J. J. BUTLER AND J. D. VAN DER WAALS

BELL BEAKERS AND EARLY METAL-WORKING IN THE NETHERLANDS

Figs. 1–46.

CONTENTS

INTRODUCTION

Once upon a time, the Bell Beaker folk enjoyed the reputation of being a culture of 'prospectors, metallurgists and traders' who introduced metal-working to large areas of Europe. This generalization is now seen to have but limited applicability to some areas, and in other areas not to apply at all. In East Europe the idea has been officially repudiated (Hájek, 1966, p. 416); people seem to have been practicing metal working in that area for a good 2000 years before Bell Beakers appeared at all. In the Iberian Peninsula, it is now held that Bell Beaker metallurgy marks a technical regression compared to what was previously practiced in the 'colonies' there (Sangmeister, 1960). In Northwestern Europe, too, the Bell Beaker culture's reputation for metallurgical pioneering has suffered a decline. On both sides of the North Sea, it has been noted that the occurrence of metal objects in Bell Beaker graves is not exactly a normal, every-day thing; in Britain and in the Netherlands only one Beaker grave in twenty contains any metal at all. Piggott (who in 1954 degraded British Beakers from the Early Bronze Age to the Middle Neolithic and in 1963 handed many of them back to the Bronze Age again) characterized the metal equipment of British Beaker folk as 'scanty'. The standard textbook on the prehistory of the Low Countries (De Laet & Glasbergen, 1959) treats the Bell Beaker culture as a 'Late Neolithic' culture, possessing only occasional metals – the word 'smith' not even being mentioned in passing in this context. In Ireland, the Beaker folk were only nine years ago (Coghlan & Case, 1957) recognized as the probable introducers of metallurgy to that island; but as the reader of this volume will see below (Case, 1966, p. 141) the evidence for this is rather indirect and circumstantial. In Brittany, it is difficult to obtain a clear picture as to what is Bell Beaker metallurgy and what, if anything, is or could be earlier; this question has not been expressly dealt with in all the recent literature. In the German Rhineland, it is not easy to see whether there existed any Bell Beaker metallurgy at all: how many Bell Beaker metal objects are actually known in that region? (in SAM I we find mention of only two!). One might, in short, seriously wonder if the whole story of pioneer Bell Beaker prospecting and metallurgizing was not a pure and unadulterated myth.

The reader will undoubtedly have guessed, from this introduction, that we intend in this article to demolish the idea of Bell Beaker metal-working as far as the Netherlands is concerned. Quite the contrary; we intend to show that Bell Beaker smiths *did* actually introduce metal-working into the Netherlands.

In so doing, we first examine the evidence for metal-work associated with the Bell Beaker culture in this country. This consists, in the first instance, of the metal objects themselves; we have attempted to put together what is known or could be learnt not only of their typology and associations, but of their physical structure and chemical composition. Comparative data are presented, in so far as available, relating to the metal objects associated with the preceding Neolithic phase, and with the following phase of the Early Bronze Age (= Reinecke A 1). In the second place, we publish

herewith the previously overlooked evidence from two Bell Beaker smith's graves, containing sets of stone metal-worker's tools. Lastly, we consider the question of the possible origin of the metal used by the Dutch Bell Beaker smiths; and suggest that this metal came not, as has recently been argued, from Bavaria or from the Middle Rhine region, but rather from the West.

Thanks to the collaboration of several laboratories*, we are able to bring to bear specialist reports concerning the chemical composition and physical structure of a number of the metal objects concerned (*cf.* Appendix I). Twenty-nine new spectrographical analyses have been made for this study; so that, with those previously done by JSS, forty analyses of Aeneolithic and Reinecke A1 objects from the Netherlands are now available. Seventeen objects were submitted to a metallographic examination. The results of these technical studies are summarized in App. II. In comparing the Dutch analyses with those from other areas, we have been aided by the graph method devised by H. T. Waterbolk and recently described in print (Waterbolk & Butler, 1965).

The number of Dutch analyses is small, and they are rather heterogeneous, so that conclusions can be drawn from them only on a tentative basis, and these conclusions might have to be modified should more material become available. They do, however, enable suggestions to be made as to the probable affinities of at least some of the metals.

A picture of the early metal alloys employed in the Netherlands can be obtained from Table I, p. 88, where the alloys used are listed in order of their numerical importance, and the graphs Fig. 26-36; see also Part IV below.

* We wish hereby to extend our heart-felt gratitude to those authorities and institutions, named below, who gave generously of their time and resources in connection with this study. The metallographic examination was done by the Material Advies Bureau of the Research en Bedrijfslaboratoria Koninklijke Nederlandsche Hoogovens en Staalfabrieken N.V. (Royal Dutch Steel Works), IJmuiden; we are particularly thankful for the friendly collaboration of Mssrs. A. Ph. Krijff, H. A. Sciarone, and A. R. Schilt, whose report constitutes Appendix II and of Mssrs. A. J. Schotman and M. Bosman, who assisted. The copper and bronze analyses were made by the Analytisch Instituut of the T.N.O., Delft (Dr. G. J. van Kolmeschate, Director; Mr. J. de Jong). The stone anvils and hammers were submitted for determination of the material to the Geologisch Instituut of the State University at Groningen (Mr. G. J. Boekschoten and Prof. Dr. L. M. J. U. van Straaten). The stones were examined for traces of metals by the Research Laboratory for Archaeology and the History of Art, Oxford (Dr. E. T. Hall, Director) and the Laboratorium voor Anorgeanisch Chemie of the State University at Groningen (Mr. J. Lanting).

Dr. H. H. Coghlan kindly helped with the functional determination of the stone objects; helpful comments were also made by Prof. Dr. Ir. R. J. Forbes (Amsterdam); Mr. Dennis Britton (Oxford) and Ir. J. Lodewijks (Amsterdam).

We also take this opportunity to extend our thanks to the directors of the various museums who kindly lent objects in their charge for study and/or permitted the taking of samples for laboratory examination and to three private owners of objects (Prof. H. Sanders, Roermond; Mrs. L. C. van der Pijl, Amsterdam; and H. Teunissen, Berchem).

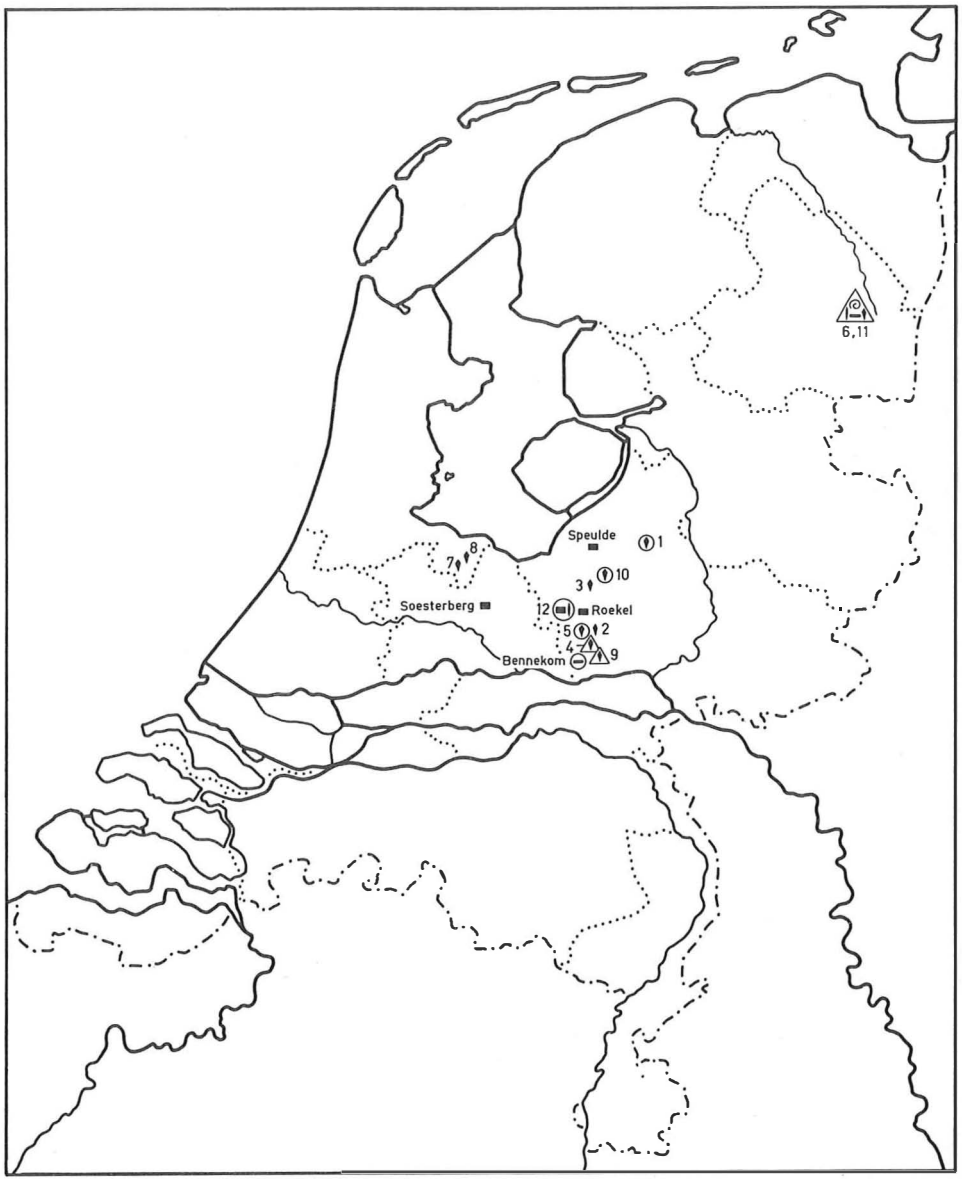


Fig. 1. Distribution of Bell Beaker metal objects and metal-worker's tools in the Netherlands; the numbers are the serial numbers in Appendix I.

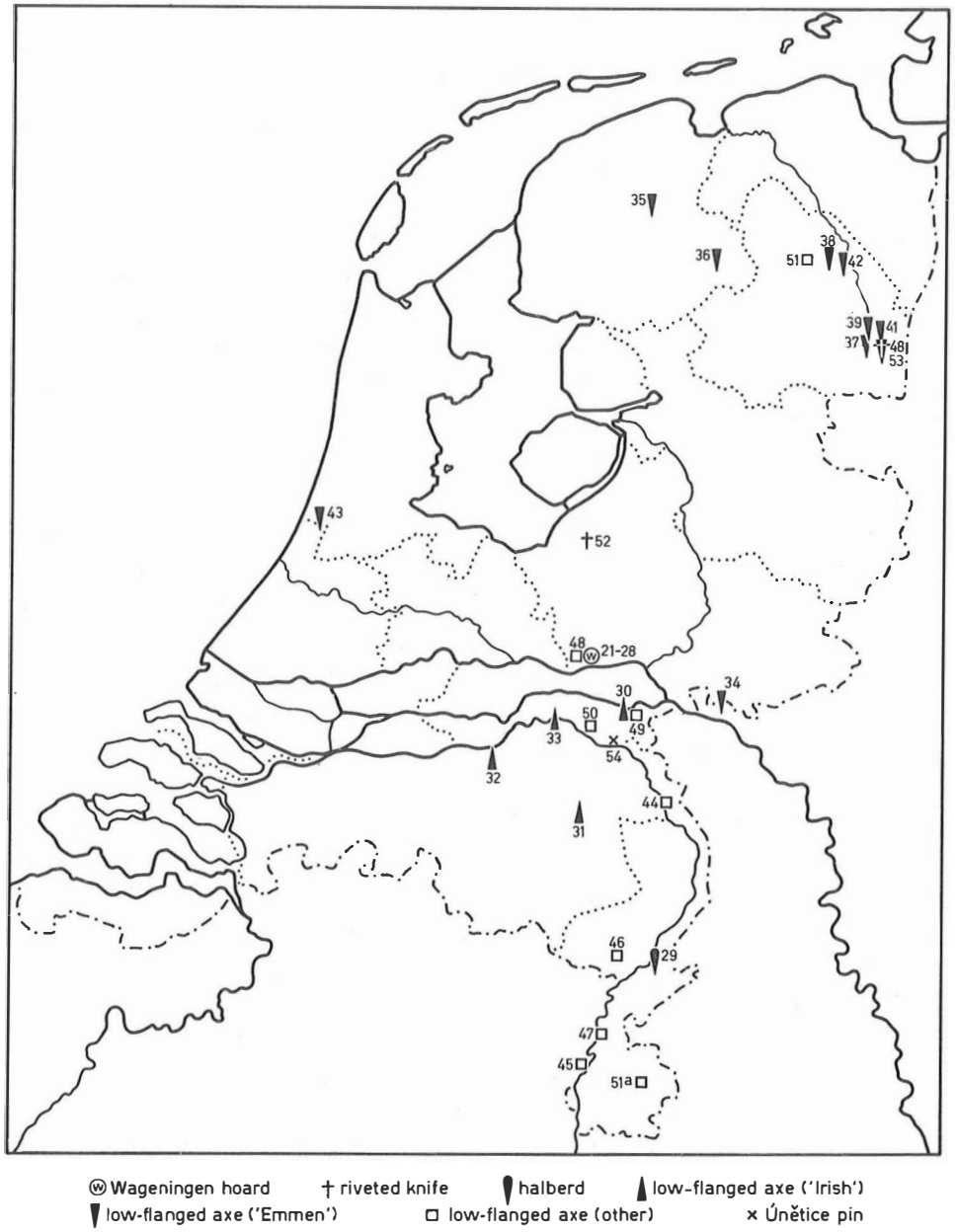


Fig. 2. Location map of early metal finds mentioned in this article, other than Bell Beaker finds; the numbers are the serial numbers in Appendix I.

I. BACKGROUND

A. **Bell Beaker Groups in the Netherlands**

To see the problem of metal-work in the Bell Beaker culture in the Netherlands in its proper perspective one must have a picture of the present state of knowledge concerning the culture as such in this country.

Studies of the Bell Beaker culture in the Netherlands have hitherto focussed on the pottery, resulting in a detailed typological classification (Van der Waals & Glasbergen, 1955; *cf.* also Bursch, 1933). A survey of the Bell Beaker groups in this country and the problems concerning their relationship to other cultures and Bell Beaker groups elsewhere in Europe, with C14-datings of Dutch Bell Beakers and other Late Neolithic cultures, has recently been presented by one of us (Van der Waals, 1964, p. 27–37, 52–53). Papers by Mariën (1948) and De Laet (1963) complement this picture as far as Belgium is concerned.

Aspects of Bell Beaker economy are dealt with in papers by Waterbolk (1956), Modderman (1963) and Van Zeist (1967, in press). Pollen spectra from beneath Bell Beaker barrows differ from those of PFB culture (= Protruding Foot Beaker culture, the Dutch branch of the Battle Axe – Corded Ware family) barrows, and appear to be of the same character as those referring to the TRB culture.

In the present context, it is convenient to distinguish four main groups among Bell Beakers in the Netherlands. These are:

a. Beakers with maritime decoration (zonal decoration of diagonal dentated spatula hatching, alternating in direction from one zone to the next; Van der Waals & Glasbergen, 1955, type 2^{1a}, Pl. VIII: 22; 1959, fig. 10 with caption of fig. 9). They are few in number. They occur as stray finds with a scattered distribution, but there are also the settlement finds from Oostwoud (Van Giffen, 1961) and Vlaardingen (Altena *et al.*, 1962, p. 233), and the Beaker and a bowl from the primary grave of the tumulus of Mol, just over the Belgian border (Beex & Roosens, 1962). Sherds of two vessels are known from *Hunebedden* in the north of the country.

Although their decoration clearly belongs to the Atlantic Bell Beaker tradition, other elements in this group already represent eastern influence. Whether the bordering of the zones with cord-impressions on some of the Beakers of this group represents influence from the PFB culture (Corded Ware) is still disputed (see below, p. 54), but the tumulus which covered the grave of Mol must represent such an influence. Some of the Beakers are of a slender S-shaped profile, and the high position of the greatest width of the body is also more reminiscent of Bell Beakers in the Rhineland and Central Europe than of those of the Atlantic area. Moreover, in the Vlaardingen Bell Beaker level a small polypod bowl is also considered to be of Central European origin (Sangmeister, 1963, p. 29). Whether the sherds with a more

varied decoration associated at Oostwoud with true maritime Beaker sherds are also indicative of Central European influence, or belong to the 'much wider assemblage' of the European Bell Beaker group of Clarke (1966), and thus find their normal place along with maritime type Beakers in the Atlantic Bell Beaker provinces as well, remains at present an open question.

No other objects have so far been found associated with Beakers of this group. This fact, and the regular occurrence of Bell Beakers of the Atlantic groups in tombs of the local cultures, has given rise to the assumption that these Beakers can not be regarded as representing a Bell Beaker *culture* (Junghans, Sangmeister & Schröder, 1960). But the recent settlement finds of Vlaardingen and Oostwoud and the tumulus of Mol, certainly seem to testify to the presence of groups of Bell Beaker *people*. There is as yet no evidence that these people practised metal-working.

For the maritime Bell Beaker level at Vlaardingen there is a series of four C14-datings (GrN–2419, –2481, –2159, –3097), the average of which is 1940 ± 25 B.C. (Vogel & Waterbolk, 1963, p. 177–8).

b. On the Veluwe and especially in the northern provinces, Bell Beakers occur which must be local derivatives of the Beakers with maritime decoration (Van der Waals & Glasbergen, type 2^{Ib}). These are generally slender S-profiled Beakers with incipient zone contraction. Some are still exclusively decorated with the simple diagonally hatched decoration of the maritime tradition (Fig. 4–5). Others, however, also show the more varied patterns of Central European origin (Fig. 3). These Beakers do not

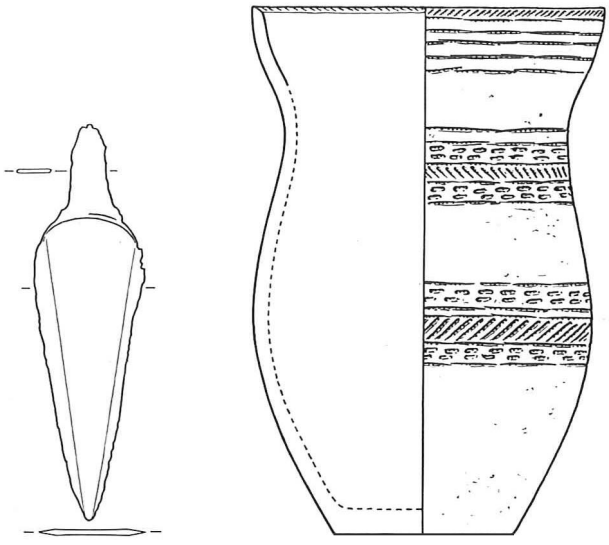


Fig. 3. Ede (Veluwe), "de Kweekerij". Bell Beaker (maritime derivative, type 2^{Ib}) and copper knife, found in a tumulus, probably from the same grave (Appendix I : 4; III : 1. Drawing W. Glasbergen, B. Kuitert. Scale 1 : 3).

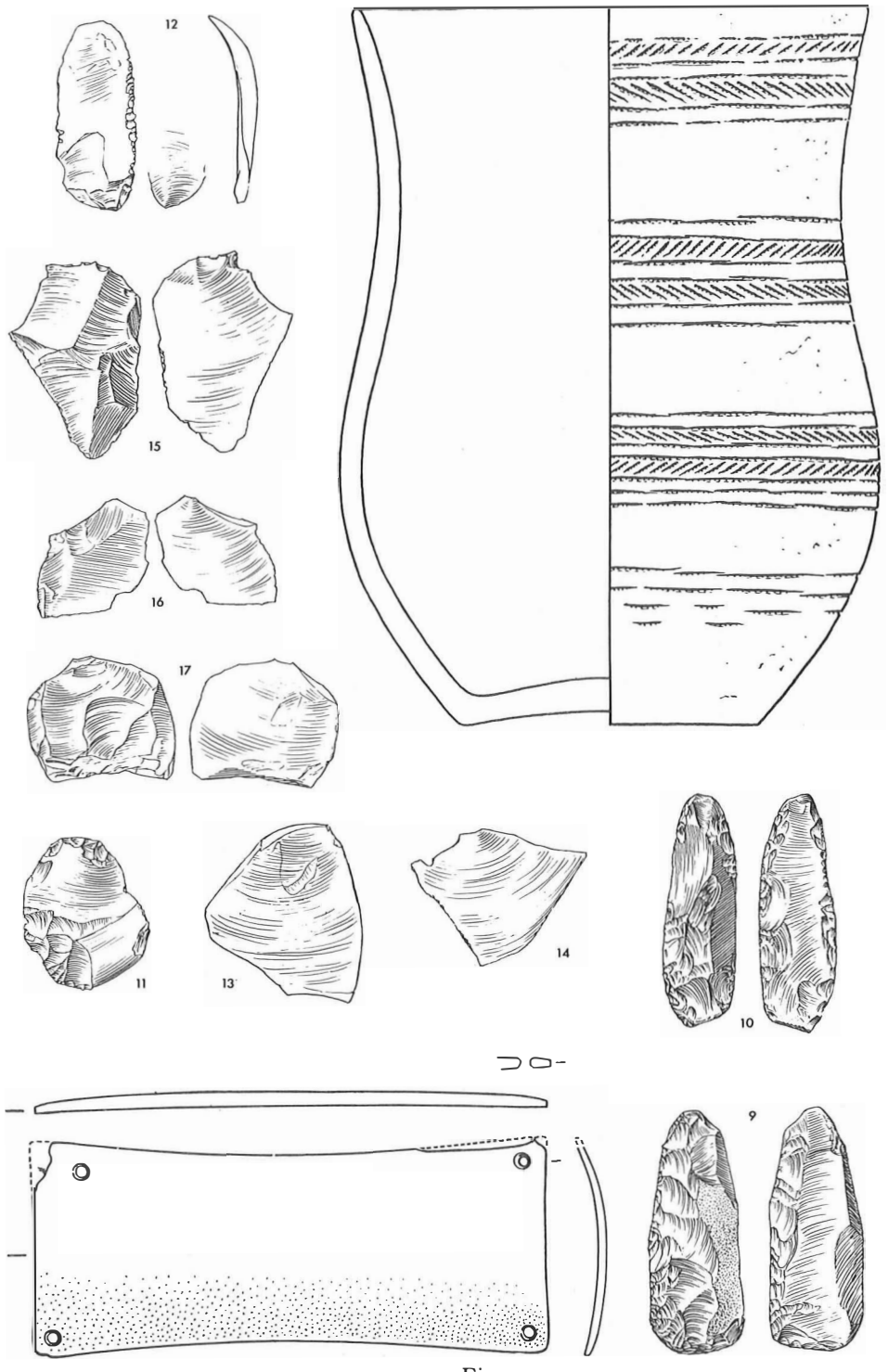


Fig. 4*a*.

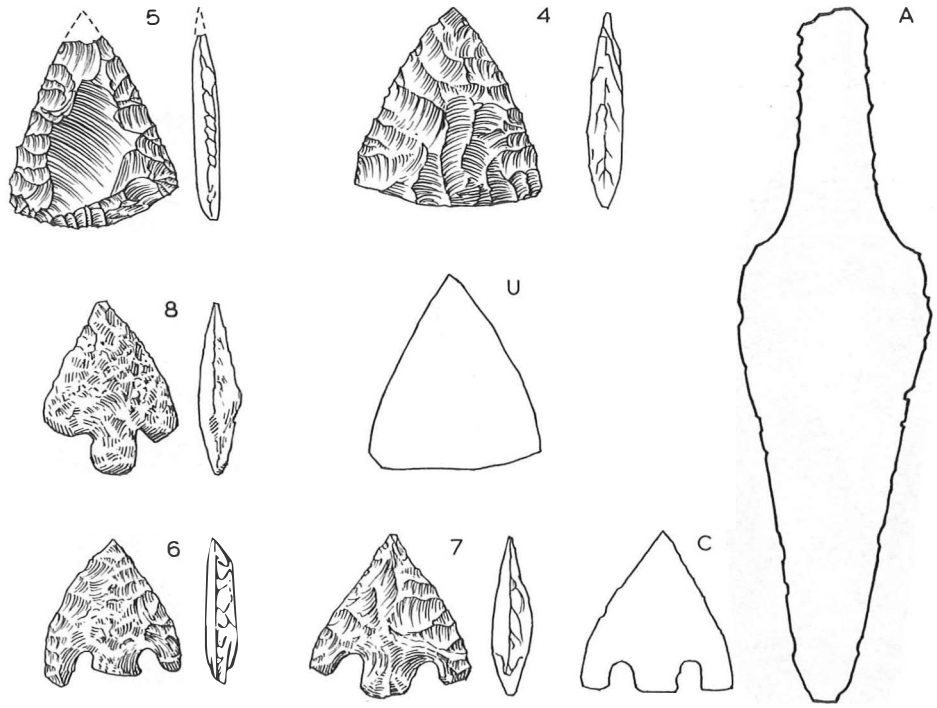


Fig. 4*a–b*. Ginkelse Heide (Veluwe). Grave group from a tumulus with Bell Beaker (maritime derivative, type 2^{Ib}.) and associated finds (App. I : 9; III : 2. Drawing B. Kuitert. Scale 4*a* 1 : 2, 4*b* 1 : 1).

represent an integrated group; among them specimens may be found related to Beakers of the Rhein-Mainz area and to the W/MR and NI/D groups of Clarke (1966). Most of the Beakers are from graves, which may be either flat graves or graves under tumuli.

Associated objects comprise in three cases copper knives (Fig. 3–5) among which is the knife of the famous Exloo grave find, which also contained a copper diamond-shaped awl, a copper spiral bracelet, two sheet-gold ornaments, two amber beads and a Beaker. Almost as rich is a grave find from Ede (Veluwe; Fig. 4; *cf.* Appendix III, no. 2), which contains a.o. a copper knife, a Beaker, an arched wrist guard of pisolith tuff with four holes, and seven flint arrowheads of both triangular and barbed-and-tanged type. The third copper knife belonging to this group is probably from the same grave as a Beaker closely related to Clarke's NI/D group (Fig. 3; *cf.* Appendix III, no. 1). So far, no C14-datings are available. But the distribution suggests that this group, which is strongest represented in the northern provinces where practically no Beakers of Veluwe type are present, largely coëxisted with the *floruit* of the

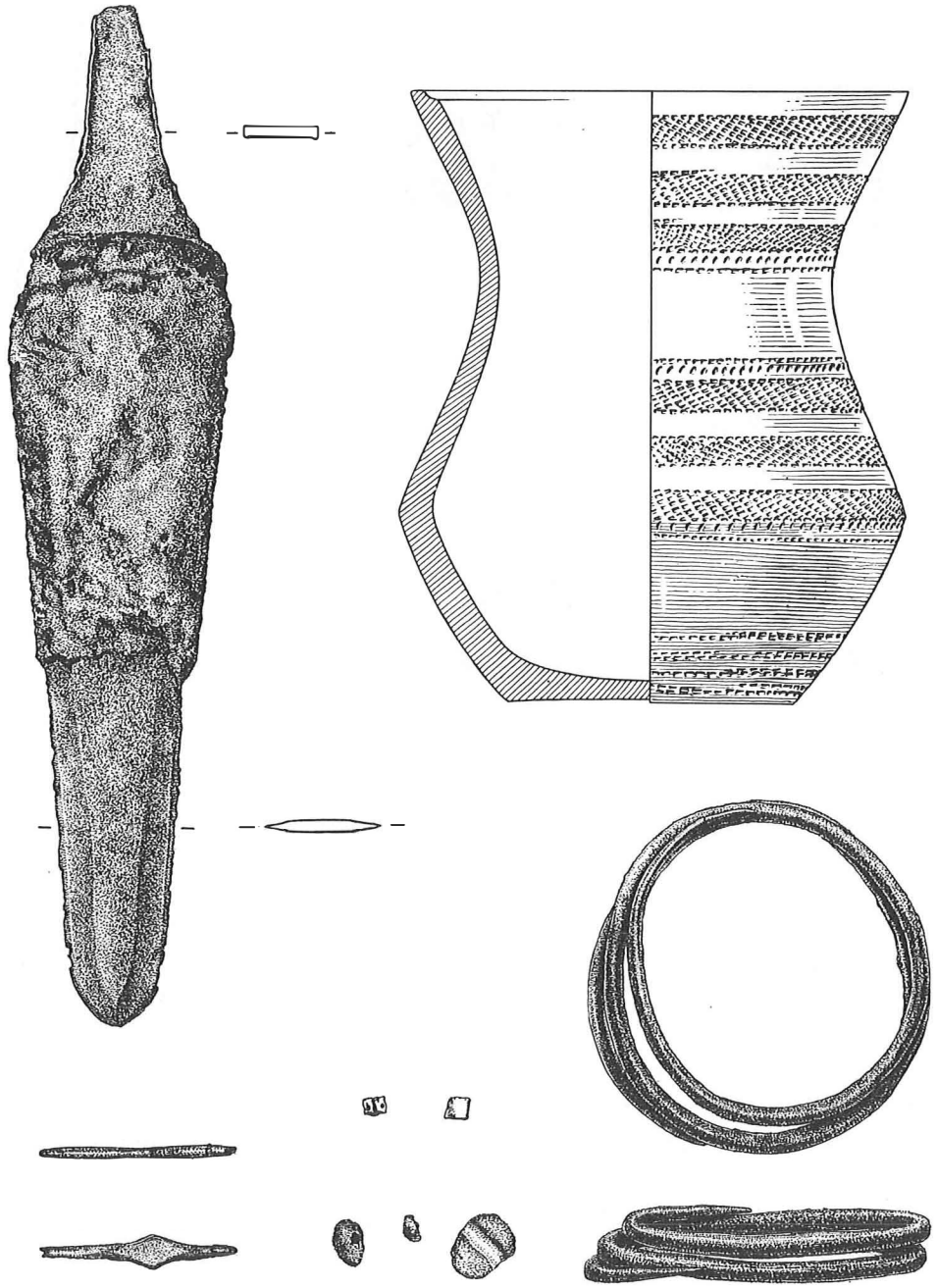


Fig. 5. Exloo (Drenthe). Grave group from a tumulus with Bell Beaker (maritime derivative, type 2^{1b}) and objects of flint, amber, and metal (App. I: 6. After De Laet & Glasbergen. Scale beaker 1: 2; associated finds 2: 3).

