haaster 2012). Van Haaster classes tomato among the fruits, but if tomato is regarded as a vegetable, the Maastricht-Grote Staat cesspit even produced two vegetables. He considers tomato a high status product, but the finds in block 2 show that this need not be the case.

The last category is ornamental plants. It is a category that is often undervalued in the analysis and interpretation of plant remains. Vermeeren *et al*. (2010) remark that some plants that are generally classed as medicinal or industrial are as a matter of fact ornamental plants. They interpreted their The Hague 15th century teasels as such. Van Haaster found Chinese lantern in 's- Hertogenbosch. They were found exclusively in a low-status context. Why this plant should be low-status is not clear and there are as yet too few observations in cesspits to allow a full understanding of the significance of this plant. Nevertheless it is remarkable that in the Grote Staat no remains of ornamental plants have been found, neither as macro remain nor as pollen. It cannot be true that rich people did not decorate their interiors with flowers. However, they may have had fresh flowers in their vases whilst the poor did with the longer-lasting dried flowers such as teasel and Chinese lantern. The latter are more easily detected.

To summarize; from this study it can be hypothesized that only the quality of the flour and the presence of dried flowers may mark the difference between low and high status in the plant remains analyzed for this time period for Maastricht.

Why were the plants remains not more informative about the socio-economic differences in the Marktmaas quarter of Maastricht? A possible answer is that the differences in provenance were not as sharp as originally assumed. The Langs de Maas cesspits belonged to a household that occupied a L-shaped lot with two separate dwellings: a front house facing the main street and a house in the rear, in the short leg of the L. A court lay in between, but the two were connected by a gallery (source Bouwhistorische beschrijving MarktMaas, Stadsherstel Limburg). The cesspits were situated in the short leg of the L and probably served the inhabitants of the rear house. It may safely be assumed that the owners of the enterprise lived on the main street side. The other buildings along the street did not reveal any cesspit. It is more than probable that their inhabitants did not use cesspits anymore and that the owners of nr 34 did not do so either. In that case the users of the LdM34 cesspits may not have belonged to the higher socio-economic class as previously assumed. The same kind of reasoning may be applied to the Markt houses. The majority of these did not have cesspits. Therefore, the material on which the present study is based is not optimal for studying socio-economic differences.

Still this cannot be the only explanation. The picture is not blurred by the absence of 'luxury' food, but precisely by its presence in what is thought to be low status. It is implausible that this is simply a result of the consumption of left-overs from rich people's tables. Explaining these finds as traces of festive occasions does not seem very likely either. For that the remains are seen too often.

It is possible that what is seen here is the influence of the food education that was strongly stimulated from the end of the 19th century onwards. Both food education and food information became part of domestic instruction and led to a decrease in differentiation. In the period *c*. 1880-1940 regional diversity in food habits disappeared (Jobse-van Putten 1987). It may well be that within towns a similar decrease took place. It is a subject that warrants further more in-depth research.

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Corresponding author:
C.C. Bakels
Faculty of Archaeology
Leiden University
PO Box 9514
2300 RA Leiden
The Netherlands
c.c.bakels@arch.leidenuniv.nl

Appendix

List of plants found. cf = identification likely

cultivated etc	Weeds from fields and gardens	Others
Asphodelus spec.	Agrostemma githago	Agrostis spec.
Avena spec.	Anagallis arvensis	Calluna vulgaris
Brassica nigra	Anthemis arvensis	Campanula cf rapunculoides type
Cannabis sativa	Anthemis cotula	Carex spec.
Capsicum annuum	Arenaria serpyllifolia	Chenopodium spec.
Carum carvi	Arnoseris minima	Cuscuta spec.
Corylus avellana	Bromus secalinus	Erica tetralix
Cucumis melo	Centaurea cyanus	Galium spec.
Daucus carota	Chenopodium album	Hypochaeris spec.
Dipsacus sativus	Echinochloa crus-galli	Knautia arvensis
Fagopyrum esculentum	Fallopia convolvulus	Lapsana communis
Ficus carica	Fumaria officinalis	Mentha aquatica/arvensis
Foeniculum vulgare	Hypochaeris cf glabra	Phleum spec./Poa spec.
Fragaria cf. vesca	Legousia speculum-veneris	Pinus spec.
Hordeum vulgare	Lolium spec.	Ranunculus sardous
Humulus lupulus	Papaver argemone	Rumex acetosella
Malus sylvestris	Papaver dubium/rhoeas	Sambucus ebulus
Mespilus germanica	Persicaria lapathifolia	Sambucus nigra
Morus nigra	Plantago major	Senecio spec./Hieraceum spec.
Oryza sativa	Polygonum aviculare	Silene vulgaris
Panicum miliaceum	Ranunculus arvensis	Solanum spec
Papaver somniferum	Raphanus raphanistrum	Stellaria palustris
Phoenix dactylifera	Sinapis arvensis	Taraxacum officinale
Physalis alkekengi	Spergula arvensis	Urtica dioica
Prunus avium	Stellaria media	Verbena officinalis
Prunus cerasus	Thlaspi arvense	Viola spec.
Pyrus communis	Tripleurospermum maritimum	
Raphanus spec.	Valerianella dentata	
Reseda luteola	Vicia hirsuta	
Ribes nigrum		
Ribes rubrum		
Ribes uva-crispa		
Rosmarinus officinalis		
Rubus caesius		
Rubus fruticosus		
Rubus idaeus		
Secale cereale		
Sinapis alba cf.		
Solanum lycopersicum		
Triticum aestivum		
Triticum spelta		
Vaccinium cf. myrtillus		
Vitis vinifera		

Research design and dialogue: dynamics of participatory archaeology in Chalcatongo and Yosondua, Mixteca Alta, Mexico

Alexander Geurds

This paper illustrates the collaborative aspects of archaeological research in two communities in the southern Mixteca Alta region of Oaxaca, Mexico. Whilst in several parts of the world archaeologists have developed multiple ways of informing, involving and collaborating with local communities, the case-study presented here observes that internal communal divisions determine the dialogue of archaeologist and community members and that an awareness of the political and social context underlying these divisions needs to be central to such participatory approaches. This paper, based on field seasons conducted between 1998 and 1999, first presents a background to the role of communities in the regional archaeological tradition, followed by a brief discussion of the results of a non-systematic survey project undertaken in the two communities. These results – and the project goals that led to them – are then compared to the mentioned local context that shaped the project. It is concluded that this contemporary context ultimately determined the possibilities to develop the aspired participatory elements.

1 Introduction

The last three decades have witnessed a growing debate on the politically charged relationship between archaeological field investigations and the communal position of local stakeholders, much of this in the arena of postcolonial studies and archaeological heritage debates (see Schlanger *et al*. 2013 for one of numerous available overviews). For several world regions, case-studies have emerged, with a noticeable regional emphasis on case studies from parts of Asia, Australia, and North America. Archaeological projects with an explicitly community-oriented focus originate in regions or nations where stakeholders in the local past have come forward. Parallel to this, archaeological management strategies are valorizing research along lines of societal impact and engagement. In this development, indigenous peoples seen cultural descendants represent an important segment, but are certainly not the only one: in principle, all contemporary inhabitants close to an archaeological site qualify in this set of practices, as a community that can interact with the archaeological investigation.

The Mixteca Alta region in southern Mexico has not yet witnessed the same amount of organized voices for cultural self-representation that is coming from the abovementioned other areas of the world. The demand for a legislative voice or meaningful control over local archaeological heritage through management of sites as well as authorizing archaeological research activities, was not often found in the Mixteca at the turn of the millennium. Whereas archaeologists engaged in research focused on the local indigenous past in numerous parts of North America, Australia, the Near East and Asia, reconsidered some of the basic dimensions of their practice, in the Mixteca this has occurred only on the local, incidental level. Indeed, how archaeologists regard their own research practice is one of the elements in generating locally engaged investigations. For example, the critical views on historical archaeology being conducted in North America have grown in recent years (Harrison and Schofield 2010; Leone 2005; Schmidt and Patterson 1995), and this critical self-awareness in archaeology will probably continue to be a presence in the near future. The impact of US federal legislation addressing issues of Native American cultural ownership is having on the archaeological practice, is far-reaching and certainly not yet fully addressed nor to be considered ideal (Watkins 2005; 2006). The issue of who gets to interpret whose history remains a deeply political one, and indeed powerful proof that political matters, and social context therefore, are inextricably linked to the archaeology of precolonial material culture on the American continent.

In this ongoing shift in autonomy, the unrestricted access to cultural remains, enjoyed by nationally authorized archaeological investigations, is eroding, creating an arena of power in which the authority over sites, material culture and collections, in other words over the past itself, is by definition subject to negotiation. By now several decades of dialogue between individual and indigenous organized bodies, ranging in scale from a local community to the UNPFII[1], have resulted in a profound transformation of the archaeological praxis. In contrast, even though some indigenous individuals from the Mixteca Alta have been actively involved in for example UN forums from the 1980s onward, the impact of these indigenous voices on archaeology remains incidental. Elsewhere, the field praxis of archaeology has and continues to change due to the dialogue between archaeologist and local stakeholders in the indigenous past.

The repositioning of archaeologist and his praxis serves the following three related goals. First, avoiding entirely losing authority on the material remains in light of local stakeholder concerns and demands. Secondly, to improve the overall involvement and exchange between archaeologist and local stakeholder and, third, to let this mentioned interaction mutually benefit archaeological findings and local historical knowledge. The concept that emerged in the early 2000s from all these efforts is that of community archaeology, by now one of the fast-growing sub-fields within archaeology (Davidson *et al*. 1995; Geurds and Van Broekhoven 2006; Geurds 2007; Marshall 2002). A large segment of the archaeological research taking place within community archaeology is oriented toward reflexive approaches to its praxis and an awareness of the delicate territorial and power-laden political position taken up by the archaeologist in the local context (Tully 2007). The individual experiences by archaeologists in the field have led to initiatives to further the perceived relevance and more generally the local *communis opinio* on archaeological field projects. Community archaeology initiatives are therefore oftentimes not so much planned methodology as they are responses to social contexts that present themselves in the field praxis. This reflects ethical considerations on the archaeological praxis from recent years (*e.g*. Meskell and Pels 2005; Scarre and Scarre 2006; Vitelli 1996; Zimmerman *et al*. 2003), which are characterized by attempts to outline ethically 'good practice' as well as making attempts at defining the importance of local social contexts to archaeology.[2]

This paper is based on research undertaken in 1998 and 1999 when a total of six months was spent living in the community of Chalcatongo de Hidalgo in the Mixteca Alta region in southeastern Mexico (fig. 1). The data presented here aim to demonstrate how the need to develop a community approach became evident during the field research in addition to the predefined goals for establishing a record of surveyed archaeological sites. Secondly, the transition from intention to outcome is presented and discussed, shifting the balance from assumed community coherence to the observed multitude of local identities and interests and thereby challenging some of the earlier assumptions that initially fuel collaborations with stakeholders (see also Smith and Waterton 2009). The adaptations that this project underwent revolved around a) the changing interaction with community members the field crew experienced as the project began and evolved and, b) the reflection by the field crew members on their position in the community. The interaction and dialogue that the field crew had with members of the Chalcatongo community when the project was introduced and submitted, and the expressed examples of interest and disinterest by inhabitants, had significant impact on the subsequent development of the mentioned participatory engagement. Accordingly, the particular nature of the various local social contexts, in part defined by power structures, will be outlined. The influence of these contexts and subsequent importance for participatory archaeology will be stressed.

The discussion this paper offers consists of two parts. I set out by describing the background of the archaeological knowledge concerning the Mixteca Alta and the results from the survey conducted in the Chalcatongo and Yosondua valleys. This part also provides a brief background to community archaeology and the collaboration it sets out to accomplish. The second part consists of a reflexive analysis on the contexts of interaction with the involved villages of Chalcatongo and Yosondua. This analysis allows for identifying the dilemmas of conducting community archaeology in practice, contrasting to some of the traditional community-based archaeological methods. It will show that submission of research plans and community consultation did not have the aspired impact as to enable a successful community-based archaeological project. Even though this consultation and dialogue with the municipal leadership has become standard practice in professional archaeology in the Mixteca, the reality in these settings shows a divided and contentious perspective on the communal archaeological heritage.

The Mixteca Alta region is marked by the colonial-era legacy of a highly fragmented political landscape and, as a result, long-term territorial feuds that scar the social landscape, divorcing nearby communities, and not infrequently resulting in violent conflict (Stephen 1997).

Figure 1 Villa Chalcatongo de Hidalgo

Archaeology in this region is locally viewed through multiple lenses, but it is at least a delicate and sometimes conflictive enterprise. Looking to other world regions, community archaeology surely holds promising new avenues for dialogue and participation but, as this paper will demonstrate, the implementation of previously established guidelines of conduct and communication, does not necessarily lead to improved local understanding or a more harmonious field project.

2 Participatory approaches in the Mixteca Alta

It's a commonplace to state that archaeological projects have to some degree always sought to achieve the involvement of local residents in the Mixteca Alta. The regional archaeology has traditionally depended on working out an arrangement with landowners on which an archaeological site is situated; relaying government permits for archaeological investigations and possibly contracting local workers in excavation activities. Thinking on how to critically consider archaeological research and its outcomes in the Mixteca Alta is considerably more recent (see Pérez Rodríguez 2013:101-104 for an overview), as is striving to model the diffusion of research results (Pérez Rodríguez 2002) or an analysis of patrimony management (Johnson 2009; Robles Garcia 1996). What comes out of this are methods to successfully communicate with local residents that might otherwise potentially complicate the particular archaeological project. The municipal political complexity of the Mixteca Alta community San Pedro y San Pablo Teposcolula is a prime example of the disenfranchisement of political leadership and factions in the general populace, complicating the archaeological enterprise (Johnson 2009; Santos Pérez 2008). The majority of work thus aims to achieve ethically virtuous forms of consultation with local Mixtec communities. However, though still rare, archaeological research is beginning to emerge that frames local involvement as more central to the project as such, foregrounding questions of oral history, knowledge of sacred landscapes and co-created research impact initiatives (Jiménez Osorio and Posselt Santoyo 2015; Zborover 2015).

For the better part of the twentieth century, the majority of communicative arrangements were either provided for by state or national legislations or contained within fieldwork conducted as part non-state commissioned individual archaeological projects. The worldwide increase in recent decades of indigenous peoples striving for cultural recognition, recuperation, as well as more broadly for political and territorial self-determination, has run parallel to more attention to the ethical sides of how the archaeological praxis is constituted (Derry and Malloy 2003; Dongoske *et al*. 2000; Marshall 2002; Shackel and Chambers 2004; Swidler *et al*. 1997; Thomas 2000; Watkins 2001). It is no longer a radical position to claim that archaeology strives for a more humane society (McGuire 2008) and it can be argued that efforts for a more open and inclusive discipline are part of this. These wider developments also continually give rise to efforts in the Mixteca Alta to seek a merger in the interests of both descendant communities and archaeology. Though not a term actively used in the Mixteca, the main conceptual heading to develop during the 1990s as a result of this in other world regions remains community archaeology.[3] Community archaeology transcends mere negotiation and consultation and attempts to actively involve local stakeholders in the archaeological process. Effectively attempting to perceive community members as equal partners in a given project, community members are encouraged to participate in co-determining the direction of research, data analysis, and the eventual management of materials for archival and locally meaningful educational purposes.

