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RESEARCH ARTICLE

New chronological research of the late Bronze Age in Scandinavia

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The concept of time dominating in archaeological science differs widely from that of prehistoric cultures. Still, 'time' is one of the most important criteria for the reception of cultural and historical processes. Compartmentalising time creates artificial breaches, used as methodical means of breaking down the continuum. This article analyses the currently valid chronological concept for the late Nordic Bronze Age created by Evert Baudou with the objective of finding possible toeholds for further subdivisions. Baudou's generous conception of the time periods IV–V makes the realisation of chronological adjustments very difficult. Using Baudou's catalogue of Danish grave finds, the author tries to further subdivide these time-horizons with the help of a correspondence analysis. By making use of several intermediate steps, it is possible to discern two more temporal subdivisions within the devolution of periods IV–V. The existence of these four phases is supported by ^{14}C-dates.

Keywords: Bronze Age; grave finds; correspondence analysis; chronology

Understanding time

The term 'chronology' etymologically derives from the Greek expressions 'chrónos' meaning time and 'lógos' generally translated as 'the study of' – both to arrive at 'the study of time'. However, the term 'chronology' – as used in archaeological science – relates to the study of chronological developments, an order of events, as well as to the establishment of time sequences and/or dates. It seems evident that the contemporary archaeological concept of time differs widely from that of former times and that an archaeologically established chronological order cannot possibly apply to the idea of measured time.

Western civilisation is generally known for being dominated by a linear concept of time. This linearity, however, includes various successions of cyclic elements: days, months and years, which continually revolve. Historiography and the application of a successive order to these cyclic elements results in the establishment of a progressive timeline (Nowotny 1995, Olonetzky 1997), so 'time' as used in our Western civilisation is strongly connected to a progression of singular events. Past time is lost forever (Weis 1995).

On analysing time concepts used by different cultures, one often realises the commingling of varying time concepts that have been developed according to certain rules. The agronomically determined circle (also part of religious belief) may be followed by a linear succession of history accompanied by political and religious power. On the whole, it must be stated that many different aspects of time circulate: the striving to understand the concept of time having persevered in prehistoric cultures can therefore amount to nothing but mere speculation (Bogacki 1999, 40 f., Hölscher 1999). The most important criteria to be taken into account while trying to reconstruct prehistoric time reception are climate and geographical position of the cultures in question. The succession of two to four seasons accompanied by a change of vegetation, winter and summer solstice, as well as astronomical changes of stellar constellations highly depend on the geographic latitude. They are essentials to the determination of the starting point of sowing (Meller 2004, p. 27).

The fabric of time described in this article consists of interwoven cyclical and linear points of view and mirrors the quality of human life. Time may be measured individually or determined by other biological patterns. It is not a given that time necessarily depends on a solitary cyclical system. However, the perception of linear time is only possible by the observation of a succession of events deemed crucial to a society. Nowadays, time may be measured arbitrarily and subdivided down to the smallest fraction of a second. By making use of this time scale, we are able to fix events in a certain order, arranging our immediate past. As van Rossum states, *Zeit hat mit Wahrnehmung zu tun und daher mit Geschichte* [Time relates to perception and therefore to history] (Van Rossum 2003).

Understanding chronology

Archaeological science feeds on quite a different understanding of time than has been hereto ascertained for prehistoric cultures or modern society. The concept of

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time is the major means of every archaeologist for evaluating structures of historical development. Artificially subdividing time into successive compartments is a purely methodical but nevertheless essential tool. As has been surmised by Manfred Eggert in 2001, archaeological science tends to break down the prehistoric sphere into individual time periods, assembled in a linear order. The Stone Age is followed by the Bronze Age and the Iron Age, but – different from what has been pointed out with regard to the circular calendar of modern times, which is divided into months, days, hours and minutes – it is not possible to observe any regularity as to the length of the established periods. Chronological order should be perceived as a structure made of inhomogeneous-sized blocks (or even as a tower of building bricks) reigned by absolute contemporaneity (Eggert 2001, 149ff.).

The archaeological timeline derives from the typological comparison of finds and their assemblage in a closed find complex, the best example still being Montelius' model of time periods: a particular ornamentation style circulates, predominates over a certain period of time and is thereafter replaced by new, equally temporary styles. The succession of such patterns provides the chronological structure of Montelius' time phases. Every individual style undergoes a certain development, from its early occurrence, followed by a time of frequent occurrence and subsequently ending in a gradual receding of occurrence. This model applies to nearly every article of daily use in human society and thus resembles today´s fashion trends. Finding several such objects deposited together in different closed complexes enables the archaeologist to establish a linear time order, as is – in a sense – also the case for statistical methods such as a seriation analysis.

Martin Trachsel lately examined the issue of establishing time phases with the help of typology (2004, p. 14–22). Contradicting Montelius, Trachsel states an acute difference between the period of production and the period

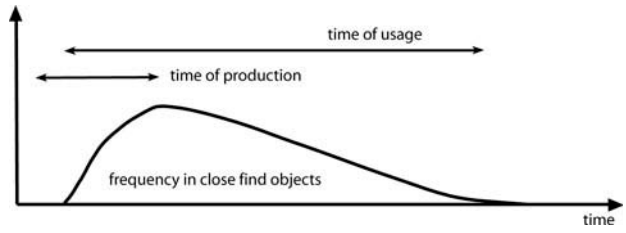

Figure 1. Diagram depicting the frequency of an artefact in relation to time (after Trachsel 2004).

of usage of an object. According to his model, the early form of an object is found together with older artefacts. These have been collected over a longer period of time. Therefore, the 'early' form does not necessarily possess a chronological relevance. The so-called 'late' forms of a pattern or an object have been used longer than the actual production time lasted. Montelius' concept corresponds to the Gaussian distribution, whereas Trachsel's model results in a gradient of steep beginning and a rather flat ending (Figure 1).

The chronological analysis of grave finds holds further problems in store, as Trachsel's example of a mature individual found at Magdalenenberg (Central European Hallstatt epoch), Schwarzwald-Baar-Country (Figure 2), demonstrates: the production times of the different types of finds assembled in this grave varied considerably. The deceased acquired the burial objects at very different times throughout his life. The characteristic of this closed grave complex could therefore lead to the deceptive conclusion of a much longer lifespan than stands to reason. The aim of constituting time periods shorter than 50 years even carries the problem further if the individual lifespan has taken longer than 50 years.

As for the Nordic Bronze Age, Trachsel's assumptions only partly apply. First and foremost, the duration of the time periods IV–V each adds up to over 100 years and

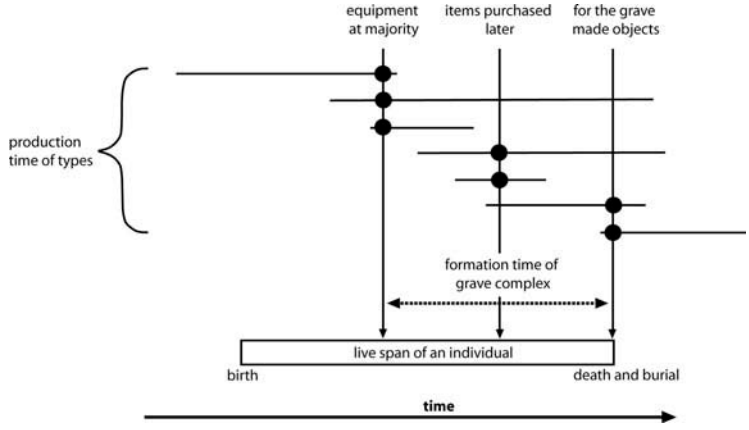

Figure 2. Diagram depicting the relation between the production time of different types of artefacts and the accumulation process of the grave inventory (after Trachsel 2004).

therefore outlast the usual lifetime of human individuals. Furthermore, Trachsel had the advantage of building his chronological tuning on richly provisioned burials common for the Early Iron Age of the South of Germany. Apart from grave finds, Trachsel's approach is barely applicable. Accumulative depositions of settlement debris in a pit are much more difficult to scrutinise than a limited number of finds within a grave. As for the dating of single finds, to determine a precise date within a given time range remains impossible. Therefore, the analogy of a tower of building bricks prevails as the best model for understanding chronological structures based on the assembly of objects along a given timeline. Within one time interval, the objects are absolutely contemporaneous.

Evert Baudou's chronology

Let us now turn to the practical example of the grave finds from the Nordic Late Bronze Age. The chronological framework of Evert Baudou is essential for research into the Late Bronze Age. The succession of types of artefacts established by Baudou with the help of closed find complexes remains valid to this day (Baudou 1960). A further subdivision of the chronological order of finds within the Period IV–V, however, has been fruitless – with the exception of only a few types (Baudou 1960, p. 112). In order to examine material for my doctoral thesis on the stratification of urns displaying anthropomorphic features throughout Northern and Central Europe (Kneisel 2012), the necessity for taking a closer look at these crucial phases arose: only on the basis of a finer chronology was it possible to make supra-regional comparisons. The methodical means of a correspondence analysis (CA) seemed more promising than a seriation, because it is based on the progressive order of groups of artefacts. This order comes closer to a real timeline than our archaeological time periods.