Veluwe group (see below). Other arguments for this coëxistence are the similarity of the flint arrowheads represented in both groups, the similarity of the knives of both groups as to shape and metal composition (see below, p. 96), and the resemblance of the decoration of some of the Beakers present in the North to the decoration of Beakers of Veluwe type.

c. By far the largest group of Bell Beakers in the Netherlands comprise those of Veluwe type (Van der Waals & Glasbergen, 1955, types 2^{Ic-f}). This homogeneous Bell Beaker group represents the final integration of the elements of Atlantic and Central European origin. It is chiefly characteristic of the Veluwe and the adjacent part of the province of Utrecht. Smaller concentrations are in the Hilversum and Nijmegen areas; only one or two finds are so far known from the northern provinces. A number of closely related finds has been recorded in the Lower Rhineland, especially in the Neuwieder Becken[1].

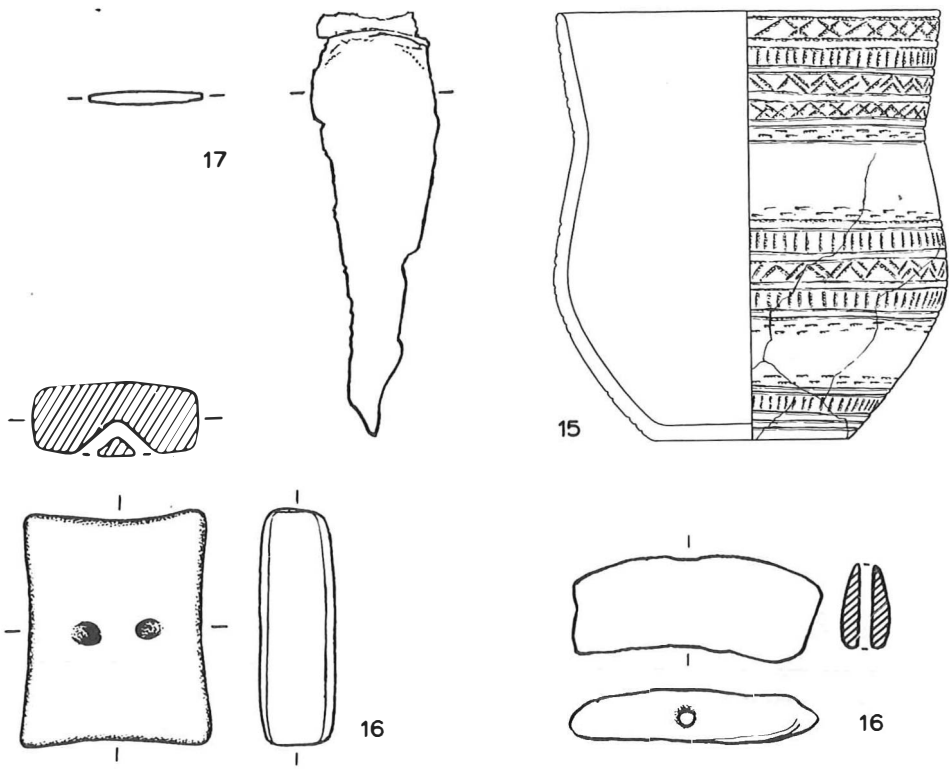


Fig. 6. Vaassen (Veluwe). Grave group from a tumulus with Bell Beaker of Veluwe type (2^{Id}), objects of amber and copper knife (App. I: 1; III: 5. Drawing B. Kracht, G. de Weerd. Scale beaker 1: 3; associated finds 1: 1).

For the Beakers of Veluwe type the angular junction of body and neck and the complete zone-contraction are characteristic. The angular transition between body and neck may derive from Moravian prototypes, as is suggested by a Beaker of pure Moravian type with exactly this angular transition from Harskamp (Veluwe; Van der Waals & Glasbergen, 1958) and by a few Beakers of this same shape from Šlapánice in Moravia (Fig. 37). The varied patterns of the decoration have already been alluded to as of Central European origin.

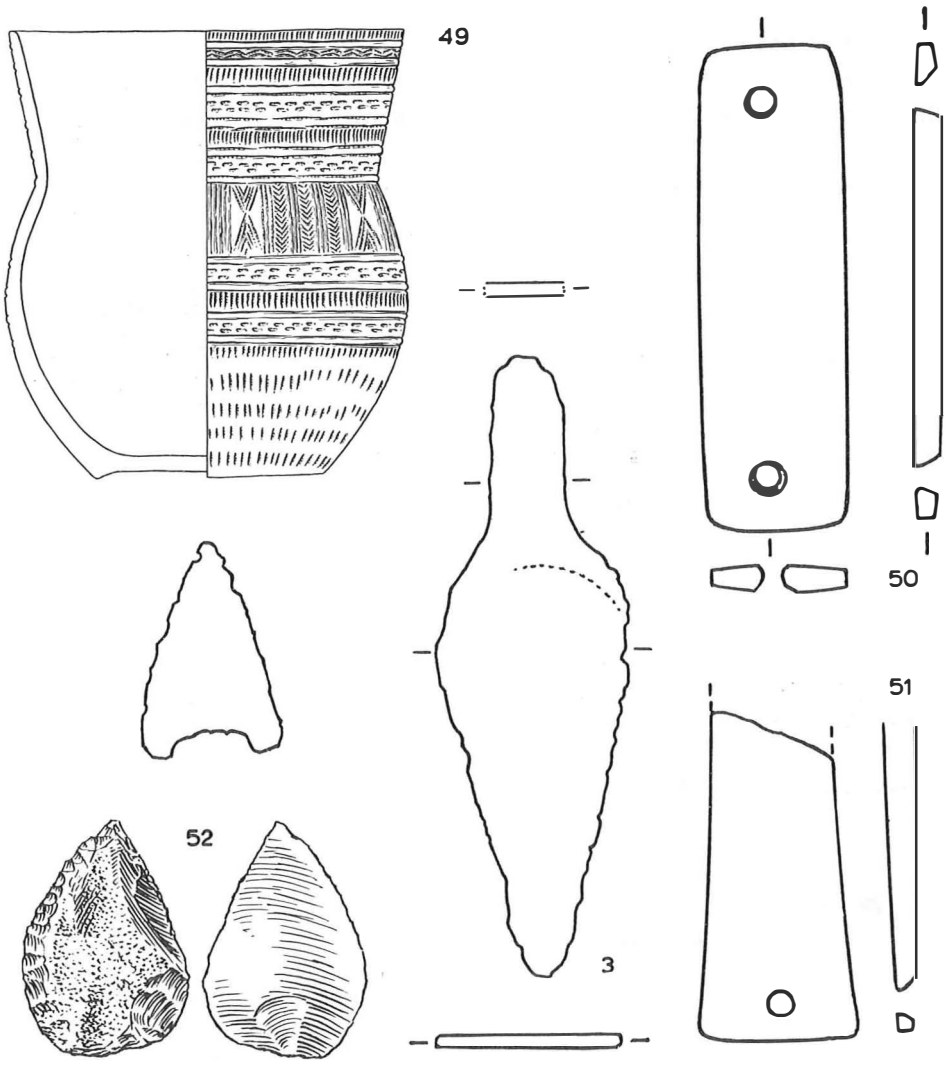


Fig. 7. Lunterse Heide (Veluwe). Grave group from a tumulus with Bell Beaker of Veluwe type (2^{Id}), copper knife, wrist guard and arrowheads (App. I: 5; III: 3. Drawing B. Kuitert. Scale beaker 1: 3; associated finds 1: 1).

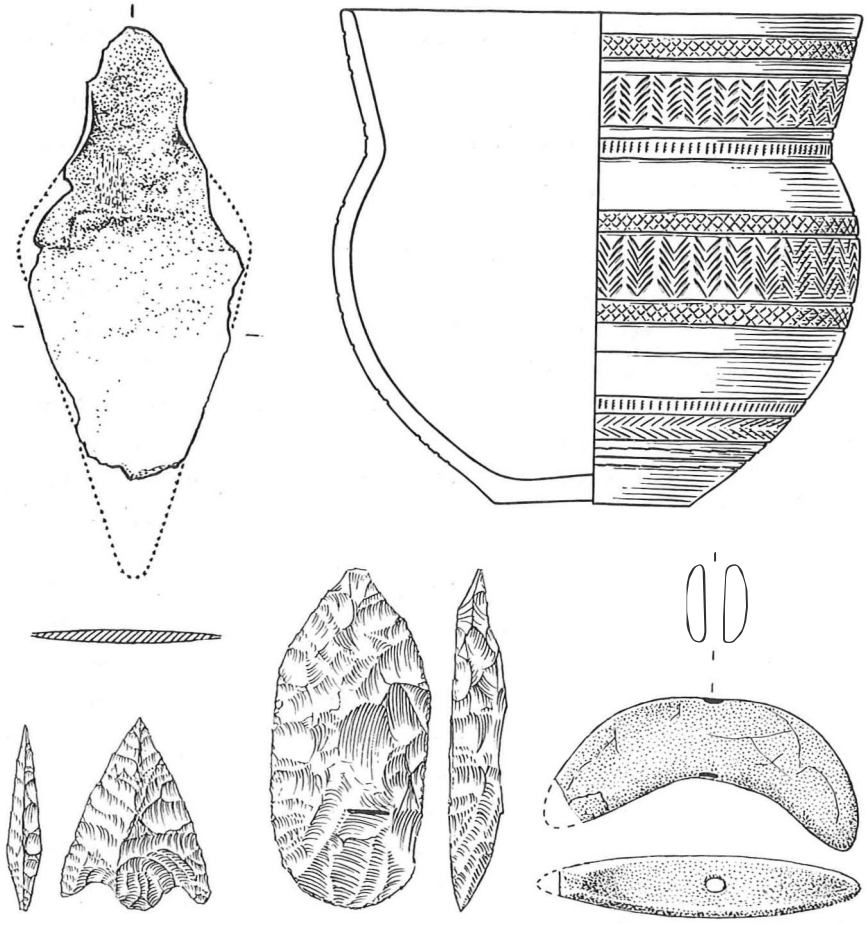


Fig. 8. Nieuw-Millingen (Veluwe), „de Mottenkuil". Grave group from a tumulus with Bell Beaker of Veluwe type (2^{Ic}), objects of flint and amber, and copper knife (App. I: 10; III: 6. Drawing B. Kuitert. Scale beaker 1: 3; associated finds 1: 1).

The numerous associated finds also contain elements of Central European origin: over twenty simple flat four- and two-holed wrist guards (Fig. 7), a series of V-bored amber buttons (Fig. 6) and a small number of horseshoe- and lunula-shaped amber pendants (Fig. 6, 8; Bursch, 1933, Taf. VI: 39–40). On the other hand, the many triangular, hollow based and barbed and tanged flint arrowheads regularly found with Veluwe type Beakers (Fig. 7–8) belong to the Atlantic sphere (Sangmeister 1963, p. 46). Metal finds comprise three copper knives (Fig. 6–8; *cf.* Appendix I, nos. 1, 5, 10; III: 3, 6–7), one copper awl (Fig. 11*b*; App. I, no. 15; III: 8), and the Bennekom sheet-gold ornament (see below, p. 62). To the inventory of associated types can now be added stone metal-worker's tools (see below, p. 63–75).

It is generally assumed that the Veluwe group is a relatively late branch of the Bell Beaker family. In fact, the Beakers of Veluwe type find their place at the end of the typological series of the Bell Beakers in the Netherlands (*cf.* Van der Waals & Glasbergen, 1955, fig. 9; Van der Waals, 1964, fig. 10). But an overlap with the previous group is, as we have seen, highly probable. The simple two-holed wrist guard, the V-bored button, and the lunula-shaped pendant are characteristic of the third Bell Beaker phase of Sangmeister (1966). C14-dating is, so far, not very helpful for the Veluwe group. There is one date with a considerable statistical margin of error from a grave containing two Veluwe type (2^{If}) Beakers from Bennekom (Veluwe): 1915 ± 180 B.C. (GrN–326, Vogel & Waterbolk, 1963, p. 182). A second date, from St. Walrick (Nijmegen area), refers to the youngest of the three graves in a tumulus, the oldest of which contained a Veluwe type Beaker (2^{If}), and the second an Únětician copper wire-wound ornament, possibly a *Schleifennadel* (fig. 25; see below, p. 87): 1755 ± 80 B.C. (GrN–2996, Vogel & Waterbolk, 1963, p. 182).

d. The fourth group of Dutch Bell Beakers (types 2^{IIa-c} in the typology of Van der Waals & Glasbergen, 1955) are those decorated with the techniques of the PFB culture (the Dutch branch of the Battle Axe – Corded Ware cultures). This decoration may consist of zonal cord-impressions interchanging with dentated spatula impressions, all-over cord- impressions (*Schnurzonenbecher*), or all-over herringbone decoration. The associated finds also comprise PFB culture elements: small flint axes which are indistinguishable from those found in PFB graves and battleaxes. The burials in single graves, often under barrows, must also represent a PFB element.

Opinions on this group are highly controversial; the reader should compare the interpretations given by Sangmeister (1966) in the present volume and Clarke (unpublished thesis, Cambridge 1965). The writers agree with Sangmeister that Corded Ware influence is undeniable in this group. In shape, these Beakers show much affinity to the Beakers of our group (*b*), the local derivatives of the Beakers with maritime decoration. Accordingly, one should expect a dating for these hybrids at least as late as the Beakers of group (*b*), *i.e.* certainly later than the true maritime Beakers of, for instance, Vlaardingen. In fact, Sangmeister (1966) ranges them with his third Bell Beaker phase. But, curiously, we dispose of a series of six C14-dates, all ranging between 2190 ± 70 B.C. (GrN-851, Eext) and 1930 ± 40 B.C. (GrN-939, also from Eext; *cf.* the table of C14 chronology, Van der Waals, 1964, p. 52–53). Either one must conclude that the Beakers of this group are parental to the maritime Beakers and their derivatives, as does Clarke, or one must assume that there was an early phase of maritime and derived Bell Beakers which is not yet detected. Clarke is inclined to put the cord-decorated Bell Beakers at the beginning of the whole Bell Beaker series, and suggests the Gulf of Lions coastal area as a possible centre of origin. It is clear that this suggestion excludes the possibility of Corded

Ware influence. A satisfying explanation, accounting for all the contradictions involved, seems as yet impossible.

In accordance with the early dating is the fact that (in the Netherlands, at any rate) this group still preserves a formally Neolithic character; no copper objects being known among the associations. Nor do other typical Bell Beaker objects such as wrist guards or V-bored buttons occur. On the other hand, daggers of Grand-Pressigny flint, which never occur with Beakers of groups (*a–c*), appear to be typical of this group (*cf.* Van der Waals, 1964, p. 35–37, and map fig. 14).

In the present context it is important to note that copper objects and indications of metal working only occur with our groups (*b*) and (*c*) *i.e.* with the local derivatives of the Beakers with maritime decoration and with the Beakers of Veluwe type. As we have seen, elements of both The Atlantic and Central European Bell Beaker provinces are represented in these groups.

B. The Chronological Problem and the *Rückstrom* Theory

Basic to an evaluation of the role of the Bell Beaker culture in the spread of metallurgy is an appreciation of its chronological relation to other cultures and metal industries. Whether formally labelled 'Late Neolithic', 'Aeneolithic', or 'Early Bronze Age', the Bell Beaker culture was generally held to have formed a bridge in many parts of Europe between the non-metal-using cultures, or those which knew metals only as occasional imports from distant regions, and the bronze-using cultures of the Reinecke A1 phase. Recently, another view of the chronological position of Bell Beakers – or at least of that part of the Bell Beaker culture which actively concerns us in this paper – has been put forward: the *Rückstrom* or Reflux theory of Sangmeister. In this view, the main movement of Bell Beaker elements outward from Central Europe to the South and West (termed *Rückstrom* in relation to the assumed primary northward movement from the Iberian peninsula) occurred not prior to the Early Bronze Age, but during it, *i.e.* during the Reinecke A1 period, and indeed not long before the border of that phase with Reinecke A2. In the JSS view expressed in SAM I, this movement was coupled metallurgically with the first spread of the 'Alpine' F metals (F1 and F2), claimed as being the constituent metals of some Dutch and English Bell Beaker objects. The determination of the Exloo (Odoorn) awl as being of Reinecke A1 type, and of JSS group A metal ('Adlerberg-Singen', also coming into use only in the Reinecke A1 period) served to support this picture. This Reflux theory is itself at the moment in a state of flux. Prof. Sangmeister re-defines it on p. 395 ff. of this volume, so that we need not here summarize his newer views. Suffice

it to remark that Sangmeister here, as in his earlier work, relies on a shortened and compressed chronology, which others would prefer to see as a rather more drawn-out affair. Against Sangmeister's 1800–1700 for his *Rückstrom* phase, there are the by now well known C14-dates for All-over Corded Beakers in the Netherlands of c. 2200–1900 cited above, p. 54. (Recent developments in C14 theory tend to suggest that published datings must be, if anything, too low rather than too high.) Again, a century or so is rather a short time to allow for the emergence and development of the Únětice culture to the remarkable technological climax represented by the Leubingen-Dieskau phase. In SAM I, the South German Early Bronze Age consists of three phases (A1: 1, A1: 2, A2), corresponding more or less to the conservative three phase division of the Únětice culture suggested by Mandera. In the meantime, various more complicated chronologies for Únětice have made their appearance.

Of special interest in this connection are two recent papers from Central Europe. The first is the paper by Točik (1963) on the Nitra Group of Southwest Slovakia. According to Točik, the Nitra Group (in which bone and shell ornaments occur commonly in the graves, sometimes together with copper wire and "willow leaf" ornaments) represents a phase later than that of the Bohemian-Moravian Bell Beakers (the place of which is taken in Southwest Slovakia by the Nagyrev culture and the Veselé group), yet demonstrably earlier than the classical Únětice material in the area. The metal used for most of the Nitra artifacts of the stage characterised by 'willow leaf' ornaments is quite different from that used by Bell Beaker smiths in Czechoslovakia, to judge by the admittedly limited number of quantitative analyses so far published. Surprisingly, however, the Nitra Group's metal greatly resembles (as will be shown elsewhere; Waterbolk & Butler, in press) the metal identified in the JSS scheme as Group A, and used characteristically by the Adlerberg and Singen cultures, and also (but more incidentally, and then normally alloyed with tin) by Únětice. Slovakian authorities assume that the Nitra Group's metal was obtained from the nearby Slovakian Ore Mountains. Thus, we have in Southwest Slovakia a 'Nitra Group' phase, using a smelted metal with high As, Sb, Ag and Ni; followed by a classical Únětice phase, presumably using high tin bronze in Southwest Slovakia as it did in Bohemia-Moravia and Central Germany.

Independently of this Slovakian work, a study has appeared by a student of Sangmeister, Christlein (1964), who offers a detailed chronology, based in part on horizontal stratigraphy at Gemeinlebarn and elsewhere, of the Early Bronze Age flat-grave cemeteries in the Central European area. Christlein's Phase I has comparatively few copper artifacts and a great variety of bone and shell ornaments; in content it strongly resembles the Early Nitra phase. Furthermore, Christlein states, on the authority of Sangmeister, that objects of metal of JSS Group A occur at Gemeinlebarn only in the part of the cemetery characterized by Phase I artifacts. Christlein's

Phases 2 and 3 contain types traditionally associated with classical Únětice, while Phase 4 has traditional 'Reinecke A2' forms.

Interesting, too, is Christlein's determination that both Straubing and Adlerberg begin in his Phase I – in both cases with JSS Group A metal – but that Singen seems to begin only in his Phase 2. This is not the place to go into the problems involved in detail; what concerns us at the moment is that we have now two independent schemes which agree on the existence of an early phase of the Central European Early Bronze Age, immediately post-Bell Beaker, and preceding the classical Únětician-Reinecke A1 phase, in which metal of the type of JSS Group A was already in use over a considerable area. The Christlein chronology has been accepted by Sangmeister (1966).

If we postulate a date of around 2000–1900 for the Central European Bell Beakers and c. 1600–1500 for the Christlein 4 (Reinecke A2) phase, the following absolute chronology could be suggested for Central Europe:

a. Bell Beakers	2000–1900	(= Předmostí phase of Hájek)
b. Christlein 1	1900–1800	(= Early Nitra phase); Straubing, Adlerberg begin
c. Christlein 2	1800–1700	classical Únětice, Straubing, Singen
d. Christlein 3	1700–1600	development of classical Únětice
e. Christlein 4	1600–1500	Reinecke A2 (parallel with Shaft Grave epoch).

One need not expect that either this relative scheme or the absolute dates applied to it will be strictly and literally true, especially in view of the wide and diverse area involved[2]. It appears, however, to represent the best framework obtainable at the moment, and a suitable background for the unfolding of our analysis of the Dutch Aeneolithic and Early Bronze Age metal-work.

II. BELL BEAKER METALS AND METAL-WORKING

Bell Beaker metal-work known in the Netherlands comprises ten tanged knives (two of which were also riveted), two awls, one spiral bracelet with pointed ends, and three sheet gold ornaments (Fig. 1:3–10, 11*b*; for details, literature, *etc*. see Appendices I–III).

Of these sixteen objects, five come from a single find, the well known grave-group from Exloo (Drenthe; Fig. 5), which contained a large, well-made tanged knife, an awl, the spiral bracelet, and two similar sheet gold ornaments, together with a Bell Beaker of our group (*b*), two amber beads, and flint objects. This is one of the richest

Bell Beaker grave groups known; yet it is quite isolated as a Beaker find with metals in the north of the country; the other metal finds being from the Veluwe or from the Hilversum area. The main concentration of the metal objects is that on the Veluwe, and where associated with pottery, they are with Bell Beakers of maritime derivation (two besides Exloo) or with Bell Beakers of Veluwe type (three, *cf.* App. III).

A. **The Copper Objects**

1. Tanged knives (App. I, No. 1–10; Fig. 10)

The ten tanged knives are of greatly varying length. The longest (Exloo) measures 21 cm; the shortest about 8 cm. The majority of the knives have tangs with hammered-up flanges. One example has a single, central rivet in the tang, like some British specimens (Piggott, 1963, fig. 16: 2–6); one has rivet-notches at each shoulder, like the knife (a much longer one) from Toome Bridge, Co. Antrim, Ireland (Piggott,

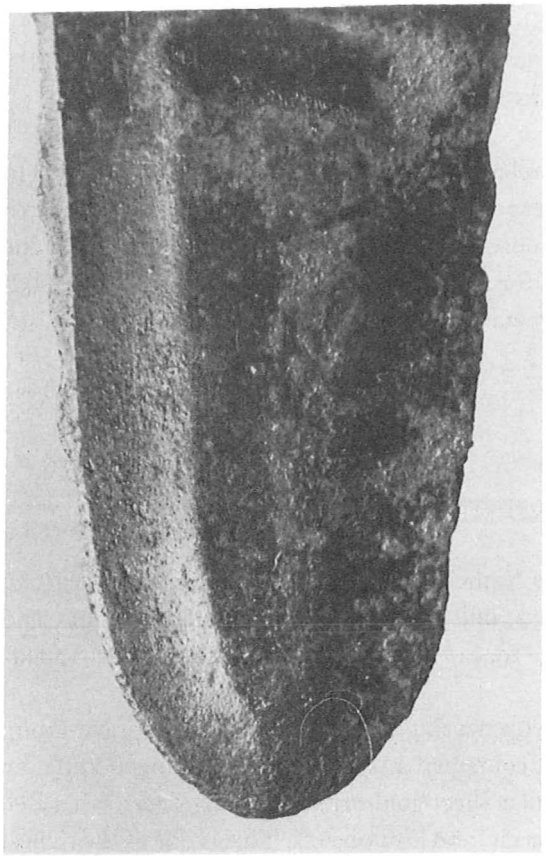


Fig. 9.
Exloo (Drenthe).
Detail of copper knife,
showing working of cutting edge.
Photo C.F.D., Groningen.

1963, fig. 16: 9), but also like examples from Central Europe[3]. A majority of the specimens have a broad zone bordering the cutting edge which is slightly concave in section; as the detail photo (Fig. 9) shows, the Exloo knife had a double hollow zone, a feature known in the British Isles, but also in Sardinia and South Germany; in the last-named area it occurs on Early Bronze Age as well as Bell Beaker knives (Piggott, 1963, p. 70, with further references; were the hollows ground or hammered? *cf.* App. II: 6). All these features have at least occasional parallels in other Bell Beaker provinces; Piggott is, however, undoubtedly right in emphasizing a relationship between the Dutch and British knives. But the difficulty in pinning down exclusive typological relationships between different provinces is illustrated by the finely made knife from Exloo, which can be as readily matched as to form by specimens in Czechoslovakia (*e.g.* Hájek, 1966, Abb. 2: 5) as in Portugal (Leisner, 1965, Taf. 181: 2)[4]. Hilt marks are present on most of the Dutch knives; in most cases they are arc-shaped, but four specimens have a hilt outline resembling the cross-section of an inverted flat-bottomed bowl with a broad flat rim.

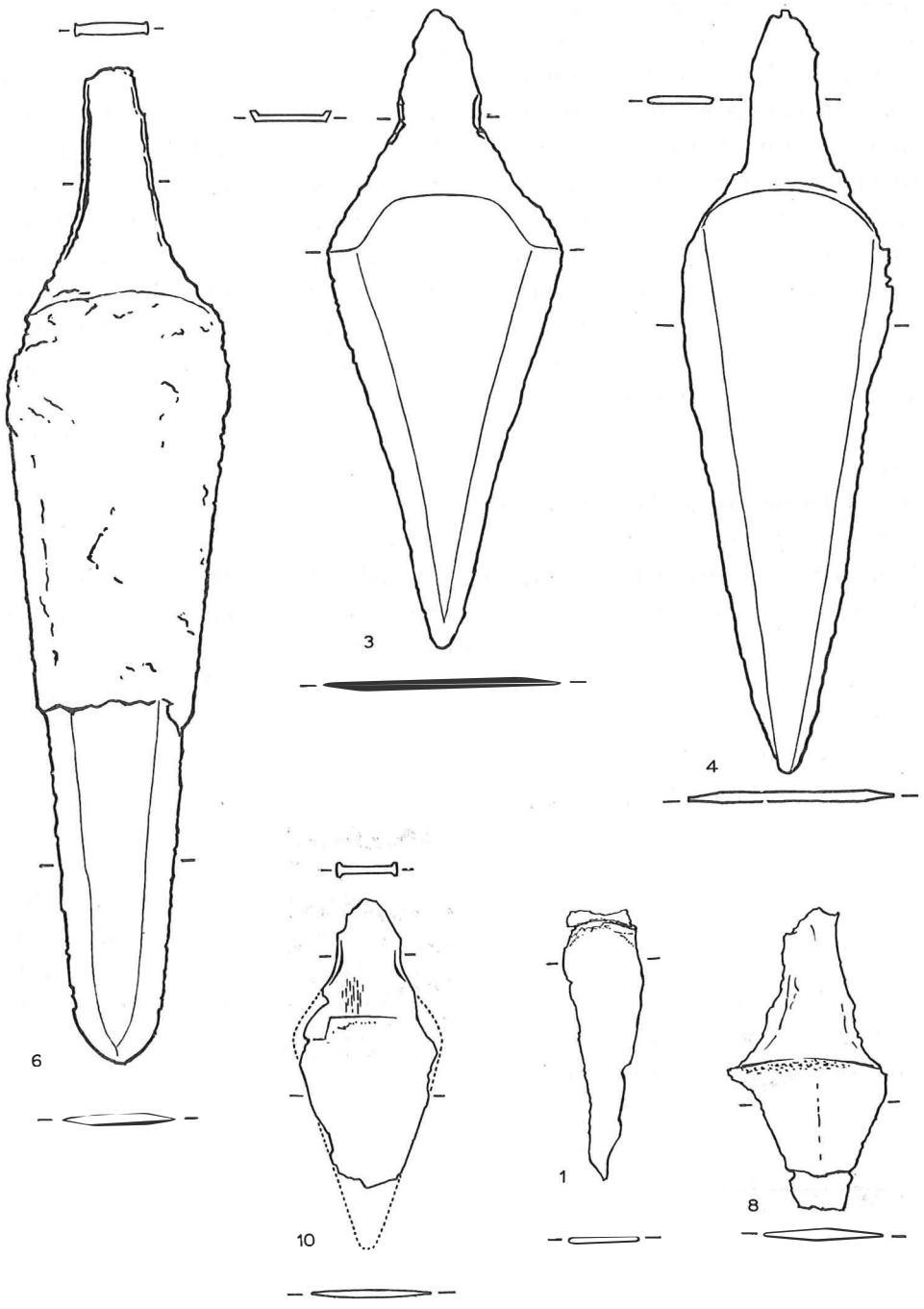
Seven of the knives have been spectrographically analysed; six by JSS and one by us. The results are shown in App. I, No. 1–7, and on the Graph (Fig. 28). Of these, five at least may be said to be fairly homogeneous in composition. The knives from Vaassen, Stroeërzand, Ede, Exloo, and Lunterse Heide are characterized by high As and moderate Ni, with other elements low or absent. The Lunteren awl appears to be of the same metal. Only one other analysed Dutch object, the flat thick-butted axe from 'Limburg' (Fig. 28) shows a similar composition; so that the alloy concerned appears to be typical for the Dutch Bell Beaker copper-work. One Bell Beaker knife (Hilversum) is of arsenical copper; another (Lettense Berg) is of a deviant composition, having high As and Ni and moderate Pb, Sb and Fe.