Part of the essence of community involvement with archaeology in the Mixteca is illustrated by the publication record. As a region marked in recent history by an abundance of small rural settlements, the interaction of archaeologists with these communities has been frequent and goes back to archaeology's earliest presence in the Mixteca Alta. As early as the reports by Alfonso Caso, a pioneer of Mixteca archaeology, the traces of this interaction are visible. During his first visit to the community of Santiago Tilantongo, Caso explicitly mentions Esteban Avendaño, an inhabitant of that community, on multiple occasions. Namely, he refers to him as the person who pointed out the presence of the Late Formative period (300-0 BC) site of Monte Negro, and is quite likely the one who guided Caso and his associates from the centre of Tilantongo up the Cerro Negro hill to indicate the precise location of the site.[4] Avendaño is mentioned in the report as the *vigilante de la zona Mixteca* (Caso 1938:52) and even features prominently on one of the included photographs (ibid.:55). Ironically, this early prominence also seems to have been the final depiction of a local inhabitant of the Mixteca Alta in *any* archaeological report published since 1937.[5] Currently, the status of people living at or near the many archaeological sites in the Mixteca Alta is peripheral to archaeological narratives, restricted to the front matter and article acknowledgments. This is the primary location where local knowledge is explicitly reflected on by the author of the archaeological text.

Despite the apparent invisibility in publications, few would argue that local residents are *not* an integral part of archaeological research in the Mixteca Alta. Through description of the circumstances in which archaeological research takes place in combination with the background of all those involved, it can be attempted to illuminate the structures and forces responsible for the production of knowledge about the archaeological past. The local public involved, and the partnership an archaeologist might undertake with that public, co-determines the political impact a project may have locally. That is, how the established partnership and the ensuing generated knowledge is used by individuals and groups within the local public. The application of community archaeology effectively acknowledges the influence that various types of social contexts have on the archaeological praxis, and turns it into its focus of analysis.

The archaeological handling of the past in the Mixteca Alta shows an apparent contrast to archaeologies in other indigenous contexts, where the participatory approach is more central to archaeological field practices, yet an answer as to why this disparity has come about is not easily available. Placing the causality primarily among archaeologists active in the region would disregard the many sincere efforts of archaeologists grappling with this issue at some stage of the project. The example of research projects from the neighboring Mixteca de la Costa region, offers stimulating contrasts to the Mixteca Alta.[6] Moreover, the Mixteca does not seem to be an isolate in this matter, since comparable situations can be found in other parts of Mexico. When comparing Mexico to settler colonies like those of Australia and the US, it can be observed that these have undergone divergent paths concerning the political position of the respective indigenous peoples living there, even though in all those locations indigenous peoples are facing tremendous societal challenges. The legislative voice achieved in both nations is thought to be different from the *de facto* non-status of different indigenous identities in Mexico. Even though UN legislation was passed concerning the indigenous peoples and later also by the Mexican federal government, it did not much more than acknowledge their existence, thus remaining far removed from the situation in Australia and the US. This is not to say that those two nations demonstrate a flawless ability to involve indigenous people, but it is on a formal basis certainly much more central to archaeology. It also provides insight into why Mexican academic degree programs in archaeology are still firmly rooted in the processual stance, when compared to North American archaeological praxis that may be considered in a state of flux. Archaeologists trained in North America have had to rethink fundamental aspects of their practice and many now approach their discipline in very different ways. This shift has arguably been the most determining development in the practice of archaeology after the introduction of processual archaeology (Hegmon 2003; Watkins 2003). The seeming disparity seen up until now in archaeological research in the Mixteca Alta can be understood as resulting from the lack of formal need as well as the absence of a Mixtec organization providing challenging cultural critiques on parts of some of the local archaeological research tradition. The national situatedness of indigenous peoples in Mexico (and numerous other Latin American nations) has quite possibly indirectly impeded the growth of an identifiable indigenous voice regarding archaeology, which, even though problematic in itself, might have *forced* archaeology to reconsider its field praxis, rather than merely *contemplate* changing it.[7]

The example of Chalcatongo stands to illustrate the problems that arise when community-based archaeology is applied in the fragmented socio-political realities that constitute many villages in the Mixteca Alta. Although Chalcatongo stands out for its increase in urban development it has witnessed since the 1970s to the present day, it is certainly not unique in the Mixteca Alta with regard to long-running intra-communal social conflicts, which perhaps only intensified due to this urban growth. As such, it makes it a fitting case-study for the application of participatory archaeology in a Mixteca Alta community.

3 The project area

The archaeology of the Southern Mixteca Alta where Chalcatongo and Yosondua are located is somewhat represented in published work (cf. Spores and Balkansky 2013, but see Whittington and Workinger 2015 and Kowalewski *et al*. 2009, 272-284). In contrast to the relatively extensive surface surveying conducted in other parts of the Mixteca Alta, as well as on the coastal Mixteca, this transitional region from the elevated highlands to the tropical lowlands is all but well understood. Recent surface surveying around Tlaxiaco, Cuquila and Chalcatongo and excavations at Achiutla are now providing promising new data to begin to address this gap (Davenport and Golden 2016; Forde 2016; Jiménez Osorio and Posselt Santoyo 2012; 2015; 2016). Despite its important geographical position, characterized by narrow canyons and mountain passes that connect the tropical coastal environment to the more temperate highland, archaeology has focused predominantly on long-term projects in either coastal river valley research (*e.g.* Joyce 1991; 1993; 1994; 2010; Joyce and Goman 2012; Joyce *et al*. 2004) or projects situated more northerly in the Mixteca Alta (Balkansky 2000 *et al*; Barba Pingarron *et al*. 2009; Byland and Pohl 1994; Heredia Espinoza 2008; Kowalewksi *et al*. 2009; Pérez Rodríguez 2003; Spores 1972; Stiver 2001) and the adjacent Mixteca Baja (Rivera Guzmán 2008). This lacuna was the original motivation to start building an inventory of the archaeological settlements present in the Chalcatongo and Yosondua valleys and study the socio-political relationship they may have maintained to their neighboring areas.

The village of Villa Chalcatongo de Hidalgo is situated in the heart of the southern Mixteca Alta. The modern municipality covers an area of 111 square kilometers and is politically placed within the Tlaxiaco District, as is Santiago Yosondua. The name Chalcatongo is of Nahuatl origin (*chalco* = 'Place of Jade'; *atenco* = 'at the lip (border, side) of the water' and translates to English as 'Place at the edge of the water'. It is estimated, though never geologically verified, that at some point during the pre-Hispanic period a body of water existed in the lowest area of the valley where agricultural activities are concentrated today. The municipal territory is bordered by those of San Miguel El Grande to the south-west, west, and north-west; by Santa Catarina Ticuá to the north-west, north, and north-east; by Santa Cruz Tacahua to the east, south-east, and south; and lastly by Santo Domingo Ixcatlán to the south and by Santa Lucía Monteverde to the south and south-west, with Santiago Yosondua bordering on Ixcatlán.

Santiago Yosondua is derived from the Mixtec (*yoso* = 'plain'; *ndua* = 'vegetable', 'arrow', 'huajes') and translates as 'Plain of Vegetables/arrows'. Yosondua covers a total area of 216 square kilometers and is limited by the municipalities of Zapotitlán del Río to the south-east and south; by San Andrés Cabecera Nueva to the south, south-west, and west; by Santa Lucía Monteverde to the west, and north-west; by San Miguel el Grande to the north-west; by Chalcatongo to the north-west and north; by Santo Domingo Ixcatlán to the north; by Santa Cruz Tacahua to the north and north-east; by San Francisco Cahacua to the north-east, east, and south-east; and finally by Santa María Yolotepec to the east.

Both municipalities are situated within a mountainous region of mainly calcareous soil types. Chalcatongo lies at an average altitude of 1,760 m.a.s.l. Yosondua is situated at 1,780 meters. Large vegetation includes several types of pine forests, red and black oak trees, and juniper tree. Topsoil erosion in advanced stages is observed in several areas of both communities. Given the altitude, the climate tends to display significant shift from temperate to cold. Mean annual temperatures are about 16-17° centigrade, but during the winter period temperature may fall well below freezing, whilst in the warmest period temperatures can rise up to 37º centigrade. Precipitation is mostly sudden and severe, and limited to the summer months.

3.1 Dominant theories in analyzing the Southern Mixteca Alta

Archaeological analysis in the Mixteca Alta focuses on the development and change of political complexity and the emergence of the *cacicazgo* system of socio-political organization at some point during the Postclassic period (AD 900-1521). This still poorly understood system, brought with it a reorientation of at least the monumental architectural complexes and possibly also the residential patterns. In addition, a set of stylistically similar valuables developed in the Mixteca. This Mixteca Puebla Style has been studied through the different media it was prominently displayed on including ceramics, pictorial manuscripts based on deer hides, jewelry, wall paintings among others (cf. Hernandez Sanchez 2005). The Mixteca Puebla Style has its florescence in the later stages of the Postclassic, and often is related to the emergence of the *cacicazgo* and its respective governing elites, as a system of exchange gifts of primary importance.

Besides socio-political organization, economic trade has also received attention by archaeologists and ethnohistorians. The transition between the high and dry Alta and the lowland Costa offered the possibility for a diverse approach to agriculture during the pre-Hispanic period, as still today. The marked shift in landscape features and flora and fauna is formed by sharp ridges completed by small rivers running to the south from the northern Alta to the Río Putla and the Río Verde in the Costa area (Spores 1967). This diversity is considered an integral part of the Mixtec economic system (Monaghan 1994). Monaghan referred to this system of product circulation between the different climatic zones as 'vertical integration'. These goods, such as corn, beans, tropical plants, cotton and cacao, were redistributed through the cacicazgos under the mediating role of the elite.

Within the spectrum of these Mixtec sociopolitical entities during the Late Classic (AD 600-900) and Postclassic period (AD 900-1500), Chalcatongo is ascribed an important ideological role in Late Postclassic manuscripts as well as early colonial documents. Jansen and Pérez Jiménez identified a pictographic reference mentioned in several pictorial manuscripts as being Chalcatongo (Jansen 1982; Jansen and Pérez Jiménez 2009). Especially the information found in the codices Bodley/Ñuu Tnoo and Selden/Añute permit the identification of this 'Place of Death' as Chalcatongo. In contemporary Mixtec known as *Ñuu Ndeya* ('Place of Abundance'), which is a derivative of *Ñuu Ndaya* ('Place of Death'), Chalcatongo has thereby been signaled as the most southern cacicazgo of the Mixteca Alta.[8] Present knowledge of monumental structures and their relation to the ideological importance of the Chalcatongo peer polities is limited (but see Jiménez Osorio and Posselt Santoyo 2015).

4 The settlement pattern in the study area

The survey conducted in the Chalcatongo and Yosondua Valleys was executed in an area totaling 620 ha and recorded eight sites, all but one monumental centers with a rich spectrum of structures including raised platforms, mound-plaza configurations, stairs and sporadic evidence for sculpted iconography. The opportunistic survey method was based on indications by cognizant residents and included field walking across encountered sites, estimating their perimeter and documenting surface features and artifact scatters. All activities formed part of the ongoing state-wide archaeological registration project conducted by the Centro INAH-Oaxaca. Included in the survey were the piedmont and hilltop areas in the valley. The valley floor itself was not surveyed. Conditions on the ground prevented yielding a representative result for this area due to intensive agricultural practices and the space taken up by the presumed lake area. Vegetation and ground cover consisted primarily of pine trees, as well as oaks at the lower levels. Animal grazing, plowing, logging, or erosion frequently exposed artifacts in these piedmont and hilltop areas.

The structures recorded during the survey can broadly be classed as Primary Monumental Centers and Secondary Monumental Centers. Additional features encountered include caves (accessible and inaccessible) and artifact scatters.[9] Isolated residential structures were sighted on the line terracing below most hilltop monumental centers, but the advanced stages of slope erosion prevented any detailed recording. In all cases, these residential structures were identified based on the partial preservation of wall foundations visible on the surface.

The Secondary Monumental Centers are significantly smaller in size and architecturally less complex than the Primary Monumental Centers. They minimally feature one non-domestic structure, but typically will be characterized by three to five examples of such public ceremonial structures, mostly rectangular platforms of different height and volume, arranged along the sides of an open plaza of rectangular shape or one that conforms to the overall shape and slope of the topography. This is what will be referred to as a group. No ball courts were recorded at any of the Secondary Centers.

The Primary Monumental Centers demonstrate greater architectural complexity and exceed the Secondary Centers in average number of hectares. All but two of these Primary Centers are located in the Chalcatongo Valley, with one located just north of Yosondua and one south of Yosonotu. The architectural complexity is not so much expressed through the elaborate nature of individual structures as through their total number and relative morphological differences at any given site. Looting and erosion have also here prevented the preservation of almost all specific characteristics that a structure may have possessed. Primary Centers are further marked by the presence of more than one independent group. The groups may or may not be joined together through walkways or line terracing running along the upper slopes of the hilltop.

The Secondary Monumental Centers recorded consisted of Yucu Tahñu, Yucu Ñaña, and Cerro del Fortín. All these three sites are comparatively small in size, ranging between no more than 1.0 to 2.3 ha in area. They are heavily looted and demonstrate a single component Classic period (AD 300-900) occupation. Pottery diagnostics, such as extensive amounts of Nochixtlan Cream Wares were identified locally. The site location in the natural landscape tends to differ from one of the less elevated hilltops in the southeastern end of the Chalcatongo Valley in the case of Yucu Tahñu to the highest local summits in the valley. Yucu Tahñu (2550 m.a.s.l.) features one group with an architectural alignment typical for the region of a plaza delimited by three low elongated and narrow platforms and one principal structure exceeding the others in volume and height (fig 2). Yucu Ñaña is a small center 2.1 ha in area located on a promontory (2440 m.a.s.l.) with dominating views in all directions. It features one group of mounds consisting of a 20 by 15 meter platform with three height levels. On the highest platform level two mounds are located on the northwestern and southwestern sides (fig. 3). This group is delimited to the southeast by a large open plaza, measuring 100 meters on a side. Cerro del Fortín consists of two mounds and two plazas, thereby adhering to the single group form, and at the same time demonstrating the internal architectural variations possible within those groups. The group consists of two mounds situated next to a quadrangular platform. This Secondary Centers showed a relationship to two water sources in the direct vicinity reinforcing the hypothesis of ritual practices related to water at these small ceremonial centers.