The following analyses presented in this article are based on Baudou's *'Die regionale und chronologische Einteilung der jüngeren Bronzezeit im Nordischen Kreis'* published in 1960. Baudou created a gradation of phases, which he – referring to Montelius – termed Period IV–VI. His results were based on the closed find complexes encompassing the region from Schleswig-Holstein up to Norway. A catalogue has supplemented his work. Baudou took both grave and hoard finds into account, but the analyses presented in this article relate solely to the burial finds. Hoards provide ample ground for discussions about their nature and the chance of determining the correct time of their deposition. Furthermore, this article excludes the finds north of Denmark in order to eliminate the occurrence of regional varieties as far as possible. At first, the data was based on the analysis of 436 graves from periods IV–VI in Denmark and Schleswig-Holstein. The types defined by Baudou are divided into artefact classes like razors, tweezers, pins, buttons, fibula, bracelets and pendants. There are more classes like celts or sickle, which do not appear in graves, but only in hoards. Some artefacts occur very rarely like the swords or knives. Only if the types exist in more than one grave and the grave contains more than one artefact are they included into the analysis. The main artefacts that occur in the following graphs are shown in Figure 3. All the type names used are similar to Baudou's typology (Baudou 1960, tables 1–18). The computing of the data was carried out using the statistical software application WinBASP (Bonn). The established dates for each grave, as have been stated by Baudou, are noted to facilitate a quick overview of the whole material.

First correspondence analyses

Running the first CA resulted in isolating the Period VI finds from the rest of the material (Figure 4). The find complex of Bordesholm, Schleswig-Holstein, (Baudou 1960, Kat. No 13) consisting of a disc-headed pin with straight shaft (TYP XXVB2b), is located between the per. IV–V finds orientated along the Y-axis and the per. VI graves relating to the X-axis. Pins representing this type are usually dated to per. V, but are also known from the occurrence in the per. VI find complex of Vesterby, Fuglsebølle sogn, Langeland herred (Baudou 1960, Kat. No 192). Except for this pin type, no connections between the types of Period IV–V on the one side and Period VI types on the other side occur, which means that in Period VI we deal with a completely new spectrum of types. A chronological progression in this CA is therefore very unlikely and the result of the analysis therefore lacks relevance. In taking this into consideration, the per. VI finds were excluded from further investigation, so that only the per. IV–V finds remained.

Second correspondence analyses

The analyses of the per. IV–V finds did not show any significant chronology (Figure 5).[1] A sequence of per. IV (black) and per. V (grey) can be made out along the second axis, but the burial objects of per. IV spread over a wide range along the X-axis. This scattering pattern can be pinned to several factors, as another figure featuring the same analysis and displaying the different artefact types should help to discern (Figure 6). The distribution of artefact types is marked by the different categories of finds such as razors, tweezers, bracelets, pins and buttons.

(1) The pins (TYP XXXVB1, H2, G1, G2) are fixed in the double positive area, far away from the main finds cluster.

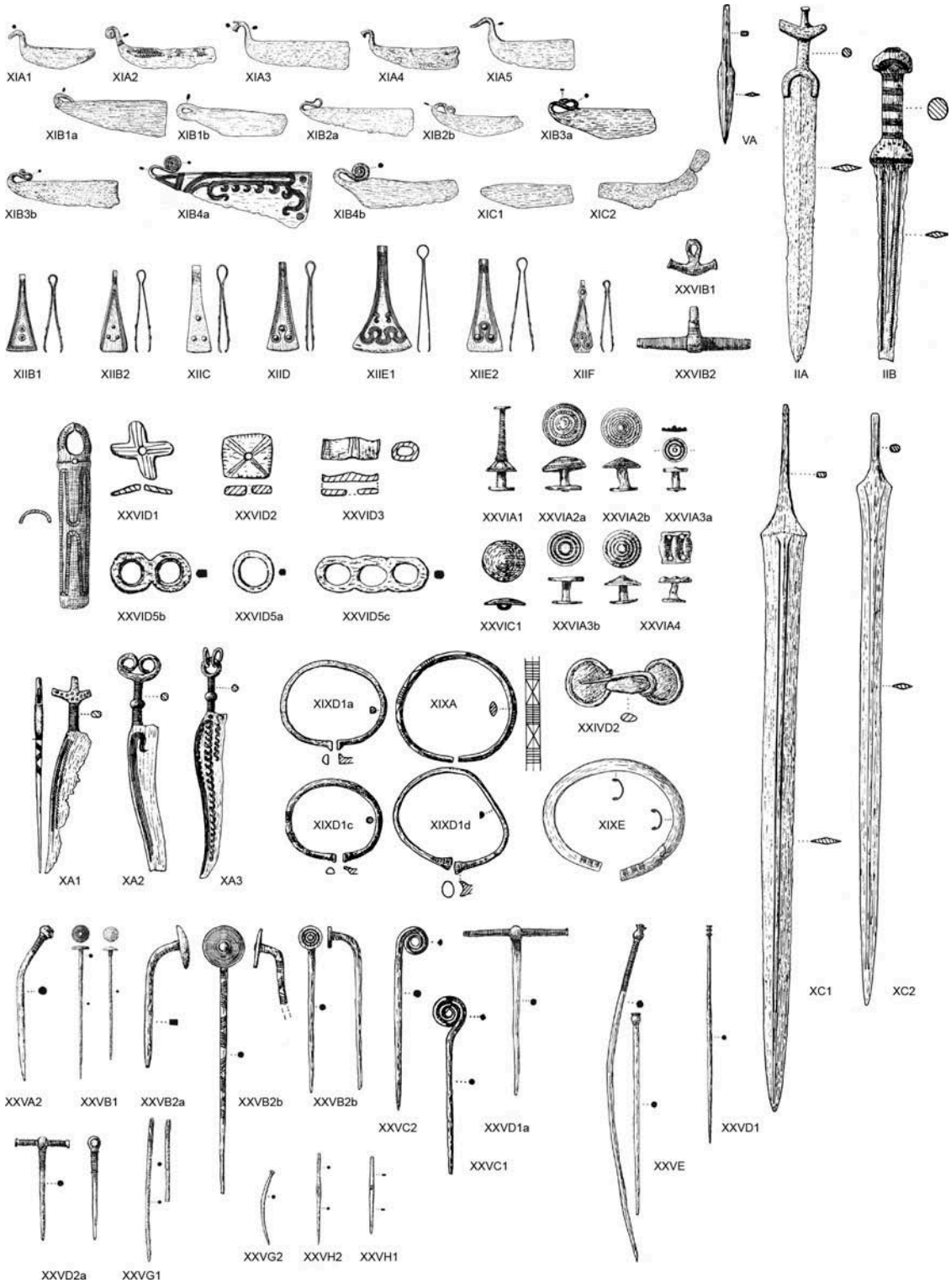

Figure 3. The types of Evert Baudou according the CA in this article Copyright Kneisel 2012. This image is based on Baudou's original tables (Baudou 1960, tables 1–18).

(2) In the lower right quadrant, the types of buttons are located (TYP XXVIC2, D1–D5), as well as the pendant belonging to type XXVII.

(3) The lower left quadrant is occupied solely by buttons belonging to type XXVI A1, A2a, A3–4.

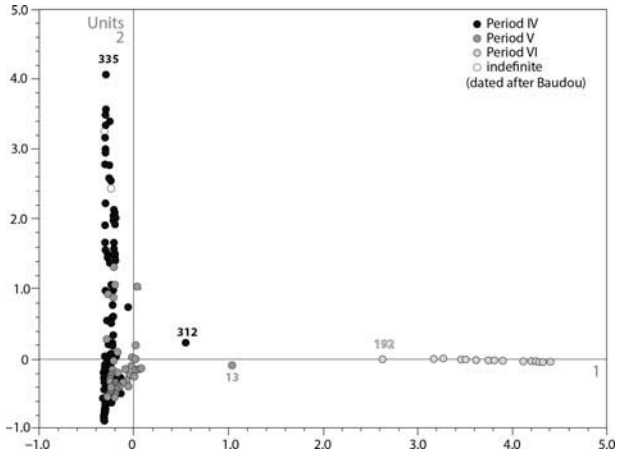

Figure 4. CA of closed grave complexes featuring Baudou's per. IV–VI finds (Baudou 1960). 1st in relation to 2nd eigenvector (Inertia 2.9 /2.7). The numbers refer to Baudou's catalogue.

The different types of buttons seem – with the exception of the button with a loop (TYP XXVIB) – to stay within the negative area of the Y-axis. The analysis of this group reveals that the buttons made of bone cluster on the right side of the diagram, whereas the metal buttons are located on the left. On re-focussing upon the groups of pins mentioned above, which are scattered around X 1.6–2.0 and Y 0–1.0, the noticeable dominance of bone types (three out of four) catches the eye. Therefore, it is more than probable that the X-axis may be interpreted as the division between the materials of bone and metal. However, this division does not necessarily result from chronological matters. Social and regional differences may also be the reason for this remarkable result. To ensure a chronological relevance of the material, social and regional differences have to be ruled out first.

To be able to determine the possible impact of social differences on the result of the analysis, the various combinations of grave goods have to be examined. The graph (Figure 7) displays burial inventories divided into those including buttons and pins made of bone and those containing only metallic objects. The specimens made of bronze (light grey) are listed at a percentage rate based on the total number of graves containing metallic objects. Showing a rate of 62%, razors are by far the most common burial good.[2] Forty graves contain bone pins (grey), which are frequently found together with bracelets, tweezers, buttons, pins, and of those the most frequent combination is with the disc-headed pin type XXVB1 (occurring 26 times). Twenty-four graves held bone buttons (black), which could be found combined with pins, buttons and – less frequently – with tweezers and razors. The most frequent combination of bone artefacts was together with other bone buttons or – as has been the case 11 times – with bone pendants.