Five of the knives have been submitted for metallographic examination. All five had been made from cast blanks. Three showed traces of cold-working; all five showed probable or certain traces of annealing. Hardness figures are in the range 98 to 111 on the Vickers scale (HV5), except that the well preserved Exloo knife showed exceptionally high figures (surface 119; cutting edge 153–172) (*cf.* the Gieten axe, App. II, no. 32; see also Parker, 1963).

2. Awls (App. I: 11–12; Figs. 5, 13*b*)

Of the two awls found with Bell Beakers in the Netherlands, one (Lunteren) is rectangular-sectioned, with both ends tapering; the other (Exloo) is of the type with lozenge-shaped central thickening.

The Lunteren awl offers us no special problems; as already mentioned, its metal composition agrees with that of the main group of Dutch tanged knives. But the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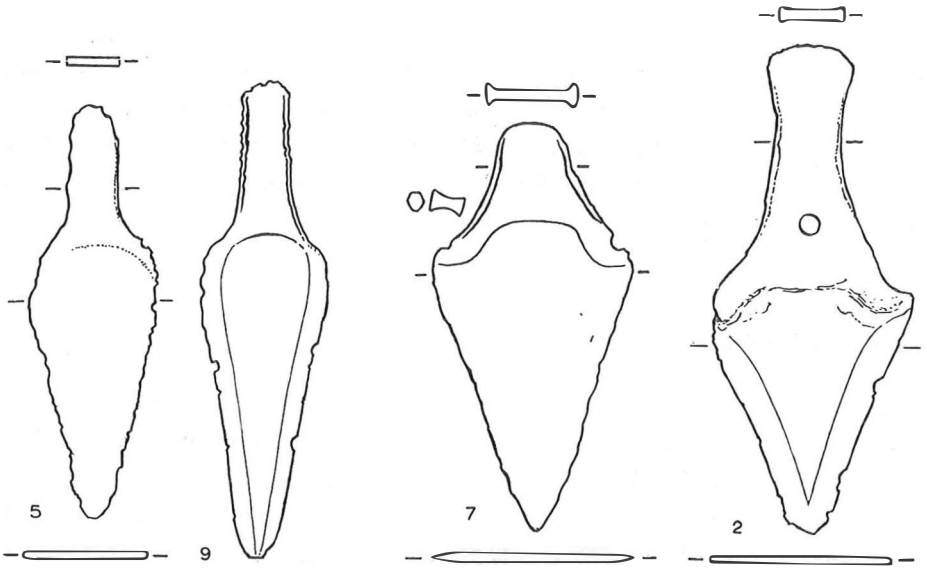


Fig. 10*a–b*. Bell Beaker knives from the Netherlands. For further details, see Appendix I: 1–10, Scale 2: 3.

Exloo awl is, according to JSS, of a type specifically characteristic of Central European Reinecke A1, and of a metal composition with high Sb and Ni and moderate As and Ag, so that in composition it is indistinguishable from objects of the 'Singen metal' discussed below (p. 88ff). This awl plays a key rôle in the JSS dating of the *Rückstrom* to the Reinecke A1 period. A similar awl, illustrated by Točik (1963, p. 755, Obr. 256: 8), from the Nitra-Group site of Tvrdošovce, is presumably a product of the Earlier Nitra phase; awls of the same form, and in two cases made of JSS A metal, occur also in graves of the Adlerberg culture together with bone rings typical for the Christlein I phase (Adlerberg, grave 6 and Ludwigshafen-Mundenheim, Krügerst., grave 7; *cf.* Köster, 1966, 27, Taf. 8: 33–6, Taf. 9: 4–8). This evidence suggests that JSS are right in postulating a 'Reinecke A' date for the Exloo grave, but wrong in so far as this implies contemporaneity with classical Únětice phenomena; the intercalated Christlein I phase provides a happy compromise solution.

3. The spiral bracelet (App. I: 13; Fig. 5)

The Exloo grave also contains a copper coiled bracelet, made of thin wire with pointed ends. Oranaments of this type are otherwise unknown in this region, so our bracelet is presumably an import from a distance. The type is not one which has attract-

ed much specific discussion, so that it is difficult to be sure of its exact range in space and time. We content ourselves here with noting the occurrence of similar spirals in the earlier phase of the Nitra Group, *e.g.* in Branč Grave 160 (Točik, 1963, Obr. 261); and from the Christlein I graves at Gilching and Kronwinkl in Bavaria (Christlein, 1964, Abb. 23C, Abb. 22E). The Adlerberg culture find from Nierstein: Achbacher Steige (Köster, 1966, Taf. 32–4) is presumably also of this phase.

B. **The Gold Objects**

Three gold objects from two finds are known to have occurred with Bell Beakers in the Netherlands. The most important is the sheet gold ornament from Bennekom, found with a Veluwe Bell Beaker (Glasbergen & Butler, 1956). It consists of a strand of rectangular-sectioned wire (made by rolling and hammering together sheet gold) with expanded, oar-shaped ends, which are ornamented in a manner strongly reminiscent of that on British gold basket earrings of the Bell Beaker period. This type of ornament is undoubtedly related to the copper 'willow-leaf' ornaments of the Nitra Group, the Mierzanowice culture, the Monteoru culture, and other East European groups, recently surveyed by Točik (1963). These are in turn related to, or (one should perhaps suggest) derived from, the gold, silver or electrum Bell Beaker earrings from Czechoslovakia (Hájek, *Inventaria* ČS 11: 1, Čs 14(2) 1: 2; *cf.* recent find in silver in Switzerland: copy seen in RGZM Mainz). Very similar gold examples are known in Portugal (Leisner, 1965, Taf. I: 38, Taf. 90: 144–5). All these have only one oar-shaped end. Double-ended versions in gold (with the ends sometimes of unequal size) have been found in Denmark, and (with equal-sized but short, unornamented ends) in Belgium (the Arlon ring) and Brittany (three finds; Briard, 1965, 74–6, Figs. 19: 2, 20: 4–5, 21: 2); copper versions of the Breton type are known from Britain (Glasbergen & Butler, 1956).

Gold basket earrings generally resembling the Irish-British type have also been found in Poland. Perhaps of special importance is the stylistic resemblance of the Bennekom ornament to that of the gold earrings from Orton, which were almost certainly associated with a gold lunula closely related to the lunulae of the Kerivoa hoard, which also contained an Arlon-type ornament with oar-shaped ends. The groove-decorated early lunulae, which were exported to Northern Europe, thus appear to belong to the same complex as the Western and Northern European ornaments with oar-shaped ends (of which the Bennekom ornament is one) and the Western basket ear-rings; and all these are tied to the period of the Veluwe Bell Beakers by the Bennekom find.

The other gold objects found with Dutch Bell Beakers are the two tiny sheet gold ornaments from the Exloo grave (Fig. 5). They consist of rectangular sheets of gold,

each rolled into a rough cylinder and perforated, presumably for attachment to a thread for use as beads. They are traditionally supposed to be imports from Brittany (Van Giffen, 1947); the Breton parallels are generally similar but larger and unperforated (cf. Briard and L 'Helgouach, 1957, Pl. 6).

C. **Stone Metal-Worker's Tools**

The inventory of types associated with the Bell Beaker culture is in general so well known that one rarely has occasion to add something new to it. It appears, however, that we have in the centre of the Netherlands a hitherto neglected series of stone tools – including in one case a set of four, and in another a set of three stone implements – which appear to represent a major addition to our knowledge of Bell Beaker metallurgical practices. So far we know of four Dutch finds (Fig. 11–16), all in a strikingly limited area within the territory of the Veluwe Bell Beaker culture (Fig. 1), containing a total of nine of these stones.

Five examples, distributed among all the four finds, are shaped more or less like building blocks or sofa cushions; for these, we propose the short name of 'cushion stones'. They are, in general, of regular shape, with some or all surfaces polished to different degrees. Some surfaces still show traces of having been shaped by a pecking technique. The faces are generally almost flat or slightly convex; some stones have somewhat facetted angles. One stone has a very broad, shallow longitudinal groove on one of its faces. A few of the faces are still rough. As to the size of the cushion stones, there are two categories. Two examples measure about 14 × 11 × 7 cm, and are too large to be used as a tool in the hand. The other three are much smaller and can easily be handled. As to the function of these stones, the larger ones would obviously make very good anvils; the smaller ones could have served as small anvils, heavy hammers, polishing stones, or for a combination of these purposes. But before going into the arguments for this suggestion, the other stone tools of the group should be described. Associated with the cushion stones in the finds from Lunteren and Soesterberg are single examples of:

1. an elongated slab-shaped grindstone of micaceous quartzite, with transverse, somwhat curved traces of grinding on one face (Lunteren, Figs. 12–13*a*);

2. An elongated pebble of irregular rectangular cross-section, of the same type of stone as the cushion stones, the slightly convex sub-rectangular end-faces of which have been polished, making a double-headed hammer. Two of the sides have also been polished, suggesting that this implement has also been used for smoothing (Lunteren; Fig. 13*a*);

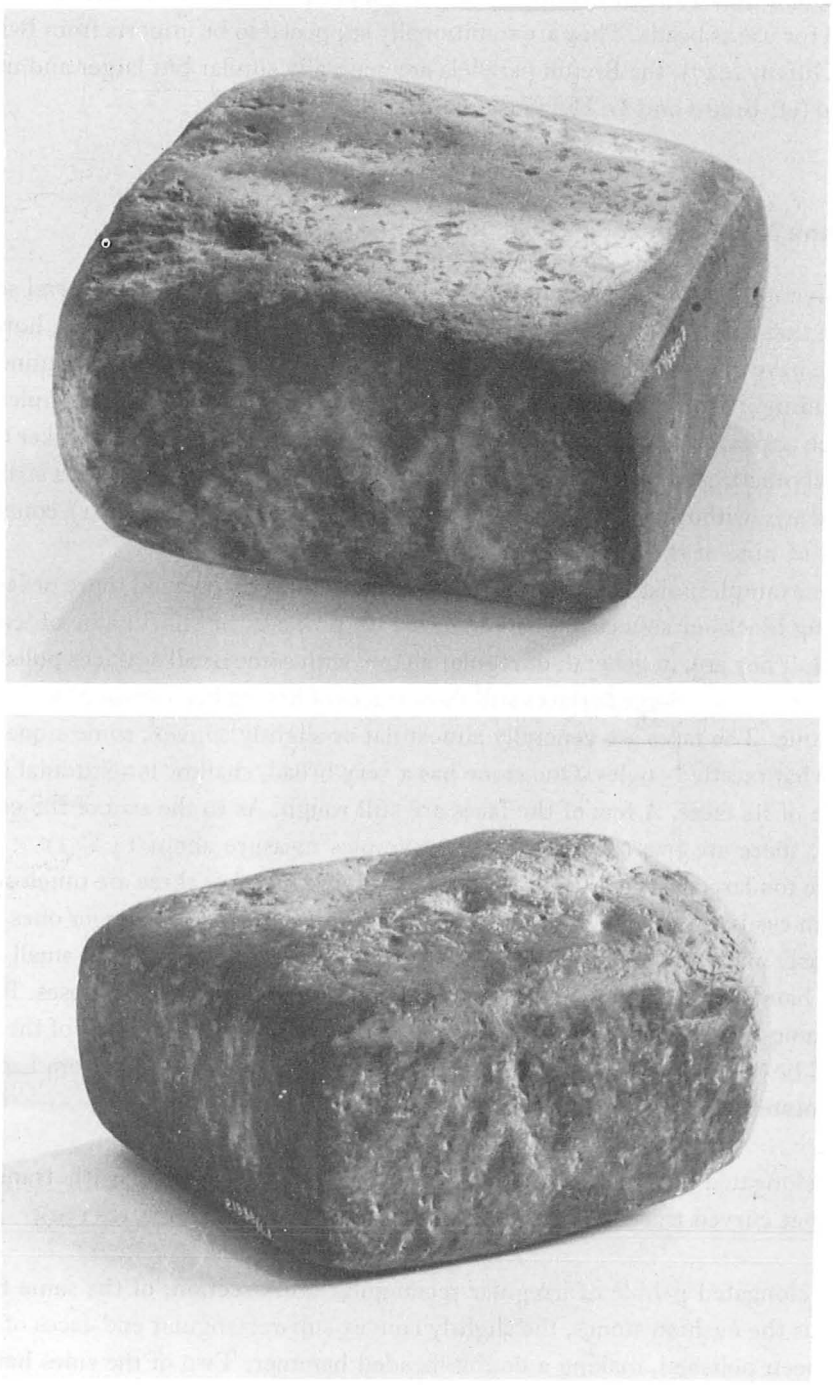


Fig. 11. Lunteren (Veluwe). Large cushion stone from Bell Beaker grave group. Scale c. 1 : 2. Photos C.F.D., Groningen.

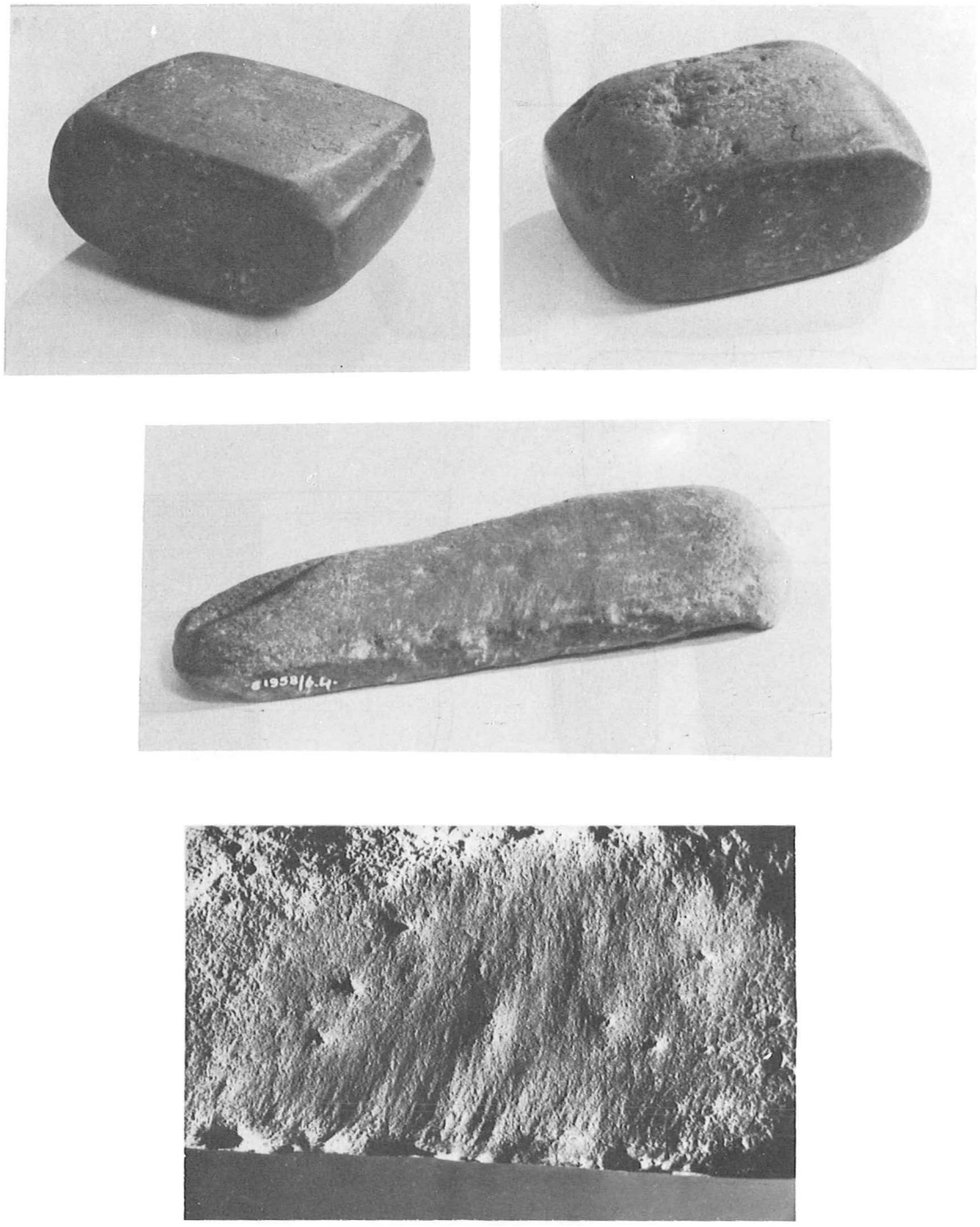


Fig. 12. Lunteren (Veluwe). Small cushion stone, whetstone (top and centre; scale c. 1: 2) and detail of surface of whetstone (bottom) from Bell Beaker grave group. Photos C.F.D., Groningen.

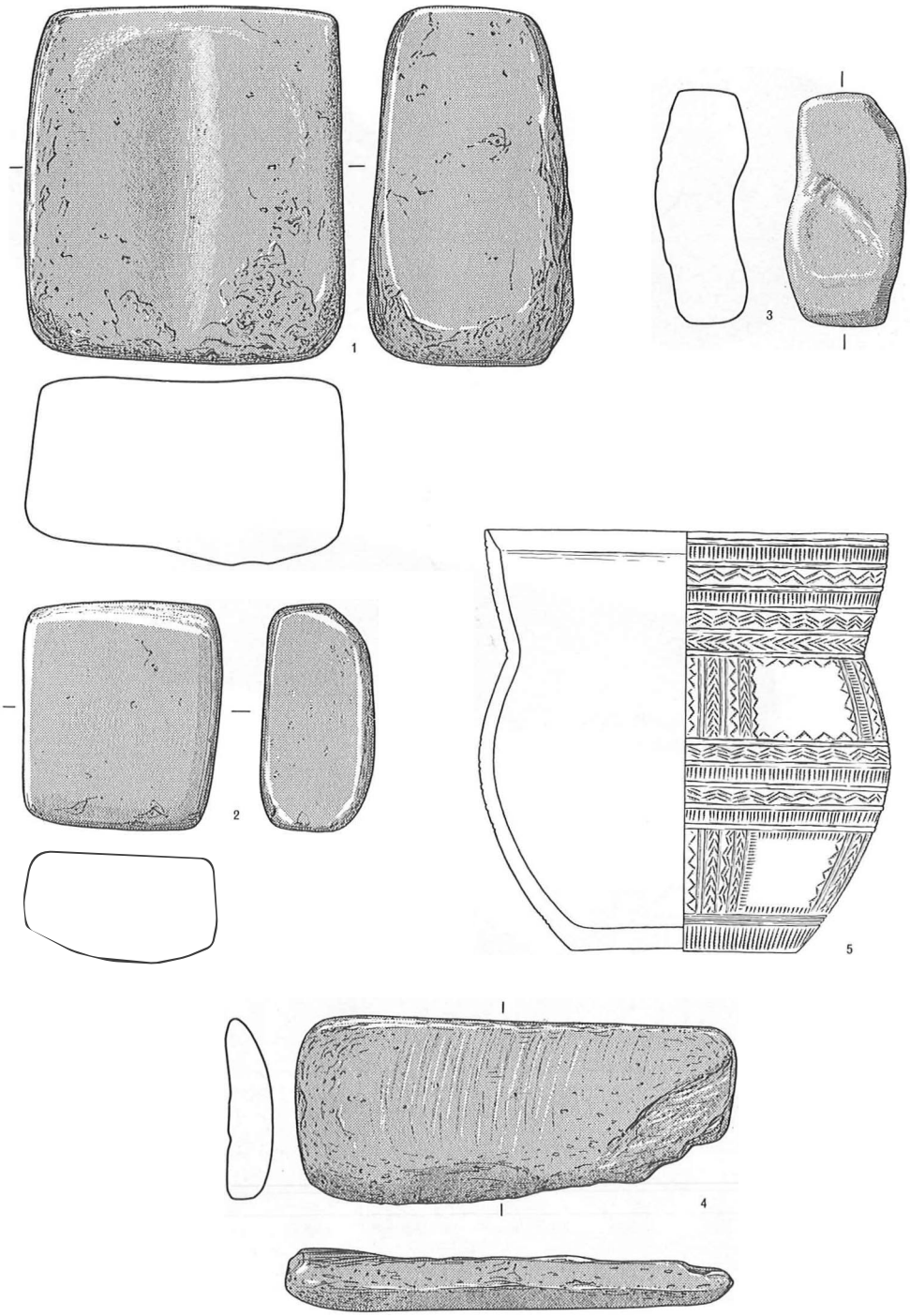


Fig. 13*a*. Lunteren (Veluwe). Bell Beaker tumulus. Metalworker's tools and one of the two Bell Beakers of Veluwe type from grave 1 (see also Fig. 37, bottom right, and App. III: 8. Drawing G. de Weerd, B. Kuitert. Scale 1: 3).

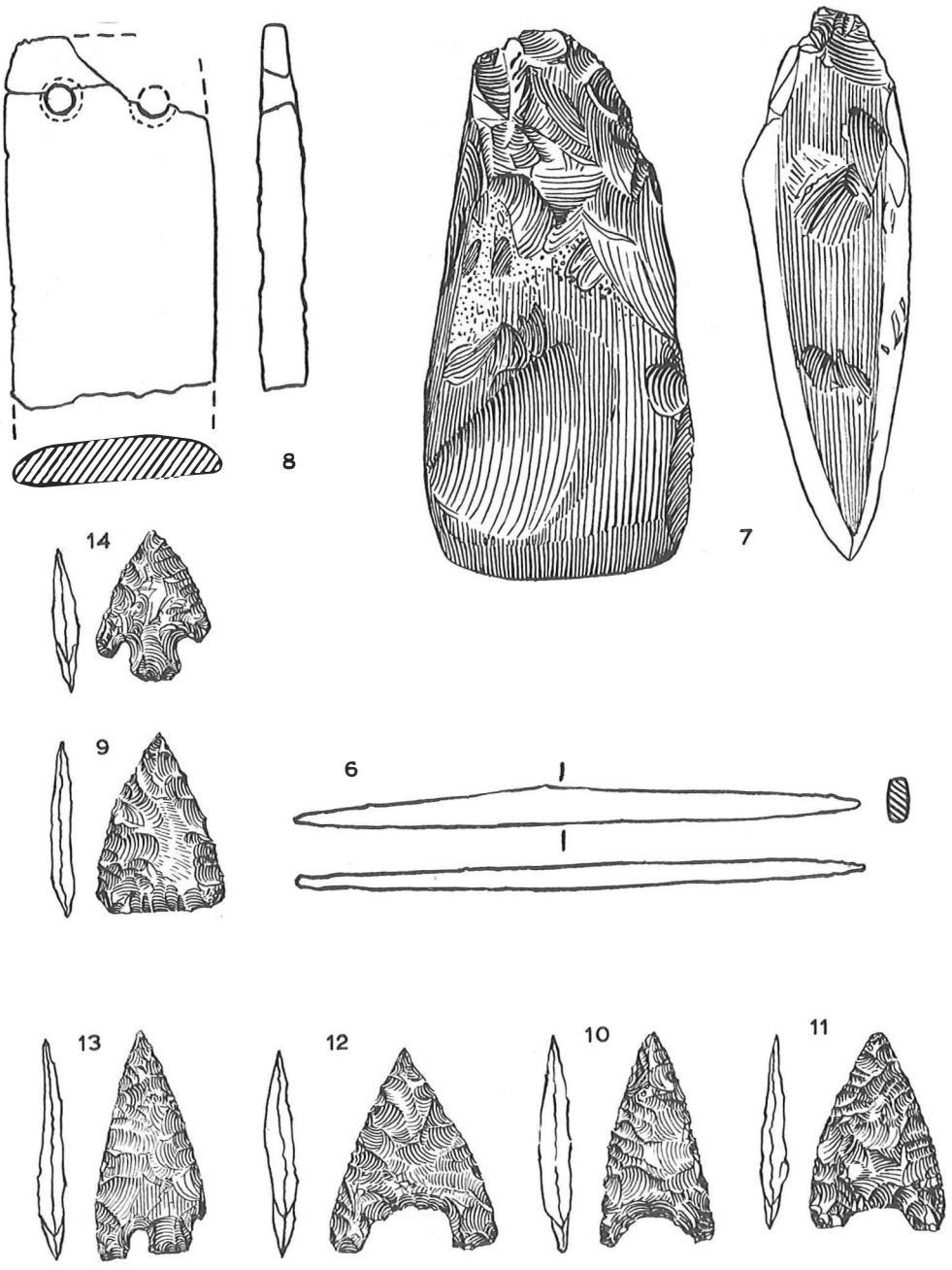


Fig. 13*b*. Lunteren (Veluwe). Bell Beaker tumulus. The smaller objects from grave 1 (App. I: 12; III: 8. Drawing G. de Weerd. Scale 1: 1).

3. the broken upper half of a point-butted stone (graywacke) axe of oval cross-section, with narrow facets on the sides. The face of the break has been pecked flat and retouched along its edges, so that the broken end fits comfortably in the hand. The butt end opposite has been used as a hammer (and perhaps also for smoothing), for which purpose it had been flattened to a small oval plane (Soesterberg; Fig. 14–15);

4. a stone hammer of truncated conical shape, oval in cross-section, with a broad shallow encircling groove; both ends have been flattened and polished to make a heavy double-headed hammer (Soesterberg; Fig. 15–14). One of the sides has also been pecked and ground flat, but not polished[5]. This object, like the previous one, has a history involving at least two periods of different use. It began its working life as a grooved hammer or maul. The preparation of the ends of the implement for use as a metal-worker's hammer and the grinding of one of the sides (which partially does away with the encircling groove on that side) are thus secondary. The latter operation also suggests that when in use by the smith the tool was held in the hand, and not hafted as it was in its original function (unless, of course, the flattening of the side for use as a rubber was a tertiary adaptation).

The richest, and at the same time the most fully documented find is from a grave, apparently a double burial, in a tumulus at Lunteren (Figs. 11–13). It was excavated in August 1939 by Dr. F. C. Bursch, but never published. It contains the set of four stone tools (one large and one small cushion stone, a hammer stone and the whetstone) together with two Veluwe Bell Beakers of best quality (type 2^{Id}), part of a four-holed flat wrist guard, a copper awl of rectangular cross-section, a small irregularly shaped and atypical flint axe, and six flint arrowheads of hollow based, barbed-and tanged, and triangular form. The Soesterberg find (Fig. 14–15) contains the set of three stone tools (one large cushion stone, the re-used stone axe, and the double-headed stone hammer), together with two boar's tusks, a wrist guard (now unfortunately lost but seen by one of the writers and by Mr. J. A. Bakker), and a decorated pot (now lost) which was almost certainly a Bell Beaker. These objects were found during the laying of a railway track on Soesterberg airfield during World War II. The wrist guard (and the decorated pot?) confirm the attribution of the Soesterberg find to the Bell Beaker culture, as the axe fragment would have done in the eyes of a former generation[6]. Two of the smaller cushion stones are stray finds from Roekel and Speulde (Fig. 15–16). For detailed information on these finds and full descriptions, the reader is referred to Appendix III, nos. 8–11.

In considering whether these stones could have been used as metal-hammering implements two facts, dealt with elsewhere in this paper, should be borne in mind: 1.