The Primary Monumental Centers include four sites, two if which in the Chalcatongo Valley, one in the Yosondua area, and a final near the boundary of the Monte Verde and Santa Catarina Yosonotu municipalities. They all vary in size, but have a significantly larger total surface area than the Secondary Centers. Individual structures are greater in volume and size (including examples of up to seven meters high), and also display more elaborate variability in shape. On three occasions, more than one individual architectural group is present, sometimes separated by a considerable distance. Two Primary Centers, Yucu Uncuu and Yucu Chayuu, are situated in close proximity to each other in the Chalcatongo Valley, and one, Yucu Ñuu, is located in the Yosondua *agencia* of Imperio. With the exception of Yucu Ñuu, these centers all occupy hilltop locations following the existing unevenness on slopes and purposefully containing the sediment for even ground surfaces. This natural landscape unevenness is incorporated in the site lay-out through platforms or esplanades, and in some cases, for example at Yucu Ñuu, these esplanades serve as delimiters to a plaza. Dating the occupation of these sites was based on observing surface artifacts, consisting primarily of ceramics, complemented by lithic material. While a large majority of the ceramic material consisted of monochrome utilitarian wares, Gray Wares and Fine Cream Wares were also abundantly present, the latter indicating a Classic period occupation for these Primary Centers (Geurds and Caretta,

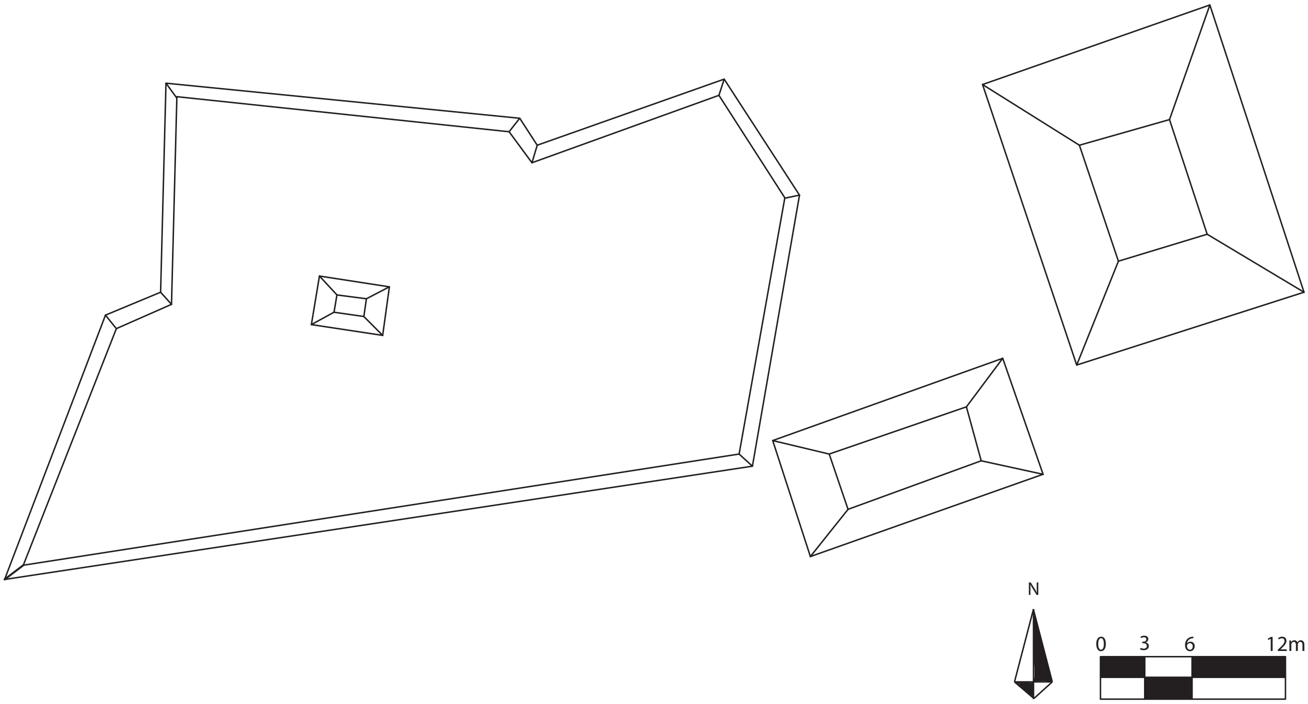

Figure 2 Plaza 1 at Yucu Tahñu, Chalcatongo Valley

1998; Winter, personal communication). The architecture and site location is consistent with this finding. Lithic materials consist of ground stone objects, such as hand axes, corn grinders ('manos'), mortars, and grinding stones ('metates'). The encountered obsidian was visually determined to be exclusively of the Otumba and Cerro de las Navajas (green gilded) types, as well as the clouded gray type (Pico de Orizaba).

Yucu Uncuu, located on the summit of Cerro Iturbide (2500 m.a.s.l.) and Yucu Chayuu both are architecturally defined by a central plaza featuring three or four platform structures along the sides. Yucu Uncuu, situated to the southwest of Chalcatongo within the terrain of the agencias of Progreso and Iturbide, shows two groups of structures (fig. 4). These were constructed with worked stone of various sizes. The smaller blocks were used in the central parts of the walls, and the larger blocks served as façade or retainers near or at the corners. Some blocks displayed a size of up to 75 cm, however, many of these had been removed, possibly, to serve in the construction of houses. In similar fashion, many of the smaller blocks have been removed to serve as stone field boundaries, or *tecorrales*. At the eastern side of one the principal mound structures a petroglyph is visible on one of the upper stones (fig. 5). For this part of the structure,

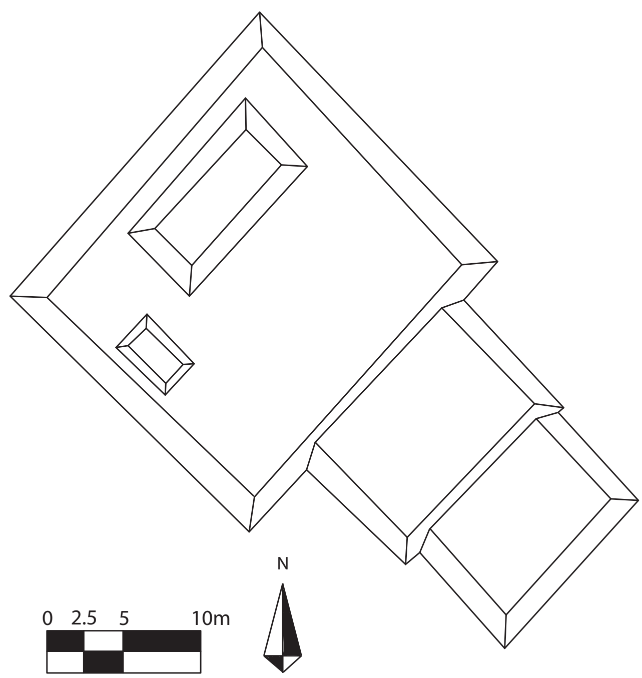

Figure 3 Yucu Ñaña, Santiago Yosondua

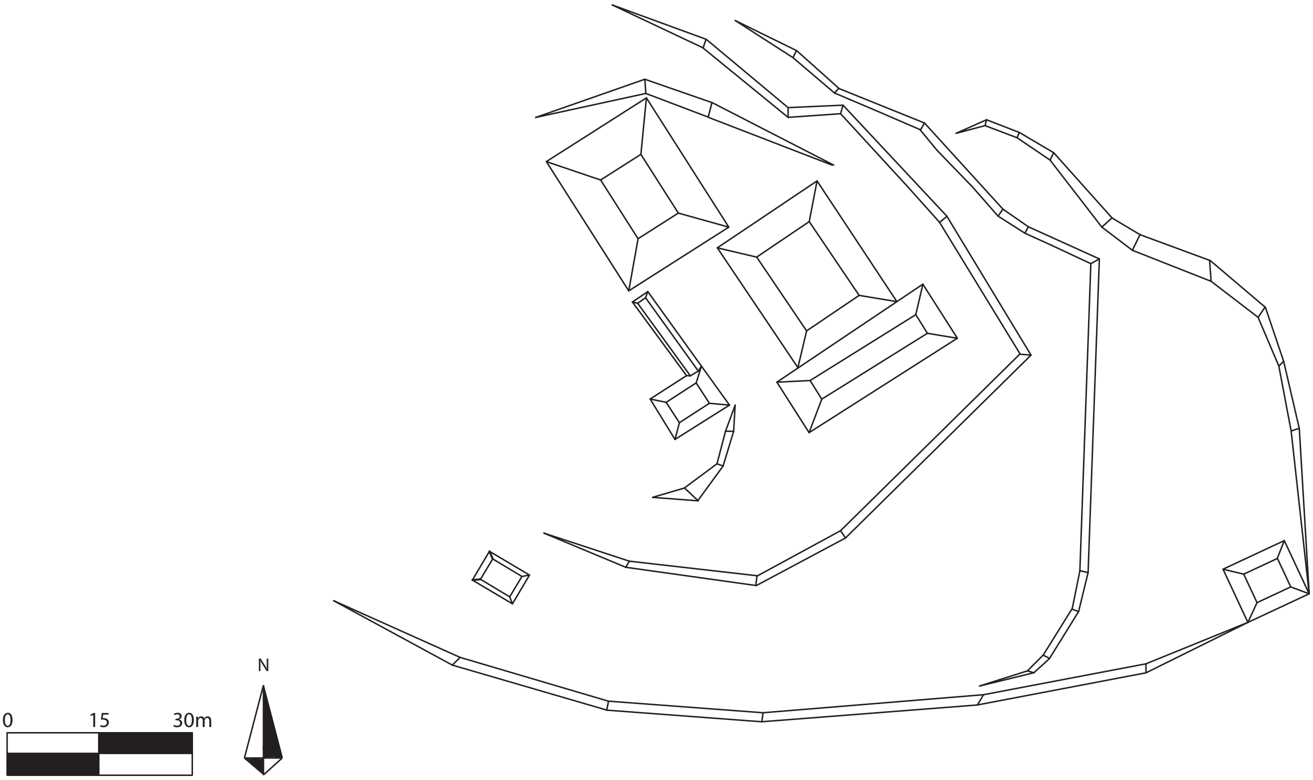

Figure 4 Yucu Uncuu, Chalcatongo Valley

Figure 5 Cornerstone petroglyph at Yucu Uncuu. Possibly a rendering of the calendar sign for Movement

as well as many others, architectural analysis was hampered by the numerous looting pits situated in their immediate proximity. Walls that had collapsed, or were at the point of collapsing, were seen on numerous occasions.[10]

The highest architectural diversity of all Primary centers is displayed by Yucu Chayuu. This site consists of eleven mounds, five plazas, one internal patio, and one sunken patio, of which most are rectangular in shape and differ in dimensions (fig. 6). The mounds have an average height of 2 to 5 meters. The material used for construction includes both calcareous and extrusive igneous rock. Yucu Chayuu, situated approximately 2 kilometers north of Chalcatongo (2550 m.a.s.l.), on the summit of the hill with the same name (also referred to as Cerro de Chapultepec), follows the hilltop shape in its form featuring a north-south axis of 350 meters and an east-west axis of 150 meters. Exceptional to this site is the construction of levelled surfaces on this fairly narrow hilltop by means of massive walls that characterize the west and east lateral sides of the site. The West Wall stands out with an approximate length of 65 meters.

Whereas at Yucu Chayuu the grouping of buildings is compacted on a relatively small and narrow ridge top, the spacing at Shini Tiinduu Yucu at Santa Catarina Yosonotu is

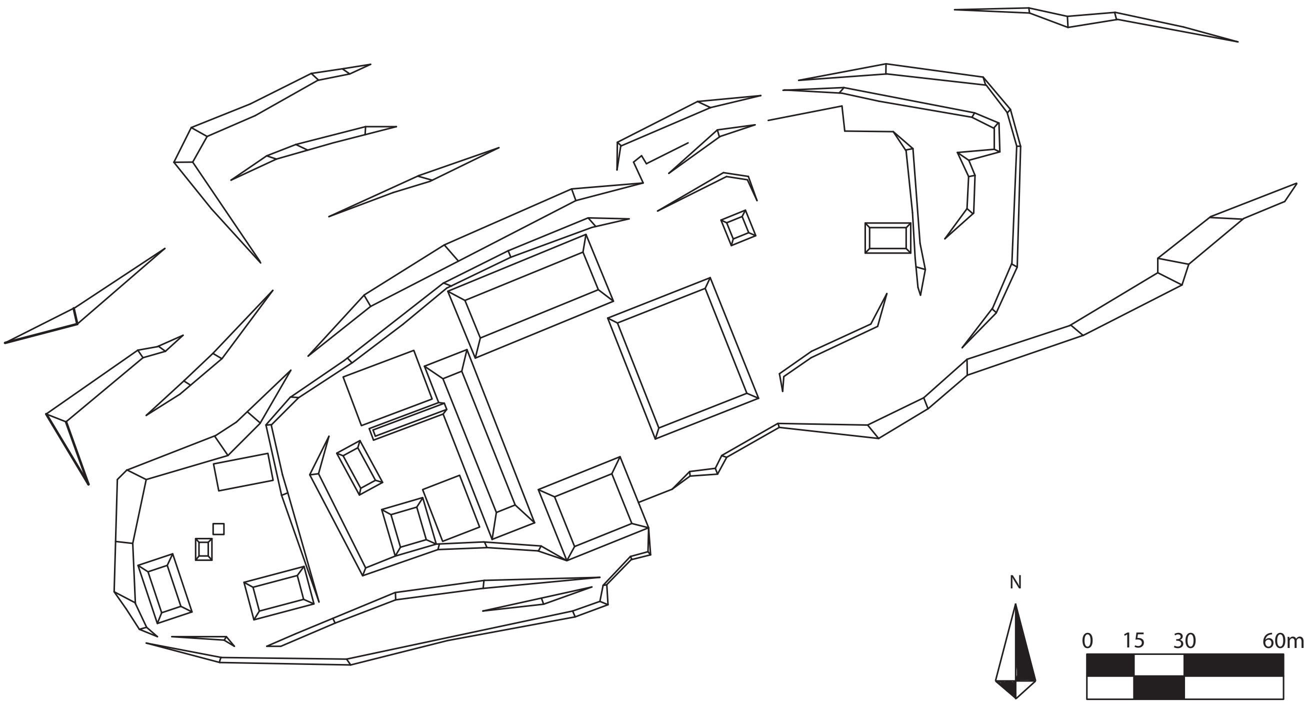

Figure 6 Yucu Chayuu, Chalcatongo Valley. Three plazas are situated at different levels in addition to several smaller mounds, at times featuring staircases. In the central part of the plaza a sunken patio was encountered

much wider. Individual structures are built on small natural peaks along a hilltop extending for approximately 500 meters (fig. 7). The location of this site along the contested municipal limits of two communities made a detailed recording process impossible at the time of the visit.

Lastly, the site of Yucu Ñuu is located on the higher parts of a hill slope (2360 m.a.s.l.) and is the only site where architecturally semi-intact tombs were recorded (fig. 8). Two types of tombs can be discerned. The first type consists of three chambers arranged in perpendicular form around a quadrangular central antechamber. The second type is made up of tombs consisting of individual chambers lacking the antechamber but with varying overall length. An extraordinary example of this is Tomb I with a horizontal length of approximately 12 meters (fig. 9).

The distribution of monumental centers is associated to the presence of sufficiently large tracts of drained flat surfaces in the immediate proximity (1 to 1.5 kilometers). In the peripheries of Yucu Uncuu, El Fortín, Yucu Chayuu and Yucu Ñuu, *lama bordo* agricultural zones are situated directly below the monumental architecture.