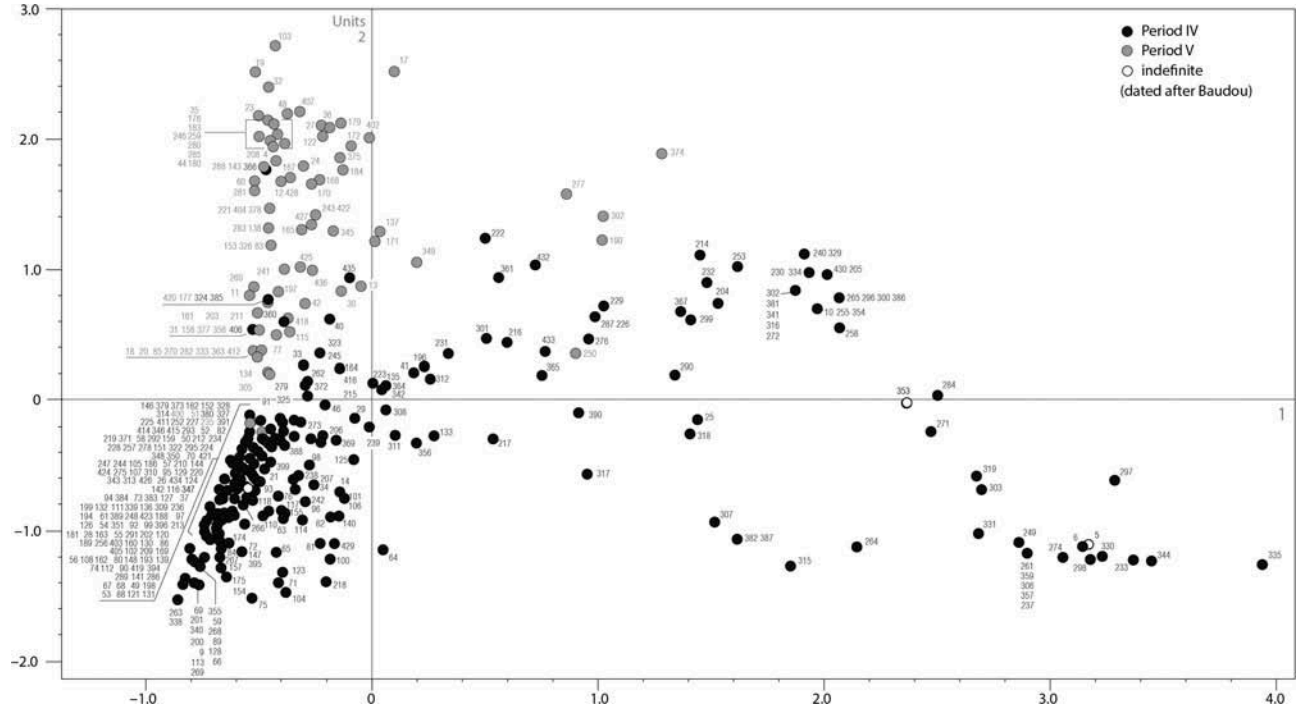

Figure 5. CA of closed grave complexes featuring Baudou's per. IV–V finds (Baudou 1960). 1st in relation to 2nd eigenvector (Inertia 3.0 /2.9). The numbers refer to Baudou's catalogue.

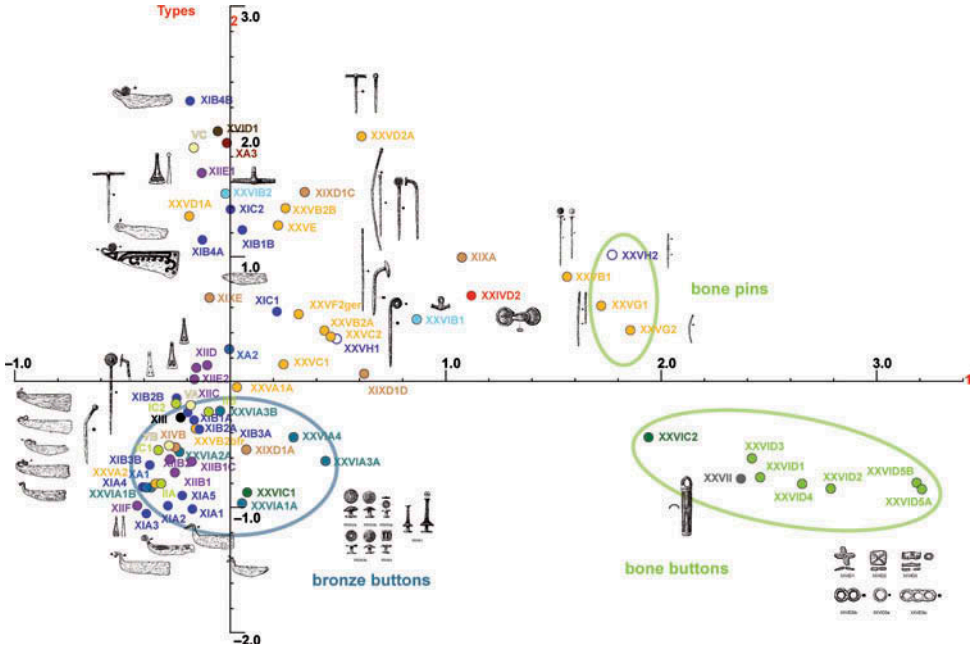

Figure 6. CA of closed grave complexes featuring Baudou's per. IV–V finds (Baudou 1960). 1st in relation to 2nd eigenvector (Inertia 3.0 /2.9). The colours mark the different types of artefacts.

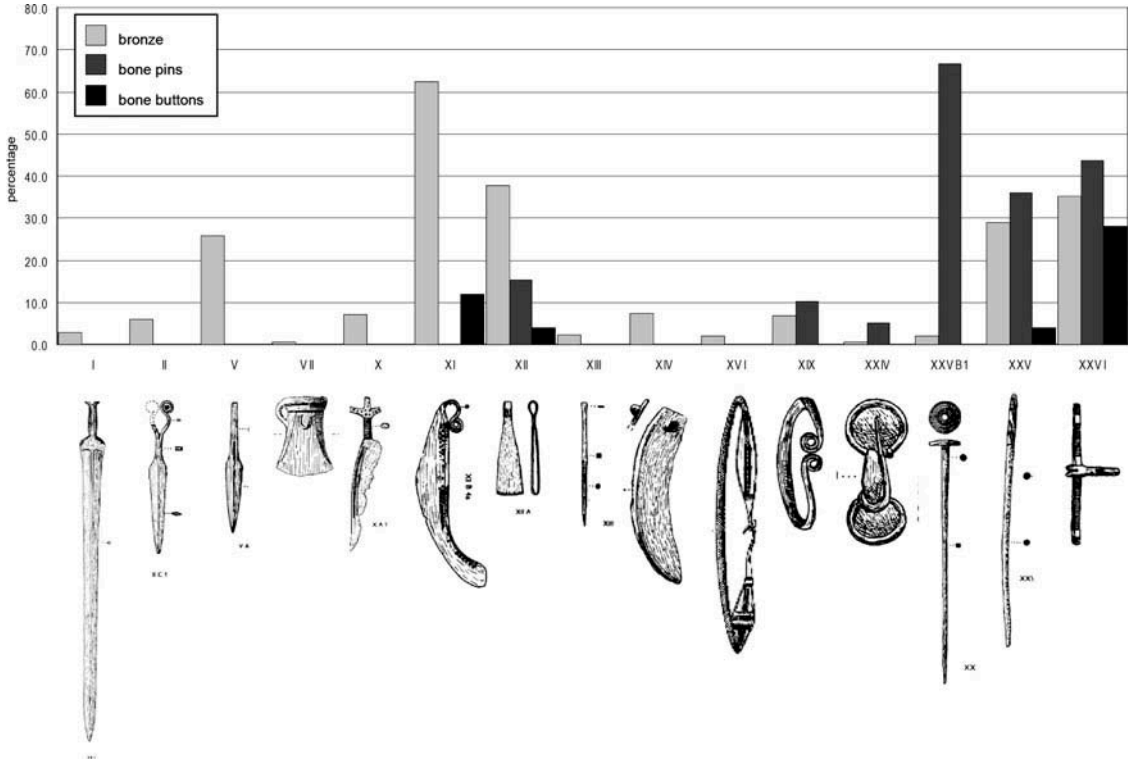

Figure 7. Quantitative distribution of the combination of bronze artefacts, bone pins and bone buttons with regard to the artefact types.