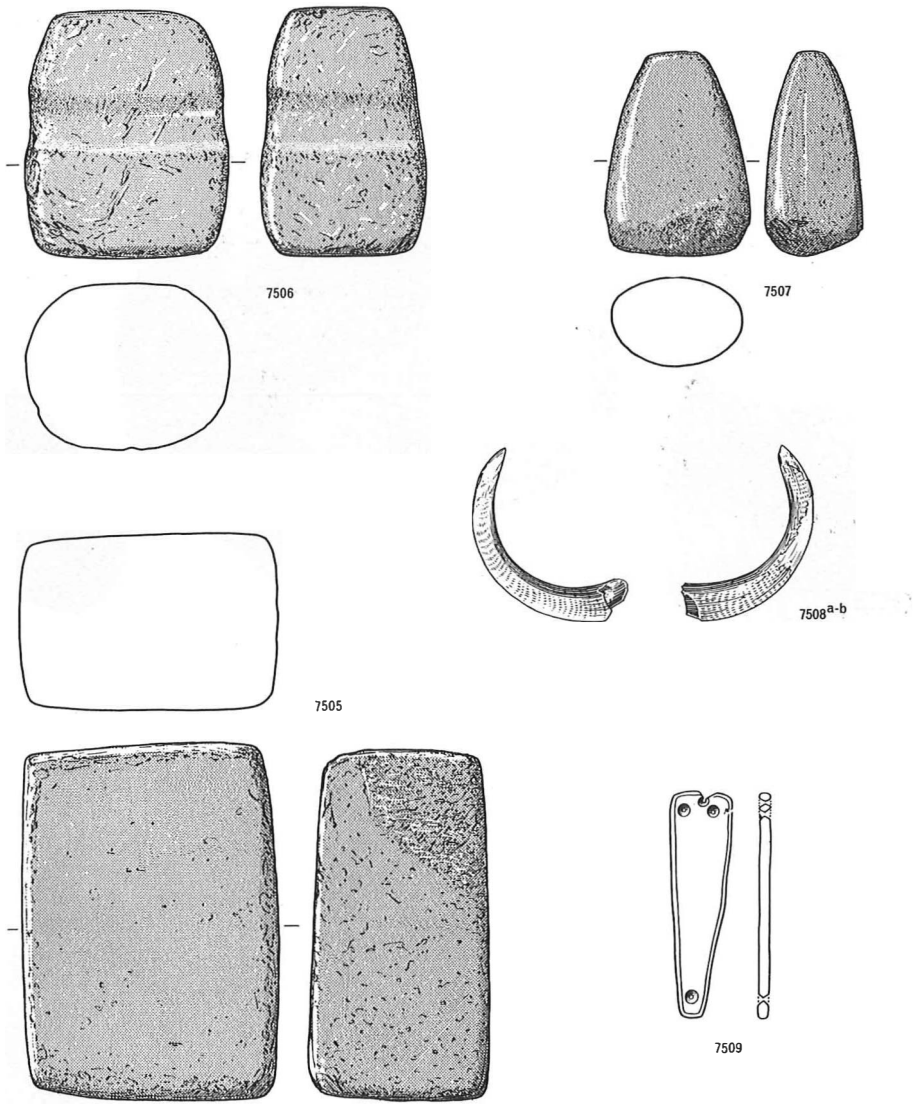


Fig. 14. Part of the Soesterberg find: stone metal-worker's tools, wrist guard and boar's tusks (App. III: 9. Drawing J. A. Bakker, B. Kuitert, G. de Weerd. Scale 1 : 3).

that hammering played an important role in the metal-working of the Bell Beaker people (*cf.* p. 58–9 and Appendix II; *cf.* also the Bennekom and Exloo gold ornaments, which are made of hammered sheet gold, see p. 62–3), and 2. that in view of the special composition of the Bell Beaker metals in the Netherlands it is reasonable to surmise that Bell Beaker people in this country practised metal-working. Apart from this, a number of questions should be faced: do the types of stone of

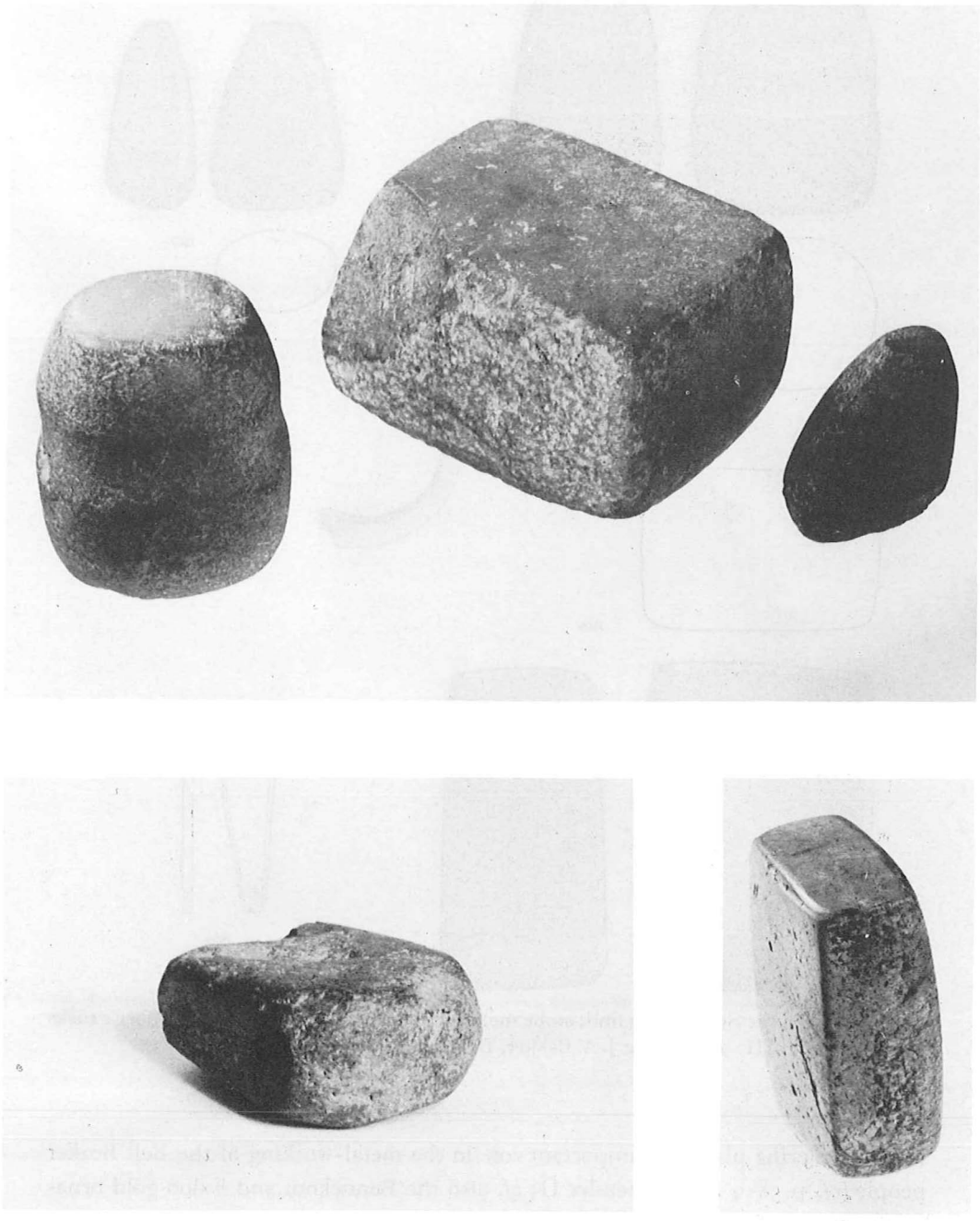


Fig. 15. Metal-worker's stone implements from Soesterberg (Utrecht; top) and cushion stones from Speulde and Roekel (Veluwe; bottom left to right). Photos C.F.D., Groningen.

which these implements are made and their shape lend themselves to use for hammering?[7] Are there traces of metal left on the stones? And, finally, are there counterparts for these stones elsewhere that might confirm their connections with the Bell Beaker culture and their use for metallurgical purposes?

As to the types of stone, it should be stressed that all but one of the cushion stones (the large Soesterberg example, which is of ordinary quartzite) and all but one of the stone hammers (the Soesterberg axe fragment, which is of graywacke) are made of quartzite of a special type, which has been formed in an arid climate or as a deposit in volcanic sources[8]. This type of stone, called in German *Zement-Quartzit*, is known for its extreme toughness as well as for its heat-resisting qualities. It thus seems very well suited for anvils and hammers. As a rock it occurs native in the Ardennes and the *Rheinisches Schiefergebirge* and it is found as erratics in the basins of the Meuse and the Rhine. On the Veluwe these erratics are by no means rare, so that it is difficult to say whether the stone for the tools was specially imported for the purpose or was found locally.

In respect to their shape, too, the cushion stones, with their variety of planes from almost flat to slightly convex and with their facets and varying angles, are well suited for the hammering of metal. The hammers likewise offer the variety in weight (from 250 to 930 gr.) and size of hammering surface which one would expect the hammersmith to have required. This is especially clear in the case of the Soesterberg find, in which two hammers of different weight (250 and 930 gr.) offered the choice of three hammering faces of varying size. The same possibly applies to the Lunteren find, if we are right in imagining that the smaller cushion stones may have served not only as an anvil but also as a hammer, in which case the Lunteren smith would have had at his disposal two anvils of different size and two hammers (290 and 750 gr.). This variety of tools available in both the Lunteren and Soesterberg finds stresses their affinity. The variety in weight and size is also characteristic of the ham-

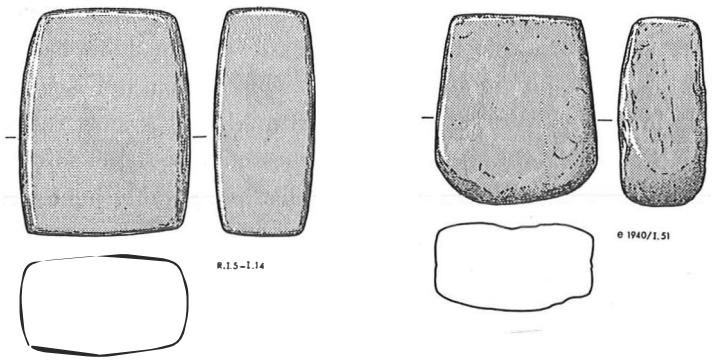


Fig. 16. Cushion stones from Roekel (left) and Speulde (right; App. III: 10–11. Drawing G. de Weerd. Scale 1: 3).

mers of the traditional brazier of our times, but his toolkit may contain many more of these implements.

If our stones have served the hammering of copper and/or gold, should one not then expect traces of these metals to survive, hammered into the surface of these stones?

In order to detect possibly surviving traces of metal, the stones were subjected to careful investigation by the x-ray fluorescence spectographic method both at the Oxford Laboratory for Archaeology and the History of Art and at the Laboratory for Inorganic Chemistry at the State University of Groningen, but no traces of metal were detected. These could, however, have disappeared after nearly 4000 years of exposure to rainwater, etc.

Little is so far known of related finds outside the Netherlands. Only the grooved maul in its primary shape appears to be a widespread type of rough tool. It is frequently found in many parts of Europe in association with traces of ancient ore-mining, or in places where such mining is presumed to have occurred[5]. As the type is not, so far as we know, otherwise represented in the Netherlands, our specimen might be considered to be an import; yet the stone could have been picked up locally on the Veluwe.

As to the cushion stones, a small example (8,5 × 5,7 × 3,3 cm) of fine-grained reddish sandstone (Fig. 17) has recently been found in a rich Bell Beaker grave at Stedten in Saxony (Matthias, 1964). Apart from this stone, the grave's content consisted of a male skeleton, three flint arrowheads, a copper tanged dagger, one boar's tusk, miscellaneous pig bones (evidently representing a grave gift of meat), two implements of antler, and an undecorated Bell Beaker. In this context, the stone in the well-known Early Bronze Age *Fürstengrab* of Leubingen in Saxony should also be cited (Fig. 17; Höfer, 1906). Even if this specimen is somewhat more elongated in shape then the Dutch and Stedten examples, its resemblance to the more finely worked specimens of our group is striking (the material is described as *Schiefer* in the original report, but according to Dr. H. Behrens (*in litt.*) the stone has never been actually determined). At our request, the stones of Stedten and Leubingen were inspected by Prof. Dr. H.T. Waterbolk when visiting Halle (August 1966). According to Professor Waterbolk, the Stedten stone appeared to be rather soft if compared with the Dutch examples, and had completely flat and slightly hollow faces. The stone of Leubingen appeared to be more similar to the Dutch examples, both in toughness of the type of stone and in the shape of its faces. Two cushion stones in the National Museum of Ireland (Fig. 17; one is of a different type), of which we were kindly informed by Dr. H. J. Case, are from Northern Ireland. Their exact provenance is unknown; like the examples from Saxony, they are from a more likely region for metallurgical tools than the Veluwe! (*cf.* this volume, p. 174, note 50).

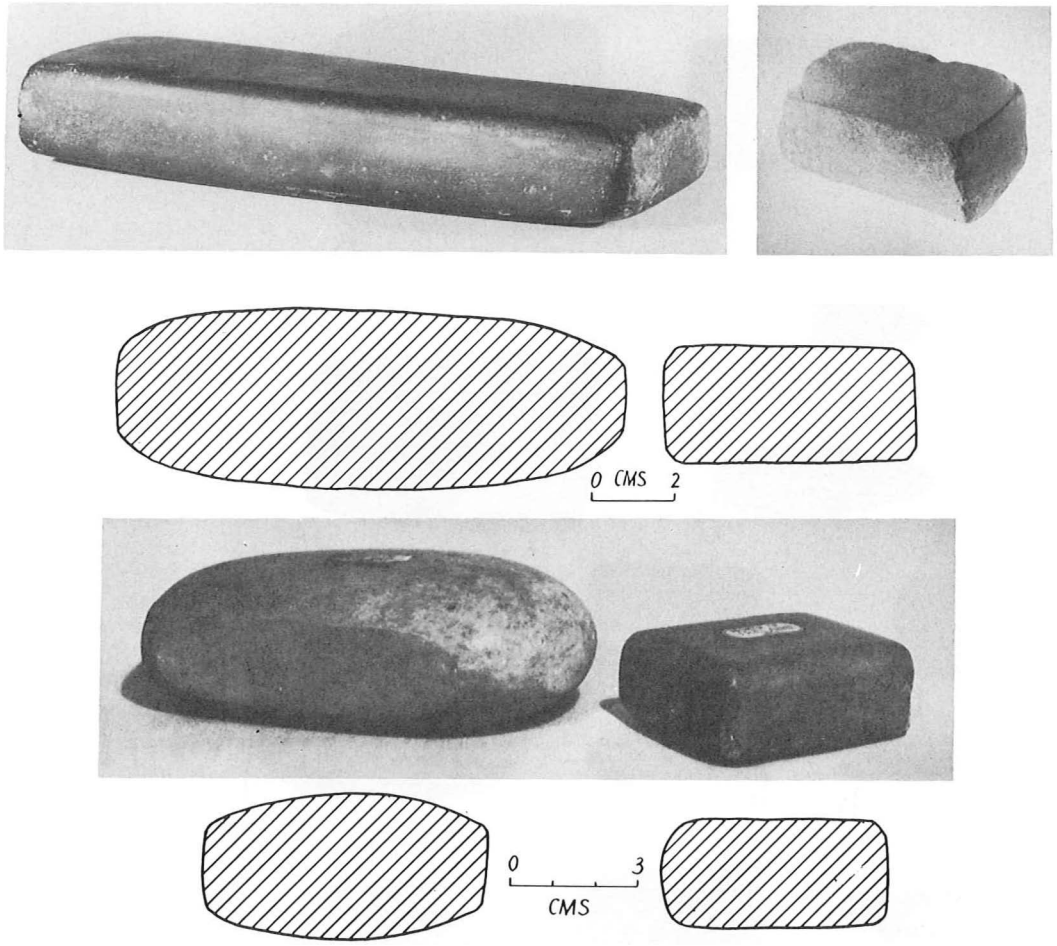


Fig. 17. Cushion stones from Leubingen (top, left) and Stedten (top, right; photos courtesy Landesmuseum Halle) and from Ireland (bottom; photo courtesy Ashmolean Museum Oxford).

Stones of generally similar form, but of greatly varying size, are not uncommon in South Russia (verbal information from Dr. I. I. Artemenko and Dr. W. S. Titov, Institute of Archaeology of the Academy of Sciences, Moscow). At least one example, quite strikingly similar to our cushion stones, but plano-convex in section, occurs in a smith's grave, accompanied by a series of clay bellows-nozzles and polishing stones together with a pot typical of the Catacomb culture, at Zhutovo in the district of Volgograd (the former Stalingrad; Shilov, 1966). The clay nozzles resemble those found in smith's graves of the Srubno (Timber Grave) culture, but are unornamented[9].

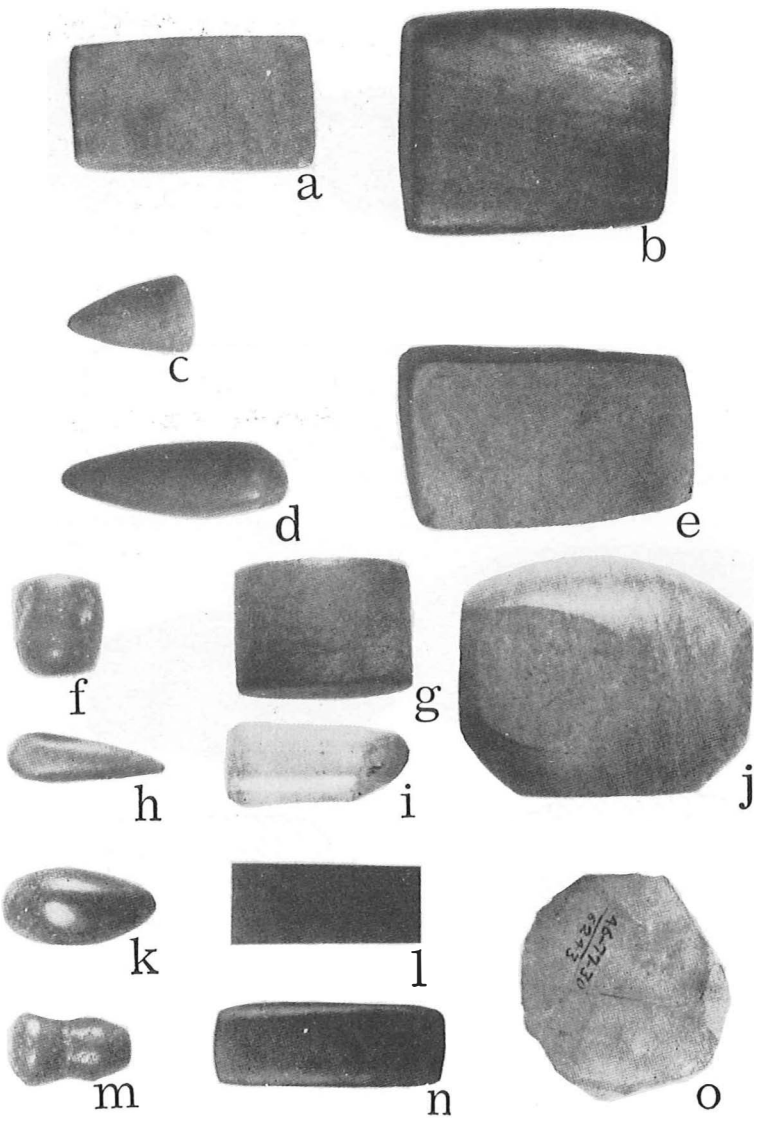


Fig. 18. Stone metal-worker's implements from the Central Coast of Peru (after Lothrop). Scale c. 1: 2.

The most curious counterparts of our cushion stones, kindly drawn to our attention by Dr. D.L. Clarke, are a group of some 15 stone tools from Peru (Fig. 18). In publishing these stones, Lothrop (1950) cites Garcilasso de la Vega (ca. 1539–ca. 1615, born in Cuzco and of half Inca descent) who relates that the metal-workers of Cuzco "used certain very hard stones ... instead of anvils. They ... held them in great estimation because they were very rare. These tools were the shape of dice with the corners rounded off. Some are large, so that the hand can just clasp them, others middling size, others small, and others lengthened out to hammer on a concave. They hold these hammers in their hands to strike with, as if they were pebbles". Lothrop underlines Garcilasso's words regarding the variety in size, which in fact is mirrored in one of the Peruvian closed finds, consisting of four tools of different sizes. Some of the Peruvian stones, which generally are made of fine grained types of stone, show great resemblance to our smaller cushion stones. Garcilasso's account, together with the actual finds, provides interesting ethnographical support of our view that the cushion stones have been used as anvils and hammers. It is at least a proof that such stones *can* be used for metal-hammering, and with what possible results is sufficiently known from the superb products of Inca craftmanship[10].

In Egypt, goldsmiths of the 18th dynasty are pictured using plano-convex hammer-stones and flat stone anvils mounted on a wooden block in the grave of Rachmire (Thutmosis III – Amenophis II, ca. 1450 B.C.; Wreszinski, 1913, Taf. 317–8). Closer to home, the use of stone anvils and hammers by metal-workers is said to have survived in Ireland until a comparatively recent period (Wilde, 1857, p. 81).

III. OTHER EARLY METAL-WORK IN THE NETHERLANDS

The Bell Beaker metal-work in the Netherlands can be compared and contrasted with a limited quantity of metalwork of (at least potentially) 'earlier' Aeneolithic character, on the one hand, and a somewhat more extensive assortment of Early Bronze Age metal-work on the other.

The 'Aeneolithic' materials include a small number of finds from *hunebedden* which are attributed to the TRB culture, and should thus be Middle Neolithic in date, and a few stray finds of Aeneolithic type thick-butted flat axes. The Early Bronze Age (Reinecke A1) metal objects consist predominantly of low-flanged axes, but there are also a few knives, halberds, and ornaments, and there is one important complex hoard, that from Wageningen; grave finds with metals in this phase being extremely rare.

A. **The 'Hunebed Metals'** (App. I: 14–15)

Metal objects associated with the Funnel Beaker culture in the Netherlands are limited to the pair of small copper coiled strips from *hunebed* D28 at Buinen (App. I: 14–15) and a number of scraps of metal from the *hunebed* D19 at Drouwen. Both sites are in Drenthe. It is perhaps worth emphasizing that both these tombs have yielded material of later date as well as the predominant TRB material; so that in both cases it would be possible to argue that the metal objects could be post-TRB intrusions into the tomb.

The Drouwen scraps are not classifiable typologically, and have not been spectro-analysed, so that no useful comparisons can be made with them. The two Buinen spirals are a different case. Generally similar spirals are known from a number of TRB contexts in Denmark and North Germany so that a Middle Neolithic date for them would seem to be quite in order; in any case it would be difficult to suppose that the two specimens are of different origin or came into the Buinen tomb at different times, given their similarity in form and the fact that the type is otherwise totally unknown in this area. Difficulties arise only in connection with their metal composition. JSS assign one specimen (836) to their C1 group and the other (837) to their group C2; groups which allegedly come into use only in the Early Bronze Age. That both spirals appear in C groups results from their both possessing 0.08% of bismuth, which is in fact the minimum value for the C groups in the JSS scheme. Actually, 837 agrees in values so well with other arsenical-copper objects found in TRB contexts (which in turn agree in composition with the 'Altheim axe' grouping, Waterbolk & Butler, 1965, Graph 3) that there seems little ground for attaching primary importance to the border-line bismuth value. The analysis for 836 is more troublesome. The high values for As, Sb and Ag, combined with the cited bismuth value, agree perfectly with the most common and characteristic *Ösenring* metal, and are difficult to match among the Aeneolithic metals.

Full discussion of this discrepancy and its possible implications would take a great deal of space, without shedding any light in particular on the central problem with which we are here concerned, so further consideration of this point can best be reserved for another occasion.

B. **Thick-butted Flat Axes** (App. I: 16–20; Figs. 19–20)

Thick-butted flat axes, generally comparable to those found in early North European finds such as Bygholm and Riesebusch, or to the 'Altheim axes' of Central and Eastern Europe, are rather rare in the Netherlands. We can name only five or six finds, and not all of these have an exact provenance. Examples have been found in the south of the country (Limburg), in the east-centre (Twenthe and the Nijmegen

area) and the centre (Veluwe), but not, so far, in the north-eastern provinces, or in the west.

The two examples from the Veluwe (App. I: 16–17, Fig. 14) are identical in form, and so patinated that one must certainly evaluate them as representing a small hoard, even if their exact find-spot and find circumstances are unrecorded. The other examples are stray finds.

Four specimens have been spectro-analysed. Somwhat surprisingly, not one of them proves to be of typical 'Aeneolithic' metal, *i.e.* of pure copper or arsenical copper (which together account for c. two-thirds of the 336 flat axes listed in SAM I). The 'Limburg' axe (Fig. 15: 1) is (as already mentioned) of a composition closely comparable to that of the Dutch Bell Beaker metals. As we shall see, flat axes of similar composition occur with regularity only in Brittany, although an isolated flat axe of similar metal is from 'Hessen–Nassau' (OW 1003). Unfortunately, analyses are not available for the axes from the Breton hoard of Rezé (Trentemoult), Loire-Atlantique (Briard, 1965, p. 315, no. 374; p. 59, fig. 14: 1–4), which included nine flat axes of our 'Limburg' – 'Veluwe' type and a Palmella point; the latter suggesting a date in the Bell Beaker period. The two 'Veluwe' axes are perhaps best to be compared in composition with the 'Singen' metals; they possess, at any rate, the required impurities (As-Sb-Ag-Ni), although the levels are on the low side in comparison with other objects assigned to the 'Singen' metal group. It will be recalled that the Exloo awl is also of 'Singen' metal, though it is otherwise unrepresented in Bell Beaker contexts. It is noteworthy that JSS Group A metal, *i.e.* 'Singen' metal, is only rarely used for flat axes. In SAM I, only 12 flat axes out of 336 are assigned to Group A, and not all of these 12 axes are Aeneolithic in type! Finally, the Beek flat axe (Fig. 15: 3) is of *Ösenring* copper, which is otherwise represented in the Netherlands only by (enigmatically) the one Buinen spiral and the Únětice-type Bargeroosterveld knife.

It would thus appear that none of the Dutch flat axes are of metal types known to have been regularly in use in the period of the TRB culture. While holding in reserve the possibility that certain metals now supposed to have come into use only in the late Aeneolithic or the Early Bronze Age may ultimately appear to have found at least occasional employment earlier, there would not at the moment seem to be any firm evidence at all for the use of copper axes in the Netherlands in the Middle Neolithic. One need not categorically assert that there never were any; specimens may have been imported, used, and later melted down for other purposes, or they may simply never have been found. But it is surely safe to assume that if they existed they must have been comparatively rare, and there is certainly no ground whatever to suppose local manufacture. Our four Dutch analysed specimens are likely to be not earlier than the Bell Beaker metals. Thus there is no evidence for metal-working in the Netherlands prior to the Bell Beaker phase.

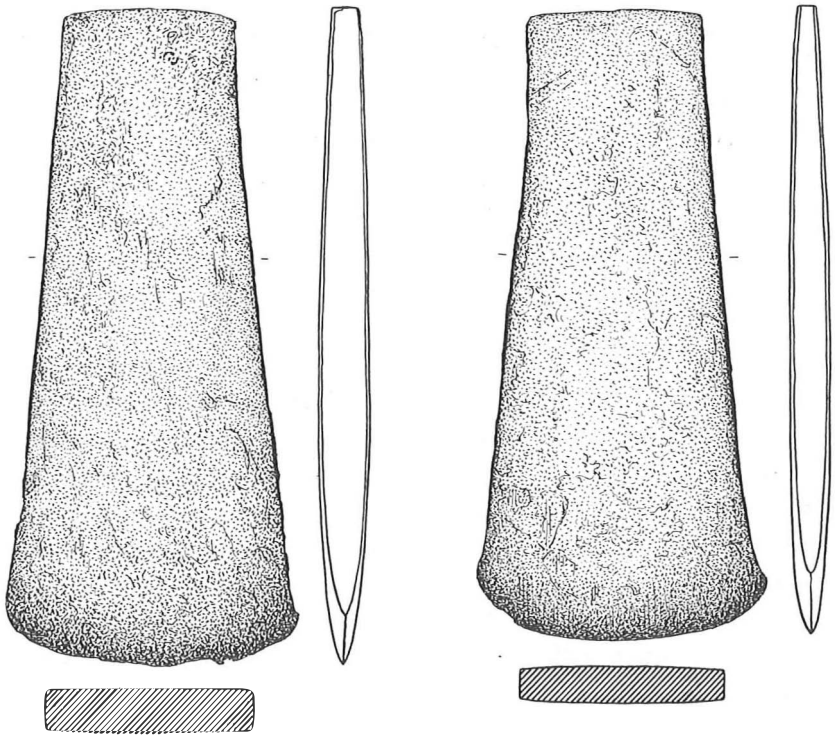


Fig. 19. Thick-butted flat axes probably found together on the Veluwe (App. I: 16–17. Drawing G. de Weerd. Scale 1: 2).

C. **Early Bronze Age (= Reinecke A1) Metals**

Dutch finds of Early Bronze Age (Reinecke A1) metals are not overly numerous, but include at least one hoard of importance (Wageningen, Gelderland; Fig. 21) and a fair scattering of individual finds. These consist mainly of axes, but include a few knives, halberds, and ornaments. In this period, metals have only very rarely been encountered in graves in the Netherlands.

Typologically considered, the Early Bronze Age objects found in the Netherlands are predominantly of Western European character; influences from Central Europe are present but of limited importance. In recent publications the contribution from Ireland has been particularly stressed; the Wageningen hoard has been cited as evidence for the presence of an itinerant (Irish?) smith, and there is a scatter of Irish-type axes in the centre of the country. A somewhat divergent group of low-flanged axes, more widespread but with a noticeable concentration in the northern provinces, has been interpreted as a regional equivalent of the Scandinavian Pile-axes; *i.e.* a local group of axes, locally manufactured of imported material, and gene-

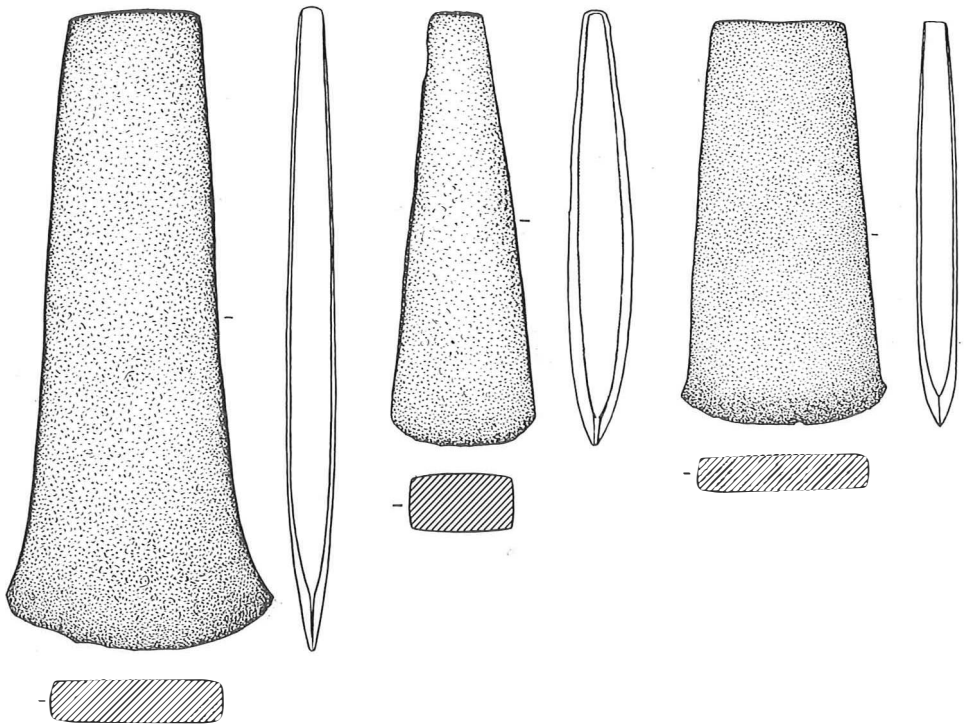


Fig. 20. Thick-butted flat axes from (left to right) 'Limburg', Glanerbrug, and Beek (App. I: 19, 20, 18. Drawing B. Kracht. Scale 1: 2).

rally imitating the Irish axes in form. These have been named 'low-flanged axes of Emmen type' (Butler, 1959*a*, 1963*a–b*)[11].