Monumental construction reached a peak during the Classic Period, and it is thus consistent with findings from

Figure 7 Shini Tiinduu Yucu, Santa Catarina Yosonotu. Note the wide spatial arrangement of groups

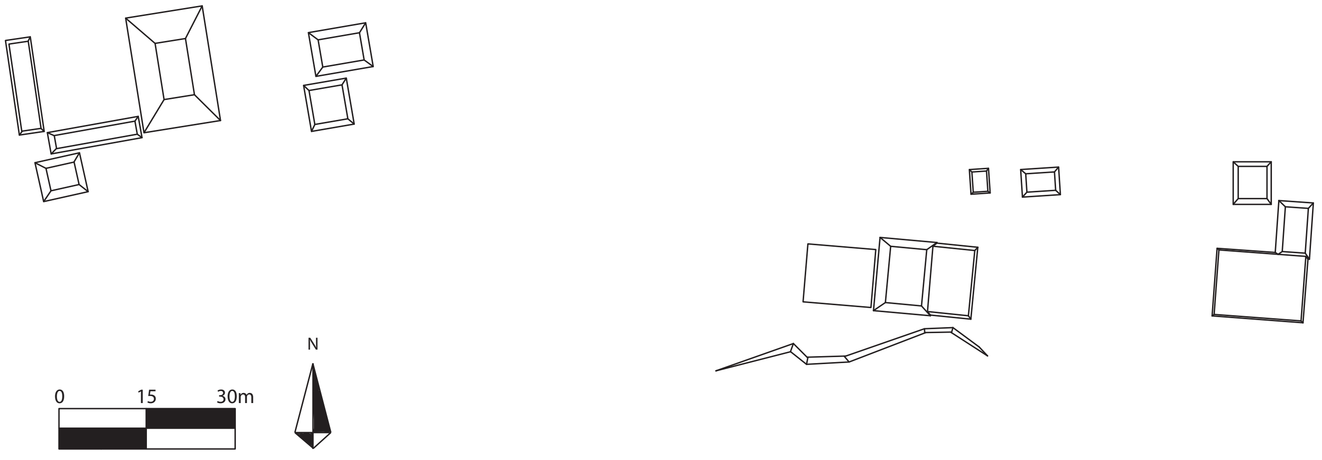

Figure 8 Yucu Ñuu, Santiago Yosondua

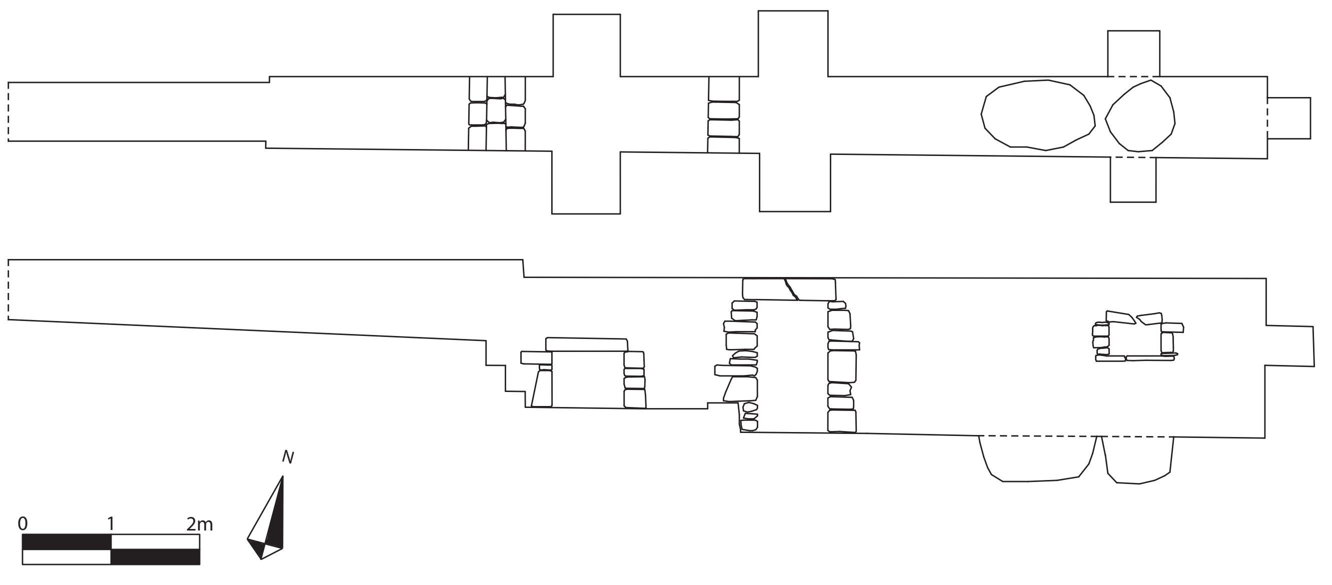

Figure 9 Tomb I at Yucu Ñuu, exceeding twelve meters in depth. Note the composition of a straight tunnel and three sections, beginning with a very small access of almost 60 cm, but acquiring a height at the back end of 1,8 meters. There are two series of large niches on each side of the walls of the tomb and three niches of minor size in the final part of the tomb. The entire construction was constructed with rectangular limestone rock without making use of some type of mortar

more northerly areas of the Mixteca Alta, to conclude that the settlement pattern in the southern Alta was also dominated by these centers. The architectural lay-out of Yucu Chayuu and Yucu Uncuu, for example, mirrors a comparably elaborate monumental form that is prominently present at for example Yucuñudavui (Spores 1984). In order to address the role of the Chalcatongo –Yosondua area in Postclassic times, illuminated by references to the Chalcatongo place name in several Late Postclassic pictorial manuscripts, more intensive surveying will most likely lead to improved insights into this period. The first indications from this survey, however, do not seem to warrant the confirmation of a major Postclassic period regional importance, as hinted at in the mentioned manuscripts. Two alternatives can be considered here: (1) The Chalcatongo place name geographically points to an area, perhaps adjacent to, but other than the present Chalcatongo Valley proper or (2), its referred to regional importance is reflected differently in the archaeological record. Ongoing work by Jiménez Osorio and Posselt Santoyo are likely to further advance this issue. Aside from this, all sites merit more consolidation and protective activities. If no action is undertaken in the near future, continuing destruction due to natural and human agents is more than likely.

5 An introduction to community social complexity

The above reflects the archaeological findings from the two field seasons undertaken in 1998 en 1999. The first season of fieldwork was undertaken in the spring and summer of 1998 and consisted primarily of the localization of the described archaeological sites in the area directly around Chalcatongo and, further to the south, around Yosondua. The second field season was complementary to the 1998 survey area and took place in the spring of 1999.

We initially visited Chalcatongo accompanied by a local resident and a representative of INAH. The first action taken was to solicit a meeting with the municipal president in order to express our interest in the local archaeological record and to stress the need to establish a preliminary overview of the sites in the area. It took several days to set up a meeting with the municipal president, who was often several times called away at the last moment to attend meetings elsewhere. At the time, I presumed it was to be expected that a municipal president of a larger community in the Mixteca Alta would indeed have many people asking for his attention. When we finally did manage to secure an appointment, the conversation was formal and rather brief. I was accompanied by an INAH official and a number of local residents were present. They voiced what seemed to me at the time a polite discourse outlining the importance of Chalcatongo and the equal importance of archaeology, to which the municipal president would reply with a similar discourse. This formal conversation took its course for about twenty minutes after which the municipal president evaluated what had been proposed to him, and consented the research. Other than granting us permission for the field activities we also received an option for lodging in the community. In later stages of the project, it became increasingly complicated to meet up with representatives of the authorities, who were rarely present at the municipal building.

During this introductory period, we had not yet had any contact with other Chalcatongo community members, other than the family who had agreed to rent out a small house at the edge of town. The first period of work, however, was now set to begin and we thus drew up our work schedule, and started out in the course of the days that followed to begin the actual survey activities. This implied early departing from the house we had rented and exiting Chalcatongo to walk the surrounding fields, taking the surrounding hills as a specific target. A community guide had been appointed to accompany us on our activities, but after a couple of days the communal responsibility he had been entrusted with had eroded to such a degree that he would only occasionally still show up. Typically, in the afternoon daily results were processed back at the house. That way, our daytime activities typically took place away from the actual community, and the nighttime activities were mostly limited to working in the house. In practice those first weeks in Chalcatongo were marked by little contact with community members, much less the establishment of close working or personal relationships.

In addition to the work schedule and its practical implications, language was another crucial element. The communication in Spanish we tried to maintain with people on the weekend or at other non-work related moments was, at the time, a considerable challenge for several members of the research team myself included, and this proved to be a major impediment for talking to people about everyday things. Effective dialogue on what we were doing in Chalcatongo was even more limited. Being confronted with this, maintaining the reciprocal relationship became a concern. Though at the outset of the project we had explicitly intended to incorporate actions to involve community members and work according to their remarks and interests, the field praxis turned out to be much more challenging. It became clear that the structure of our project was ill-fitted to reach these community-based archaeological goals.

This initial period therefore, led to the identification of these problems as part of the project structure itself. We were working on a rather tight time schedule that involved the execution of a certain number of site descriptions in a limited amount of days. Many of the activities that could have established or reinforced social relationships were not intrinsically tied to formal archaeological fieldwork, but left to chance. This would typically involve being invited over to attend social events, and mostly also simply sitting down with people and having conversations with them. But again, this did not seem to comply with a form of community-oriented archaeology at the time. It was certainly friendly and respectful social conduct, but what we were doing out in the field during the day or processing and analyzing at night, was a topic seldom touched upon in these social events.

As can be seen in the results reported on above, the archaeological perspective we held and the goals we had set with regard to studying the local archaeological record, left little room for local involvement. Research foci such as the change in socio-political development during the Postclassic period are not a major topic of local concern and the designed field-walking campaign consumed almost all of the time in order to be completed in time. This effectively already assured the communicative disconnect that became noticeable as the project evolved.

An important structural element in the project that impeded local involvement on the individual basis was the local balance of power. The municipal president, it became quickly evident after our initial arrival, was a particularly unpopular communal leader. This is not exceptional in the Mixteca Alta, a region where political divisiveness and mistrust is a chronic phenomenon in local governance. At the time, however, we were unprepared for this. If community archaeology was not to be introduced by outsiders to a community through its leadership, how should it be done otherwise? Gradually the communal political landscape became evident, where a small group of inhabitants still supported the municipal president, and a large section were at the very least abstaining their opinion about him. As it turned out, several of the people we had established contact with, were among his supporters.

At no time did anyone try to obstruct or openly criticize our presence or activities, the concerning element was rather that no one seemed to care; no discussions were held, and thus no dialogue established. One exception occurred during our stay at Yucu Ñuu. After a few days, some markers we had used for measurements had been removed. Part of the equipment stored at the site to avoid carrying additional weight to the site each day, was stolen or destroyed. In addition, the entrance to one of the tomb chambers was covered, which subsequently prevented exact registration. One of the stone slates functioning as a ceiling and as a threshold in the entrance of the west tomb chamber was damaged, causing it to collapse. Finally, a tomb was damaged by graffiti and the discarding of trash. When we informed as to who might have done this, a surrounding resident told me that at least two of the tombs were looted recently and that it appeared to him a common activity. However, he preferred not to venture too deep into the matter because most people in the area are relatives and *"pues, mejor no rajar leña"*.[11]

Meetings with the municipal authorities of Santiago Yosondua and Santa Catarina Yosonotu took on a similar character, reaching instances where it was implicitly advised not to speak to the authorities at all. In all of these cases permissions were granted and formal collaboration thereby effectively established. Though the lack of communication did not affect the objectives of the two field campaigns, it did generate a lack of fulfillment at the aspired collaborative aspect of the field research.

5.1 Project flexibility

Power issues were not restricted to the intra-community arena; there was also a discomforting power agenda between the community and us as a research team. Preset research priorities were largely guiding in assessing what was worth investigating and what should be regarded as a waste of time and energy. It seemed beyond discussion that our handling of the material past was the correct way to proceed. Paradoxically though, archaeological field research seldom adheres to the strict planning that may have been set up back at the university. More often than not, particular events or unexpected finds force the archaeologist to reschedule the time table, and this famously always occurs near the scheduled end of the field activities. Local social circumstances are equally important to involve in this time table, failure to do so was in this case-study not so much perceived as breaking a moral code, but rather as a confirmation of one's status as an outsider archaeologist who cannot be expected to, even though temporarily, form part of the community.

As outlined in the first half of this paper, the intentions for this research showed quite some similarities to the predominant ways in which archaeological research is conducted in the Mixteca Alta. Since its early days in the middle part of the twentieth century, this archaeology emphasizes the analysis of regional socio-political and economical processes of change, as well as an interest in the interregional ties to the Valley of Oaxaca and Monte Albán specifically (overviews in Joyce 2010; Pérez Rodríguez 2013). Accordingly, this work involved large regional survey projects (Balkansky *et al*. 2000; Kowalewski *et al*. 2009) combined with excavation campaigns at several of the larger sites. The relation between ecological conditions and the development of societies is primarily studied along the coastal region of the Mixteca, centering on the Río Verde basin (Joyce 2013).

With regard to these research emphases, the chosen southern region of the Mixteca Alta promised to be a fitting addition to the existing research in the surrounding regions. However, the intentions to fulfill this research project and doing so whilst remaining in dialogue with the community of Chalcatongo and, to a lesser degree, Yosondua, could not be maintained after the two field seasons. In evaluating the fieldwork, it became clear that the goals had to be aligned according to this perspective: effective dialogue with the community would not succeed with a research agenda that did not rely on local input. Monologues, in the form of well-intended explanations of what we were doing in the community were at best respectfully acknowledged, but never challenged or discussed. These interactions did not seem to hold up any notion of exchange of information, much less true dialogue.

The two briefly described fieldwork seasons did not succeed in establishing an open dialogue with the involved communities. Such a dialogue is a first step in beginning to understand the meaning ascribed to pre-Hispanic material remains and the specific interests that inhabitants may hold in these materials and sites. Crucial herein was the lack of a critical understanding of the heterogeneous nature of these communities and the absence therefore of multivocality in how the project was to be executed. Such an understanding of communities is an element I now consider essential to any form of participatory archaeology, as I have argued elsewhere (Geurds 2007; 2011). One possible outcome such dialogue could have resulted in is an emphasis on the named localities and stories dotted around the Chalcatongo and Yosondua landscape. The incorporation of that cultural landscape memory could have led the field research to the same archaeological sites, but most likely also to other locations of cultural importance which would have gone unnoticed or yielded no archaeological deposits relevant to the research questions. Later research has amply demonstrated this for other cultural landscapes in the Mixteca Alta (*e.g.* Geurds and Jansen 2008; Gehring 2012). To allow for local participation, involving local knowledge systems with archaeological perspectives will reveal some of the different ways in which landscapes can be culturally remembered and reconstructed. This can lead to shifts in the aims of a project, thereby necessitating flexibility in the project design. This adaptability was not considered during the described fieldwork, and this ultimately contributed to the cessation of communication.

6 Conclusion

What this paper has illustrated is that participatory goals in archaeological field research can be decisively determined by social and political conditions in local communities (cf. Merriman 2004). The heterogeneity of such cultural settings is challenging to reconcile with the establishment of guidelines for practicing archaeologists. These settings range from urbanized areas where building contractors; local or supra-local governing bodies; and other local stakeholders are involved in the archaeological fieldwork, to indigenous settings like the Mixteca Alta where comparable supra-local bodies fill very different social roles and local political actors may have determining voices in the archaeological activities taking place. Stakeholders in the local material culture, based on culturally hereditary ties to these materials, undeniably is a significant influence on the archaeological praxis.