Jewellery seems to be lacking in graves displaying weaponry, a fact that seems to advance an explanation of social division, separating burials with jewellery from those containing weapons. At the same time, a clearly regional explanation seems to leave its mark on the results of the CA. One of Baudou's maps (Baudou 1960, map 51)

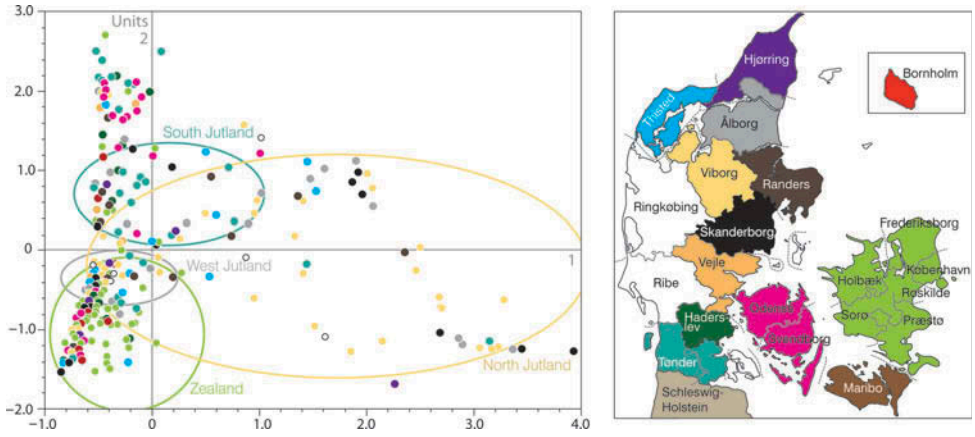

Figure 8. CA of closed grave complexes featuring Baudou's per. IV–VI finds (Baudou 1960). 1st in relation to 2nd eigenvector (Inertia 3.0 /2.9). Colours mark different (now defunct) Danish administration districts (*Amt*).

displays a striking accumulation of bone artefacts in Northern Jutland. In analysing the outcome of the statistical calculation, it is evident that both a social and a regional difference have to be considered.

In order to highlight the regional component, the finds were classified according to existing parish borders and marked by different colours as shown in Figure 8. Four more or less definite locations could be discerned. The buttons made of bone evidently separate the Northern Jutland-Group (right side). The agglomeration of the Zealand-group (bottom left) coincides with the main distribution of bronze buttons called type XXVIA (Baudou, maps 47–48).

On the whole, the following statements sum up the second analysis:

Material difference
- Bone and metal are divided by the X-axis.

Social difference
- The bone artefacts only appear in burials without weapons, thereby enhancing the separating effect of the X-axis.

Regional difference
- Bronze and bone buttons do not share the same areas of distribution. Zealand and Jutland are fairly separable along the X-axis. Several clusters of local groups mark the Y-axis.

The analysis implies an obvious difference between bone and bronze artefacts, defined by material, social, as well as regional aspects. These factors are closely related and emphasise the complexity of the find material.

Third correspondence analyses

It was not possible to state a chronological proposition based on the results of the second analysis. A third calculation was adjusted in order to eliminate the aforementioned aspects and thus had to exclude the buttons (TYP XXVIA, C, D), the bone pendants (TYP XXVII), as well as the bone pins (TYP XXVG1–1, H2). Consequently, the data was reduced to a number of 283 burials. The result displayed in Figure 9 shows an alignment of the finds along the X-axis. The negative range of X is occupied by the graves dated to per. V according to Baudou. The positive range holds the per. IV graves. Furthermore, the grave entities are scattered stray along the Y-axis. Focussing on the combination of the different types of finds (Figure 10), it is once again possible to distinguish between various groupings. One – located in the lower area of the graph – consists of a dominant association of razors and tweezers with pins. A grouping of pins with bracelets can be made out above the X-axis. The upper group mainly contains various types of pins. The second eigenvector (component) seems to correspond with the various patterns of burial equipment. A chronological relevance may be already assumed for the first eigenvector, but only the application of the fourth eigenvector helps to really clarify this quality, due to the inertia-values of the components. The inertia shows little distance variance; wider spacing can only be perceived between the second and third component. Further components only vary on a scale of one decimal place (inertia first axis 3.6; second axis 3.4; third axis 3.0; fourth axis 2.9; fifth to sixth axis 2.8). Therefore, the fourth eigenvector had to be introduced; resulting in a much clearer correspondence map with a nearly parabolic graph (Figure 11(a)). The different types of finds spread along the X-axis. The figure shows the distribution of razors along the two eigenvectors (Figure 11(b)). The early forms represented by types XIA3 and XIB3b dominate the bi-positive quadrant at the end of the curve, whereas the later per. V razors occupy the left-hand area of the graph. The distribution of tweezers or pins displays similar chronological successions.

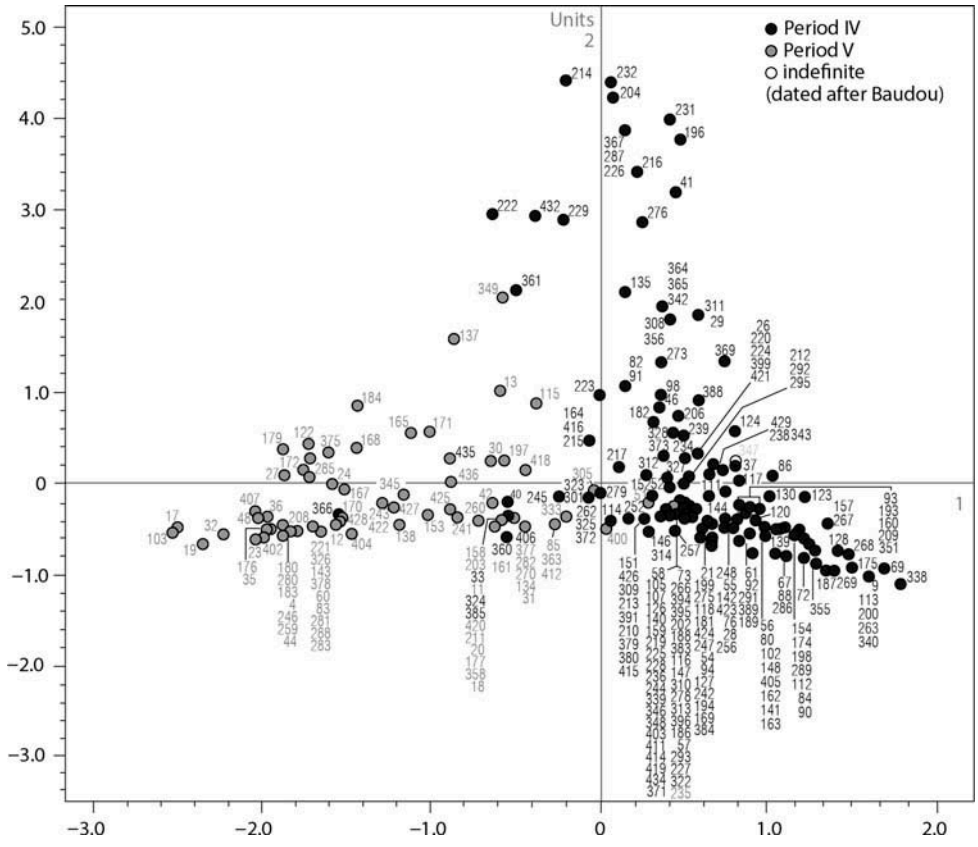

Figure 9. CA of closed grave complexes featuring Baudou's per. IV–V finds (Baudou 1960) excluding bone artefacts and the cluster of bronze buttons from Figure 6. 1st in relation to 2nd eigenvector (Inertia 3.6 /3.4). The numbers refer to Baudou's catalogue.

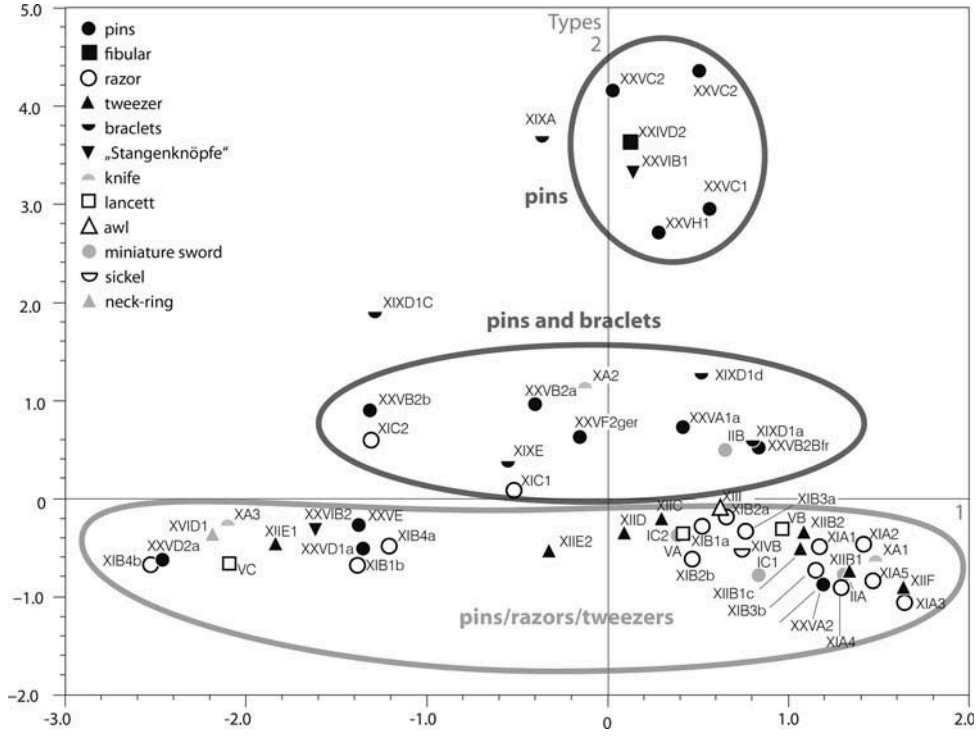

Figure 10. CA of closed grave complexes featuring Baudou's per. IV–V finds (Baudou 1960) excluding bone artefacts and the cluster of bronze buttons from Figure 6. 1st in relation to 2nd eigenvector (Inertia 3.6 /3.4). Colours mark the different types of artefacts.