For analytical purposes, then, we can group the Dutch metal objects of the first phase of the Early Bronze Age into a number of more or less contemporary groups:

1. *the Wageningen hoard;*
2. *the Irish element*; consisting of the Central Netherlands group of 'imported' axes and the halberds;
3. *the Emmen axes;*
4. *the Central European element;* and
5. *miscellaneous.*

The spectro-analytical evidence for the metal types represented in each of these groups or grouplets may now be considered.

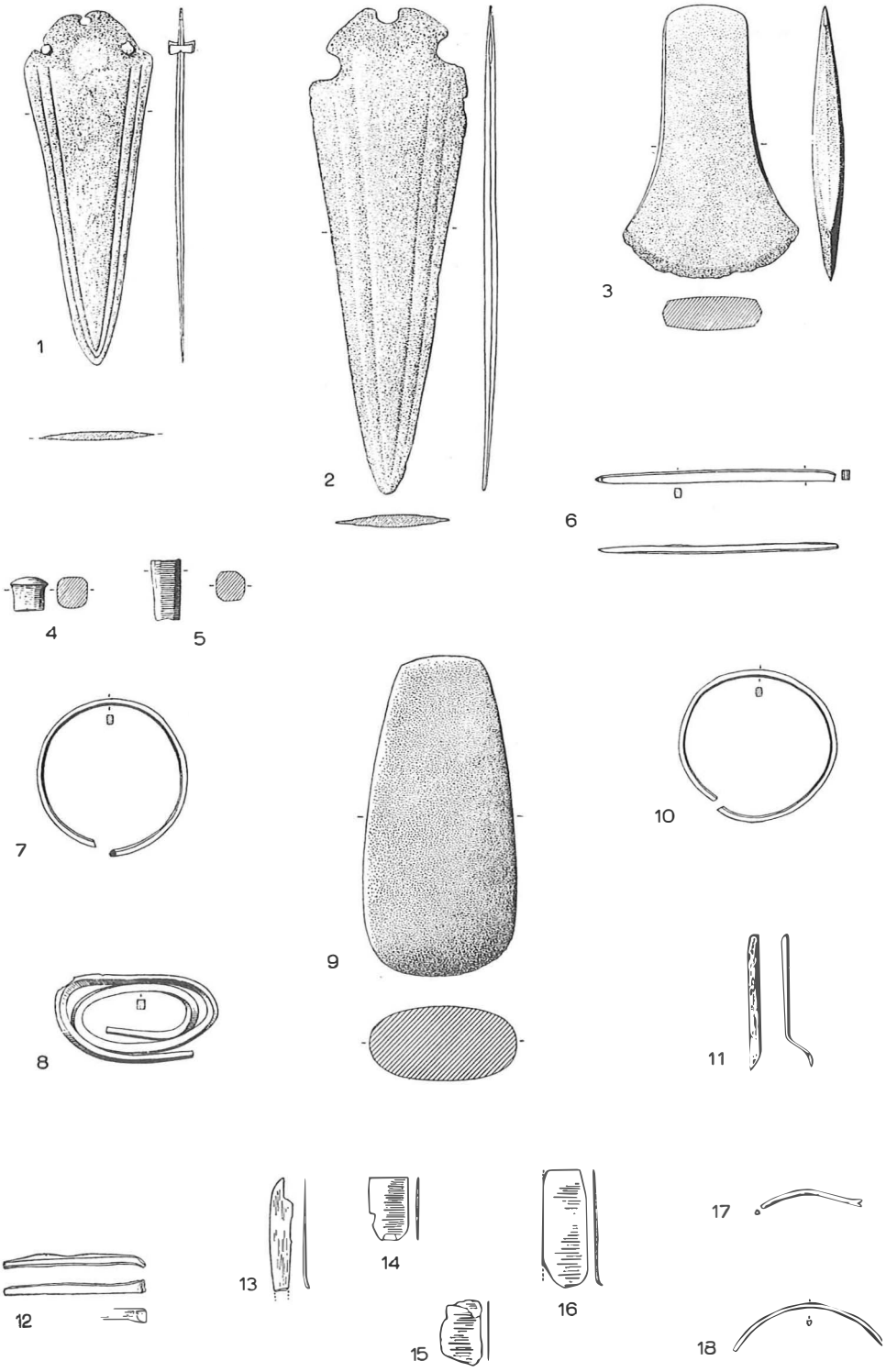


Fig. 21. The Wageningen hoard. (App. I: 21–28; III: 12. Drawing B. Kuitert. Scale 1: 3).

1. THE WAGENINGEN HOARD (App. I: 21–28; III: 12; Fig. 21)

The metal objects in the Wageningen hoard must be considered to be a 'group' in themselves, since the types represented in this hoard do not recur in other finds in the Netherlands (except for the halberd). The Wageningen hoard is certainly a closed find; correspondence recently re-discovered removes all possible doubt on this score (see App. III: 12). The presence of unfinished rivets, an ingot rod and scrap pieces as well as finished objects suggests strongly that the hoard was the property of a smith; this is therefore direct evidence for early metal-working in the Netherlands. Of primary value for dating is the presence of a flat riveted dagger with an unusually formed hilt plate; the only close parallel known to the writers is an unpublished specimen from a grave at the Singen cemetery. The halberd connects with Irish as well as Saxo-Thuringian Early Bronze Age finds. The flat axe is unlike those of Group 2 above, but closely resembles the British-Irish type described as 'thin-butted faceted' by Coghlan and Case (1957) and some axes within the Migdale group of Britton (1963). This axe and the halberd with the thick, faceted halberd rivets form a British-Irish element in the hoard. The simple bracelets of rectangular cross-section and the long awl or punch are, however, types frequently found in the south of France and the Iberian peninsula, and foreign to Northwestern Europe. The Wageningen objects, therefore, appear typologically to be of rather heterogeneous origin. As to be expected, they are also rather heterogeneous in metal composition.

Eight analyses are available. As will be seen in Table I, five of the eight analyses (including the Irish-looking 'thin-butted faceted' axe, the equally Irish-looking halberd rivets, the Iberian or South French-looking awl, and the ingot bar) are of metal of 'Singen' type. Two objects – the 'Irish' halberd and the knife, which typologically appears to reflect Singen influence – are of an arsenical copper, greatly resembling the copper frequently used by Central German smiths especially for halberds; while the tested knife rivet is of arsenical copper with just over 1% of tin.

Noteworthy are (*a*) the absence of high-tin bronze, (*b*) the absence of the Irish copper of Coghlan and Case Group I and (*c*) the absence of Dutch Bell Beaker metal, although Wageningen lies at the centre of a rich concentration of Veluwe Bell Beaker finds. It appears, then, that the smith responsible for the Wageningen deposit had collected up a variety of metal objects of varied origin, no doubt with the intention of re-melting them. That there is no trace in the hoard either of the characteristic Bell Beaker metal which, as we have seen above, was normally used for Bell Beaker implements in the area, or of objects of types found in Bell Beaker graves, is a very strong argument that the Wageningen hoard is later in date than the Veluwe Bell Beaker phase; this should weigh against any temptation to retain or revive the 'Reflux' dating of Bell Beakers discussed above (p. 55). The absence of tin and of Irish metal and the predominance of 'Singen' metal in the assemblage indicates

that the smith did not bring metal from the West with him (or had exhausted his original supply), but depended (at least at the time of the hoard's assembly) on metal acquired locally, which was predominantly of Central European origin.

2. THE IRISH ELEMENT

Low-flanged axes (App. I: 30–33; Fig. 22)

Apart from the flat axe from Wageningen (above), there are a number of low-flanged, sometimes decorated axes in the centre of the country (map, Fig. 2) which, judged on form alone, could well be direct Irish exports to the Continent. It is undoubtedly significant that of the four low-flanged specimens spectro-analysed, three are of

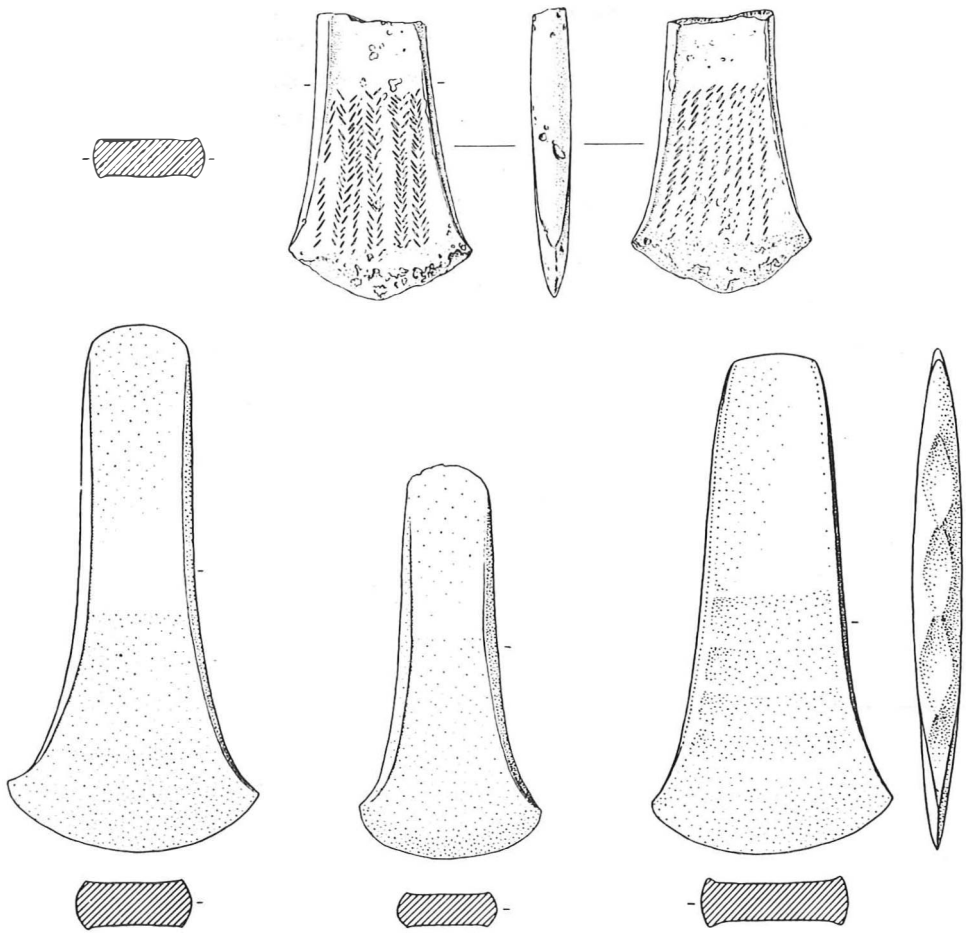


Fig. 22. Lowflanged axes from (top to bottom right) Haren, 's Hertogenbosch and Gemert Noord-Brabant) and from the Kam collection, Nijmegen (App. I: 33, 32, 31, 30. Drawing B. Kracht. Scale 1: 2).

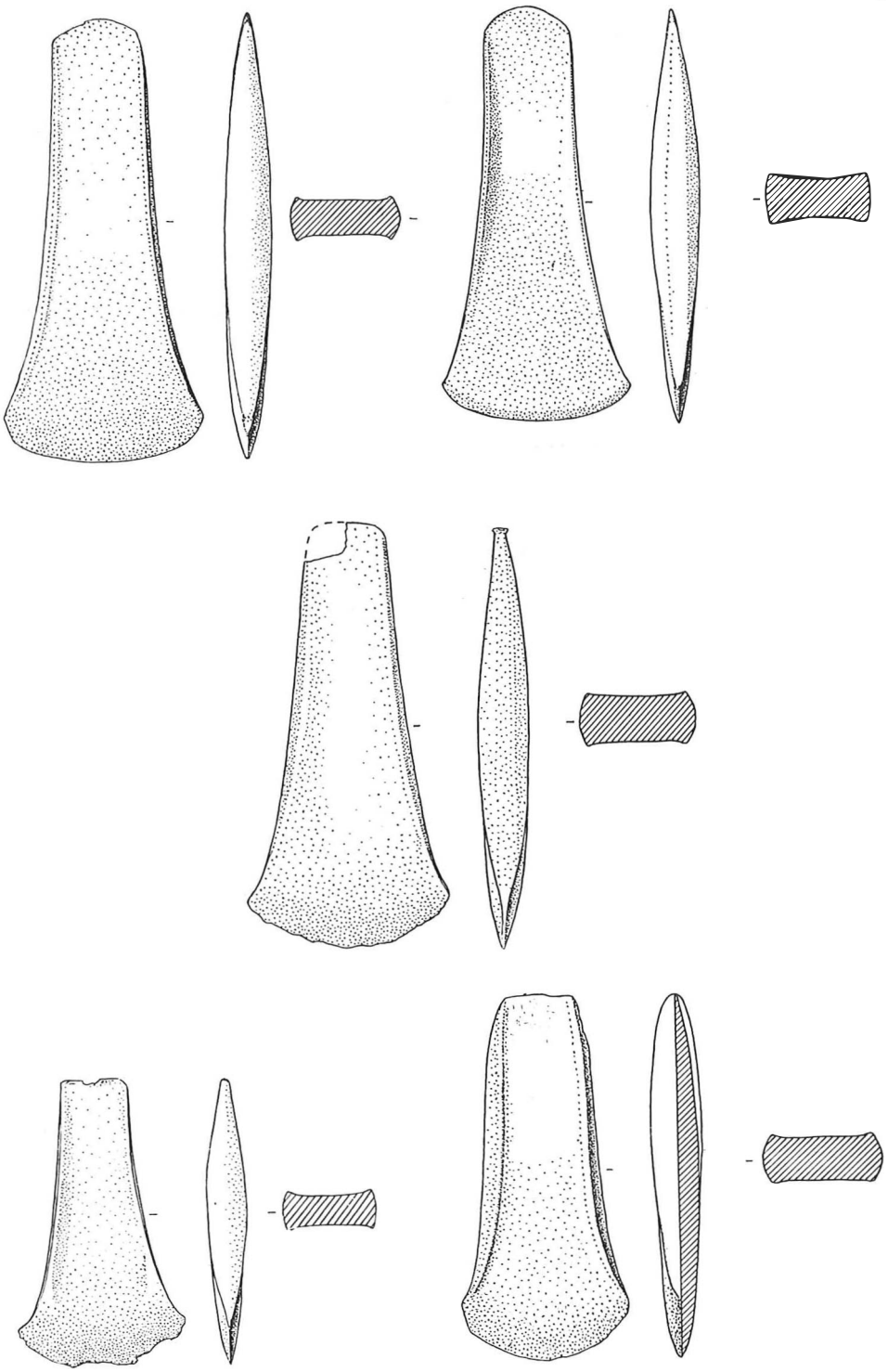


Fig. 23. Lowflanged axes of Emmen type from (top left to bottom right) Valtherspaan (Drenthe), Suawoude (Friesland), Emmen and Gieten (Drenthe) and 's Heerenberg (Gelderland) (App. I: 39, 35, 37–38. Drawing B. Kracht. Scale 1: 2).

high-tin bronze; a remarkable ratio when one considers the rarity of true bronzes in the rest of the Dutch material of this period.

Since a number of Irish-type axes found in Germany have also been found to be of high-tin bronze, the Dutch analyses strengthen a pattern previously noticed (Butler, 1963*a*, p. 40). That Irish-type axes on the Continent were normally of high-tin bronze must surely have been a factor enhancing their prestige; and we must assume that they enjoyed a high prestige when we see how often they were imitated (often in inferior metal) in Scandinavia, Germany and the Netherlands.

It had hitherto been suggested by various authorities that Irish-type axes were manufactured by intinerant Irish smiths working on the Continent. Were this the case, one would expect such Continent-found axes of Irish model to be made in non-Irish metal; and that is in fact what is found by the spectrographic analyses. None of the tested examples in Germany or the Netherlands is of Coghlan and Case Group I metal. Two of the Dutch specimens (Haren, Nijmegen?) are of bronze with moderate arsenic as the main impurity; one (Gemert) is of bronze with moderate As, Sb and Ag and low Ni, and is rather like the Westphalian specimens Sassenberger Heide (OW 474) and the Irish one from Co. Carlow (CC 68) in composition; the fourth piece ('s-Hertogenbosch) is of 'Singen metal', with only 1 % tin, thus resembling in composition the majority of Emmen axes in the country.

Halberds (Figs. 21, 24)

Only two halberds are known from the Netherlands. The Roermond specimen is a fine example of the Irish Type 4 of O Ríordáin; it closely resembles the well-known Irish halberd in the Dieskau hoard in Central Germany (OW 303). The Wageningen halberd (from the hoard) is smaller, and has notches instead of rivet-holes; it is thus a slightly devolved specimen.

Neither of the Dutch halberds (nor the Dieskau specimen) is of the Irish halberd-metal (Coghlan and Case Group I). They are both of an arsenical copper, generally similar to each other, and also of similar metal to the knife from Wageningen, the Drie riveted knife, and the Bell Beaker tanged knife from Hilversum. The arsenical copper concerned generally resembles that from Iberia or the comparable group from Brittany, but is specifically closer to the arsenical copper favoured by Central German Únětice smiths for their halberds (the Dieskau Grouping, Waterbolk & Butler, 1965, Graph 11).

It is also noteworthy that the Wageningen halberd rivets (which are unfinished, and therefore most probably made by the Wageningen smith himself) are of quite different composition: they are of 'Singen metal' with exceptionally high antimony (discussed below, p. 89); a metal also sometimes used by Central German halberd-smiths.

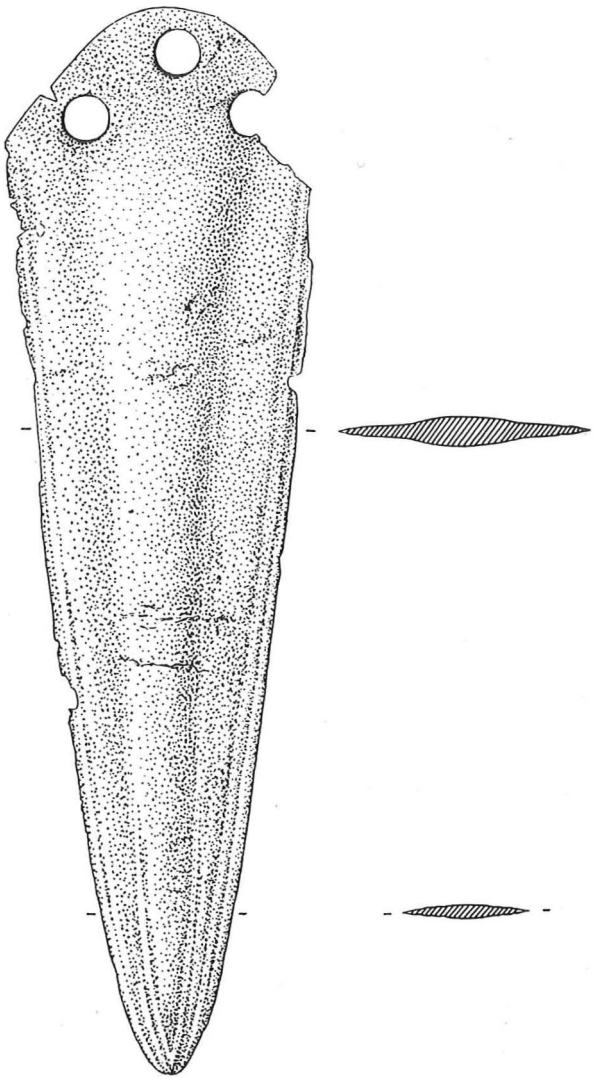


Fig. 24.
The Roermond halberd
(App. I: 29.
After Glasbergen & Butler.
Drawing B. Kuitert.
Scale 1: 2).

Thus, we have the somewhat paradoxical-looking situation that the Early Bronze Age objects in the Netherlands which appear typologically to be of Irish origin are of rather heterogeneous, but in any case not Irish, metal. The chief unifying feature for the Irish axes in the Netherlands and Germany is that they are of true bronze; whilst the Irish-type halberds are of presumably Central German arsenical copper, with (in one case at least) rivets of 'Singen metal'. This picture would be consistent with the traditional interpretation of the Irish migrant smith at work on the Continent, if it be assumed that such smiths brought a supply of tin with them, but acquired their copper supplies locally, presumably by re-melting used objects.

3. THE EMMEN INDUSTRY (App. I: 34–43; Fig. 23)

Attention has been called to another group of low-flanged axes in the Netherlands, termed *axes of Emmen type*. These lack the decoration or fluting of the Irish specimens, are slightly thicker, generally lack the transverse ridge on the face, and are slightly less widely splayed in the blade. Their distribution is peripheral to that of the genuinely British-Irish-looking specimens; indeed, their main occurrence is in the northern provinces. This is surprising; no similar group of axes has so far been recognized in Northwestern Germany[12], although there are a few isolated specimens (*i.e.* one of the axes from Sassenberger Heide, Westphalia; found with a British-Irish axe, which thereby dates the group). The distribution of Emmen axes suggests, as already stated, that they are a North Netherlands equivalent of the Pile type; that is, a local product derived from and imitating the 'Irish' axes. Of the seven Dutch examples determined spectrographically, only one ('s-Heerenberg) is of high-tin bronze (like the German example from Sassenberg Heide already mentioned); four have lower tin percentages (0.37% to 3.0%) and two are of copper with little or no tin. Five of the examples were of 'Singen metal'; two were of arsenical copper. Neither the metal nor the distribution pattern of Emmen axes suggest any connection with Bell Beaker metallurgy.

The analyses thereby differ quite sharply from those of the typologically related, but nevertheless distinct, and differently distributed, 'Irish' low-flanged axes in the Netherlands. That one 'Irish' axe is of a composition resembling Emmen axes, and one Emmen axe is a high-tin bronze like the 'Irish' axes, emphasises the contact or overlap between the two groups that one also sees in the Sassenberger Heide find in Westfalia, where an 'Irish' axe and an Emmen axe were found together. The derivation of the Emmen axes from the 'Irish' is hardly to be doubted. Emmen axes thus represent the earliest indigenous metal product in the northern part of the country, and were made by smiths who were presumably trained by those of the Irish school. They had access to a regular supply of 'Singen metal' from the south, but not to regular supplies of tin. One may suppose that the Emmen smiths made objects of other types as well as axes, but it does not seem to have been the local custom to deposit metal objects in graves at the time, and insufficient material has come to light to permit the determination of other Early Bronze local types of the Reinecke A1 period.

4. IMPORT FROM CENTRAL EUROPE (Fig. 25)

Imported objects of Central European Reinecke A1 types are not very numerous in the Netherlands.

A miniature axe (of 'Singen' copper alloyed with high tin) comes from Exaten in

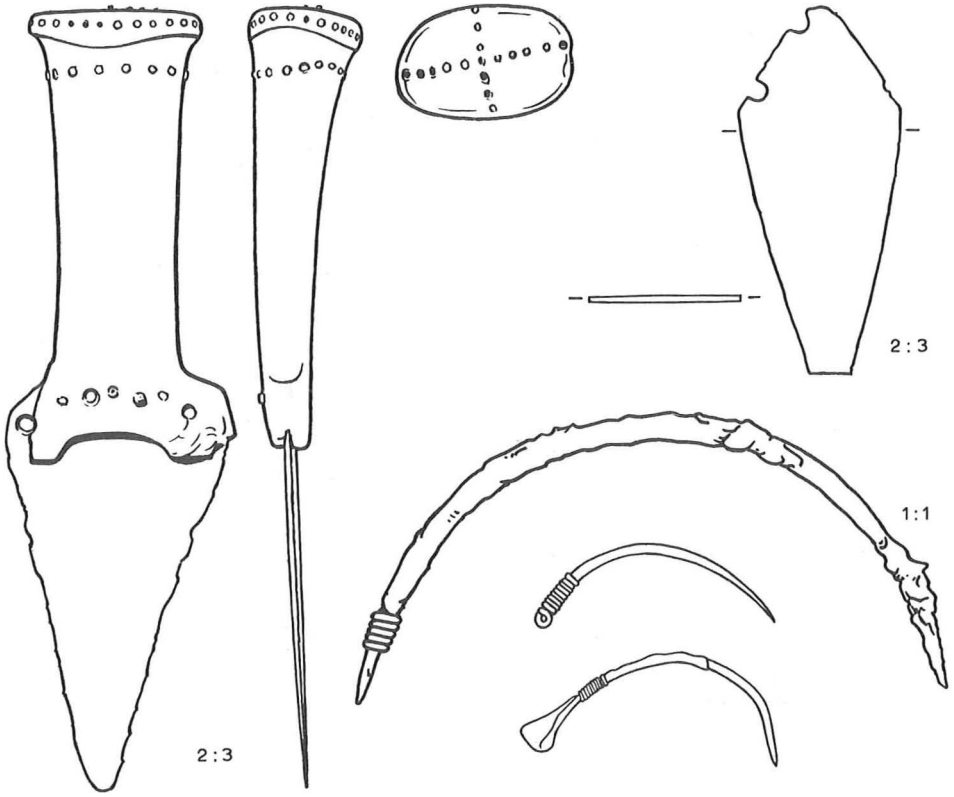


Fig. 25. Riveted knives from Bargeroosterveld (Drenthe, left) and Drie (Gelderland, top right; drawings B. Kuitert); *Schleifennadel* from Wychen (Gelderland, bottom right, after Groenman-van Waateringe) and two possibilities of its original form (after Hundt and Köster).

Limburg; a large 'Saxon' axe *mit italienischem Ausschnitt* is attributed to Wageningen (not part of the hoard!); a broken specimen is known from Kessel in Limburg; and there is one small specimen from Ellertslo in Drenthe. The Bargeroosterveld dagger (bronze with 2.8% tin, high arsenic, antimony and silver; tin nails in the horn hilt) belongs here, and there is an Únětice ornament from a grave (found stratigraphically above but palynologically not significantly later than a grave with a Veluwe Bell Beaker; both earlier than a grave C14-dated 1704 ± 80, GrN 2996), at St. Walrick near Overasselt, Gelderland). It is surprising how few South German A1 types followed the Rhine route to this area. Again, there is no evident connection with Bell Beaker metallurgy.

Not clearly assignable to any of these groups is the small riveted triangular dagger from Drie on the Veluwe, a stray find, made of arsenical copper. Its triangular hilt-plate and three small rivets are reminiscent of specimens in Italy in Remedello-Rinaldone contexts.

TABLE I. COPPER ALLOYS USED FOR EARLY METALS IN THE NETHERLANDS (AENEOLITHIC AND REINECKE A1)

Alloy	Total no.	Catalogue numbers of objects, arranged by typological groups (see Appendix I)							
		Buinen spirals	thick-b. flat axes	Bell Beaker objects	Wageningen hoard	'Irish' axes	halberds	Emmen axes	other
'Singen metal' (Cu+mod. to high As, Sb, Ag, Ni) Graph: fig. 16	15 or 16	–	16, 17	11 (awl)	21* (flat axe) 23, 24 (halberd rivet) 27 (awl) 28* (ingot)	32*	–	36, 37* 38, 39, 40	44, 46* (?) (lowflanged axes)
'Dutch Bell Beaker copper' (Cu+high As, mod. to high Ni) Graph: fig. 15	7	–	19	12 (awl); 1, 4, 5, 6, 3 (tanged knives)	–	–	–	–	–
Arsenical copper (Cu+high As) Graph: fig. 17	6	15	–	7 (tanged knife)	22 (halberd) 25 (riveted knife)	–	22, 29	–	53 (riveted knife)
Arsenical bronze (Cu + Sn > 1%, mod. As) Graph: fig. 18	5	–	–	–	26* (knife rivet)	30*, 33*	–	34*, 35*	–
Other bronzes (see p. 00)	2 or 3	–	–	–	–	31*	–	–	45*, 46* (?) (axes)
'*Ösenring* copper' (Cu + high As, Sb, Ag)	3	14	18	–	–	–	–	–	54* (riveted knife)
A deviant (Cu + high As and Ni, mod. Pb, Sb, Fe)	1	–	–	2 (tanged knife)	–	–	–	–	–
Totals (no. of objects)	40	2	4	9	8	4	2	7	6

N.B.: In the 'Alloy' column 'high' signifies that the values are all or mostly in the range 1% to 10%; 'moderate', 0.1% to 1%. 'Low' would thus signify 0.01 % to 0.1 %, 'very low' below 0.01 %. (The same system is used in the text of this paper). * = Sn>1 %. Anal. No. 22 is cited in two categories (Wageningen hoard, halberd); Anal. No.46 can be either 'Singen metal' or 'other bronze'. The totals therefore add up to 42, although there are only 40 objects.

IV. THE COPPER AND BRONZE ALLOYS

(*cf.* Graphs, Figs. 26–36)

Forty analyses are obviously a small number upon which to base far-reaching generalizations concerning the Aeneolithic and Early Bronze Age metals used in the Netherlands. Yet the forty objects represent almost our entire early find material; so that, barring totally unusual discoveries, the number of available Dutch analyses for the period is not likely to increase significantly in the foreseeable future. We are compelled, therefore, to draw what conclusions we can from the evidence as we have it. With the help of the graph method (Waterbolk & Butler, 1965) it is possible to obtain a reasonable picture of the principal alloys employed, and to suggest probable affinities among the various groupings recognized amidst the mass of so far published analyses in Europe as a whole.