Ultimately, the fragmented political environment in Mixteca Alta communities, in tandem with the multitude of perceptions among community members, perceptions based on past conflicts and current divisions among families or intra-communal social units, leads to the paradoxical view of communities that as a dialogue partner on archaeological remains *de facto* do not exist. The fieldwork analyzed here has shown that basic elements of community archaeology may not provide the outcomes aspired by the researcher. Similar to conceptual debates surrounding the notion of a community (Cohen 1985), participatory archaeology needs to have an ethnographic awareness of local stakeholders, rather than assume outwardly displayed political structures as sufficiently representing community voices. Since this research, subsequent archaeological field projects, that aspire to involve the local surroundings of archaeological objects of study, now more critically consider the entangled social and political conditions of communities having a stake in archaeological remains (Pyburn 2011; Smith and Waterton 2009). Beyond public archaeology in the United Kingdom and NW European settings, a more global perspective is emerging, even though Latin America and certainly Mexico remain often overlooked sources for comparative cases (see for example Waterton and Watson 2011). A weighty tome of 34 chapters, the *Oxford Handbook for Public Archaeology* (Skeates *et al*. 2012) includes a single chapter on Latin America (Funari and Bezerra 2012). A recent issue of the journal *World Archaeology* (2015), dedicated to public archaeology, does not include the Americas at all.

There is a case for having a better sense of what it means to strive for a participatory archaeology in the Mixteca Alta. Considerations should at least include (1) an awareness that the project is conducted in unknown social contexts; (2) a project design that is open for ongoing negotiation through dialogue in practical aspects but also in the goals it sets for itself; (3) a presence in the community that enables recognition of the social contexts and the intra-communal balance of power, through forming partnerships that do not merely focus on archaeology; and (4) an understanding that the limits of what is attainable may lie beyond what is possible.

Acknowledgments

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Notes

1 United Nations Permanent Forum for Indigenous Issues.

2 These individual experiences in the field have given rise to a prioritization for the local diffusion of archaeological information. This is reflected in both the ethical codes of conduct of the Society of American Archaeology (www.saa.org/AbouttheSociety/PrinciplesofArchaeologicalEthics/tabid/203/Default.aspx, accessed on October 15, 2016) and the World Archaeological Congress (http://worldarch.org/code-of-ethics/, accessed on October 15, 2016).

3 Historical archaeology in North America can be referred to here again as a sub-field which has seen a significant number of projects in which contemporary communities fill an important role (Orser 1996; Little 2002; Paynter 2000).

4 'En primer lugar el señor Esteban Avendaño, localizó una gran zona arqueológica que parece haber sido el Tilantongo primitivo, pues su nombre así lo indica. En efecto se llama actualmente Cerro o Monte Negro, y Tilantongo quiere decir en mexicano "el lugar negro" (Caso 1938: 55).

5 Avendaño might also feature on a group photograph taken at the Caso encampment at Monte Negro a year later (Acosta and Romero 1992: 24). This would be the person standing next to Caso and mentioned as 'persona no identificada'.

6 Archaeological research pioneered by Arthur Joyce in the 1990s in the Río Verde drainage basin on the Pacific coast of Oaxaca basin and currently co-directed with Stacy Barber has successfully established strong community ties. It's long-term presence and explicitly developed community initiatives are key to this success (www.colorado.edu/rioverdearchaeology.org, accessed on February 19, 2017).

7 I have analyzed additional reasons for this situation elsewhere (Geurds 2007).

8 Place of Death is associated with the place-glyph characterized by one or several skull(s). As for example in the Codex Bodley, where Lord 8 Deer 'Jaguar Claw' is shown in his grave besides his brother-in-law / father-in-law Lord 8 Lizard; who is seated on the place name *Ñuu Ndaya* (Jansen 1982).

9 The site of Cueva del Coyote is such a cave site of which there are many in the study area. It is situated on the eastern face of the Fortin hill, on the border of the Chalcatongo and Santa Catarina Ticua (*agencia* Paz y Union) communal terrains. The access to the site is easiest from the western face lain in the municipal lands of Chalcatongo. The overall cave dimensions are considerable: approximately 30 meters deep and 4 meters wide. There was a limited presence of ceramic material similar to the material encountered on Yucu Uncuu and Yucu Chayuu.

10 On the northern and western part of the hill are some agricultural areas. To delimit these areas, a considerable number of blocks and stones belonging to the structures are used, leading to extensive damage to the structures. Within the limits of the site area various looting pits have been registered. At the foot of the western side of a principal structure one of many looting pit was recorded. This pit emitted a cool draft; this may possibly relate to the existence of an underground connection to a cave which is situated to the south at a distance of approximately 400 meters. The entrance to this cave has collapsed.

11 It was further commented that detecting the tombs is an easy task. It was done by stepping firmly on the soil around potential area and listening to the resonance. This was not always successful, but in many cases small holes were dug next to them.

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Alexander Geurds
Institute of Archaeology
University of Oxford

Faculty of Archaeology
Leiden University
PO Box 9514
2300 RA Leiden
The Netherlands
a.geurds@arch.leidenuniv.nl

The image of archaeology: consistencies and deflections through time among the Dutch, concurrences and deviations across Europe

Monique H. van den Dries and Krijn Boom[1]

A 1996 survey on the perception of archaeology among 3,820 Dutch citizens demonstrated that they attached a strong value to archaeology. Interest and concern was solid, however historic consciousness was low and the degree of participation even lower. The new 2015 NEARCH research project has collected comparable data on a larger scale, for nine European countries. This paper will compare the 1996 data to the 2015 data to evaluate differences in societal perception through time. The Dutch data will also be compared to the data from the other countries to evaluate national differences. Information will be assessed regarding the public image of archaeology, the level of knowledge, societal interest in and support for archaeology, and the participation and consumption patterns. This information is crucial to developing an optimal strategy for inclusion of and interaction with the public in archaeological research.

1 Introduction

There is an abundance of data on the public's view of archaeology and on the societal significance of archaeology in the Netherlands. In 1996, the Dutch archaeological sector initiated the first large public survey which was carried out by a specialised agency (NIPO/AIC 1996). Through interviews and questionnaires, 3,820 citizens were asked about their knowledge of Dutch archaeology, as well as their attitude and response to it. The general trend was that a majority (56%) of the participants valued archaeology, but that 60% did not participate in activities like site visits, or in consuming archaeology products. The people that did were mostly males aged 45 and above, with a high level of education and a high living standard.

During the consecutive decades, the government's social and cultural trends watching agency (Sociaal en Cultureel Planbureau) monitored developments in cultural participation and observed a slight increase in attention for cultural heritage, and higher visitor numbers for various museums and monuments between 1995 and 2007 (Van den Broek *et al*. 2005; Van den Broek *et al*. 2009, 9). This increase was however most pronounced with those particular segments of the public that were already used to participating.

Additionally, the Archaeological Heritage Management chair group of the Faculty of Archaeology (Leiden University) and its students conducted several studies on public engagement and participation. While these included mainly small, local target groups, they too revealed a consistency in positive attitudes, yet underdeveloped participation levels (*e.g.* Lampe 2010; Van den Dries *et al*. 2015; Van den Dries *et al*. 2016; Wasmus 2010; Wu 2013).

In 2015, the NEARCH research project[2] conducted a survey on society's perception of archaeology among 4,516 adults (age 18 and older) from nine European countries (England, France, Germany, Greece, Italy, Netherlands, Poland, Spain and Sweden). It included a representative sample of at least 500 people from each of these countries.[3] The questionnaire was composed by the NEARCH research team, and data collection was carried out by Harris Interactive, a company specialised in public surveys. Harris Interactive selected participants from its access panels, between December 29th 2014 and January 6th 2015.[4] For the Netherlands, the 500 survey respondents were divided into five age categories (18-24; 25-34; 35-44; 45-59; 60 and more), four regions (North, East, South, West) and three socio-professional categories (SPC+, SPC- and inactive people)[5].

With the addition of the latter survey to the existing dataset, diachronic and synchronic comparisons are possible. These comparisons show interesting developments within the last twenty years in public perception in the Netherlands, as well as some noticeable differences between the Dutch and other European countries. This article discusses the Dutch and wider European image of archaeology, the public's acquaintance with sites and heritage management policies, its interest in and support for archaeology, and its participation levels, by comparing the rich dataset amassed over the past decades to new survey data collected in 2015.

2 Image

The NEARCH 2015 survey results indicated that the Dutch public views archaeology primarily as an academic endeavour; the respondents most commonly defined it (Q1) as a 'study of the past' (51%). A majority (77%) also associated archaeology with the word 'science', when they were asked to select two keywords from a list of six (Q3).[6] Moreover, they considered its prime role as '*knowing* the

	Eng	Fra	Ger	Gre	Ita	Neth	Pol	Spa	Swe
A science	46	60	82	88	65	77	68	67	65
A profession	33	29	27	13	25	33	21	27	23
A cultural activity	28	30	29	27	33	17	14	23	27
A leisure pursuit	6	6	4	2	1	4	7	2	4

Table 1 Responses (in percentages) of the NEARCH survey participants across Europe to the question 'As you see it, archaeology is…' (Q3). The participating countries are represented in alphabetical order

Italy	Greece	Spain	England	Netherlands	Poland	France	Germany	Sweden
24	21	13	9	8	7	5	4	3

Table 2 Percentages of the NEARCH survey respondents believing archaeology contributes to national or the local economy (Q4). The European average was 10%. The order of the countries follows the rank order of the percentages (from high to low)

Italy	Greece	Germany	England	Spain	Poland	France	Sweden	Netherlands
9	9	7	7	6	6	5	5	3

Table 3 Percentages (from high to low) of the NEARCH survey respondents believing archaeology participates in the sustainable development of an area (Q4). The European average was 6%

Greece	Spain	Italy	Germany	France	UK	Sweden	Netherlands	Poland
7.0	5.6	4.1	3.8	3.6	3.5	2.4	1.9	1.7

Table 4 Travel and tourism's direct contribution to the GDP, 2014 (source: http://www.wttc.org/-/media/files/reports/economic%20impact%20research/ countries%202015/spain2015.pdf)

Italy	Spain	France	Germany	United Kingdom & Northern Ireland	Greece	Sweden	Poland	Netherlands
51	45	42	41	30	18	15	14	10

Table 5 The number of inscribed World Heritage sites in 2016 (source: http://whc.unesco.org/en/list/)

Greece	Spain	France	Germany	UK	Poland	Italy	Netherlands	Sweden
13.7	6.9	6.7	4.2	4.2	3.7	3.2	2.9	2.8

Table 6 Travel and tourism investments' contribution (in percentages) to the total capital investment, 2014 (source: http://www.wttc.org/-/media/files/reports/economic%20impact%20research/ countries%202015/spain2015.pdf)

France	Spain	Italy	Germany	UK	Greece	Poland	Netherlands	Sweden
14.4	11.2	8.3	5.7	5.6	3.8	2.8	2.4	1.8

Table 7 Share (in percentages) of international tourist arrivals in 2014 (source: United Nations World Tourism Organisation 2015, 8)

history of the Netherlands' (56%). Between the subgroups of the Dutch sample, there were not many statistically significant differences, except that 48% of the 18-24 years old considered archaeology 'a profession', against only 24% of those in the age group of 25-34.

Some interesting differences in opinions could be observed between different European countries. The emphasis on *knowing* was for instance stronger among the Dutch than in other European countries, as the average European score for 'knowing the history of [my country]' was 44%. And despite the fact that in *all* countries archaeology was principally seen as 'a science', rather than, for instance, 'a profession' (table 1), this correlation was strongest among the respondents from Germany and Greece. The population in England showed the least strong correlation between the concepts of science and archaeology (46%). This difference could be related to variations in the meaning of the word 'science' in different languages.

The survey demonstrated that few people in Europe directly link archaeology with social and economic values; for instance only a minority of respondents per country considered it a cultural activity (table 1), and even less considered it a leisure activity. Only Poland had fewer people who considered archaeology a cultural activity than the Netherlands, while the respondents in Italy, France and Germany selected this option significantly more often than the European average of 25%.[7]

Even when the question about the value of archaeology was posed in a different way (Q4) and people were asked what they consider the three main roles of archaeology, only 5% of the Dutch thought of archaeology as having a role in entertaining citizens (against 4% for Europe as a whole) and 4% indicated that it contributes to the quality of life (4% for Europe as a whole). The younger age categories (18-24; 25-34) selected these options more often (11% and 9%) than those above the age of 35. It was only in Poland that slightly more people (9%) thought of archaeology as having a role in entertaining citizens. It was again in Poland that most people thought of archaeology as contributing to the quality of life (8%). Overall these are rather low numbers, and they suggest that the European political bodies designate a stronger role to cultural heritage in regard to social and economic development than the public.

Another interesting result was that when asked to give their own definition of archaeology (Q1), nobody in the Netherlands defined it as 'the preservation of remains (objects)'. This is striking, as the safeguarding of remains has been a core aspect of our profession from the very start; the first resolution to protect archaeological remains – i.e. the megalithic tombs (*hunebedden*) in Drenthe – dates back to 1734. Moreover, protecting monuments and other important cultural heritage objects has always been the prime objective of the Monument Act since it was first implemented in 1961. The number of respondents that spontaneously thought about the preservation of remains when thinking about archaeology was low in all European countries (1%).

When subsequently asked why they considered archaeology useful (Q2), 79% of the Dutch answered 'to *know* where we come from/to *learn* about our past' (against the European average of 75%). Fortunately, none of the respondents from the Netherlands selected the option that archaeology is *not* useful. On the other hand, the Dutch did not consider it valuable for 'tourism/economy/employment' either.

When asked about the main roles of archaeology (Q4), only 8% of the Dutch respondents indicated that it contributes to the local or national economy (table 2). More men (14%) than women (4%) were convinced of this. For Europe as a whole, the average was 10%, but a remarkable difference in opinions could be observed among the people in Greece and Italy, where 21% and 24% indicated that archaeology contributes to the economy. Spain scored above the European average as well (13%). The smallest numbers of people believing archaeology contributes to the local or national economy was counted in Sweden (3%).

Not surprisingly then, Greece and Italy also had the largest number of people indicating archaeology contributes to the sustainable development of an area (Q4); 9% of the respondents selected this answer in both countries (table 3). Of all participants, the Dutch had the least faith in archaeology as an agent in the sustainable development of an area.

These differences in how archaeology is valued in economic terms are intriguing, yet rather difficult to explain. For the various countries there may be particular reasons why people think archaeology is, or is not, an important economic asset. In Greece and Italy it may for instance be related to the fact that (archaeological) heritage tourism has a high contribution to the GDP (table 4). This contribution is smallest in Poland, the Netherlands and Sweden. The number of World Heritage sites is also likely to be an important factor (table 5); Italy and Spain have the highest number, Sweden, Poland and the Netherlands the lowest. Additionally, Greece has the highest investment levels in tourism (table 6), far more than the Netherlands, Sweden and Poland. Furthermore, Greece had experienced an exceptional growth of 23% in international tourist arrivals in 2014 (United Nations World Tourism Organisation 2015, 7), just before the NEARCH survey was conducted.