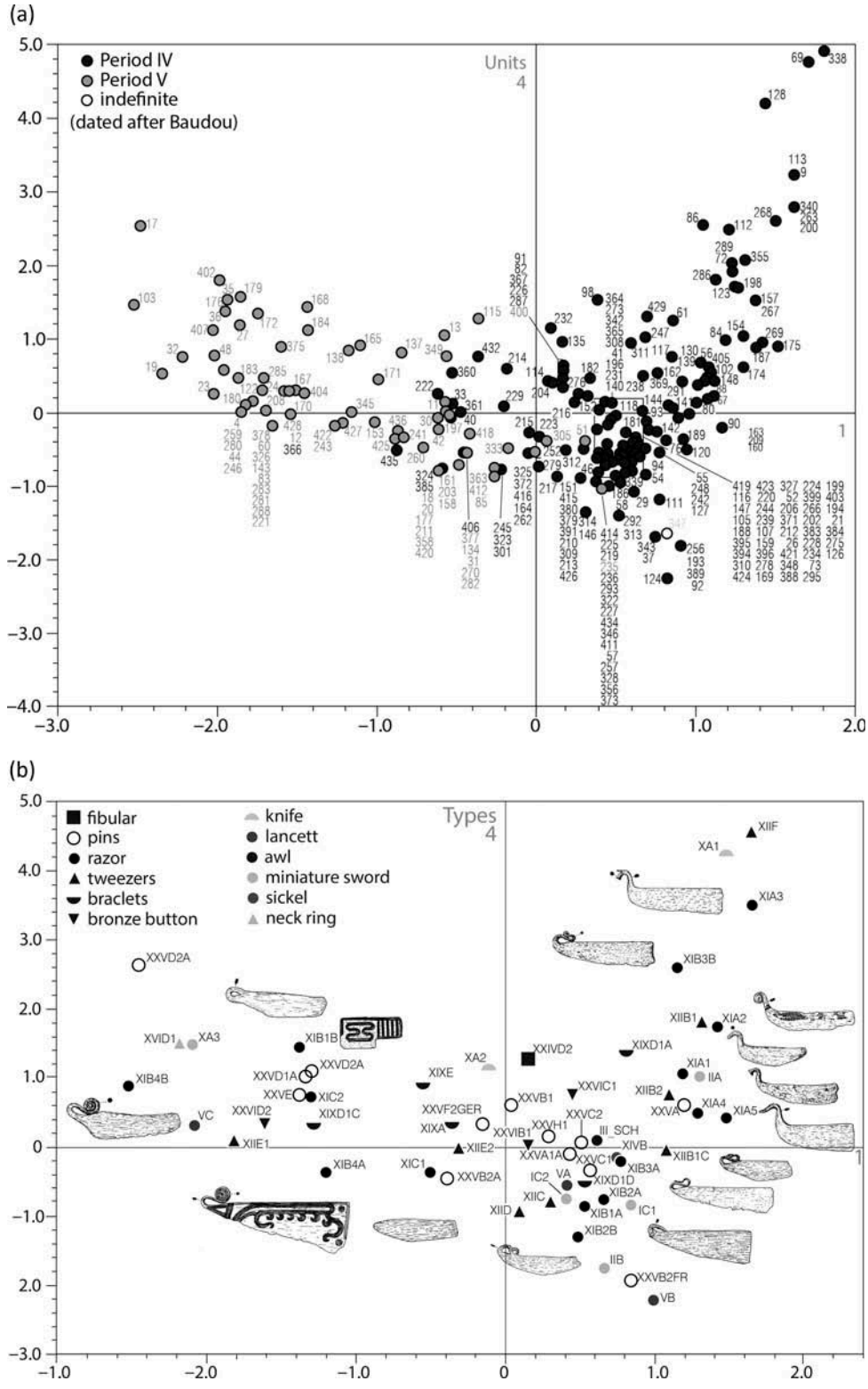

Figure 11. (a) CA of closed grave complexes featuring Baudou's per. IV–V finds (Baudou 1960) excluding bone artefacts and the cluster of bronze buttons from Figure 6. 1st in relation to 4th eigenvector (Inertia 3.6/2.9). The numbers refer to Baudou's catalogue. (b) CA of closed grave complexes featuring Baudou's per. IV–V finds (Baudou 1960) excluding bone artefacts and the cluster of bronze buttons from Figure 6. The distribution of different razors shows the chronological relevance of the parabola. 1st in relation to 4th eigenvector (Inertia 3.6/2.9). Symbols mark the different types of artefacts.

Furthermore, the application of the regional component did not result in an agglomeration along the axes. But still, the chronology had to be verified by independent dates.

Independent dating (^{14}C)

Several ^{14}C-dates are available located in the Scandinavian area of late Bronze Age. However, to ensure the highest possible comparability, only finds containing similar types to those presented and examined by Baudou may be taken into account. Unfortunately, some of the dates belong to Swedish finds, which have not formed part of the analysis. A new one is connected with the house urn from Fardume, Gotland (Sabatini 2007, p. 233). The data also includes the radiocarbon dates published by Vandkilde (Kneisel 2012, p. 56, table 2, Kneisel *et al*. 2013).[3] In addition, a few new dates have been applied: Nørre Dalgaard Syd (*AUD* 1999, p. 312); Rom (*AUD* 2001, p. 291); Lustrupholm (*AUD* 2000, p. 327, *AUD* 1998, p. 299) and Virkelyst (*AUD* 2001, p. 290). Recently published new dates by Hornstrup *et al.* (2012) are also taken into account. They are related to cremated bones and are well-published (see also Olsen *et al.* 2011, p. 265, table 1). Of all known ^{14}C-dates, 25 are applicable to the types of Baudou introduced in the CA (Figure 12 and Table 1). For calibration OxCal 4.2 with IntCal 09 was used (Ramsey 2009).

Context of the ^{14}C*-Dates*

The recently published graves with new ^{14}C-Dates are only briefly mentioned. For a more detailed description, see Hornstrup *et al.* (2012).

Grave of Bjergby, Jutland
See Hornstrup *et al.* (2012, p. 36, figure 25). The grave contains amongst others a button of Baudou's TYP XXVIB1.

Grave J of Gl. Brydegård, Odense
See Hornstrup *et al.* (2012, p. 37, figure 27). The grave contains several grave goods that can be compared with Baudou's TYP XIIE1 (tweezers), TYP XIB4A (razor), TYP XXVIB2 (button), TYP XXVB2b (pin) and TYP VC (lancet) and an iron awl (TYP XIII). Two ^{14}C-dates are taken, which have an R_combine date of 895–824 cal BC in 1-σ range.[4]

Grave B of Fardume, Gotland
The house urn contains a bronze double button, bronze tweezers with ornament lines and three knobs (TYP XIID) and a fragment of a razor, probably TYP XI B or C. The tweezers as well as the razor belong to per. IV or transition to per. V. The ^{14}C-date (St-8854 2525 ± 150 BP 804–431 cal BC) allows us – because of the Hallstatt plateau – only to date the burial into a wide time range from the eighth to the fifth century BC.

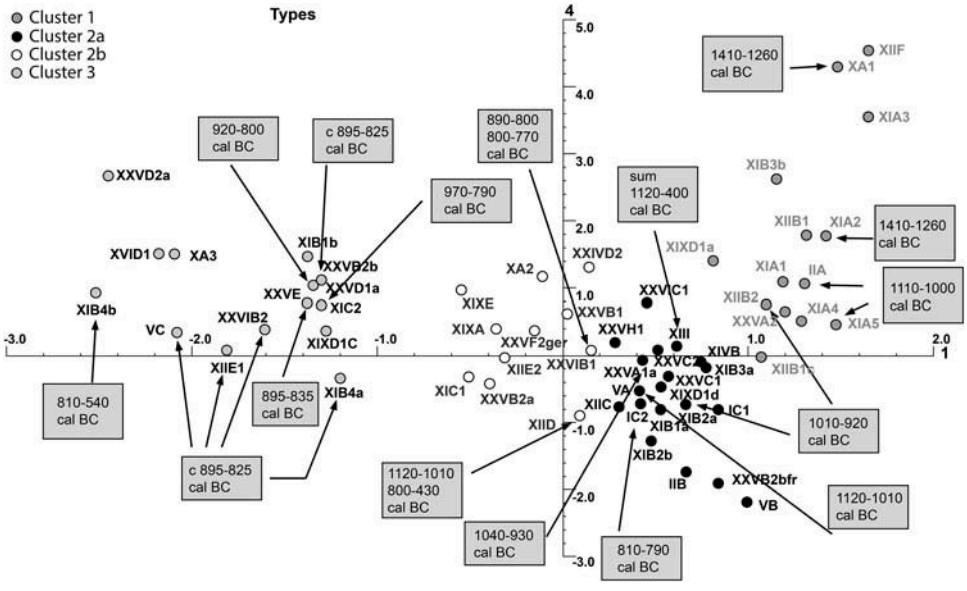

Figure 12. CA of closed grave complexes featuring Baudou's per. IV–V finds (Baudou 1960) excluding bone artefacts the cluster of bronze buttons from Figure 6 with correlation of the radiocarbon dates. First in relation to fourth eigenvector (Inertia 3.6/2.9). Grey-shading indicates the different clusters mentioned in the text.