Of the 40 analyses, some two-fifths (15 or 16 specimens) can be grouped as having moderate to high As, Sb, Ag and Ni, with variable Sn and little or no Bi. This grouping compares well in detail with the metal characteristic for the Singen culture in Southwest Germany and Adlerberg in the Middle Rhine area; this is the copper which JSS classify as their Group A. Very similar metal was also in use in the Nitra Group in Southwestern Slovakia (Točik, 1963, cf. Fig. 27). JSS 'A' metal is said also to occur in the earliest phase at Gemeinlebarn in Austria (Christlein, 1964, p. 27). The Únětice culture made use of similar metal, but often alloyed it with high tin, contrary to the practice in Singen, Adlerberg and Nitra, where the tin content is very variable, but only occasionally c. 10%. For the Dutch metals of 'Singen' character, the best match is found in the metals belonging to the Singen culture, but outside the site of Singen itself (Waterbolk & Butler, 1965, Graph 9). A few of the Dutch metal objects of this type show, however, somewhat lower values than Singen; whether this represents a difference in the degree of refining, or alloying with copper of a lower impurity level, or even another metal entirely is difficult to say. Noteworthy are the two Wageningen halberd rivets with exceptionally high Sb values; examples with Sb values of the same order of magnitude are rare, but examples can be found at Singen am Hohentwiel and also in Central German Únětice (see OW Table 16), where it was sometimes used for halberds and halberd rivets. The occurrence of a number of *Rippenbarren* ingots of this high-impurity 'Singen metal' in Bavaria (Straubing-Mariaposching, Schabenberg; JSS 400–2,277) is also noteworthy. Most of the Dutch examples are indistinguishable from the normal Singen metal. In the Netherlands this metal was employed chiefly for low-flanged axes of Emmen type; it was also used for some of the objects in the Wageningen hoard. It also occurs in two flat axes, one Bell Beaker awl, one 'Irish' axe, and two other low-flanged axes. This high impurity As–Sb–Ag–Ni copper is never described or discussed in stand-

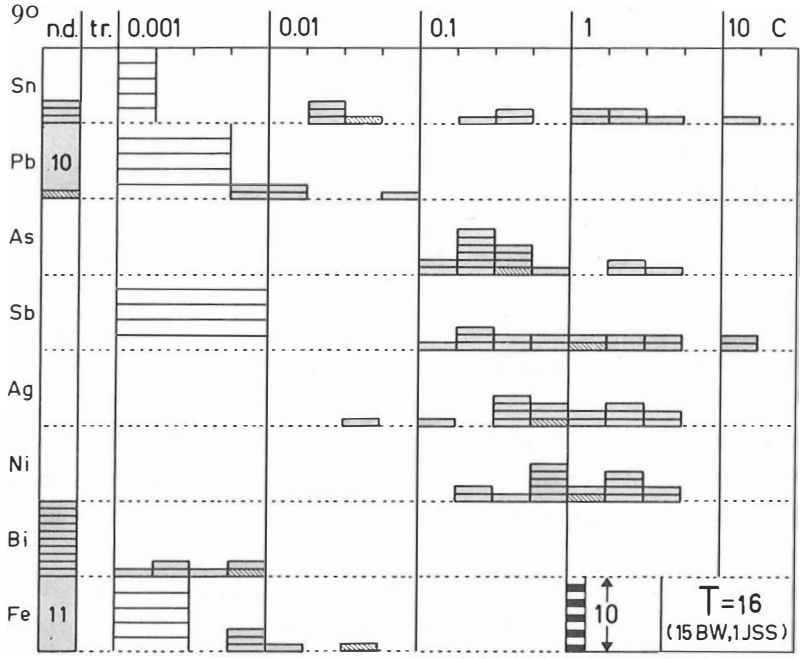


Fig.26. 'Singen metal' in the Netherlands
(*Cf.* Table 1)

▨ Exloo Bell Beaker awl

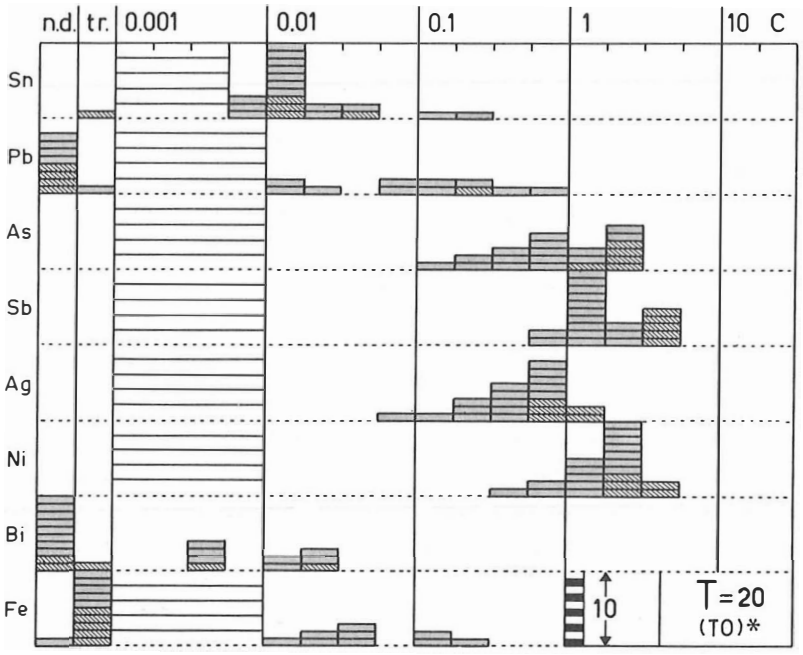


Fig.27. Nitra group (E.B.A., SW Slovakia)

▨ Sub-group with higher As, Sb, Ag, Ni (TO 22, 23, 24, 28, 29)

Included: TO 2, 4, 8, 10–13, 18–30

Excluded: 10 ex. (various deviants)

*12 Stuttgart, 8 Baku analyses

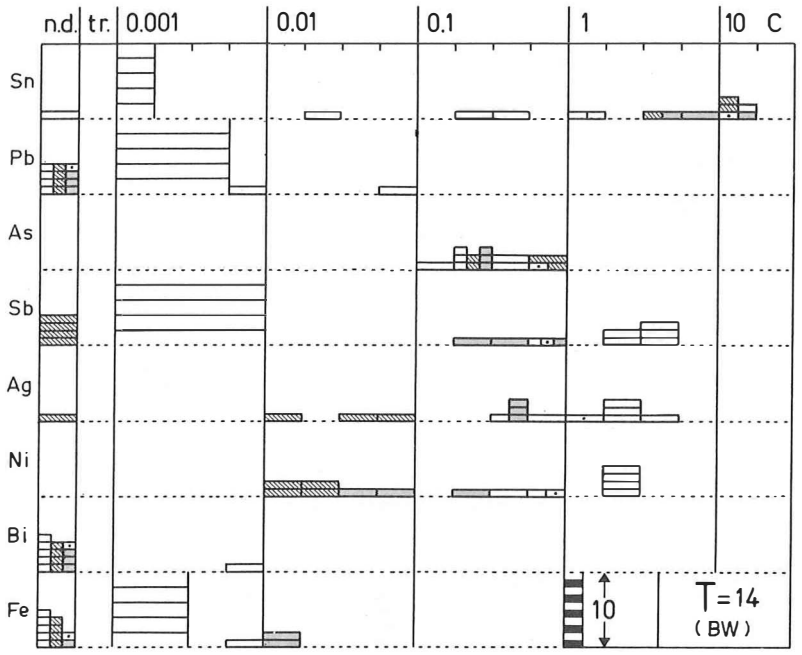


Fig.28. Low-flanged axes in the Netherlands

'Singen metal'

bronze with mod. As

other bronzes

Cat. no. 46 (can be 'Singen metal' or 'other bronze') (*Cf.* Appendix I)

Figs. 26–36: Abbreviations and Sources of Analyses.
Abbreviations used in graphs: C = concentration (%); n.d. = not detected or O; T = total number of objects graphed; tr. = trace.
Sources of Analyses: BW = present paper, Appendix I; CA = Coghlan, 1963 (Analyst A); CC = Coghlan and Case, 1957; DB = Britton, 1963; GBB = Giot, Bourhis and Briard, 1966; H/JSS = Hájek, *Inventaria Arch.* Cs 11, 14–16, 19 (Stuttgart analyses); JSS = Junghans, Sangmeister and Schröder, 1960; OW = Otto and Witter, 1953; TO = Točik, 1963; Mal = Maréchal (reprinted in GBB).

ard works on early European metallurgy, although it appears to have served quite an important part of Europe throughout the Reinecke A1 period in anticipation of, or as a substitute for, high-tin bronze.

The ultimate origin of this alloy requires clarification. JSS assumed an origin somwhere in Southwestern Germany for their Group A metal; Otto and Witter (1952) claimed the Saalfeld ore bed as the origin of the Ag–Ni–As–Sb alloy; Točik supposes that the Nitra metal came from the nearby Slovakian Ore Mountains. In any case, it must have come to the Netherlands up the Rhine, occasionally in Veluwe Bell Beaker times (the Exloo awl) and in greater quantity throughout the Reinecke

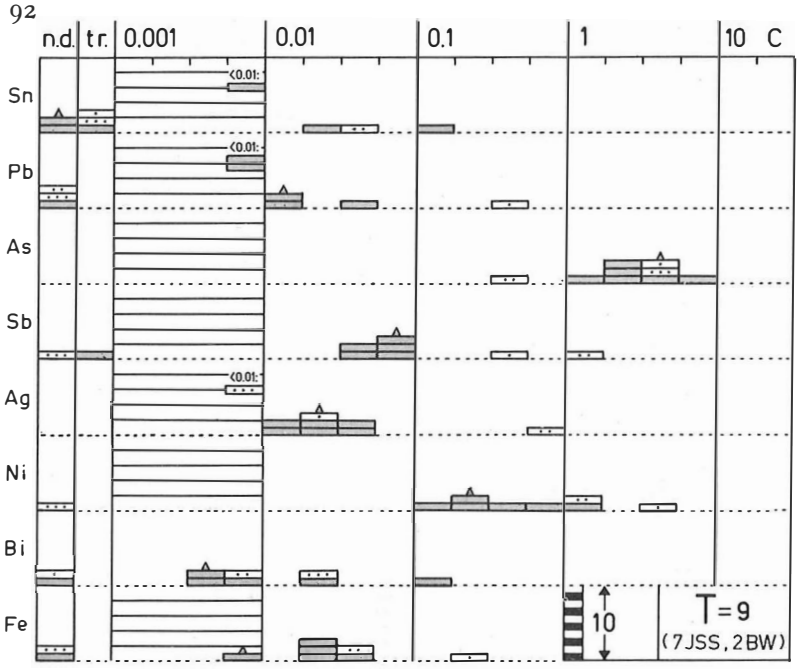


Fig.29. Bell Beaker copper objects in the Netherlands

▭ 'Dutch Bell Beaker copper'

▭ deviants (. No. 2; . . No. 11; . . . No. 7)

Δ 'Limburg' flat axe (No. 19)

(*Cf.* Appendix I)

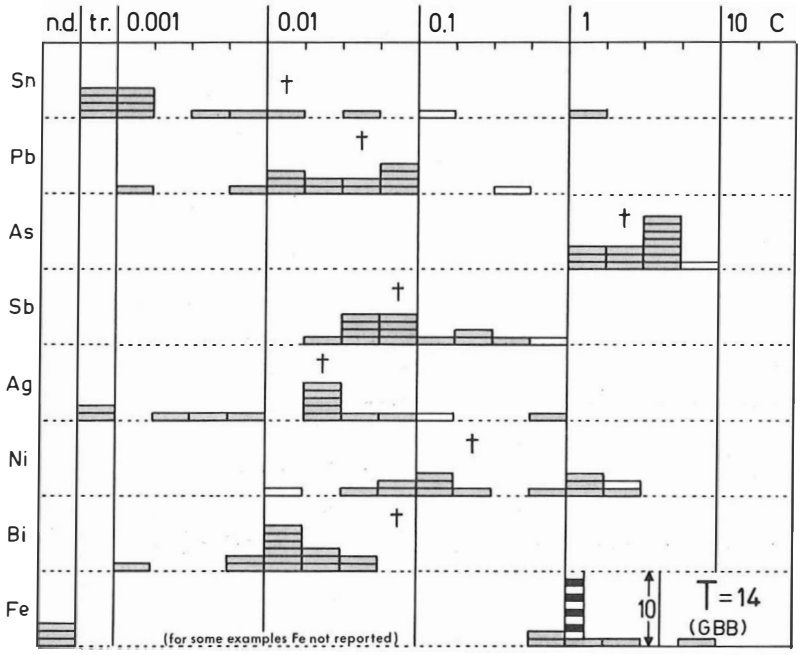


Fig.30. Flat axes of As-Ni copper in Brittany

▭ deviant (Mal 3)

† Barnenez Bell Beaker tanged knife (Mal 1)

Included: GBB 3, 4, 9–14, Mal 2–4, 6, 9, 10

Excluded: 4 ex. of arsenical copper

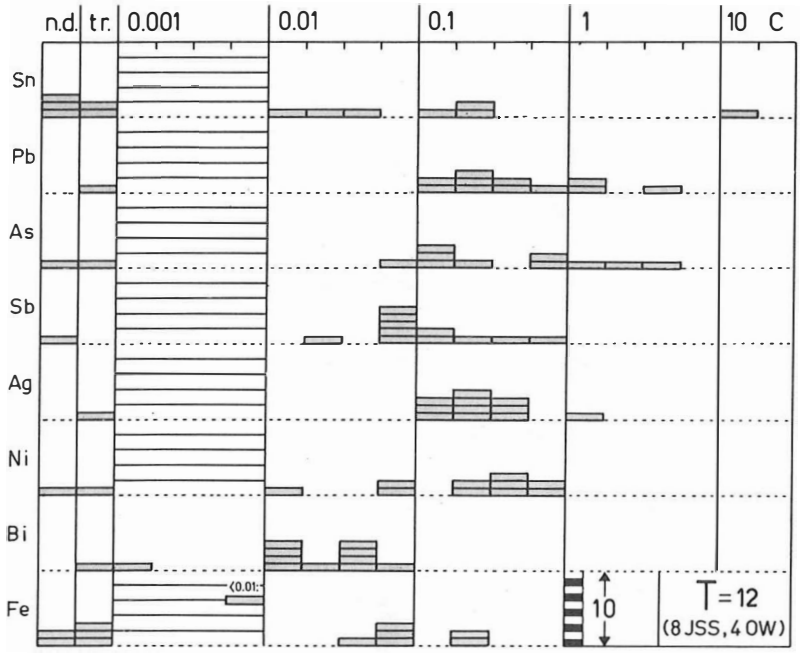


Fig. 31. Bell Beaker objects of multi-impurity copper in Germany

Included: JSS 27, 72, 174, 184, 192, 210, 211, 276

Excluded: German objects on Fig. 32

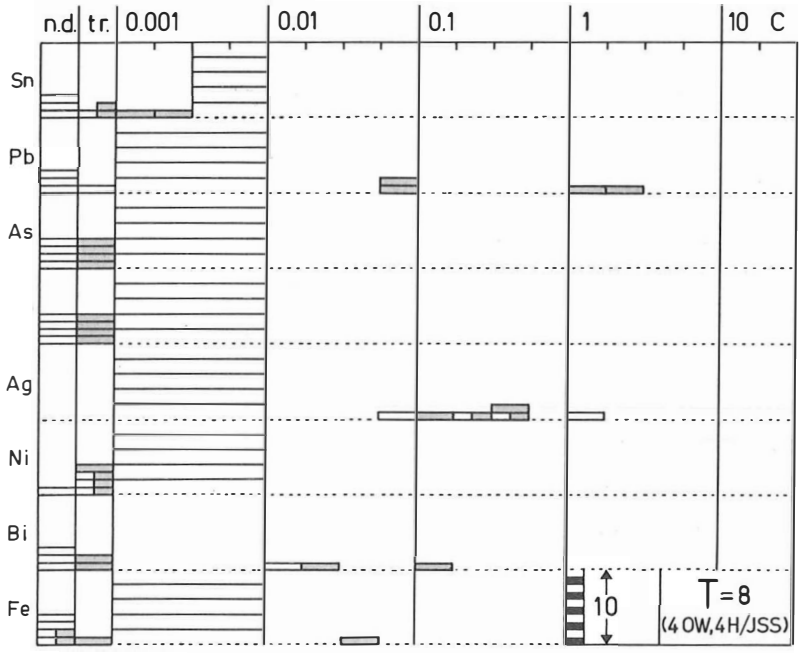


Fig. 32. Bell Beaker objects in Central Europe of Cu with Ag ▭, and Cu with Ag & Pb ▭

(Cu + Ag: 4 ex., in Czechoslovakia;

Cu + Ag & Pb: 3 ex. in Germany, 1 Austria)

Included: OW 188, 189, 190, 191; H/JSS 3245, 3255, 3364, 3365

Excluded: German Bell Beaker objects of multi-impurity Cu (see Fig. 31); H/JSS 3240, Cu with As

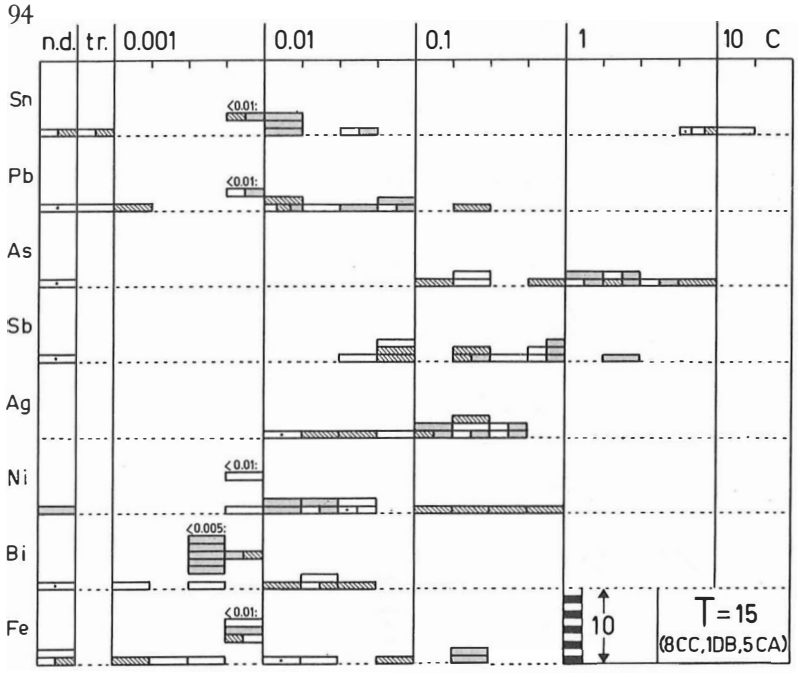


Fig. 33. Bell Beaker copper and bronze objects in England (9 ex.) and Ireland (5 ex.)
Included: CC49, 62, 79, 83, 93, 96, 97, West Overton, Dorchester; BD 1; CA 128, 145, 216, 217, 220

England Main

England w. higher Ni, *etc.*

England (W. Overton)

1 England, 1 Ireland

Ireland

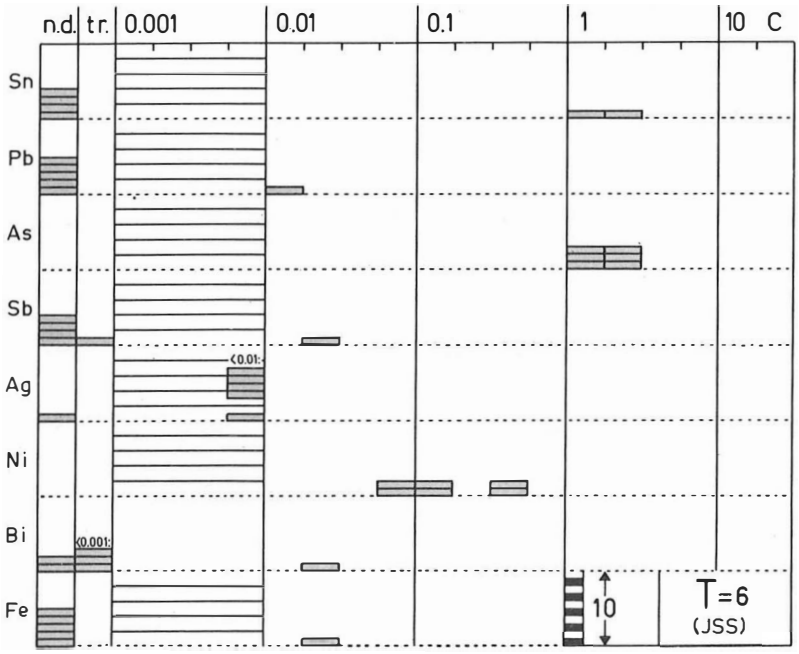


Fig.34. Carmona: objects of Cu with As & Ni (Bell Beaker period)
Included: JSS 803, 804, 807 (Palmela points), 809, 810 (awls), 830 (long point)

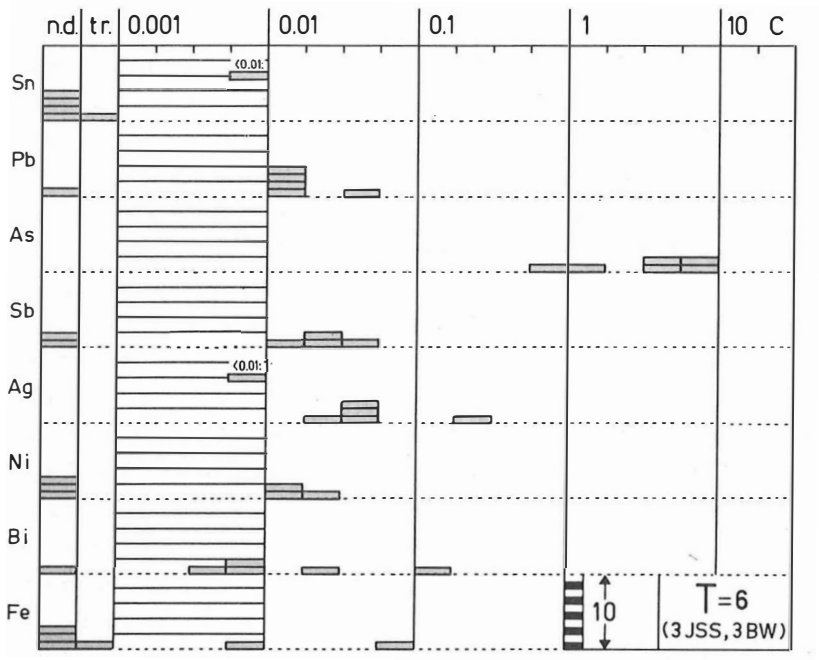


Fig. 35. Aeneolithic & Early Bronze Age objects of arsenical copper in the Netherlands
Included: JSS 680, 691, 837; BW 2, 3, 5 (Appendix I, No. 7, 15, 22, 25, 29, 52)

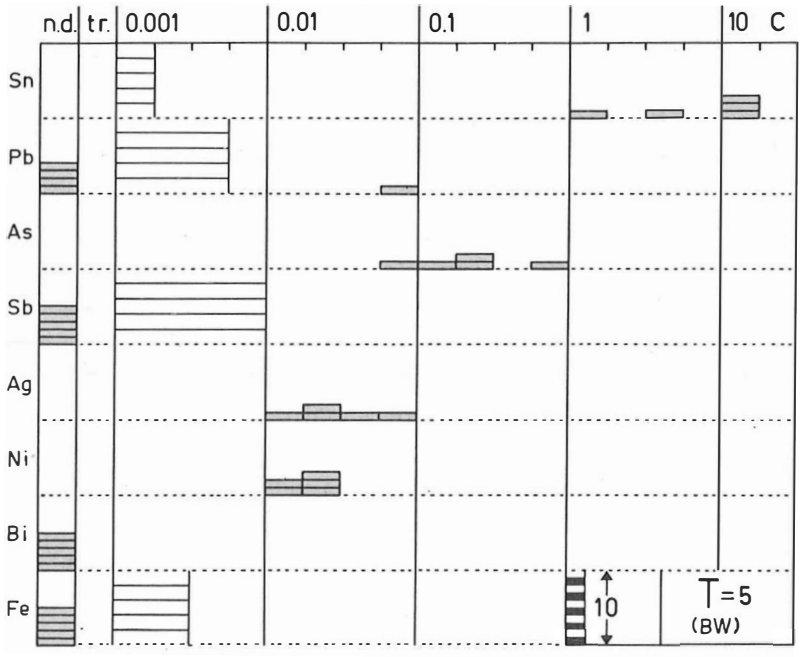


Fig. 36. Early Bronze Age (A1) arsenical bronze objects in the Netherlands
Included: BW 4, 11, 13, 21, 32 (Appendix I, No. 26, 34, 35, 30, 33)

A1 period. In Central Europe it was in use in the Earlier Nitra-Christlein 1 phase and onwards throughout Reinecke A1. Singen appears to be the only culture that used this alloy virtually exclusively, so that the name 'Singen metal' seems appropriate for it without prejudice to where it may actually have originated.

The other alloys used in the Netherlands are represented by smaller numbers, so that the suggested identifications may prove to have less definitive value. Second in order of numerical importance comes the alloy which we have tentatively labelled 'Dutch Bell Beaker metal', to which seven specimens are assigned; six of them being Bell Beaker objects (5 tanged knives, 1 awl) and one a stray thick-butted flat axe. The smallness of the number is perhaps offset by the unusual character of the alloy represented. We were, indeed, surprised to discover how difficult it was to find good matches for our small group of objects with high As and moderate Ni. The Alpine area figures in the general literature as the home for alloys with nickel; and the assignment by JSS of most of the objects concerned to their 'Alpine' F groups pointed in the same direction. Yet the JSS 'F' objects are preponderantly high-tin bronzes of the Reinecke A2 period or later; earlier objects with As–Ni proved very elusive[13]. From the literature we could cull, until recently, only a flat axe from 'Hessen-Nassau' (OW–1003), one or two Beaker knives in Britain (Faversham, CC 97, possibly Roundway, CC 96) and the Bell Beaker tanged knife from Barnenez in Brittany (Mal 1). We cannot agree that any of these are of the same metal as German Bell Beaker knives; the Pb and Ag values of the German knives in question make this identification impossible (*cf.* Fig. 31). We were, therefore, without a possible home for the metals in question until the recent Breton publication (Giot, Bourhis & Briard, 1964/65). It appears, on examination of the values for Breton Aeneolithic flat axes, that these can be sub-divided into two sub-groups (as, indeed, noted in the text, p. 12, in connection with a noticeable difference in composition of the objects in two different hoards), one of arsenical copper, comparable, as suggested, with Iberian Aeneolithic material, and the other with As–Ni. A graph of the latter (Fig. 30) shows values into which the Dutch Bell Beaker group fits surprisingly well. It is, therefore, perhaps not entirely a coincidence that the only Dutch object not of Bell Beaker type, but made of As–Ni copper, is a flat axe whilst, on the other side, the only Breton Bell Beaker tanged dagger so far analysed is also of the same As–Ni copper.

We are, however, not entirely out of the woods as far as the origin of the metal is concerned, even if we accept the identification of the Dutch Bell Beaker metal with that of the As–Ni group of Breton flat axes; for the Breton authorities are uncertain as to the probability of a local production of copper (Briard, 1965, Chapter II; Giot, Bourhis & Briard, 1964/5). The possibility must therefore be kept open that the As–Ni copper was imported by the Dutch Bell Beaker and the Breton Aeneolithic cultures from some common source; which on present knowledge is unlikely to have been either Central Europe or Ireland. Areas for which too few Chalcolithic

analyses have so far been published, and which could conceivably be involved, are Britain (where, as we have seen, one or two tanged knives in the As–Ni copper are already known) and Iberia. In the latter area, there is at least some possibly relevant material in the form of five analyses of Palmela points and awls from the Bell Beaker-period site of Carmona, in the Spanish province of Sevilla, with 1 % to 2.2 % arsenic and 0.05 % to 0.4 % nickel; a long copper point from the presumed hoard of Valenciana del Alcor in the same province (JSS 830) is of the same metal[14]. These objects (which fall into the F2 group of JSS) are few in number compared to the normal arsenical copper objects then in use in Iberia; it will be interesting to see whether in the future this metallic component of the scene, with its seeming concentration in the Carmona area, will emerge more distinctly. It is perhaps to be expected, in view of the connections of the Breton Bell Beaker pottery with Iberia (L'Helgouach, 1957, p. 4–5), the occurrence of Palmela points in Brittany, and the possibly Iberian affinities of the remainder of the Breton Aeneolithic arsenical copper.

In the Netherlands, arsenical copper was used for making two halberds, two riveted knives, a Bell Beaker tanged knife, and one of the Buinen spirals. This metal need not all be of the same origin. For some of these objects at least, the high arsenic values suggest comparison with the arsenical copper used by Central German smiths for halberds, *i.e.* in the Dieskau hoard (the 'Dieskau Y grouping'). For the making of axes, arsenical copper was sometimes alloyed with tin in the Netherlands. Three of the tested objects were made of a copper sort which is characteristic of a very large proportion of the Central European ingot rings (*Ösenringe*), which we accordingly label '*Ösenring* metal'. In the case of the Bargeroosterveld knife, this is a result one might expect, since the knife is of a Central European type; but the appearance of an Aeneolithic-looking flat axe and even one of the Buinen spirals in metal of this composition must be considered less to have been expected.

Lorenzen (1965) has shown in an ingenious study that copper ore is to be found on the island of Helgoland in the North Sea; and that from this ore an arsenical copper could be produced, by primitive techniques, which would be not unlike the copper used for Danish and North German objects associated with the TRB culture. On the other hand, the copper experimentally produced by Lorenzen agrees less well with the northern TRB copper than does the copper of the Southeast European 'Altheim axe' group (Waterbolk & Butler, 1965, Graph 3); so that one may prefer to believe that the Bygholm-type copper objects found in TRB contexts in the North were after all imported from Southeastern Europe.

V. SUMMARY AND CONCLUSIONS

After this somewhat lengthy analysis, we may now attempt to sum up what we have learnt about Bell Beaker metal-working in the Netherlands in comparison with that of the Early Bronze Age.

1. There is surprisingly strong evidence for the actual practice of metal-working by Bell Beaker smiths in the Netherlands. This includes the skilful casting and hammer-finishing of tanged knives and awls, and possibly (?) flat axes. This was done with the help of sets of stone anvils, hammers and burnishers such as we have preserved from Lunteren and Soesterberg. This activity is so far only documented for the Veluwe group of the culture but in view of the fact that knives of the same appearance and of the same metal composition as those found with Veluwe type Beakers also occur with Beakers of maritime derivation, metal-working could conceivably have also been practiced in the latter group. The metal used was in most cases an arsenical copper with nickel as the chief impurity, which differs from the coppers known to have been regularly used by Bell Beaker smiths elsewhere. The Dutch Bell Beaker copper is, however, identical in composition with one of the two copper sorts used for Breton flat axes; the only Breton Bell Beaker tanged knife so far analysed is also of this metal.