These data may explain why the Dutch, Swedes and Poles experience little perception of economic value in relation to archaeology, yet they cannot explain the whole picture. For example, Italy belongs to the top five of tourism destinations, but so do France and Spain. The latter even have a higher ranking (United Nations World Tourism Organisation 2015, 8) and a larger share of international arrivals (table 7). Why then do so few French and German citizens see economic value attached to archaeology?

2.1 Image of archaeologists

When asked about the activities that archaeologists conduct (Q6), the Dutch respondents indicated that archaeologists 'protect remains from the past' (94%), but the options that were selected most were 'they carry out excavations'(98%) and 'they discover treasures' (96%). The Dutch selected this last option more often than the other respondents across Europe (87%).

We do not know what causes these differences and why the Dutch are so focussed on the discovery of treasures. However, it does seem to be a widespread phenomenon, as during one of our community archaeology activities we also noticed that people were very focussed on discovering spectacular finds, and that they had a high expectation of finding something important during their participation in the dig (Wu 2013, 51). Some people even suggested to the organisers of the community dig that "next time they should pick pits that had equal chances to find things in the ground" as this would be more fair to all participants (idem). Perhaps part of the reason for this perception is that it is indeed through spectacular finds that archaeologists usually present their news and profession. This certainly is the focus of many Dutch media, as several studies of Dutch newspaper articles on archaeological issues have shown that the press is mainly focussed on reporting finds (Kramer 2013, 57). The newspapers that were included in these analyses also tend to associate archaeology with 'science' rather than culture as this is the section in which they publish most articles on archaeology (idem). Unfortunately, no data on media representation of archaeology is available for the other countries incorporated in this study, therefore it remains unclear whether the differences between countries visible in our data are related to differences in the journalistic approach common in each country.

3 Knowledge

3.1 Acquaintance with the system

With regard to the knowledge levels of the Dutch public, the NEARCH survey results showed there was little accurate knowledge about the heritage management system that is implemented in legislation in the Netherlands since 2007. While the introduction of development-led archaeology and a market system with contractors (in 2000) led to a fieldwork practice that has been dominated by the private sector since (see for instance Van den Dries 2013, 48), 63% of the respondents thought amateur associations were the prime actor group conducting archaeological research (Q5), followed by universities (61%) and public institutes (59%). Men in particular thought amateur associations conduct archaeological research; 71% against 56% of the women. Only 28% (25% of the males against 30% of the females) thought companies play a role in archaeological research. The older age groups (45-59; 60+) in particular believed amateurs and universities still played a major role. As this was indeed the case some decades ago, it seems they have missed out on the more recent developments.

In Europe as a whole, the role of companies was mentioned by 40% of the respondents, and significantly more often by the younger age categories (18-24; 25-34; 35-44) than by people aged 60 and up (31% only). It seems that across Europe, older people in particular had not noticed how the situation had changed in the last two decades, with the introduction of the private sector into archaeological research.

Of all European survey participants, the Dutch were the least up to date regarding the role of the private sector. It must be noted that Greek respondents selected the option 'private companies' even less often than the Dutch, but this relates to the fact that no companies are active in archaeological research there, rather than to a lack of knowledge. The Netherlands also had the highest number of people (12%, against the European average of 5%) indicating they actually could not answer this question.

When confronted with the question of who manages archaeology in the Netherlands (Q17), the Dutch public displayed a clear lack of awareness. More than half (51%) of the respondents seemed to believe that the national government is the main actor managing the archaeological heritage (Q17). Indeed, this used to be the case, but the situation changed in 2007, when the revised Monument Act (as of 2016 replaced by the Heritage Act) formally gave local authorities the prime decision power on archaeological research. Only 30% of the respondents considered municipalities the main actors in archaeological heritage management. Remarkably, 'archaeological associations' were selected as the answer by 35% of the survey group although we have no such associations in the Netherlands. It is however possible that people interpreted amateur associations as falling under this description.

Men were most pronounced in their choices; 65% thought the national government manages archaeology, against 38% of the women; 37% of the men selected 'municipalities', against 23% of the women. Females more often (30%) indicated not to know (against 12% of the males). Younger age groups picked the national government far less frequently. They seemed to have a more accurate idea of the situation than elderly people, although the younger people also indicated more often that they did not know (37% versus 14% of the 60+).

When asked about their understanding of the concept and policy of 'development-led archaeology' (Q22) – better known in some countries as 'preventive archaeology' – 75% of the Dutch indicated *not* to be familiar with it, against 64% of the European average. The people in England were the least familiar with the concept (76% indicated not to know it). Preventive archaeology was best known in Poland and Italy, where 49% and 45% indicated to know the term. Among the Dutch respondents, there were no significant differences between the region groups, gender groups or the socio-professional categories.

These are discrepancies across Europe that cannot as yet be explained due to the lack of sufficient contextual data. They may perhaps relate to how archaeology is represented in the national and local media, but this is a speculative hypothesis at best, as there is no data on this for the whole of Europe. For the Netherlands, we do know that the newspaper analyses discussed above showed that for the past couple of years hardly any news articles exist on issues such as the implementation of a new Monument Act, or of development-led archaeology (Kramer 2013, 57). If these newspapers did write about issues relating to the role of archaeology in society, it usually concerned 'problems', like the costs and other burdens involved in archaeological research (idem).

3.2 Acquaintance with archaeological sites

The respondents were asked about their acquaintance with 13 famous archaeological World Heritage sites (Q12); 8 of these (such as Pompeii, Stonehenge, and Petra) turned out to be known by the majority of the Dutch. Best known was the Acropolis in Athens (82%), followed by Italy's Pompeii (known by 80%). All 13 sites were better known by males than females. Young people (18-24 years) had the least knowledge of the sites; for instance 57% of them knew the Acropolis in Athens, against 87% of the people above the age of 60. There was also a remarkable difference between the socio-professional categories, with significantly more people in the SPC+ category being acquainted with these sites than those in the inactive or SPC- category.

Compared to other European respondents, the Dutch scored lowest for knowledge of the World Heritage sites (Q12). They were least acquainted of all respondents with 6 out of the 13 sites that were shown to them. For comparison, the French had the lowest score on 4 sites, the English on 2, the Poles and Greek both on 1 site only. Regarding the Acropolis in Athens for instance, 82% of the Dutch indicated to know it, against 94% of the Spanish, 91% of the Germans. Moreover, the Terra Cotta Army of Xian (China) was known by 58% of the Dutch, against 84% of both the Italians and Spanish (the European average was 73%). This low level of acquaintance with the Terra Cotta Army is particularly remarkable, as the Dutch massively visited the blockbuster exhibition on the terracotta army in 2008.[8] The Italians had the highest score on 6 sites, all well above the European average.

We cannot at this point explain the observable differences. Tourism studies have shown that Dutch people travel quite a lot (table 8), so they could in theory be expected to be more acquainted with famous archaeological sites. The Dutch are also in the top three of the cultural practice index of the European Commission's Eurobarometer on cultural access and participation, which states that 'The northern European countries, led by Sweden, Denmark and the Netherlands, stand out as having the highest levels of cultural engagement […]' (TNS Opinion & Social 2013, 9). Could this striking result then perhaps relate to differences in school education programmes, or to the amount of attention to history and heritage in the most popular media that the respondents (see the section on information sources below)? Again, we can only speculate as we do not know of comparative studies on this for the whole of Europe.

3.3 Information sources

The Dutch survey participants indicated that their three main sources of information on archaeology (Q8) are documentary programmes and news reports on television or on the radio (selected by 46%), news articles in the national press (32%) and regional press (29%). Far less people mentioned gathering information by visiting archaeological sites or exhibitions (23%), reading books (19%) or visiting dedicated heritage days (8%). The low percentage for this last option

UK	Netherlands	Germany	Sweden	Poland	Italy	France	Spain	Greece
29.6	21.4	15.1	10.0	7.3	6.3	3.9	3.8	3.3

Table 8 Share of the population that has taken part in outbound trips in 2014 (source: http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Population_ (aged_15_and_over)_participating_in_tourism,_2014.png)

did not come as a surprise, as there have been only very few of such dedicated days in our country. In the future, more people may be informed through such events, as in 2015 – after the survey was conducted – the National Days of Archaeology were installed, which are meant to become an annual event.[9]

Young people were significantly less focussed on written sources, television and visits and much more on social networks (20% for young people, 3-8% for the other age groups). This pattern is not unique for the archaeology domain, it was also found in both national (Cloïn 2013, 91) and European surveys (*e.g.* TNS Opinion & Social 2014, Standard Eurobarometer 82) on media use. This implies that if the archaeological sector wants to reach out to various age groups, it needs to utilize a variety of information channels.

In comparison with the other European countries, the consumption of television documentary programs and news reports by the Dutch is rather low (46%), as the European average was 56% (table 9). Dutch people do watch less television than some other Europeans (table 10), but not much less than for instance the population in England, where 59% indicated to use this as a source of information on archaeology. This lower consumption level could therefore indicate that we may have less archaeology on offer than some other countries, like for instance the United Kingdom (who had some famous programmes like 'Time Team' and 'Meet the Ancestors'), but this has never been studied.

The Dutch did consume significantly more information through the national (32%) and regional press (29%); the Netherlands scored the highest in this regard (table 11, table 12). Greece and Italy had the lowest level of local (regional) newspaper use (6%). Does this mean there is more intense (local) news coverage on archaeology in the Netherlands? There is no data available about the level of press coverage of archaeology across Europe, but a master study on the representation of stakeholder values in local Greek newspapers suggests that at least some heritage projects are extensively covered by the Greek local media (Kotsaga 2016). Perhaps the relatively high level of attention for archaeology in the Dutch local press could relate to the fact that in our country, decisions on archaeology are made by local authorities, so their impact on the local policy and local budgets may also be felt directly by local communities. A counter argument is that these figures match quite neatly other survey results on European media use (table 13), showing that a relatively high consumption of written press by the Dutch and a low consumption by the Greek is the usual pattern. These results on general media use however do not explain why the NEARCH survey found low numbers

France	Greece	England	Germany	Italy	Sweden	Spain	Poland	Netherlands
60	60	59	58	57	55	55	54	46

Table 9 Share of the NEARCH survey respondents being informed on archaeology through documentary programs, or news reports on television/radio (Q8)

Spain	Italy	Greece	Germany	Poland	France	UK	Netherlands	Sweden
92	90	88	84	83	81	81	80	73

Table 10 Share of the population watching television (almost) every day, in 2014 (source: http://ec.europa.eu/public_opinion/archives/eb/eb82/eb82_media_en.pdf)

Netherlands	UK	Greece	Poland	France	Spain	Sweden	Germany	Italy
32	26	24	23	22	22	21	19	16

Table 11 Share of the NEARCH survey respondents being informed on archaeology through articles in the national press (Q8), European average 23%

Netherlands	Germany	France	Sweden	Spain	Poland	England	Greece	Italy
29	17	13	13	10	10	9	6	6

Table 12 Share of the NEARCH survey respondents being informed on archaeology through articles in the regional press (Q8), European average 13%

for Sweden, as the Swedes generally have a high consumption of written press too (table 13).

4 Attitude

4.1 Public support

With regard to the attitude of the public, the NEARCH survey showed that there is a high level of support for archaeology and archaeological research among the Dutch respondents (Q13). An overwhelming majority of 89% indicated that they think archaeology is useful, and almost three-quarters (73%) also thought it is important for the Netherlands to support archaeology (Q14). Moreover, 76% believed that having archaeological remains is an asset for a municipality (Q14), and two-third said that the construction of a road or building would have to be postponed if archaeological remains were found (Q15).

This positive attitude was however not unanimous. There were differences in opinions between age groups that Harris Interactive calculated as being statistically significant; for instance 77% of the young people (18-24) were convinced that archaeology is useful (Q13), against 93% of those aged 60 years and more (see table 20 below). While 81% of the older people (60 and up) thought that having archaeology is an advantage for a town, this was only the case for 65% of the young people (18-24). Moreover, 58% of the young believed that supporting archaeology is important for the country, in contrast to 77% of those of 60 years and older. There was also a bit more support among men than among women, although the differences were not statistically significant. On all of the issues just mentioned, women had a score slightly below the Dutch average. There was also more support among the people in the higher socio-professional category than amongst those in the lower category or the unemployed.

In comparison to the other European countries, public support was considerably less strong in the Netherlands. Although the percentage of Dutch saying they value archaeology equalled the European average of 90% (Q13), with only England and France having lower scores (83% and 89% respectively), only 73% of the Dutch indicated that it is important for their country to support and develop archaeology (table 14), which is the lowest percentage of all evaluated countries. For comparison; in Greece and Italy almost everybody acknowledged that this is important. To give another example, 77% of all participating Europeans indicated that the construction of roads and buildings would have to be postponed when archaeological remains were to be found (Q15). In the Netherlands only 67% thought so. This was in fact the lowest score, followed by that of the Swedes (69%). The highest support was found in Greece, Spain and Germany (81%, 81% and 80% respectively).

The Dutch were the most satisfied with regard to the effort that is being made to maintain the archaeological record; only 40% said too little effort is being made, against the European average of 58%. In Italy this percentage was more than double; 90% thought much more effort should be made. The question is "how we can explain such differences between countries?". Does the Dutch level of satisfaction imply that its heritage management approach is deemed sufficient and effective and that in some other countries there are more concerns? Or does it perhaps illustrate a lack of interest?

While few people were acquainted with the concept of development-led archaeology, or 'preventive archaeology' - as was discussed above (Q22), most European survey participants seemed to support this approach to heritage management. After the questionnaire had provided information on this concept and explained that it was introduced by the Malta Convention, almost all (92%) Dutch citizens subsequently responded that they think development-led archaeology is a good idea (Q24). Most of them (95%) thought the Malta Convention is a good thing as well (Q23). Interestingly, the Italians were the most positive; 98% was in favour of the Convention. Italy also had the highest number

Sweden	Germany	Netherlands	UK	France	Italy	Spain	Poland	Greece
70	56	54	32	31	26	21	12	7

Table 13 Share of the population reading the written press (almost) every day, in 2014 (source: http://ec.europa.eu/public_opinion/archives/eb/eb82/eb82_media_en.pdf)

Greece	Italy	Spain	Germany	Poland	England	France	Sweden	Netherlands
95	94	85	82	82	81	81	77	73

Table 14 Share of the NEARCH survey respondents agreeing that it is important to support and develop archaeology (Q14). The European average was 83%

(95%) in favour of the concept of preventive archaeology (Q24). This is interesting as Italy was the last country to ratify the Malta Convention and implement the principle of development-led archaeology. In fact, Italy had not yet ratified the Convention when the survey was conducted, this happened only afterwards, on June 30th 2015 (table 15). The Germans were the least positive about the concept of preventive archaeology; they had the only negative score (9%) which was higher than the European average of 7%.

4.2 Responsibilities

When asked *who* should manage archaeology and whether the survey participants consider it the state's duty (Q18), 60% of the Dutch agreed, with males being particularly convinced (68%, against 53% of the females). A remarkably large group of 29% of the youngest respondents (18-24) disagreed, against 15% of those of 60 and above. For them it is apparently less self-evident that the state should be in charge. There were no real differences in the answers between people living in the different Dutch regions, but there were some differences between the socio-professional categories. Two-third of the people in the SPC-plus category agreed on the role of the state, against 55% of the inactive people and 56% in the SPC-minus category.