Table 1. An overview of the dated graves and containing types. Bold, in CA; cursive awls, Type XIII.

Lab	Lab Nr.	Uncal.	Std.	68.2 BC	95.4 BC	Site	Type
AAR	9518	2583	34	-805-769	-820-559	Bjergby	**TYP XXVIB1**, *TYP XIII*
St	8854	2525	150	-804-431	-1005-233	Fardume	**TYP XIID**
AAR	9570	2706	35	-895-818	-914-805	Gl. Brydegård	**TYP XIIE1, TYP XIB4A, TYP XXVIB2, TYP XXVB2b, TYP VC,** *TYP XIII*
AAR	9576	2714	34	-896-827	-922-807	Gl. Brydegård	**TYP XIIE1, TYP XIB4A, TYP XXVIB2, TYP XXVB2b, TYP VC,** *TYP XIII*
AAR	9515	2837	39	-1044-930	-1116-904	Jattrup	**TYP XXVA1a**, *TYP XIII*
AAR	9520	2683	36	-892-805	-902-801	Jersild	**like TYP XXVIB1**, *TYP XIII*
K	3538	2690	80	-924-796	-1055-571	Lusehøj	**TYP IC2**
K	3539	2610	75	-894-567	-930-509	Lusehøj	**TYP IC2**
AAR	9575	2611	33	-813-787	-836-764	Lusehøj	**TYP IC2**
AAR	4620	2380	45	-517-397	-748-380	Nørre Dalgaard Syd	*TYP XIII*
AAR	9574	2867	33	-1111-998	-1187-927	Nyhøj	**TYP IIA, TYP XIA5**
Lu	444	3070	60	-1411-1263	-1491-1130	Nymölla	TYP IB, **TYP XA1, TYP XIA2**, TYP XXVIA1, TYP XXVIA2a
AAR	8786	2722	25	-895-835	-912-816	Øster Herup	**TYP XXVE,** TYP XXVH2
AAR	4681	2815	40	-1011-916	-1107-848	Rom (D1)	*TYP XIII*
AAR	8110	2805	45	-1012-903	-1085-837	Rom (D1)	*TYP XIII*
AAR	4682	2790	45	-1006-896	-1050-831	Rom (D2)	*TYP XIII*
AAR	8111	2882	47	-1127-981	-1209-929	Rom (D2)	*TYP XIII*
AAR	9524	2886	34	-1116-1011	-1196-941	Rom (D3)	**TYP VA, TYP XXVIA3b, TYP XIID**, *TYP XIII*
U	49	2650	80	-921-767	-1008-542	Simris (43)	*TYP XIII*
U	144	2690	80	-924-796	-1055-571	Simris (71)	**TYP XXVD1a** used as pin, TYP XIII
U	145	2560	90	-812-542	-892-410	Simris (79)	**TYP XIB4b**, *TYP XIII*
U	84	2690	90	-973-792	-1110-552	Simris (94)	**TYP XIC2**
AAR	9514	2805	43	-1009-906	-1075-837	Sundby	**TYP XIB2a, TYP XIIB2**
AAR	6097	2815	40	-1011-916	-1107-848	Virkelyst	*TYP XIII*
AAR	8112	2829	39	-1028-922	-1113-900	Virkelyst	*TYP XIII*

Grave Jattrup, Jutland

See Hornstrup *et al.* (2012, p. 33, figure 18). The grave contains several grave goods, such as a razor, tweezers (like TYP XIIB1 without any ornamentation), awl (TYP XIII) and some amber. But only the pin can sorted to Baudou's TYP XXVA1a.

Grave 5 of Jersild, Jutland

See Hornstrup *et al.* (2012, p. 36, figure 26). The grave contains, beside an awl (TYP XIII) and some bronze fragments, a button that M. Hornstrup compares with so-called 'Ringknebel'. This button looks very similar to Baudou's TYP XXVIB1, only a bit bigger in size.

Grave GX of Lusehøj, Funen

Several fragments of a sword blade, identified as Baudou's TYP I C2 by Thrane (Thrane 1984, p. 142) support this analysis. The charcoal samples from the pit fill from the central burial GX (K-3538 2690 ± 80 BP 926–794 cal BC; K-3539 2610 ± 75 BP 894–569 cal BC) indicate a 1-σ (R_combine) date of 893–790 BC (Thrane 1984, p. 78). A new date for the bones exists (Hornstrup *et al.* 2012, p. 37), which shows that the pit fill and inhumation are correlated (AAR-9575 2611 ± 33). Since for dating of charcoal old wood effects have to be taken into account, the date of the bones is the crucial date for the grave (813–787 cal BC).

Grave N29 of Nørre Dalgaard Syd, Jutland

The grave was set over a ritual place (AUD 1999, p. 312). This grave contains only an awl (TYP XIII) and a fragment of amber. The date of the charcoal is quite young but shows that the awls are used over a wide timespan. The date AAR-4620 2380 ± 45 belongs to the end of the sixth until fifth century (517–397 cal BC).

Grave Nyhøj, Funen

See Hornstrup *et al.* (2012, p. 33, figure 20). On top of the cremated bones were found, among others, a miniature sword (TYP IIA) and a razor (TYP XIA5).

Grave No. 4 of Nymölla, Scania

Beneath a packing of stone, an oak log coffin wrapped in birch bark emerged, holding the burnt remains of a mature individual. A sword with a hilt featuring little horns – *Hörnerknaufschwert* (TYP IB), a knife (TYP XA1) and a razor (TYP XIA2), as well as three double buttons (TYP XXVIA1, A2a) made of bronze could be retrieved beneath the burial (Petré 1961, 44ff.). The *Hörnerknaufschwert* and razors with a spiral handle clearly indicate per. IV,

whereas knives and double buttons derive from older per. III types. To assign the inventory of the burial to the beginning of per. IV seems more than plausible. The radiocarbon date (Lu 444 3070 ± 60 BP) points to 1412–1263 cal BC at 1-σ range.

Grave Øster Herup, Jutland
See Hornstrup *et al.* (2012, p. 36, figure 23). The grave contains some grave goods, but only a bronze pin (TYP XXVE) and one bone pin (TYP XXVH2) were of typological interest.

Grave D1–3 of Rom, Jutland
Three urns from the same barrow (D1–3) were found in the eastern part of the barrow.
Grave D1 was the larger one and held an awl (TYP XIII) and tweezers without ornamentation. The tweezers are chronologically irrelevant and are common in all periods (Baudou 1960, p. 40). The pitch (AAR-4682 2815 ± 40) and the bones (AAR-8111 2805 ± 45) gave a combined date of 1000–926 cal BC.

Grave D2
The smaller (D2) contained only an awl TYP XIII (Broholm 1946, Nr. 906–7). The lid seal – pitch – provided the sample AAR-4681 2790 ± 45 BP. With the dated bones (AAR-8110 2882 ± 47) the combined date for this cremation is 1025–929 cal BC.

Grave D3
The urn grave lay on the northeastern side of the barrow and was richly equipped with a razor of unknown type, tweezers (TYP XIID), a lancet (TYP VA), an awl (TYP XIII) and buttons (TYP XXVIA3b). The date AAR-9525 2886 ± 34 shows a little older date than the other two urn graves: 1116–1011 cal BC.

Grave Complex 43 of Simris, Scania
Other ^{14}C-dates could be retrieved from the cemetery of Simris (Olson 1961, p. 154–156). One charcoal sample was taken from a circle of stones encompassing four urns. The layer of charcoal covered the badly broken urns D and E and formed part of the surface layer for the urns A and B. Berta Stjernquist argued that the charcoal may have been laid down together with the burial of the vessels A-B (Stjernquist 1961, 14 ff.). Vessel A held an awl (TYP XIII), vessel D a razor with a spiral handle bent backwards (TYP XIB4b), grave E contained a double button and grave C an awl (TYP XIII) and one more bronze button. The ^{14}C-date reading U-49 2650 ± 80 BP (921–767 cal BC) therefore counts as *terminus ante quem* for the razor, putting it before the eighth century BC.

Grave 71 of Simris, Scania
One urn contained an awl (TYP XIII) and furthermore a rod-headed button with a retrieved ending, which had formerly been a pin of similar form. The pin relates to Baudou's TYP XXVD1a. The secondary usage may have led to a prolonged circulation. The ^{14}C-date (U-144 2690 ± 80 BP 924–796 cal BC) therefore only accounts for a *terminus ante quem*.

Grave 79 of Simris, Scania
This grave is a double burial, consisting of one urn inside and another one outside a stone cist (Stjernquist 1961). The latter (grave 79a) provided the ^{14}C-date (U-145 2560 ± 90 BP 812–542 cal BC). The inventory consists of an awl (TYP XIII), the tip of a knife, and once again a razor with a spiral handle bent backwards and a broad, trapezoid blade (TYP XIB4b).