The source of this As–Ni copper, if not Brittany itself, has not yet been identified; we doubt that it can be Central Europe.

Some of the Dutch Bell Beaker metal objects are, of course, likely to be imports. The Exloo spiral (not analysed) and the Exloo awl (of 'Singen metal') are undoubtedly imports from Central Europe. The two tanged knives of deviant composition are not easy to place exactly. The gold used for the Exloo and Bennekom ornaments comes, presumably, from Western Europe, though it remains an open question where these objects may actually have been made.

Since so very few pre-Bell Beaker metal objects are known in the Netherlands, and since the objects in question (Buinen spirals, possibly one or two flat axes) must be presumed to be imports, it is very probable that the Bell Beaker smiths were the earliest metal-workers in the country.

How did the knowledge of metal-working reach the Netherlands? The simplest answer would be: as part of the original Bell Beaker complex, which could be presumed to have arrived as a unit. But we have seen already (p. 46–7) that it is not certain that the maritime Beakers in reality represent a cultural complex; moreover, there is at present no evidence that metal-working was practised during the Maritime Bell Beaker phase in the Netherlands.

All the material now known seems to belong to the later 'Maritime derivative' and 'Veluwe type' phases. It is, therefore, possible that the knowledge of metal-working reached the Netherlands only with that later, secondary stream of Bell Beaker arri-

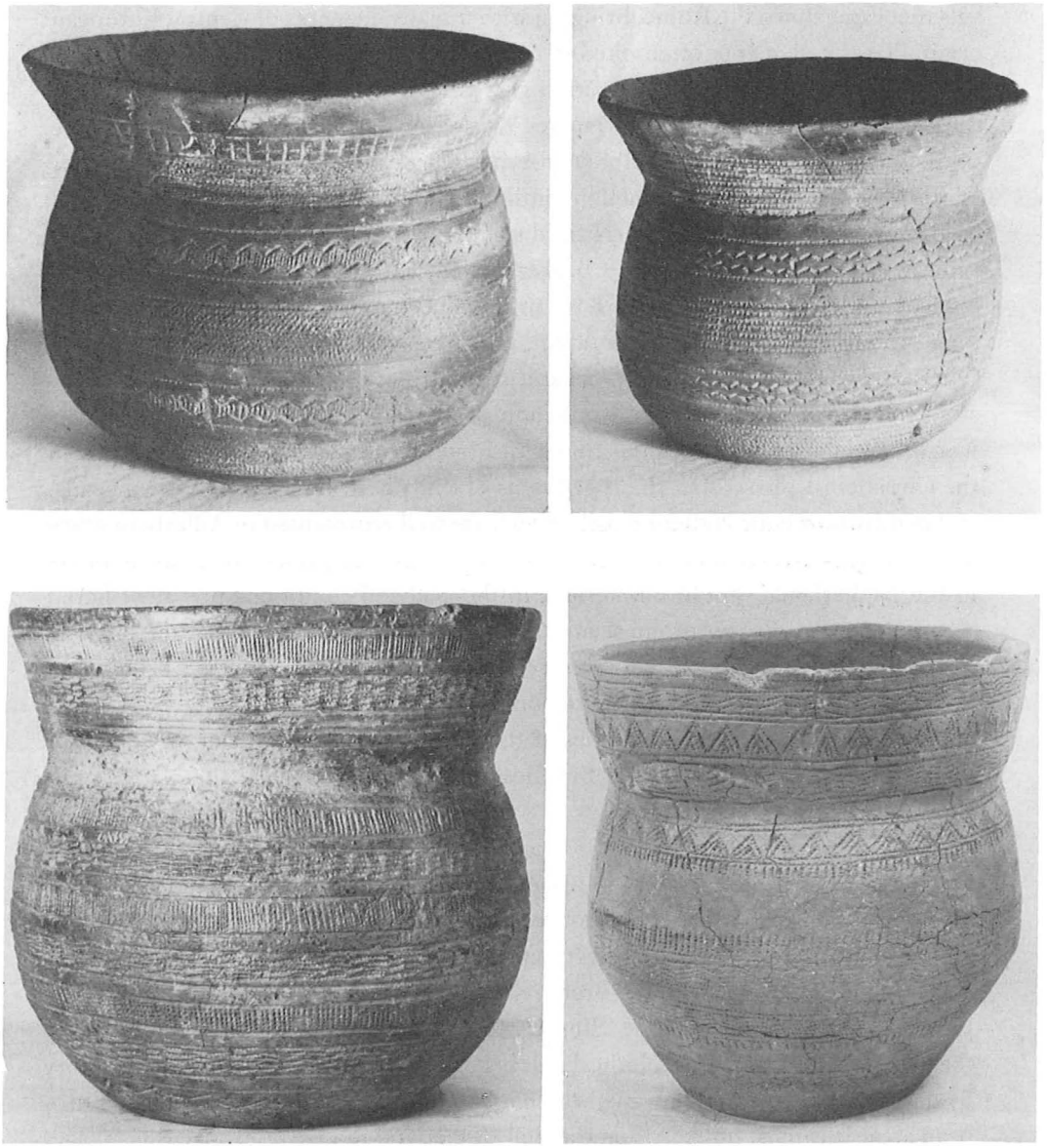


Fig. 37. Moravian Bell Beakers from Šlapánice, district of Brno (Moravsky Museum, Brno; top-left no. Pa 169/35–4, height c. 13.7 cm; top-right no. Pa 169/35–3, height c. 10.9 cm); Bell Beaker of Moravian type from Harskamp (Veluwe; bottom left, B.A.I., Groningen, height 17.8 cm) and Bell Beaker of Veluwe type from Lunteren (bottom right, now lost) (photos courtesy Museum Brno, B.A.I., Groningen, and RMOL, Leiden).

vals that came down the Rhine, bringing with it many elements of Central European origin. To the elements often cited in this context (see above, p. 53) may be added the occasional occurrence of cremation graves with Bell Beakers (as in the case of the Ginkelse Heide knife; *cf.* also van der Waals, 1964). A specially striking example of eastern connections is the Moravian-type Bell Beaker from Harskamp (van der Waals & Glasbergen, 1958), which in outline resembles so strongly specimens from Šlapánice (ca. 100 km from the Nitra district!; Fig. 37), and which anticipates the typical shape of the Veluwe-type Beaker. Exloo, with its Central European spiral bracelet and awl, also illustrates Eastern influence, and the Bennekom gold ornament, though Western in its decoration, is in form surely unthinkable without the Nitra-Mierzanowice 'willow leaf' ornaments as prototype. On present evidence the stone metal-workers' tools, too, would appear to be an Eastern element. (And it is worth bearing in mind, in connection with Eastern influences in the Netherlands in the Christlein I phase, that the type fossils of this phase are the rings, pins, beads, and pendants of bone, antler or shell, which are well represented in Adlerberg grave finds farther up the Rhine, but which, even if originally present in great numbers in the Netherlands, would not survive in the acid soil conditions prevalent here.) The Veluwe Bell Beaker group seems to have had active trade or other relations up the Rhine, for a number of Veluwe and closely related Bell Beakers have been found as far afield as the Neuwieder basin, some 250 km. up-river[1].

Thus, despite the Breton affinities of the Dutch Bell Beaker metal, it would not be unreasonable to suppose that Bell Beaker metallurgy reached the Netherlands from the Central European area.

2. There are surprisingly few points of contact between the Dutch Bell Beaker metallurgy and that of the Early Bronze Age in this area. Typology and associations as well as the metal analyses suggest that there could not have been any significant contact. The Dutch Bell Beaker-Breton flat axe metal is conspicuously absent in our Early Bronze Age objects. The 'Singen metal' which plays so prominent a part in the Early Bronze Age in the Netherlands is represented in the Bell Beaker inventory by only one object, the Exloo awl, which is surely an import from the Central European area. It is most unlikely that the Bell Beaker and the Early Bronze Age (Wageningen, 'Irish') metalworking could have co-existed for any length of time on the Veluwe without leaving far more evidence of contact than we have found. This must weigh heavily against any temptation to uphold or revive the *Riickstromhorizont* theory as originally proposed, according to which the Bell Beaker metals were to be dated 'just before Reinecke A2'. On the other hand, the clear differentiation of the Christlein I-Early Nitra horizon permits partial assent to be given to the equation Veluwe Bell Beaker phase = Reinecke A1, but the equation holds true only for Reinecke A1's earliest phase.

3. The Wageningen hoard, the 'Irish' and Únětice imports, and the local Emmen industry are contemporary with the Christlein 2 and 3 phases.

The Wageningen hoard seems to represent an intrusion by a foreign smith-trader with very heterogeneous wares, made of 'Singen metal' or of arsenical copper; but not of high-tin bronze. Perhaps slightly later, true bronze was introduced by the makers of the Irish-type low-flanged axes, who seem to have worked chiefly with an arsenic-containing copper not of Irish origin – indeed, one 'Irish' axe proves even to be of 'Singen metal'. The smiths subsequently responsible for the Emmen industry, centred chiefly in the Northeast of the country, evidently had access to supplies of 'Singen metal', but did not command a regular tin supply. They sometimes used arsenical copper, or, rarely it seems, bronze like that of the 'Irish' low-flanged axes.

Among the surprises delivered by the Dutch spectro-analyses were: the relative rarity of true bronze in the 'Reinecke A1' period, the absence of 'Irish' metal, the rarity of Central European *Ösenring* metal, and the great importance of 'Singen metal' for the Netherlands in this period.

The virtual absence of settlements of the Bell Beaker groups b and c and the Bronze Age with suitable conditions of preservation undoubtedly accounts for the absence in the Netherlands of finds of stone or clay moulds and clay crucibles and bellows-nozzles – types well represented in early metallurgy contexts in Eastern Europe. As Aeneolithic and Bronze Age settlement material becomes better known in the Netherlands, fragments of these types of artefacts may be expected to turn up.

[Revised December, 1966.]

NOTES

[1] For instance: Herfeldt–Plaidt, Kr. Mayen: *Bonner Jahrbücher* 140–141, 1936, p. 447, Taf. XI: 2; *Germania* 20, 1936, p. 55, Taf. XV: 1; Urmitz, Kr. Koblenz: Stampfuss, *Die jungneolithischen Kulturen in Westdeutschland*, Bonn, 1929, Taf. IX: 1; *Germania* 22, 1938, p. 72, Taf. 12: 6; Kretz, Kr. Mayen, *Bonner Jahrbücher* 145, 1940, p. 213, Taf. 47: 3; *Germania* 22, 1938, p. 72, Taf. 12: 15; Plaidt, Kr. Mayen: *Germania* 31, 1953, p. 114, Taf. XII: 1.

[2] The Christlein chronology is explicitly a grave chronology; as such, it attempts only to define the periods of time in which specific artefact types were deposited with burials. Deposition in graves depends, of course, not only on the types being made and used, but also on their local availability and on local burial custom; recent studies, of which that of Christlein is a notable example, try to take account of such factors. Correlation of the grave chronology with the record of the hoards remains as an open problem. In the Christlein scheme, *Ösenring* ingots and neck-rings occur only in Phase 2 – in the graves; but one must surely assume that the type was in use over a longer period, and in any case *Ösenringe* occur plentifully in Saxo-Thuringian hoards which Christlein would equate with his Phase 3. Metal axes hardly ever occur in the Central European Reinecke A1 graves; how long were "Saxon" axes current?

[3] *E.g.* Kobylnice, Moravia (*Inventaria Arch. Čs* 16: 5)

[4] Central European parallel: Stehelčeves, Bohemia (*Inventaria Arch, Čs* 12: 3). In fact, a case can be made out for the eastern rather than the Spanish origin of the tanged knife (as indeed suggested by Hájek, 1966, p. 232). Interesting in this connection is the often-cited grave from Bleckendorf in Central Germany, with its Pontic-type hammer-headed pin and its Corded-Ware pot of Sangmeister's *Westdeutsche Becher* type, comparable to Glasbergen's PF Beakers of Type Id, and probably earlier than the Bell Beaker metallurgy. The copper tanged blade in this grave could either be a tanged knife or (as suggested by Behrens, 1952, p. 58–59) a spearhead; in either case it could represent a prototype of the Bell Beaker tanged knife, which in Bohemia at least is sometimes made of identical copper (very pure, with only a slight quantity of Ag), as at Lysolaye near Prague, *Inventaria Arch. Čs* 14: 7, assoc. with Corded Ware pots and BB sherds. (*Cf.* Piggott, 1965, Fig. 39, p. 109 note 30; JSS, 1960, p. 189; Van der Waals, 1964, p. 66).

[5] Examples of grooved hammers or mauls which we happened to come across in the literature are from Ireland (Wilde, 1857, p. 85); the Mitterberg mining centre (Andree, 1922, Taf. VII: 112; VIII: 114); the French Maritime Alps, Italy, Spain, the Caucasus (Andree, 1922; de Mortillet, 1881, No. 1125–7), and Central Germany (JMV 50, 1966, p. 329, Abb. 2; verb. inform. from Dr. H.-J. Hundt, Mainz). Nowothnig (1963) drew attention to an example from an ancient-looking copper slag heap in the Harz; according to Preuschen contributory evidence for Bronze Age mining activity in that area. Wilde (1857, p. 84–7, fig. 67–8) noted, that 'as many of (these objects) have been found in ancient mines, they are usually associated with mining operations, and have been denominated "miners hammers". He cites examples from ancient mines in S.W. Ireland; the very area which recent Irish studies suggest as probable home of CC Group I metal. Similar implements are associated with primitive metal-working outside Europe (see *e.g.* R. W. Drier and O. J. DuTemple, ed., *Prehistoric Coppermining in the Lake Superior Region,* Calumet, Michigan, 1961, p. 51, 59–60, fig. p. 2 right).

[6] In Germany, pointed-butted axes used to be considered as typical for the Bell Beaker Culture (Schumacher, 1921, p. 49; Neumann, 1929, p. 40 and catalogue; Stampfuss, 1929, p. 80). In recent years, this attribution has been doubted, first by Sangmeister (1951, p. 11) and then by Brandt (in press), since not even one reliable association of an axe of this type with the Bell Beaker Culture was known. In the classification of Brandt our axe can be listed with group 1*b* of his *Felsovalbeile*. Brandt mentions the occurrence of a limited number of axes of this type made of graywacke, all showing pecking technique, as does our example. Conceivably, the *Felsovalbeile* of Brandt are not a homogeneous group; the graywacke examples could after all prove to be connected with the Bell Beaker Culture, as is the case in Soesterberg.

[7] Dr. H. H. Coghlan was so kind as to examine a number of these stones (at Newbury, 26 July 1966) and to give his opinion as to their suitability for use as metal-workers' tools. His view confirmed and strengthened our own, and we are very glad to be able to take account of his detailed and helpful observations in our description and discussion of the stones.

[8] Verbal communication from Mr. G. J. Boekschoten, Geologisch Instituut, State University at Groningen. Mr. Boekschoten acquired knowledge of this variety of quartzite in the course of his study of erratics, and has visited quarries in the neighbourhood of Bonn where this Zementquartzit has been worked; cf. B. von Freyberg, die *Tertiär-Quarzite Mitteldeutschlands*, Stuttgart 1926.

[9] Mr. J. A. Bakker (Instituut voor Prae- en Protohistorie, University of Amsterdam) kindly called our attention to this recent publication.

[10] Coghlan (1945) has described a series of Irish perforated stone hammers, of pestle-shaped or subrectangular form, which he regards as metal-workers' hammers. The pestle-shaped perforated form is common also in Britain; in both islands, beads of the same form occur. Dated examples are of the Early and Middle Bronze Age. In view of this, one wonders whether the unperforated stone pestles common in the East – *e.g.* the specimen in the smith's grave at Kalinovka – may not also have been used for metal-working.

[11] The population presumably consisted of the descendants of Bell Beaker and PF Beaker folk. From the point of view of pottery, the Early Bronze Age appears to begin with the appearance of 'barbed wire' ornamented wares; indeed, the first appearance of this pottery was officially proclaimed to mark the beginning of the EBA in the Netherlands by the Dutch Symposium on Prehistory held at Amersfoort in December 1965.

12. Südholz (1964) has, however, published a number of lowflanged axes from the Westphalian area hitherto overlooked in the literature. Alltogether we know of about a dozen finds of low-flanged axes in Northwest Germany (cf. also *Bonner Jahrbücher*, 164, 1964, p. 513–4; Bergmann, *Urgeschichte des Stadtkreises Kassel*, 1962, Abb. 30; W. Dehn, *Katalog Kreuznach*, 1941, Abb. 17: 8). South German low-flanged axes are generally much narrower than Emmen axes.

[13] Since occasional Veluwe Bell Beakers penetrate as far south as Neuwied – which is closely adjacent to the former province of Hessen-Nassau – the possibility that the Hessen-Nassau flat axe, preserved only as a fragment, is an export from the Veluwe Bell Beaker industry cannot be entirely ignored.

[14] Were one to judge by the As and Ni values alone, one would hardly hesitate to declare these Spanish specimens to be of the same metal as the Breton-Dutch As–Ni copper. Yet the Iberian analyses cited exhibit quite a different trace-element pattern, and this stands in the way of such an identification. It will be most interesting to see whether further analyses from Iberia improve or weaken the chance of such a connection.

APPENDIX I

CATALOGUE OF EARLY METALS IN THE NETHERLANDS, WITH SPECTRO-ANALYTICAL AND/OR METALLOGRAPHIC DATA

The catalogue is arranged according to types of objects. For information on find circumstances and documentation of some of the previously unpublished finds, see appendix III.

Objects. For each object is given:

a. Province (Dr. = Drenthe, Fr. = Friesland, Gld. = Gelderland, Li. = Limburg, NB. = Noord-Brabant, NH. = Noord-Holland, Ov. = Overijssel);
b. Find-spot, with Gemeente. Where no Gemeente (Gem.) is cited, it has the same name as the find-spot;
c. Museum or other collection where preserved (BAI = Biologisch-Archaeologisch Instituut, Groningen; CNM = Centraal Noordbrabants Museum, 's-Hertogenbosch; FM = Fries Museum, Leeuwarden; LPM = Limburgs Provinciaal Museum Bonnefanten, Maastricht; MGO = Museum voor het Gooi en Omstreken, Hilversum; MN = Museum 'Nairac', Barneveld; PMD = Provinciaal Museum van Drenthe, Assen; RMK = Rijksmuseum Kam, Nijmegen; RMOL = Rijksmuseum van Oudheden, Leiden; RT = Rijksmuseum Twenthe, Enschede);
d. Find-circumstances and associations, where known, in summary;
e. References to illustrations and to the bibliography in this paper;
f. Results of metallographic examination, in summary (for details, *cf*. appendix II); (//) = examined on polished surface, ($\perp$) = examined in cross-section.

Analyses. JSS indicates analyses by Junghans, Sangmeister and Schröder (1960), *cf*. also Junghans, Klein and Scheufele (1953). BW indicates analyses by TNO Laboratory, Delft (see p. 43) here first published. Analyses show the concentration of the cited elements in per cent, the remainder to 100 % being copper.

Abbreviations: n.d. = not detected; tr. = trace.

The method of analysis employed for BW samples corresponds with that described by Brown and Blin-Stoyle (1959); limits of detection for BW analyses: Sb 0.01, Pb 0.005, Fe 0.003, Co 0.001, Bi 0.001, Au 0.004, Ni 0.001, Sn 0.002.

Ser. No.	Object	Anal. No.	Sn	Pb	As	Sb	Ag	Ni	Bi	Fe	Remarks
	TANGED 'BELL BEAKER' KNIVES										
1	Gld. *Vaassen*, Gem. Epe. RMOL, Leiden, e 1945/8. 17. Secondary grave, in Tumulus III, with Bell Beaker of Veluwe type, 2^{Id}, amber button and pendant. Present paper, Fig. 6, 10; App. III: 7. Cast, annealed; traces of cold-working on face. Point ground, not forged (//, ⊥); App. II: 4.	BW 20	n.d.	0.01	5.7	0.05	0.009	0.40	0.003	0.006	Co 0.001
2	Gld. *Lettense Berg*, Gem. Ede. RMOL, Leiden, e 1936/1.91. Grave, in Tumulus, with 3 V-bored amber buttons. Present paper, Fig. 10; App. III:4. Piggott, 1963, Fig. 16: 1 Cast, annealed (//); App. II: 11.	JSS 685	tr	0.3	4.0	0.37	0.02	2.8	0	0.14	–
3	Gld. *Stroeërzand*, Gem. Barneveld. RMOL, Leiden, e 1929/-3.18. Grave, in Tumulus, with 4-holed curved wrist guard. Present paper, Fig. 10; App. III: 5. Bursch, 1933, p. 114, Taf. VI: 5,44; Piggott, 1963, Fig. 15: 6. Cast, annealed (//); App. II: 14	JSS 690	0.02	0.03	~ 3	0.06	0.02	0.5	0.005	0.02	Co 0.04
4	Gld. *Ede*, „de Kweekerij". RMOL, Leiden, e 1936/1. 63. Secondary grave, in Tumulus, with Bell Beaker type 2^{Ib}. Present paper, Fig. 3, 10; App. III: 1. Bellen, 1925; Bursch, 1933, Tabelle Veluwe 11; Piggott, 1936, Fig. 15: 5. Cast, annealed (//); App. II: 13.	JSS 682	<0.01	<0.01	2.3	0.06	0.02	0.2	0.07	0.02	–
5	Gld. *Lunterse Heide*, Gem. Ede. RMOL, Leiden, e 1936/1.3. Grave, in Tumulus, with Bell Beaker of Veluwe type, 2^{Id}, 2 2-holed wrist guards, 2 flint arrowheads. Present paper, Fig. 7, 10; App. III: 3. Bursch, Tabelle Veluwe 8. Cast, probably annealed; many tr. of cold-working on surface (//); App. II: 12.	JSS 683	tr	0.01	2.2	tr	0.04	0.1	0.02	0.02	–
6	Dr. *Exloo*, Gem. Odoorn. PMD, Assen, 1929/IX 1. Grave, in Tumulus, with Bell Beaker type 2^{Ib}, copper awl (No. 18 below), copper spiral bracelet (No. 13 below), gold and amber beads. Present paper, Fig. 5, 10. Van Giffen, 1930, p. 166–75, Taf. 112–6; 1938; 1947; de Laet & Glasbergen, 1959, Fig. 38; Piggott, 1963, Fig. 15: 7.	JSS 687	0.08	0	2.0	0.3	0.04	0.9	0	0.03	Zn 0.05

	Cast, probably annealed; traces of cold-working on surface (//,); App. II: 6.										
7	NH. *Hilversum.* MGO, Hilversum, B 240. Grave, Tumulus I. Present paper Fig. 10. Bursch, 1935, p. 49, Afb. 39: 3.	JSS 691	tr	0	3.9	0	<0.01	0	0.02	0	–
8	NH. *Zeven Bergjes,* Gem. Laren. RMOL, Leiden, g 1928/ Grave, in Tumulus 10, with 3 flint arrowheads. Heavily corroded. Present paper, Fig. 10. Remouchamps, 1928, p. 71, Afb. 42.	not analysed	–	–	–	–	–	–	–	–	–
9	Gld. *Ginkelse Heide,* Gem. Ede. Now lost. Cremation grave in tumulus, with Bell Beaker type 2^{Ib}, 4-holed arched wrist guard and many flint objects. Present paper, Fig. 4, 10; App. III: 2. Bursch, 1933, Tabelle Veluwe 8.	not analysed.	–	–	–	–	–	–	–	–	–
10	Gld. *Nieuw-Millingen,* Gem. Apeldoorn, ,,de Mottenkuil''. Private collection. Grave, in tumulus, with Bell Beaker of Veluwe type, 2^{Ie}, amber lunate pendant, flint arrowhead and knife. Heavily corroded. Present paper Fig. 8, 10; App. III: 6. Van der Waals, 1964, p. 33, Fig. 12.	not analysed	–	–	–	–	–	–	–	–	–
	AWLS WITH BELL BEAKERS										
11	Dr. *Exloo,* Gem. Odoorn. PMD, Assen, 1929/IX. 3*a*. See No. 6 above. Present paper Fig. 5.	JSS 686	0.03	0	0.27	1.05	0.56	1.1	0.006	0.04	–
12	Gld. *Lunteren,* Gem. Ede, ,,de Valk''. RMOL, Leiden, e 1958/ VI.6. Present paper, Fig. 13*b*; App. III: 8. Grave, in tumulus, with Bell Beakers of Veluwe type (2^{Id-e}), 2-holed wrist guard, flint objects and stone metal workers' tools.	BW 10	n.d.	0.01	1.0	0.03	0.01	0.35	0.003	n.d.	Au 0.01
	SPIRAL BRACELET WITH BELL BEAKER										
13	Dr. *Exloo,* Gem. Odoorn. PMD, Assen, 1929/IX.3. See No. 6 above. Present paper, Fig. 5.	not analysed	–	–	–	–	–	–	–	–	–
	SPIRAL ORNAMENTS FROM HUNEBED D XXVIII										
14	Dr. *Buinen,* Gem. Borger. BAI, Groningen, 1927/VIII. 24. With No. 15 below. Van Giffen, 1943, p. 28, 43, afb. 31; 1944, p. 429–31, afb. 10*a–b*; Ankel, 1963, p. 69, Taf. 52: 1–2.	JSS 836	0	0	1.32	1.3	1.1	0.01	0.08	0.02	–

Ser. No.	Object	Anal. No.	Sn	Pb	As	Sb	Ag	Ni	Bi	Fe	Remarks
15	Dr. *Buinen*, Gem. Borger. BAI, Groningen, 1927/VIII. 325. With No. 14 above.	JSS 837	0	0.01	0.55	0	0.15	0.01	0.08	tr	–
	FLAT AXES WITH THICK BUTT										
16	Gld. *Veluwe* (no exact provenance). MN, Barneveld, 52. Present paper Fig. 19. Cast, annealed. Edge forged below recrystallization temperature (//, ⊥); App. II: 2.	BW 18	n.d.	n.d.	0.1	0.29	0.45	0.14	0.003	0.005	–
17	Gld. *Veluwe* (no exact provenance). MN, Barneveld, 53. Present paper, Fig. 19.	BW 19	n.d.	n.d.	2.8	0.2	0.12	0.52	n.d.	n.d.	Co 0.01
18	Gld. *Beek*, Gem. Berg. RMKN, Nijmegen, 22. Present paper, Fig. 20.	BW 22	n.d.	n.d.	0.2	1.1	0.6	0.01	0.01	n.d.	–
19	Li. (no exact provenance). LPM, Maastricht, 202A. Present paper, Fig. 20.	BW 26	n.d.	0.01	4.0	0.05	0.015	0.37	0.003	0.005	–
20	Ov. *Glanerbrug*, Gem. Enschede. RT, Enschede, 417. Present paper Fig. 20.	not analysed	–	–	–	–	–	–	–	–	–
	HOARD OF WAGENINGEN										
21	Gld. *Wageningen*. RMOL, Leiden, RW 1–14. Present paper, Fig. 21; App. III: 12. Pleyte, 1889, p. 49, Pl. XI: 5–9; O Ríordáin, 1937, p. 239, Fig. 37; Butler, 1959*b*, p. 126–9, Fig. 1; de Laet & Glasbergen, 1959, Pl. 26.										
21	Flat axe of Irish thin-butted faceted type. RW 4. Cast, annealed. Traces of cold-working on surface (//); App. II: 16.	BW 1	1.6	0.01	0.2	0.13	0.33	0.66	n.d.	n.d.	Co 0.01
22	Halberd of Irish type 4; 3 rivet-notches. RW 2. Cast, annealed (//); App. II: 8.	BW 2	n.d.	0.03	7.0	0.04	0.03	n.d.	0.006	n.d.	–
23	Halberd rivet, unfinished. RW 1.	BW 5	0.02	n.d.	1.5	7.6	2.5	2.5	0.002	n.d.	Co 0.07
24	Halberd rivet, unfinished. RW 11.	BW 6	0.02	n.d.	1.5	8.6	1.3	2.5	0.002	n.d.	Co 0.07

25	Knife, triangular, with 3 rivets, shouldered hilt-plate. RW 3. Cast, annealed (//); App. II: 9.; traces of cold-working on surface	BW 3	n.d.	0.01	6.8	0.02	0.03	n.d.	0.002	0.006	–
26	Rivet of knife RW 3 (No. 25 above).	BW 4	1.1	0.07	0.1	n.d.	0.02	0.02	n.d.	n.d.	–
27	Awl of rectangular section. RW 9*a*.	BW 7	0.34	0.005	0.4	1.1	0.35	0.60	n.d.	n.d.	Co 0.02
28	Ingot of rod shape. RW 8.	BW 8	1.4	0.01	0.2	0.24	0.03	0.76	0.001	0.005	Co 0.005
	HALBERD (of Irish type 4; see also No. 22)										
29	Li. *Roermond*. Private collection. Present paper, Fig. 24. Glasbergen & Butler, 1961; Butler, 1963*a*, p. 17, Fig. 2.	BW 25	n.d.	0.01	3.0	0.01	0.015	0.05	0.003	n.d.	–
	LOW-FLANGED AXES OF IRISH TYPE										
	Present paper, Fig. 22. Butler, 1959*a*; Butler, 1963*a*, p. 30–47, Fig. 6; 1963*b*, p. 185–92, Fig. 2–4.										
30	Gld. near *Nijmegen* (?). RMK, Nijmegen, xxx.d.4.	BW 21	9.0	n.d.	0.7	n.d.	0.06	0.01	n.d.	n.d.	–
31	NB. *Gemert*. CNM, 's Hertogenbosch, 611. Allegedly found with two flint axes.	BW 29	7.2	n.d.	0.2	0.24	0.26	0.05	n.d.	0.01	–
32	NB. *'s Hertogenbosch*. CNM, 's Hertogenbosch, 9487.	BW 30	1.0	n.d.	0.2	0.6	1.6	1.5	n.d.	0.01	–
33	NB. *Haren*, Gem. Megen etc. Pvt. collection. Modderman, 1959 and ref. cited above.	BW 32	9.0	n.d.	0.2	0.04	0.02	n.d.	n.d.	n.d.	–
	LOW-FLANGED AXES OF EMMEN TYPE										
	Present paper, Fig. 23. Butler, 1963*a*, p. 30–47, Fig. 8; 1963*b*, p. 185–92, Fig. 2–4.										
34	Gld. *'s Heerenberg*, Gem. Bergh. RMOL, Leiden, e 99/VI.1. Cast, annealed (//); App. II: 15.	BW 11	9.3	n.d.	0.2	n.d.	0.01	0.02	n.d.	n.d.	–