The response to this question (Q18) further illustrates the considerable differences in opinion between the participating countries. The British citizens were the least convinced that it is the State's task to manage archaeology; the European average was 65%, but only a minority of 42% of the British said so (23% disagreed, 35% did not know). The strongest proponents of a state-driven management system were the Italians, of whom 86% agreed, followed by the Spanish and the Polish citizens, of whom respectively 76% and 74% agreed.

When it comes to financing archaeology (Q19), the national government was at the top of the list for a large majority (75%) of the Dutch respondents. The European public thought so too (the European average was 75%), although the scores did differ from one country to another. The Swedes and British scored below the average, with 63% and 68% respectively. The government was chosen most often by the Italians and Greeks (respectively 84% and 82%).

Interestingly, only 20% of the Dutch put 'people undertaking building work that requires archaeological research' – usually referred to as 'disturbers', often consisting of developers, but also farmers and ordinary citizens building a house or a shed – at the top of their list of parties that need to finance archaeology. This is remarkable, as in practice disturbers are the prime funders of archaeological research in the Netherlands.

A small minority of 8% of the Dutch selected 'inhabitants through taxes', which was less than the European average of 12%. Most positive about the tax construction for funding archaeology were the Swedes, as 20% indicated inhabitants could pay taxes to pay for archaeology. 'Sponsoring through donations' was selected by only 29% of the Dutch, versus 44% for Europe as a whole. In fact, of all European participants, the Dutch were least in favour of asking sponsors to take part in financing archaeological research. The French were most positive about this option (56%). Together with 40% of the British, the French (39%) were also the most positive about asking the disturber to pay for the archaeological excavations that their building activities may cause.

Among the Dutch participants, no significant differences were found between the two gender groups. There was however a difference in opinions between the age categories. Of the young people (age 18-24), only 55% selected 'the national government', versus 81% of those aged 60 and older. As already indicated above, the young did not think of the authorities as the prime actor. When trying to contextualize this discrepancy, the perception of authority amongst younger individuals must be taken into account. Bruggeman (2000) demonstrated that young people do think that local and national authorities play an important role in society, but they also have a rather negative image of these authorities. Panel discussions had shown that young people are more negative than positive about the performance of authorities (idem, 97) as they are not very accessible for young people due to a lack of transparency and the use of complex wording and jargon. Consequently, many young people do not have a clear idea of what the authorities actually do (idem, 97). This is potentially part of the explanation as to why young people do not immediately think of authorities as having a leading role in archaeology.

France	Sweden	Poland	UK	Germany	Greece	Netherlands	Spain	Italy
1995	1995	1996	2000	2003	2006	2007	2011	2015

Table 15 The years in which the countries participating in the NEARCH survey ratified the Malta Convention (source: http://www.coe.int/en/web/conventions/full-list/-/conventions/treaty/143/ signatures?p_auth=3RBz9R9M)

4.3 *Personal interest*

Despite the high level of support among the Dutch, they showed much less emotional attachment and interest in getting personally involved (Q14). In fact, of all European survey participants the Dutch were the least interested in archaeology (45%, against the EU average of 62%) and showed almost the least attachment to it (44%, against the EU average of 54%). Only the Poles showed less attachment (41%). The French, Greek and Swedes showed the highest levels of interest; 63%, 62%, and 62% respectively.

A typical example of this low interest is that 64% of all European respondents would agree to add archaeology to the subjects taught at school (Q14), while only 45% of the Dutch did so, followed by the Poles (48%). The Greeks and Italians were most in favour, 85% and 80% respectively. The Dutch were also the ones that were most satisfied with regard to the amount of information that is available on archaeology (Q15); only 50% indicated there is too little, against 86% of the Italians and 77% of the Poles (the European average was 69%). Together with France, the Netherlands also had the lowest number of people complaining about the attention to archaeological history in museums (both 44%, against the European average of 58%). The Italians (78%) and the Poles (67%) were the least satisfied with what so far had been offered.

Within the Dutch respondents group, there was some disagreement on several issues. For instance, the youngest people (18-24) were much more positive than the others about the level of knowledge dissemination that is going on (Q15); for only 36% it was too little, against 61% of the age category of 35-44, and 54% of the 60+. Men and women disagreed with one another as well; a majority of the males (56%) indicated there is too little information on archaeology available, against only 45% of the women. Moreover, more males (49%) than females (39%) wished to see increased attention to archaeology in museums. The higher educated people, those with the jobs in the SPC+ category, were also slightly less satisfied than those in the other socio-professional categories. Inactive people showed much less attachment (35%) to archaeology than those in the SPC+ category (50%).

These differences suggest that those who match the profile of typical participants – and probably participate most – want to have more, while the segments that participate less (or hardly at all) seem to be satisfied as it is. This actually matches the results of an evaluation among 401 participants of the national days of archaeology of 2015. When people signalled weak points regarding the content of the event, these almost exclusively (86%) concerned wishes for more; more information, more activities, more participation opportunities, etc. (Van den Dries *et al*. 2016).

4.4 *Interest in getting involved*

Despite the fact that a large number of Dutch participants indicated in the NEARCH survey to be (highly) interested in archaeology, only 14% indicated an interest in studying archaeology (Q9). In comparison with the European average of 27%, this number is quite low (table 16). In fact, of all participating countries, the lowest interest was measured in the Netherlands, the highest among the French.

For the Netherlands, no major differences were found between the various socio-professional categories, but there were disparities between gender groups, with most interest being measured among females, both across Europe (29% against 24% of the males) and in the Netherlands (16% versus 12% males). Among the Dutch, the age group of 35-44 showed the strongest interest in studying archaeology (26%). Surprisingly, interest was lowest among respondents between 18-24 years of age (12%) – the group of potential students – and those of 60 and above (8%), while across Europe young people (18-24) had the highest interest (34%).

The fact that females have a higher interest in studying archaeology is also reflected in the student numbers at the Faculty of Archaeology of Leiden University; since 2008 female students have outnumbered male students every year, in all three levels (bachelor, master and research master).[10] This may however not necessarily or exclusively be related to archaeology, as the overall trend of the last couple of years has been that slightly more female than male students start a university training (51.5% for 2015).[11] Nevertheless, it can be seen that on average in Europe there are slightly more female archaeologists (50.7%) working in archaeology (Aitchison *et al*. 2014, 30). In some countries, like Greece and Italy, there is even a strong dominance of women in the profession, with proportions of 76.3% and 70.8% respectively (idem 2014, 27).

France	**Sweden**	**England**	**Greece**	**Italy**	**Spain**	**Poland**	**Germany**	**Netherlands**
38	34	29	28	28	28	25	15	14

Table 16 Share of the NEARCH survey respondents indicating an interest in studying archaeology (Q9). The European average was 27%

The Netherlands also had the lowest number of people (40%) who would want one of their children (or other young relatives) to work in archaeology (Q14). The European average on this was 49%. Most interested in having a relative working in archaeology were the Greek and Italians (both 59%). The Dutch that were designated to the socio-professional plus-category due to their job, showed more interest (42%) in having a child or relative working in archaeology than for instance inactive people (34%).

We can only speculate as to the reasons for this relatively low interest in the archaeological profession in the Netherlands, since we have no data available on arguments. Perhaps it relates to the fact that jobs in archaeology in the Netherlands are known not to pay very well (Van Londen *et al*. 2014), although this is the case in many other countries as well. In fact, many Dutch archaeologists are rather well off, as they have a permanent contract (Aitchison *et al*. 2014). Moreover, the Discovering the Archaeologists of Europe transnational report also shows that the number of archaeologists actively employed had grown between 2006 and 2012 in countries like Germany (+88%) and the Netherlands (+75%), while it dropped seriously in Spain (-66%), the UK (-30%), and Greece (-18%) (idem, 21). The Dutch profession nevertheless had some bad press coverage when archaeologists expressed concerns in the media about the lack of work as a result of the economic crisis. Again it is mere speculation whether such expressions have an impact, but we can confidently state that a good salary and having a stable contract are important for young people. In a European survey over two-thirds of the young people expressed concerns about finding a stable job or a long-term contract, 49% were concerned about the level of salary (TNS Political & Social 2015, 14).

The results could also indicate that archaeology as a profession is not very well known, or not popular for other reasons. This may in particular be the case among groups like young Dutch migrants. They seem to prefer jobs not associated with manual labour (Adlouni and Hermsen 2009, 15). Furthermore, it may be an effect of the change in policy. At the end of 2014, Parliament accepted the government's proposal that would abolish the scholarship system as of 2015 and turn the free bursaries into loans.

Unfortunately we lack comparable data from earlier surveys, so we cannot evaluate whether this interest is declining. We do know that the number of new Dutch Bachelor students in general has decreased since 2013 (although Masters numbers have grown) and that this is not related to changes in the national demographic profile of our country (Van Eck *et al*. 2013).[12] In particular, student numbers in the domain of Language and Culture have been decreasing in the last couple of years.[13] Whatever the reason may be for this lack of interest among Dutch students, it is something the Dutch archaeological sector should pay attention to.

5 PARTICIPATION

A final aspect of the NEARCH survey concerned the actual involvement of the public, their level of participation, and their preferences regarding their involvement. More than half of the Dutch respondents indicated (Q7) they had at least once visited an archaeological monument (58%), an exhibition (54%) or a site (53%). Slightly less people had ever read a book on archaeology (42%) or visited a theme park (39%) and only 8% indicated to have ever taken part in an excavation. Participation in the latter case probably was interpreted as 'visiting', since there have been very few opportunities in the Netherlands to actually join an excavation and to actively conduct some digging (see Van den Dries 2014).

Unfortunately, when asked about specific site and museum visits (Q12), participation numbers turned out to be much lower. For example, a large majority had heard of some or most of the larger national museums with an archaeological collection – such as 75% for the National Museum of Antiquities in Leiden and 68% for the Museon in The Hague – , but only 25% and 21% of the respondents had actually visited these. The Hunebed Information Centre in Borger had the highest visitor numbers; 36% of the respondents indicated to have visited it. But again, double the amount (72%) had heard about it.

It could be observed that there was much more participation by men, by the older age categories (age: 45-59; 60 and up) and by people in the socio-professional plus-category. For instance 76% of the men indicated to have watched at least once a documentary about archaeology, against 60% of the female respondents; 27% of the youngest respondents (18-24) said to have visited an archaeological reconstruction, against 51% of those of 60 years and above (Q7). When asked about specific visits to museums or site parks, the differences between the socio-professional plus (SPC+) and minus categories were considerable; 32% of SPC+ had for instance visited the National Museum of Antiquities, against 18% of SPC-; 32% of the SPC+ had visited theme park Archeon, against 21% of SPC- category.

The results also indicated that people mostly visit heritage places that are close to their hometown; much more respondents from the northern region had for instance visited the Hunebed Information Centre in the northern part of the country, while those living in the western part had paid more visits to the museums and parks in that region. The preference for culture and leisure destinations within a short distance of one's hometown is something that has been observed in other studies as well (*e.g.* Harms 2006; Van den Dries *et al.* 2016).

Visitation and participation numbers in the Netherlands were in most cases significantly lower than the European average (Q7). For example, 76% of the European respondents indicated they had at one point visited an archaeological landscape or monument, against 58% of the Dutch (table 17); 70% visited a site, against 53% of the Dutch. The average for exhibition visits was 64% for Europe; 54% for the Netherlands. The numbers on participation in excavations were lower in the Netherlands as well, with 8% for the Dutch and 11% on average for Europe, as were those on reading a book or magazine on archaeology; 56% on average, against 42% for the Netherlands. In total, the Dutch scored below the average on 8 out of 15 activities and on all of these 8 they had the lowest count. To compare, the people in England scored below average on 14 out of 15, but had the lowest score on only 3 of the activities. The Italians participated more than on average on all 15 activities, the Greek on 11 out of 15.

A lack of participation by the Dutch was also visible in other aspects of the survey. For example, only 12% indicated to have gained information on archaeology through visits to sites during trips abroad (Q8). The European average on this was 24%, and only the Poles scored less (10%). In particular, those Dutch having a job that was designated to the lower socio-professional category and inactive people indicated not to be informed through such visits (both only 9%). For the SPC+ category this was 17%.

The Dutch paid relatively few visits to the most famous World Heritage sites (Q12). In fact, they scored below the European average with their visits to 5 sites, including the Acropolis, Pompeii, the Pyramids of Giza, and Carthage (Tunis). A clear exception were the Dutch visits to Stonehenge; 12% indicated they had visited the site (against the European average of 10%). The highest number of visits to Stonehenge were nevertheless paid by the Germans, Italians and Swedes. In those countries 13% of the respondents said to have paid a visit to it. This time the Greek scored lowest; they had paid the least visits to all 14 sites (the Acropolis was excluded from their questionnaire as a site abroad). The Italians again had the most scores above the average, followed by the Spanish; on 4 sites both had significant higher counts than the average. Overall, the average percentage of the Dutch that had visited at least one of the sites was smaller than most other countries (table 18).

These figures match other data on travelling behaviour rather well, except for Spain. They include Germany, the United Kingdom, France and Italy in the top-10 spenders in international tourism.[14] The high percentage for Spain deviates from these figures and is puzzling, as it also had far less international airplane departures in 2014 than for instance the Netherlands; 11,783,000 against 17,928,000 for the latter.[15]

There were some noticeable differences between the Dutch subgroups. Males had visited many more of the famous World Heritage sites than females; 7% of the men had for instance been to Machu Picchu (Peru), against 2% of the females; 52% of the men said to have heard of the city of Teotihuacan (Mexico), against 36% of the women. It did not come as a surprise that many more people of older ages had visited more of these sites than the youngest people (18-24). It was a bit more surprising that significantly more people in the socio-professional category + had paid visits to these sites than those that were inactive or in the SPC- category.

Visits to an archaeological:	Eng	Fra	Ger	Gre	Ita	Neth	Pol	Spa	Swe
monument	69	77	65	96	92	58	73	89	67
site	59	73	69	95	88	53	49	79	67
theme park	17	33	17	54	63	39	71	40	29
exhibition	52	58	62	58	77	54	72	80	59

Table 17 Share of the NEARCH survey respondents that have ever visited an archaeological monument, site, theme park or exhibition (Q7)

Spain	Italy	Germany	France	England	Sweden	Netherlands	Poland	Greece
9.7	9.0	8.3	7.3	7.25	7.2	7.0	5.7	3.3

Table 18 Share of the NEARCH survey respondents that had visited one of the 13 World Heritage sites mentioned in the survey. The European average was 7.3%

This difference presumably relates to the expenses involved with travelling to most of these remote locations. However, as the visits to Stonehenge showed a similar discrepancy between the socio-professional categories, while this site is relatively easy to visit for Dutch people and at relatively low costs, the differences in the number of visits between the socio-professional categories also seem to suggest there may be a difference in interests between these groups.