Grave 94 of Simris, Scania
The vessel constituting the grave contained one more razor. It might belong to the form displaying a rectangular blade and hilt (TYP XIC2) which is usually ornamented. However, it could just as well belong to the Tackenberg-type common for the Elbe-Weser-area (Tackenberg 1961/63, p. 10, map 9, list 12). They belong to per. V. With the aid of the ^{14}C-date (U-84 2690 ± 90 BP 973–792 cal BC) the grave can be dated to the tenth century until the beginning of the eighth century BC.

Grave N1 of Virkelyst, Jutland
See Hornstrup *et al.* (2012, p. 35). The grave contains only an awl (TYP XIII) and a bronze spiral. Two dates – one of the pitch (AAR-6097 2815 ± 40 BP) and the other of the cremated bones (AAR-8112 2822 ± 39 BP) – were taken. The combined date is quite early and sets the urn in the tenth century (1005–930 cal BC).

The chronology of the curve

The radiocarbon dates were matched to the types computed in the CA (Figure 12). For graves with several dates, the combined date was used; this was the case for the graves of Gl. Brydegård, Rom and Virkelyst. For the grave GX of Lusehøj, only the bone date was taken into account. The slightly older charcoal dates might be affected by the old wood effect. If several dates were available, a sum calibration was used, which described quite well the timespan the artefact type might be in use. For example, for the awls 16 dates were available (Table 1, Figure 13),[5] which were nevertheless part of the database but set to 0 value in the correspondence analysis weighting. The ^{14}C-dates display a linear temporal course along the parabolic pattern, so that a chronological interpretation is probable.

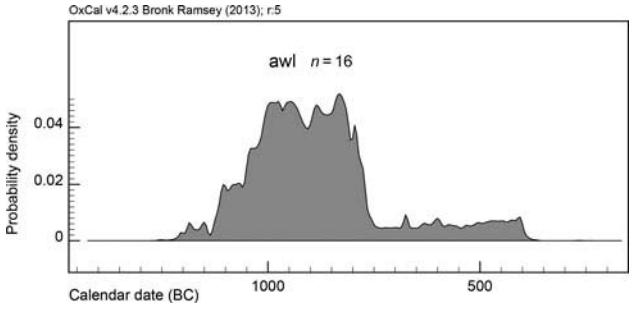

Figure 13. Sum calibration of awls. Older dates than Per. IV are also available for awls (see Hornstrup *et al.* 2012), but were not used for this graph.

After having applied the corresponding radiocarbon dates, three main clusters can be made out within the matrix of the CA (Figure 12).

1st Cluster (grey)

The date of Nymölla is located on the right-hand side in the upper quadrant, so this section is dated fifteenth to thirteenth century BC. The date seems uncommonly early, but since the sample originated from the birch bark deposited in the grave, this early date can hardly be pinned to the suggestion of secondary usage of older wood. This date of Nymölla must be viewed with some caution. Two other dates are available. The date from Kattebjerg, Skovby sogn, Odense amt, dated eleventh to tenth century. A third date from Stagstrup sogn, Thisted amt, seem a little bit too young and in fact it is connected with a Type of the second cluster (XIB2a). If the youngest type dates the grave, then this Type XIB2a is an older piece in the grave and could not be taken into account.

2nd Cluster (black and white)

The second cluster spreads around the centroid of the two axes and is quite well represented by ^{14}C-dates.

A razor from Sundby, Thisted amt of Type XIB2a represents the first part on the positive X-axis followed by a pin of Type XXVA1a from Jattrup, Ringkøbing amt, dating to the tenth to ninth century. The sword (Type IC2) comes from the burial of Lysehøj, which belongs to the end of ninth to beginning of eighth century. Another date exists for a lancet Type VA from Rom sogn, Ringkøbing amt, suggesting a date between the end of twelfth and end of tenth century. The many awls obviously belonging to this cluster cannot be taken into account, because they have remained largely unchanged over a long period of time (see Figure 13). For the second part on the negative side of the X-axis, four dates exist. A pair of tweezers of type XIID is known from two dated graves (Fardume, Gotland; Rom, Ringkøbing amt). The date of Rom is quite early and seems to belong more to the previous phase. The other dates are connected with a metal button type XXVIB1 from Bjergby, Thisted amt and from Jersild, Ringkøbing amt. The dates give a range for this subphase from the Beginning of the ninth to the eighth century.

3rd Cluster (light grey)

The left-hand side of the analysis shows several dates. Most of them came from a rich grave in Gl. Brydegård, Odense amt, containing type XIIE1, type XIB4a, type XXVIB2, type XXVB2b, type VC and type XIII. The two dates have an R_combine date of 895–825 cal BC in 1-σ range. Four more dates are available for this last phase. Two razors of type XIC2 and type XIB4b and a pin of type XXVD1a – all from different graves from Simris, Scania. A pin of type XXVE is from a grave from Øster Herup, Ringkøbing amt. The dates reach from the tenth to the middle of the sixth century. The long range is due to the *Hallstattplateau*.

Baudou's chronology encompassing per. IV and V has been thoroughly verified by the use of independent radiocarbon dates. In addition, the parabola of the distribution of types displays marked gaps, which may be interpreted in terms of further chronological subdivisions. Baudou has already suggested a possible two-stage development within per. IV (Baudou 1960, p. 112), which might be mirrored by the gap between cluster 1 and 2. Cluster 1 holds the typologically older forms, such as slender tweezers with straight ornamentation and the razor showing a

Table 2. The types of Evert Baudou separated according the CA; see Figure 12.

Period IV early	Period IV late	Period IV–V	Period V
Cluster 1	Cluster 2a	Cluster 2b	Cluster 3
IIA, XA1, XIA3, XIA1, XIA2, XIA4, XIA5, XIB3b, XIIB1, XIIB2, XIIB1c, XIIF, XIXD1a, XXVA2	IC1, IC2, IIB, VA, VB, XIB1a, XIB2a, XIB3a, XIB2b, XIIC, XIII, XIVB, XIXD1d, XXVA1a, XXVB2b, XXVC1, XXVC2, XXVH1, XXVIB1, XXVIC1	XA2, XIC1, XIID, XIIE2, XIXA, XIXE, XXVB2a, XXIVD2, XXVB1, XXVF2	VC, XA3, XIB1b, XIB4a, XIB4b, XIC2, XIIE1, XVID1, XIXD1c, XXVB2b, XXVD1a, XXVD2a, XXVE, XXVIB2

wire-like, bent-forward handle (TYP XIIB, XIA). They may clearly derive from the much older forms belonging to per. III.

Cluster 2 consists of slender tweezers with circumferential band incision ornamentation (TYP XIID), miniature fibulae (XXIVD2) and miniature antennae-swords (TYP XIC). Baudou has suggested, that these finds have to be placed within a later stage of per. IV and, as was his opinion, could have easily strayed into per. V as well. The finds of cluster 2 solely belonging to per. IV are located nearer the Y-axis (white). The transition from per. IV to V depicted in the CA and dated according to Baudou seems to be gradual. Most on the positive X-axis are per. IV, only three graves (Nr. 400, 51, 235) belong to per. V according to Baudou's definition. But on the negative side of the X-axis, the percentage of per. IV graves is more than one-third (Figure 11(a)). Find complexes belonging to both per. IV and V are located between the values X 0 and −0.6 and make a further subdivision of cluster 2 necessary: The first, belonging to per. IV, encompasses the scale of X 0.2 to 1.0 (cluster 2a, black), the second ranges from X 0.2 to −0.6 (cluster 2b, white). The third cluster mainly contains finds belonging to per. V (light grey).

To sum up the results of the analysis, it seems safe to suggest a four-stage gradation between the periods IV and V. Some inventories may have to be re-examined with regard to their assumed periodisation, but still it remains remarkable to be able to verify the hereto only assumed chronology for the first time. The four stages can be described as follows. A subdivision of per. IV with cluster 1 representing the older and cluster 2a the later phase. Furthermore, we may postulate a transition phase between per. IV and V (cluster 2b) and last but not least point out per. V (cluster 3) as clearly separating itself from the subsequent per. VI (Figure 4). The clusters represent artefact groups defined by similarity and frequency in grave contexts (Table 2).

The high number of ^{14}C-dates now available provides some more possibilities. The third CA shows, with the first against the fourth eigenvector, a chronological order of artefacts through their assemblage in graves. This change in grave goods is as close as possible to a readable linear timeline, a linear order of assemblages. This allows us to take the values of the first axis as values for time. But the distance between single points is not uniform. The distance in the middle of the graph is smaller than at the edges. This means 1 cm distance in the middle of the graph between types is not equal to 1 cm distance at the edge. Only a multidimensional analysis would give us an equal distribution between artefact types (Hinz and Müller forthcoming). Nevertheless, the order of artefacts and connected ^{14}C-dates allowed us to use Bayesian statistics. The relative order of the dates is a sequential order and can be calculated as a sequence (Figure 14). A few problems

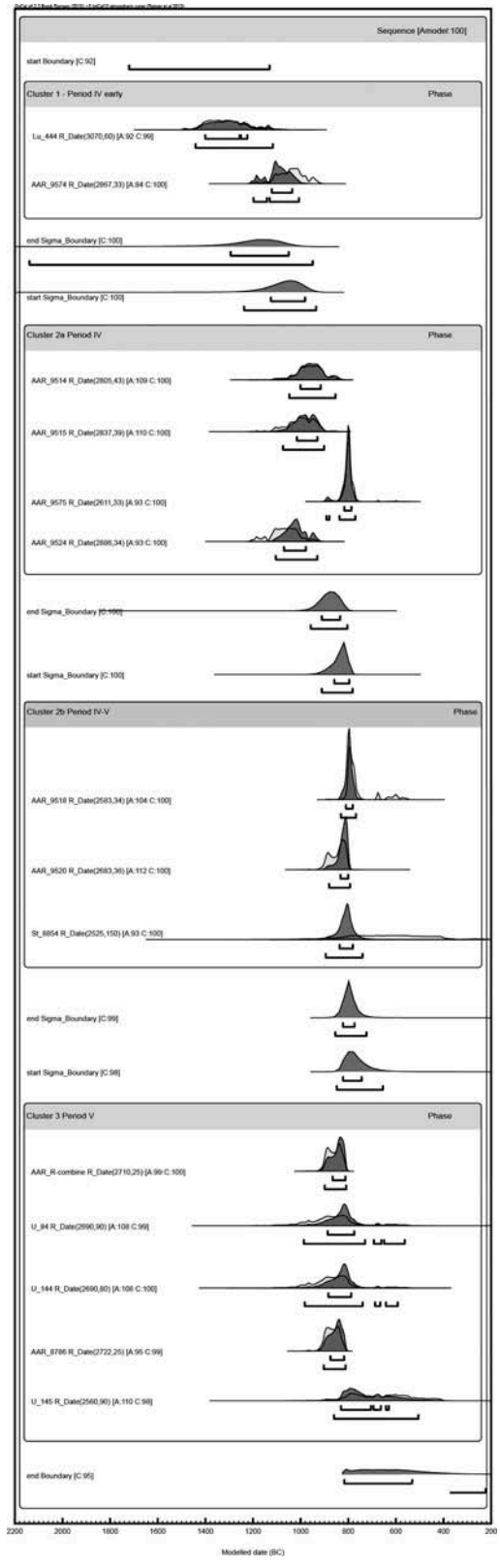

Figure 14. The chronological sequence of a Bayesian analysis performed with OxCal 4.2. The order of the dates follows the 1st eigenvector of the CA (see Figure 12). The results are shown in Table 3.

occur; several dates are connected with more than one artefact type, even in different clusters. Also, for the last cluster the most artefact types are associated with only one date, which is the combined date of grave J from Gl. Brydegård. Furthermore, some Swedish dates were used, even if those graves are not included in the CA. This needs to be considered if we want to interpret the results.

A Markov Chain Monte Carlo (MCMC) analysis with all dates in the sequential order, including repeating and overlapping dates, gave only poor results for an A_{model}. Therefore, a phase model was calculated (for details, see Ramsey 2009) and the duplicate dates were excluded.[6] The phases were separated by sigma_Boundaries to calculate a smooth transition in opposition to the aforementioned building brick model (Figure 14). The overall agreement of the A_{model} is 100.1%, which is far above the minimum acceptable level of A_{model} = 60.0%. Because data for an earlier phase than per. IV are missing, the beginning of per. IV is difficult to estimate, in part also because of the rather early date from Nymölla, Scania. But the phase per. IV early lasts until approximately 1050 BC. Period IV seems mainly fit into the tenth century and partly beginning of ninth century, while per. IV–V starts in the middle of the ninth century and lasts until middle of eighth century. The beginning of Period V can be assumed to be sometime in the eighth century; however, the ending is unclear because of the *Hallstattplateau* (Table 3).

The radiocarbon dates provide the basis for the absolute dating. Following Vandkilde's plausible argument (Vandkilde 1996; and newest Olsen *et al*. 2001, p. 271 figure 3), the beginning of per. IV may be ascribed to around 1100 BC. The end-boundary of the model suggests an end for per. V between 820 and 530 BC, which is too late according to the following per. VI and caused by the *Hallstattplateau*. The other feature is the fact that no date of the parabola strays younger than 540 BC, mirroring perfectly Vandkilde's thesis, which suggests – with regard to the settlement finds – an end of per. V at about 700 BC. Based on all dates it seems reasonable to have per. V (cluster 3) start around the year 820 BC. Cluster 2b (transition per. IV–V) would consequently represent the time between 950/20 and 820 BC, Cluster 2a (per. IV) between 1050 and 950/20 BC and Cluster 1 (per. IV early) the time of 1100–1050 BC. In comparison with the Bayesian model of Olsen et al., the timespans are slightly different for period IV and V due to new data sets and could be divided in two phases (Olsen *et al.* 2011, p. 270).

Table 3. Bayesian model according to Figure 14. A_{model} = 100.1%; $A_{overall}$ = 101.2%.

Name	Unmodelled (BC/AD)				Modelled (BC/AD)			
Sequence	1σ		2σ		1σ		2σ	
start Boundary					−1721	−1131	−5408	…
IV Early Phase								
Lu_444 R_Date (3070,60)	−1411	−1263	−1491	−1130	−1401	−1225	−1442	−1117
AAR_9574 R_Date (2867,33)	−1111	−998	−1187	−927	−1122	−1036	−1198	−1008
end Sigma_Boundary					−1294	−1050	−2139	−950
start Sigma_Boundary					−1125	−982	−1238	−936
IV Phase								
AAR_9514 R_Date (2805, 43)	−1009	−906	−1075	−837	−1001	−916	−1048	−854
AAR_9515 R_Date (2837, 39)	−1044	−930	−1116	−904	−1016	−930	−1075	−902
AAR_9575 R_Date (2611, 33)	−813	−787	−836	−764	−817	−788	−892	−771
AAR_9524 R_Date (2886, 34)	−1116	−1011	−1196	−941	−1071	−979	−1105	−931
end Sigma_Boundary					−911	−835	−958	−804
start Sigma_Boundary					−859	−796	−911	−782
IV_V Phase								
AAR_9518 R_Date (2583, 34)	−805	−769	−820	−559	−811	−782	−831	−768
AAR_9520 R_Date (2683, 36)	−892	−805	−902	−801	−833	−801	−881	−793
St_8854 R_Date (2525, 150)	−804	−431	−1005	−233	−837	−782	−895	−741
end Sigma_Boundary					−823	−774	−855	−724
start Sigma_Boundary					−823	−744	−849	−655
V Phase								
AAR_R-combine (2710, 25)	−895	−824	−905	−811	−865	−811	−898	−808
U_84 R_Date (2690, 90)	−973	−792	−1110	−552	−886	−774	−986	−562
U_144 R_Date (2690, 80)	−924	−796	−1055	−571	−883	−787	−982	−592
AAR_8786 R_Date (2722,25)	−895	−835	−912	−816	−874	−817	−903	−811
U_145 R_Date (2560, 90)	−812	−542	−892	−410	−830	−629	−859	−505
end Boundary					−817	−533	…	−223

Conclusion

In conclusion, the chronological system of Evert Baudou could be verified. The order of the types of artefacts shows a great variation based on regional, material and social differentiation. But it was also possible to outline a statistically proven chronological order of the artefacts. The parabola could be divided into three clearly separated clusters, which give a clearer insight into the combination of grave goods and their usage during the time periods of the Late Bronze Age.

The conclusions presented in this article have a new impact on the chronology of the late Bronze Age, but the material still needs to be reviewed and the results verified by including more recently published material and the hoards. The results of the analysis are based only on the grave finds published by Baudou and have been limited to the areas of Schleswig-Holstein and Denmark. It is necessary to include other graves and also the Swedish finds in order to examine the effect of an enlarged database on the present statements.

Even if this material is quite heterogeneous and includes mainly social and regional aspects, chronology is an underlying factor. The human individual of the late Bronze Age did not collect his burial objects with regard to 'modernity' – to him and his people it was much more of an issue to make a territorial or social statement. The two smaller gaps in the CA show the change of assemblages, but only at the passage of per. VI, when a completely new assemblage of different types is introduced to the burial ritual, a truly new era dawned.

To return to the prehistoric time concept, this article tries to divide the bricks of Montelius' Period IV–VI into smaller pieces. The choice of correspondence analysis opened the possibility for visualising the sequence of artefacts and artefact combinations on a timeline instead of as boxes. The sequence of artefacts given in Figure 12 shows that the differentiation between Periods IV and V is much smaller than that between the early and late parts of per. IV. The gap between per. IV/V and per. V means that a greater change in the artefact ensemble took place than between per. IV and V. We can also assume that the X-axis of the CA with the first eigenvector more closely approximates a timeline than the building brick model of periods with their concurrent types of artefacts.

Notes

1. Per. VI consisted of 26 grave finds and nine artefact types on the whole. The new database arrived at 385 artefacts. The statistical relevance depended on two types of artefacts per find and two locations per artefact type. Therefore, every grave containing only one burial object and singular artefact types had to be excluded from the database.
2. Awls have been excluded, because they are common at all times and have no part in altering the results (weight = 0).
3. Many thanks to Helle Vandkilde for letting me use her database, as well as Karen Margrethe Hornstrup for pointing out new dates to me.
4. All following dates are given in 1-σ range.
5. Older dates than Per. IV are also available for awls (see Hornstrup *et al.* 2012), but were not used for this article.
6. Many thanks to Marie-Josée Nadeau for helping me with the MCMC analysis of OxCal.

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