5.1 Wishes and preferences regarding participation

When asked what archaeological period the Dutch respondents would prioritize if they had to select a site or exhibition visit (Q11), no unanimous preference could be distinguished. Prehistory, Classical archaeology (including the Roman Era) and the Middle Ages all got almost equal scores (of 21%, 22% and 19% respectively) and one quarter of the respondents did not choose at all. Interestingly, this pattern of spread preferences was rather similar for the whole of Europe, except that Antiquity had a higher count in Italy (54%) and Greece (60%) (against the European average of 36%).

As this lack of outspoken preference for a particular era among the Dutch has been noticed before (*e.g.* Wasmus 2010)[16], it is important to acknowledge, and should be taken into account by local authorities, in particular when they decide on selection policies. It seems to suggest that the selection preferences of the local authorities as they were found in municipal policy plans a few years ago (Van Vuuren 2010), may not necessarily coincide with the interests of society at large. It must be said however that the question posed in the NEARCH survey was about visiting an exhibition or site, not about selection policies. We do not know if given the dilemma's local authorities are faced with in making selection choices, the public would choose the same.

There were however some differences in interest between the Dutch age categories; young people (age: 18-24) seemed significantly more interested (11%) in younger periods (the modern era) than all other age categories (2-6%). Again, the reason for this is not known, but it could perhaps be related to the fact that the Dutch (primary) school curriculum follows a chronological approach rather than a thematic, in which much more attention is paid to the historical periods than to the Roman period and prehistory. For instance in the 2006 implemented Canon of the Netherlands, which consists of 50 time frames of important events in Dutch history, and which is meant to direct history education, the whole of prehistory and the Roman period is discussed in two frames, the middle ages in seven, the other forty one deal with the modern and contemporary period.[17]

The survey results also indicated a significant difference between males and females with regard to the interest in the middle ages. While for the prehistoric and classical periods no differences were found, less women (16%) than men (23%) showed an interest in the middle ages. As we have recently witnessed a difference in interest in participation between men and women in the context of a community project in Oss (Van den Dries *et al*. 2015, 227), and as the NEARCH survey also showed more interest with women (45%) than men (42%) for participating in an excavation, the question could be raised how well the outreach activities, outreach products (like books and movies), and exhibitions that so far have been on offer, have suited the interest and wishes of both men *and* women. Could there perhaps be a causal connection between their interests, the engagement options offered, and the participation levels that are lagging behind for women? This question is further fuelled by the fact that we found a larger interest in consuming archaeology and in participating with older males, but a larger interest in studying archaeology among young females.

Another interesting outcome of the survey is that 72% of the Dutch respondents would like to visit an archaeological site in their own country, 43% would like to take part in it, and 32% have a wish to be involved in the decision making process in case of a nearby archaeological project (Q16). Males were overall more interested than females, and in particular in taking part in decision making processes (39%, against 26% of the females). People in the higher job category (SPC+) were also more interested in joining an excavation (46%) and in making decisions (40%) than inactive people (36% and 23% respectively). The same was the case with people between the age of 25 and 34; 63% wanted to join an excavation, 46% had an interest in decision making. With those of 60 and up this was only 33% and 32% respectively.

Even though the interest in getting actively involved in fieldwork or in participatory governance was not expressed by a percentual majority, the results do indicate that there is a demand for this in at least forty per cent of the population. This result was expected based on previous small scale quantitative and qualitative studies conducted or supervised by the current authors (*e.g.* Amsing 2015; Lampe 2010, 39; Van den Dries *et al*. 2015; Van der Heijden 2016; Wasmus 2010; Wu 2013), and can now be consolidated on a national scale with the NEARCH 2015 data. Perhaps this can provide a stimulus for the national, regional and local authorities to develop a more participatory approach to heritage management, as this is not yet practiced in the Netherlands (see also Amsing 2015; Van der Heijden 2016).

While on the one hand this public interest in involvement in governance issues is encouraging, it is on the other hand again a figure that is significantly lower than the European average of 51%. In fact, of all respondents the Dutch showed the least interest in what we could call participatory governance. In Italy for instance, 62% had an interest in taking part in a decision making process, in Greece and Poland this was 57%. The question remains whether this relatively limited interest among the Dutch represents their lack of interest or their confidence that the people in charge are doing fine. In any case, there were several other indications that interest levels are relatively low; for instance 43% was interested in participating in an excavation, against 61% of the other Europeans, and 73% of the Greek. Moreover, 29% of the Dutch would like to attend a conference on archaeology (Q16), against a European average of 52%. The Netherlands also counted the lowest number of people that would be interested in contributing to funding an archaeological excavation (table 19).

Among the Dutch respondents, the lowest interest in visiting an archaeological site was observed in the younger age groups. Of those between 18 and 24 years, 54% showed an interest in visiting an archaeological site, compared to 81% of the people between 45 and 59 years of age (Q16). This matched the other data on young people, showing their often deviating opinion and image of archaeology (table 20). Only 58% of 18-24 years also said that it is important to support archaeology (Q14), compared to 77% of the elder people. Moreover, 22% of the young thought archaeology should be added to the subjects taught at school (Q14), against 51% of respondents of 60 years and above.

Diverging patterns of interest in cultural heritage and participation for young people were found in other national and international surveys as well (*e.g.* Van den Broek *et al.* 2009, 35; TNS Opinion & Social 2013, 17). These surveys illustrate how difficult it is to attract young people and to entice them into participating. As an additional example, a master student study at Leiden University on how digital technology could help to attract youth, demonstrated that young people (16-24) would nearly all like to see a more intense use of digital technology in museums, but that they would only be persuaded to visit these museums if the experience exclusively used virtual reality (Ottolander 2015). However, a remarkable shift happened in the NEARCH survey when people were asked if they would like to take part in an excavation (Q16). This time older people showed the least interest (32% of the 45-59 years of age; 33% of those of 60 and above) and those between 25-34 the most (63%).

6 Trends in the Netherlands and beyond

Even though a comparison of images, attitudes, interests, support and participation between Europeans shows some comparative results for the Netherlands that could be considered disappointing, when we compare the results from the 1996 and 2015 surveys, some positive developments can be noted. Through the NEARCH survey we learned that more respondents have become acquainted with organisations offering knowledge and outreach activities, from 65% in 1996 to 80% in 2015. For example, the number of people acquainted with the National Museum of Antiquity (Leiden) went from 45% to 72%. For theme park Archeon (Alphen aan de Rijn) percentages went up from 55% to 80%, and for the Allard Pierson Museum on classical archaeology in Amsterdam even from 4% to 43%. Additionally, some visitor numbers have gone up as well; in 1995 7% of the respondents had visited Archeon, in 2015 this was 26%. Interest in participation has increased as well; in 1995 35% was interested in visiting an excavation (NIPO/AIC 1996, 19), in 2015 this was 43%. Furthermore, the overall perception of the value of archaeology has changed; in 2015 89% indicated archaeology to be 'useful' and 'of great value', while twenty years ago this was only 56%.

Italy	Poland	Sweden	England	Germany	Spain	Greece	France	Netherlands
36	36	34	32	32	31	26	24	23

Table 19 Share of the NEARCH survey respondents that was willing to contribute to the funding of excavations (Q16). The European average was 30%

	18-24 years of age	25-34 years of age	35-44 years of age	45-59 years of age	60 and more
modern	32	48	61	65	74
moving	77	89	88	92	93
useful	78	85	91	92	91

Table 20 Opinions of the age categories in the Dutch NEARCH survey on the question 'For you archaeology is?' (Q13)

Unfortunately, there are some downward trends as well; while in 1995 28% of the respondents showed *no* engagement with archaeology, twenty years later this is 48% (Q14). In 1996 archaeology was *not* popular among 43% of the respondents, in 2015 this number had grown to 48%.

Something which has not really changed, is how archaeology is primarily associated with education; in 1996 61% of the respondents associated archaeology with 'learning', in 2015 56% associated it with 'knowing'. This seems to be the pattern across the board, as other NEARCH survey participants had a similar association, if somewhat less strong. It is also a relation that is persistent as it was for example discussed in 1996 by the European Association for Tourism and Leisure Education Project that learning usually is one of the main motives for cultural heritage tourism (Richards 1996, 24-25) and that it almost directly emanates from education. A clear example is how 'Most of the early Grand Tourists were aristocrats for whom a trip to continental Europe was often a coda to a classical education' (idem, 11).

Another constant result throughout the years is the over-representation of older males with a high level of education (and better paying jobs) in visitor numbers. In 1996 a clear relation was noticed between interests in participating, age and living standard; heavy users were 45+, mostly males with a high level of education and good living standard (NIPO/AIC 1996, 18). The higher the level of education, the higher participation levels were. This was still the case in the NEARCH survey, and an evaluation among the visitors of the first Dutch national archaeology days (of 2015) confirmed it too. In this evaluation 54% of the visitors (not including children) acknowledged to have been in higher education (Van den Dries *et al*. 2016). It can be considered a general and continuous pattern, as various studies through time and across countries have made similar observations (*e.g*. Richards 1996; Van den Broek *et al*. 2005; Kraaykamp *et al*. 2014), that we are missing out on large groups in society, like the lower educated, the disabled, and migrants (*e.g*. Fujiwara *et al*. 2014; Kraaykamp *et al*. 2014; Prescott 2013). Richards for instance concluded in 1996 that 'In general, cultural tourists can be characterized as having a high socio-economic status, high levels of educational attainment, adequate leisure time, and often having occupations related to the cultural industries.'(45). The TNS Political & Social survey of 2015 on the European youth also said that 'The main socio-demographic difference is by level of education. Respondents who finished their education at the age of 20 or over are more likely to have participated in a cultural activity (91%) than those who ended education at the age of 16-19 (85%) or at the age of 15 or under (74%). The difference is greatest in relation to visits to monuments or attractions (70% of those who finished their education at the age of 20 or over, decreasing to 43% of those who ended education at the age of 15 or under)'(7).

These observations lead to the conclusion that even though we have seen increasingly intense public outreach activity in the past three decades, the sector does not seem to have reached a wider audience than twenty years ago. It is doubtful whether many people from the group of potential participants that NIPO/AIC distinguished (1996, 27), have been reached. Given the fact that these patterns seem to be quite consistent throughout time and present in many countries, it is tempting to simply accept them as unchangeable. There are however some concerns for the future connected with these trends. One particularly worrying trend is that young people do not seem to have a very positive image of archaeology and that student numbers have decreased. As young people are the future generation of professionals and our future consumers and participants, this should alarm the sector and its training institutes.

Moreover, as in both the Netherlands and Europe as a whole population demographics may, and probably will, change - given the current and expected migration figures - and as new heritage policies (like development-led funding) have made the sector more dependent on public support than ever, it is worrying that an actual feeling of being involved is felt only by a small segment of the population. What may for instance happen with the local (financial) support for archaeology if this segment decreases or loses power? What could happen in case of a growth of the segment of young people in local demographics? Or of migrants or other people that do not feel connected to archaeology?

7 To conclude

Based on the 2015 NEARCH public survey among 500 Dutch citizens, it can be concluded for The Netherlands that in comparison with the NIPO/AIC survey results from 1996 there is a fair amount of public support for archaeology, as a large majority, larger than in 1996, thinks it is useful. There is however little accurate knowledge among the Dutch about what is actually going on in archaeological heritage management. They also do not particularly consider archaeology useful as an economic asset or a leisure activity, or as a contributor to sustainable development, or one's quality of life. Rather, archaeology is primarily associated with science and as a useful element in the context of education and learning. Moreover, within some segments of the public the image of archaeology is not overly positive. Particularly young people think of it as rather out-dated. A positive evolution is that overall visitor numbers have increased, albeit mostly within the profile group that keeps being overrepresented namely well-educated older males. There is however far less interest in the results of public engagement efforts and in participating than in other

European countries. And what's more, there seems to be a low intention among the underrepresented profile groups to get involved in archaeology in the (near) future, in any case percentages are lower than with the other European citizens. The data gained through the 2015 NEARCH survey and the other surveys it was compared to, show the invaluable information that can be gained from directly questioning the public on their perceptions of archaeology. This information is essential in aiding researchers to create new policies and develop alternative strategies to get a wider audience connected to and involved in archaeology.

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Notes

1 The authors are partners in the NEARCH project. Monique van den Dries represents the Faculty of Archaeology (Leiden University) as the project leader. She supervises the activities and studies conducted in this context. Krijn Boom is involved as a PhD researcher. His study focuses on the effect of archaeological activities on (local) communities and how this can be measured and analyzed.

2 www.nearch.eu.

3 This is less than the 3,000 that took part in the NIPO/AIC survey of 1996, yet this number is representative for the 17 million inhabitants the Netherlands has (Source CBS 2016).

4 Harris interactive uses access panels to ensure the reliability and representativeness of the results. These panels consist of 2.5 million members for Europe from which they can invite people to join.

5 Harris Interactive uses the socio-professional category +, which includes the job categories 1: Business owner; artisan; merchant or similar occupation; 2: Independent professional (*e.g.* doctor, lawyer, or architect); 3: Business manager; government agency staff member; intellectual, creative occupation; 4: Staff professional (*e.g.* technical expert, supervisor, teacher, or nurse) 5: Farmer. The socio-professional category – includes the job categories 1: office worker; 2: Labourer.

6 The survey consisted of 28 questions, indicated in the text as Q1 – Q28. The results are available on www.nearch.eu; see also Kajda *et al*. forthcoming for an interpretation of the results by the NEARCH team.

7 The report provided by Harris Interactive indicates when the differences between the categories are statistically significant.

8 In the Drents Museum (Assen) more than 350,000 visitors were counted in 2008 (http://www.volkskrant.nl/ recensies/bezoekersrecord-voor-terracottaleger-in-assen~a890188/). Close to the Dutch border, in the Minderbroederskerk (Maaseik, Belgium), 190,000 visitors were counted in 2008/2009 for the same exhibition (http://www.demorgen.be/binnenland/organisatie-wil-terracotta-leger-xi-an-naar-ieper-halen-badb99ef/).

9 See www.nationalearcheologiedagen.nl.

10 Personal communication Femke Tomas (Faculty of Archaeology, Leiden University), based on '1cijferHO' (status October 2016).

11 http://www.onderwijsincijfers.nl/kengetallen/wetenschappelijk-onderwijs/deelnemerswo/eerstejaars-in-het-wetenschappelijk-onderwijs

12 See http://www.pbl.nl/sites/default/files/cms/publicaties/PBL_2013_Demografische%20ontwikkelingen-2010-2040_1044.pdf.

13 The number of new bachelor students in Language and Culture decreased from 5795 in 2009 to 4154 in 2015 (source: http://www.vsnu.nl/f_c_ingeschreven_studenten.html).

14 http://www.tourism-review.com/top-spenders-in-international-tourism-news3766

15 See for Spain: http://www.indexmundi.com/facts/spain/international-tourism. See for the Netherlands: http://www.indexmundi.com/facts/netherlands/international-tourism.

16 Most people (66) in this survey liked all periods equally well; 44 had a preference, but altogether the differences were small, with 12 in favour of the Roman period, 12 for the middle ages, 7 for prehistory and 3 for the period after 1600 (Wasmus 2010).

17 http://www.entoen.nu/en

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Monique H. van den Dries and Krijn Boom
Faculty of Archaeology
Leiden University
PO Box 9514
2300 RA Leiden
The Netherlands
m.h.van.den.dries@arch.leidenuniv.nl
k.h.j.boom@arch.leidenuniv.nl