Ser. No.	Object	Anal. No.	Sn	Pb	As	Sb	Ag	Ni	Bi	Fe	Remarks
35	Fr. *Suawoude*, Gem. Tietjerksteradeel. FM, Leeuwarden, 229.34. Boeles, 1951, p. 50, 482: 2, Fig. 13: 1; see also reference cited above.	BW 13	3.0	n.d.	0.5	n.d.	0.02	0.01	n.d.	n.d.	–
36	Fr. *Donkerbroek*, Gem. Ooststellingwerf. FM, Leeuwarden, 1–3. Boeles, 1951, p. 50, 482, Pl. VI: 4; see also references cited above.	BW 14	0.77	n.d.	0.2	1.5	0.35	0.51	n.d.	n.d.	Co 0.02
37	Dr. *Emmen.* PMD, Assen, 1855/I.54. Cast, annealed, flanges have been cold-hammered (//, ⊥); App. II: 1.	BW 15	3.1	n.d.	0.2	0.20	0.31	0.15	n.d.	n.d.	–
38	Dr. *Gieten.* PMD, Assen, 1872/I.15. Cast, annealed; flanges have been cold-hammered; cutting edge forged below crystallization temp. (//, ⊥); App. II: 5.	BW 16	0.37	n.d.	0.2	2.3	0.70	2.1	n.d.	n.d.	Co. 0.03
39	Dr. *Valtherspaan*, Gem. Odoorn. PMD, Assen, 1921/XII.12. Cast, annealed; traces of cold-working on surface (//); App. II: 10.	BW 17	0.02	0.005	0.3	2.9	1.7	1.5	n.d.	n.d.	Co 0.02
40	Dr. *Bargeroosterveld*, Gem. Emmen. PMD, Assen, 1962/II.36	BW 24	n.d.	n.d.	0.1	3.5	1.4	2.3	n.d.	n.d.	Co 0.03
41	Dr. *Noordveen*, Gem. Emmen. Oudheidkamer „de Hondsrug", Emmen, 1962/II 6.	not analysed	–	–	–	–	–	–	–	–	–
42	Dr. *Gasselterboerveen*, Gem. Gasselte. RMOL, Leiden, B.S.9. Janssen, 1484, p. 152; Cat. Coll. Brugmans, 1857, p. 7; and ref. cited above.	not analysed	–	–	–	–	–	–	–	–	–
43	NH. *Vogelenzang*, Gem. Bloemendaal. RMOL, Leiden, g 1947/12.2. Brunsting, 1957; and ref. cited above.	not analysed	–	–	–	–	–	–	–	–	–
	OTHER LOW-FLANGED AXES										
44	Li. *Bergen.* LMP, Maastricht, 205.	BW 27	0.21	0.05	0.3	1.6	2.7	0.40	0.006	0.005	Co 0.002
45	Belgian Limburg. *Reckheim.* LPM, Maastricht, 244.	BW 28	0.0	n.d.	0.2	0.43	0.43	0.02	n.d.	0.01	–

46	Li. *Exaten*, Gem. Baaxem. Pvt. Collection. Miniature specimen.	BW 31	11.0	n.d.	0.5	0.60	0.83	0.64	n.d.	n.d.	–
47	Li. *Urmond-Berg*, Gem. Urmond. Museum Beckers, Beek, II*b* 4.	not analysed	–	–	–	–	–	–	–	–	–
48	Gld. *Wageningen*. Gemeente-museum, Arnhem, BH 120	not analysed	–	–	–	–	–	–	–	–	–
49	Gld. *Nijmegen*. RMK, Nijmegen, GNAC 16.	not analysed	–	–	–	–	–	–	–	–	–
50	Gld. *Wijchen*, at the border with Overasselt. RMK, Nijmegen 3.1941.1. Miniature axe of 'Saxon' form.	not analysed	–	–	–	–	–	–	–	–	–
51	Dr. *Ellertsloo*, Gem. Rolde. PMD, Assen, 1909/VI.2.	not analysed	–	–	–	–	–	–	–	–	–
52	Li. *Heerlen*. Gemeentelijk Oudheidkundig Museum Heerlen A 5	not analysed	–	–	–	–	–	–	–	–	–
	RIVETED KNIVES										
53	Gld. *Drie*, Gem. Ermelo. RMOL, Leiden, e 1940/I. 107. Stray find. Present paper, Fig. 25. Lozenge shaped, 2 rivetholes. Cast, annealed (//, ⊥); App. II: 3.	JSS 680	<0.01	~0.01	0.82	0.02	0.04	0.01	0.005	0.05	–
54	Dr. *Bargeroosterveld*, Gem. Emmen. PMD, Assen, 1955/VIII. 1. Bog find; triangular knife with 4 rivets, horn hilt with tin nails as ornament. Present paper, Fig. 20. Glasbergen, 1956; 1960; Jacob-Friesen, 1954, p. 33–4, Taf. IV: 2*a–d*. Cast, not annealed (//); App. II: 7.	JSS 679	2.81	0.02	1.15	1.05	1.23	0.02	0.04	0.05	–
	SCHLEIFENNADEL (?)										
55	Gld. St. *Walrick*, Gem. Overasselt. BAI, Groningen (temporarily). From secondary grave in 3-period Tumulus I (primary grave with Bell Beaker of Veluwe type; tertiary grave C14-dated 1755 ± 80 B.C., GrN-2996). Present paper, Fig. 25. Groenman-van Waateringe, 1966, p. 72–6, 175; Fig. 41.	not analysed	–	–	–	–	–	–	–	–	–

APPENDIX II

H. A. SCIARONE AND A. R. SCHILT

REPORT ON THE METALLURGICAL EXAMINATION OF A NUMBER OF EARLY METAL OBJECTS*

Introduction and objectives

The Biologisch-Archaeologisch Instituut of the State University at Groningen requested a metallographic examination of seventeen prehistoric objects (mostly axes and daggers) with a view toward determining, where possible, how the objects were made. For eleven of these objects permission had been obtained only for a surface examination, for which purpose they were made avaiable for a period of one or two days. The remaining six objects could be studied more thoroughly.

Procedure followed

All the objects were subjected to a metallographic surface examination (hereinafter abbreviated as "//"). From a number of objects for which there was no objection to minor damage, samples were removed at points chosen by us in consultation with the B.A.I.; these samples were examined in section (hereinafter abbreviated: "$\perp$"). Vickers hardness tests (Hv5) were also carried out.

For the surface metallographic and hardness tests, an area of less than 0.5 sq. cm. was polished as finely as possible (the area was kept small so as to minimize damage to the patina of the objects). Mssrs. Bosman and Schotman assisted in this operation. The prepared surfaces were then etched with a solution consisting of five parts NH_4OH 0.91, five parts water and three parts 3 % H_2O_2. An exception was made in the case of the axe RMOL e. 99/6.7, which in contrast to the other samples had an obvious yellow colour. For this specimen the following etching medium was used: 5 gr. $FeCl^3$, 3 ml HCl, 100 ml alcohol.

The chemical composition of a number of the objects was furnished to us by the B.A.I. (Ed. note: *cf.* App. I).

* This study was carried out by the Materials Advice Office of the Research Laboratory of the Royal Dutch Blast Furnace and Steel Works (Materiaal Advies Bureau, Koninklijke Nederlandsche Hoogovens en Staalfabrieken N.V.) at IJmuiden, North Holland, 1964. The objects were made available for study by the Rijksmuseum van Oudheden, Leiden, the Provinciaal Museum van Drenthe, Assen, and Museum 'Nairac', Barneveld, the Directors of which generously accepted the necessity for a degree of damage (since made good with suitably coloured plastic) to the objects in their custody. The report has been translated from Dutch into English by J.J.B.

Results

The details regarding microstructure and hardness are given in Table I (six objects, // and ⊥) and Table II (the other eleven objects, // only). Photographs of the objects (Ed. note: here replaced by line drawings) and of their microstructure (Fig. 38–53) are appended. The points at which the structure and hardness have been determined are also shown.

Structure

One of the seventeen objects, No. 7, the Bargeroosterveld knife, has a clearly dendritic structure; the other sixteen show a grainy structure, with or without twinning.

A dendritic structure indicates a casting without subsequent working. A grainy structure can mean that the object was:

a. annealed; or
b. deformed while hot; or
c. deformed while cold, and thereafter annealed.

Twinning can arise in any of these cases. The possibility of twinning is greater in the case of (*b*) or (*c*) than in the case of (*a*).

The size of the grains increases to the extent that the annealing temperature is higher, the annealing time longer, the degree of deformation smaller, and the quantity of impurities smaller.

Since these factors may operate idependently of one another, it is not possible to draw definite conclusions from the grain size.

Below we give a brief description of the procedures which may have been employed in the manufacture of the objects. No. 1–6 are based on samples studied // and ⊥; No. 7–17 on samples examined // only.

Table I: **Samples examined // and ⊥**

1. *Assen 1855/1.54* (lowflanged axe, Emmen, of Emmen type).
   General: cast and subsequently annealed (but, in view of segregation, not for long or at a high temperature).
   Side: Additionally worked by cold hammering.
   Cutting-edge: No sample available.

2. *Barneveld 52* (thick-butted flat axe from the Veluwe).
   General: cast, then annealed*.
   Side: No sample available.
   Cutting-edge: Forged below recrystallisation temperature.

3. *RMOL e. 1940/1.107* (triangular riveted knife, Drie).
   General: cast, then annealed.*
   Side, cutting-edge: No samples available.

* Or hot deformed, or cold deformed and annealed.

4. *RMOL e. 1945/8.17* (tanged knife, Vaassen)
General: cast, then annealed; traces of cold deformation on surface..
Cutting-edge: no sample available.
Point: whetted (not sharpened by forging).

5. *Assen 1872/I.15* (low-flanged axe, Gieten; of Emmen type).
General: cast, then annealed.*
Flanges: further worked by cold-hammering.
Cutting-edge: forged below recrystallisation temperature. (*cf. Man* 1953, 150, p. 5, Fig. 4).

6. *Assen 1929/IX.1* (tanged knife, Exloo)
General: no sample available; presumably annealed.*
Cutting-edge: forged at room temperature.
Point: no sample available.

Table II: **Samples examined // only**

7. *Assen 1955/VIII.1* (riveted knife, Bargeroosterveld)
Cast.

8. *RMOL RW 2* (halberd, Wageningen hoard)
Cast, then annealed.

9. *RMOL RW 3* (riveted knife, Wageningen hoard)
Cast, then annealed; traces of cold deformation on surface.

10. *Assen 1921/XII.12* (lowflanged axe, Valtherspaan; Emmen type).
Cast, then annealed; traces of cold deformation on surface.

11. *RMOL e. 1936/1.91* (tanged knife, Lettense Berg)
Cast, then annealed.*

12. *RMOL e. 1936/1.3* (tanged knife, Lunterse Heide)
Cast, probably thereafter annealed*, much trace of cold deformation on surface.

13. *RMOL 1936/1.63* (tanged knife, Ede)
Cast, then annealed.

14. *RMOL e. 1929/3.18* (tanged knife, Stroeërzand)
Cast, then annealed.*
Cf. Coghlan, *Notes on Prehist. Met. of Copper and Bronze*, Oxford, 1951, Pl. V, Fig. 1 (spearhead from Cyprus).

* Or hot deformed, or cold deformed and annealed.

15. *RMOL e. 99/6.7* (lowflanged axe, 's-Heerenberg; of Emmen type).
Cast, then annealed. Noticeably yellow colour in contrast to the red colour of all the other specimens. The α and δ phase indicates a considerable percentage of tin (6 to 10 %).
16. *RMOL RW 4* (thin-butted flat axe, Wageningen hoard).
Cast, then annealed.* (Not very clear on the photograph). Traces of cold deformation on surface.
17. *RMOL IL 2* (thin-butted flat axe, Ireland).**
Cast, presumably then annealed.

Hardness

The hardness of pure copper in gently annealed condition amounts to ca. 40 to 50 Hv. The hardness increases with the degree of cold-forging and the quantity of impurities. The influence of cold-forging on the hardness of pure copper is shown in the following table:

Deformation (%)	Hardness (Hv5)
0	44
2	56
5	75
10	84
30	103

We have no quantitative data available as to the influence of impurities on the hardness.

The objects examined were found to have hardnesses from c. 80 to 170 Hv: the hardnesses over c. 120 were found on the clearly cold-deformed parts of objects 5 and 6. These evidently also contain considerable impurities (*cf.* Appendix I, No. 38 and No. 6).

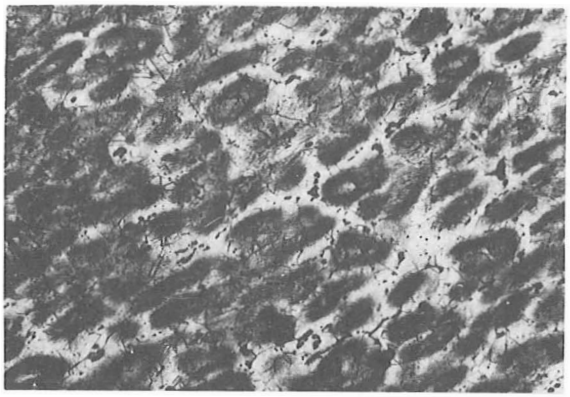
Where comparison of the hardness ⊥ and // to the surface was possible, the hardness // to the surface was found to be c. 10 points Hv higher than the hardness ⊥ to the surface. This could be the consequence of cold working (see also Note 2 below).

Some general remarks

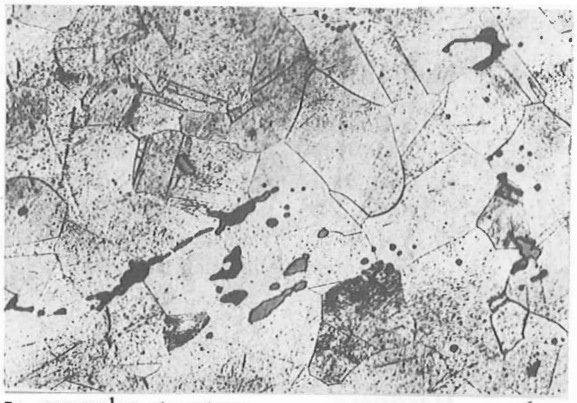
1. One should note that the metallurgical data have been obtained from surfaces which could not, under the existing circumstances, be fully prepared for examination.
2. On a number of surface specimens, slip bands appear, which could indicate cold-working. At what stage these slip bands were formed cannot be determined. They could possibly have been formed while the object was in use.

* Or hot deformed, or cold deformed and annealed.
** Not discussed in the present paper.

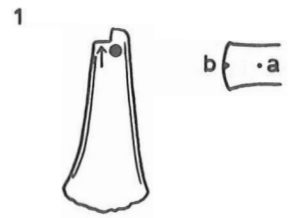
Fig. 38–43. Microphotographs of Bell Beaker and Early Bronze Age metal objects metallographically examined.

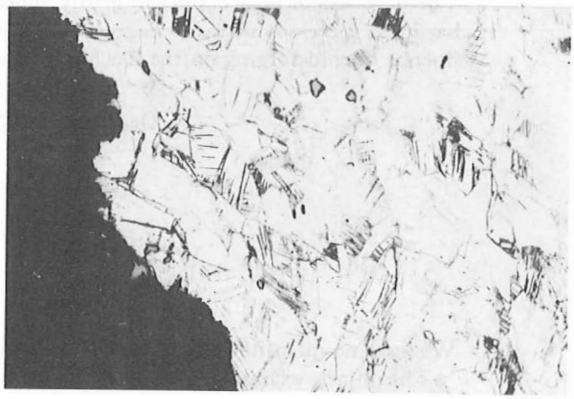


1a segregation 40 ×

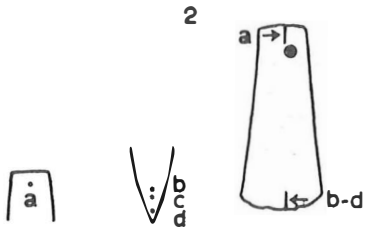


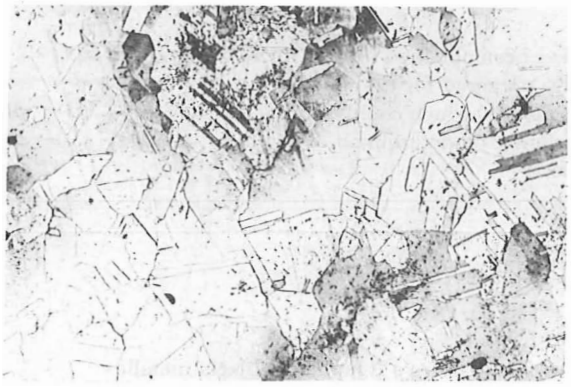
1a granular structure 160 ×



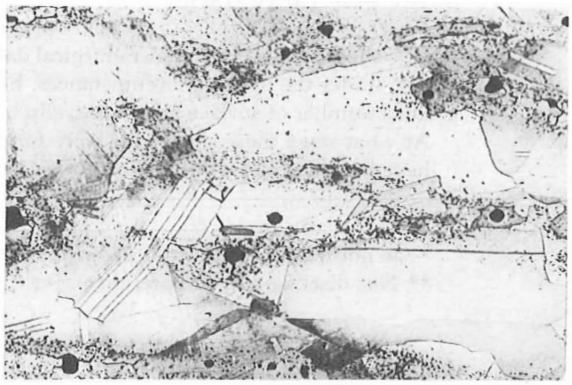


1b slip-bands 160 ×



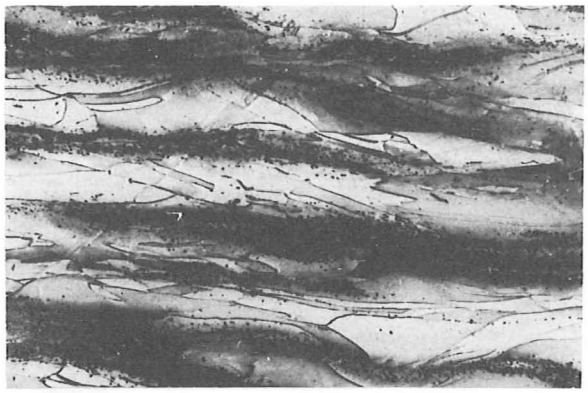


2a twinning 160 ×

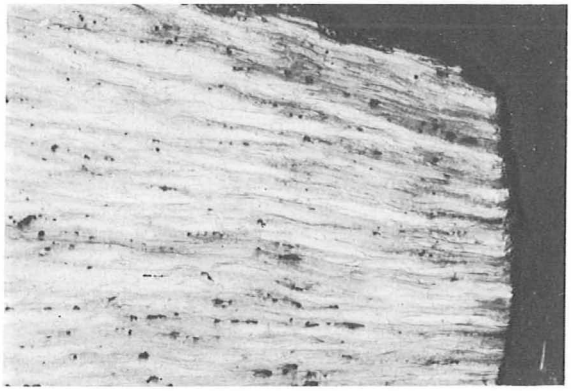


2b twinning 160 ×

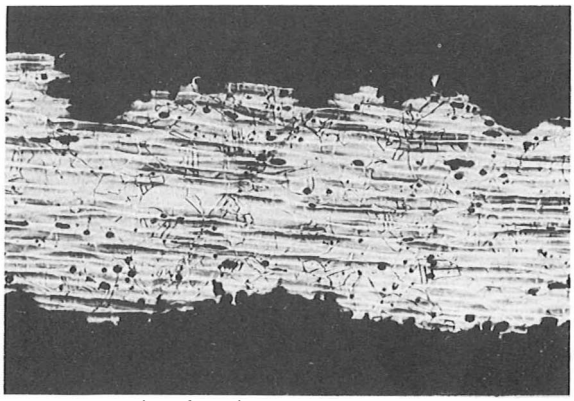
Fig. 38.



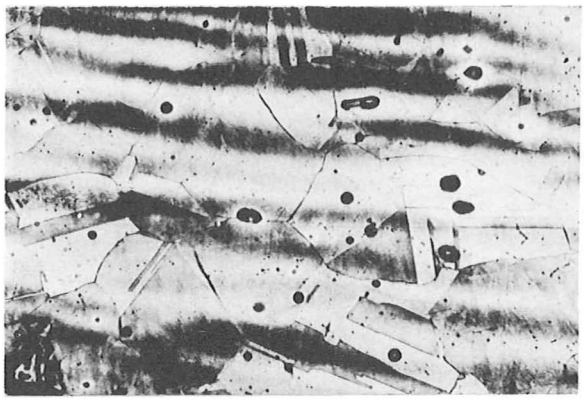
2c elongated grain 160 ×



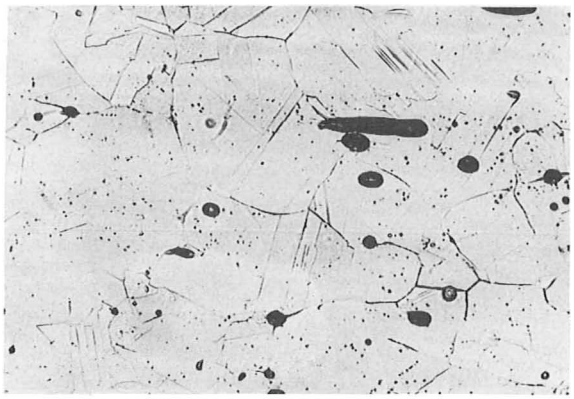
2d segregation bands 40 ×



3a segregation bands 40 ×

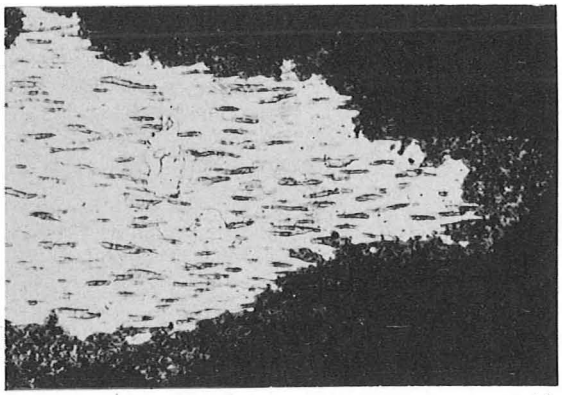


3a 160 ×

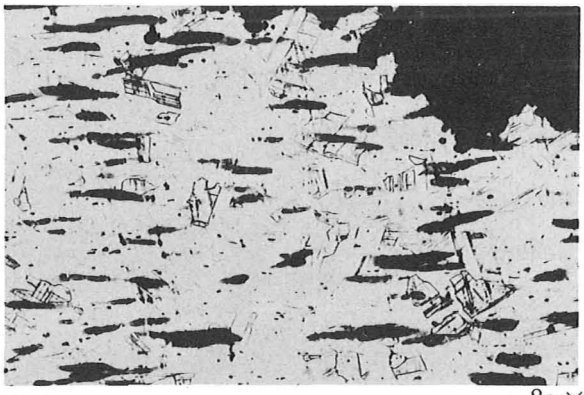


3a 160 ×

Fig. 39.

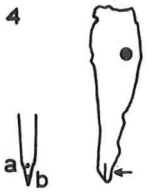


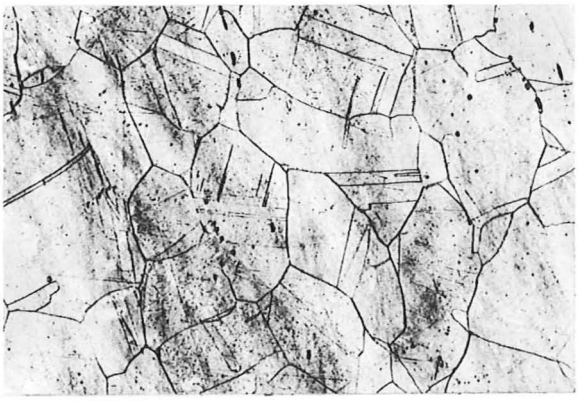
4b segregation bands 40 ×



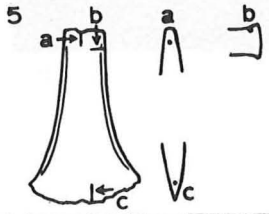
4a 80 ×

4a 160 ×





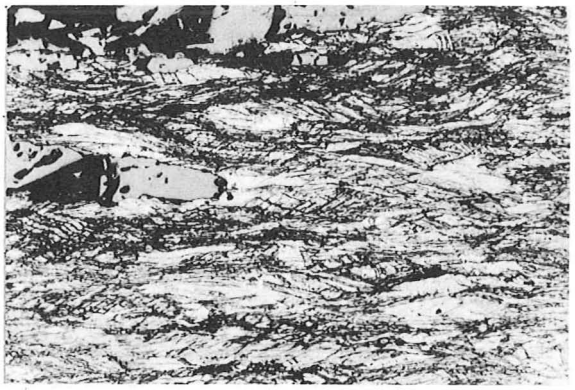
5a 160 ×



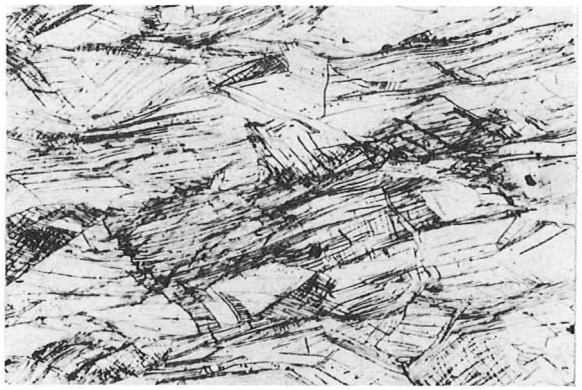
5b slip-bands 160 ×

5c slip-bands, elongated grain 80 ×

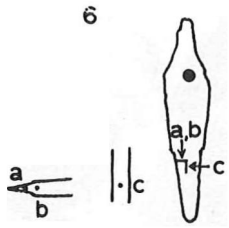
Fig. 40.

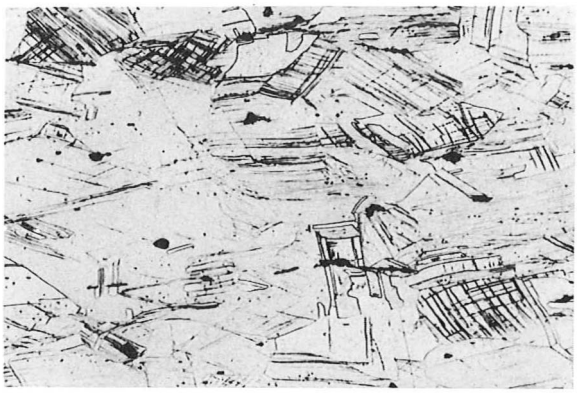


6a close to side 160 ×

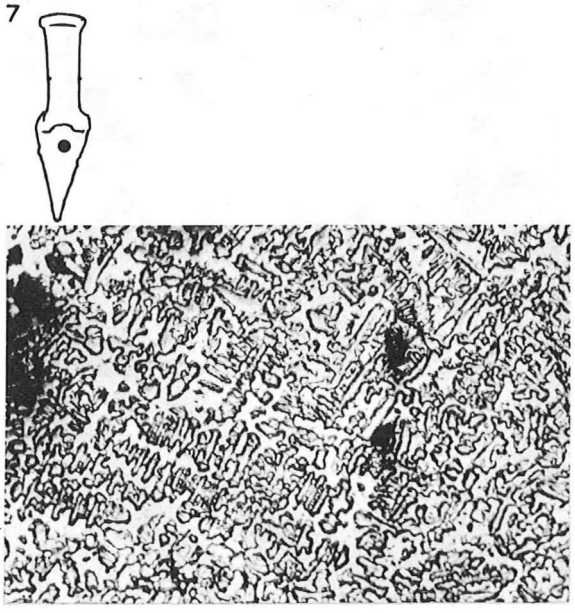


6b c. 4 mm from side 160 ×

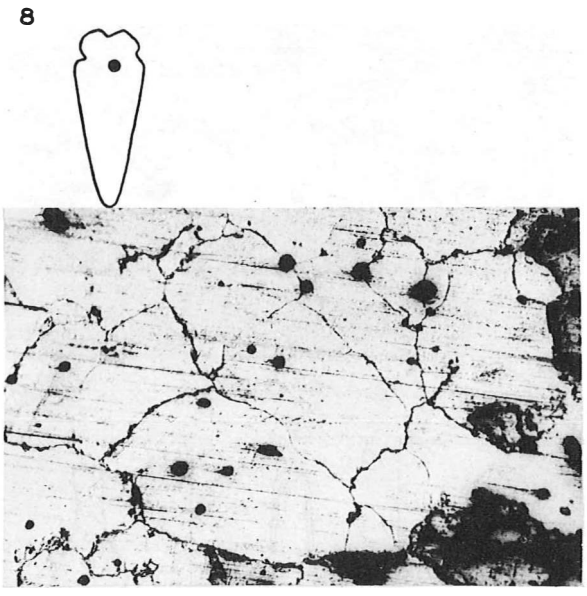




6c 160 ×

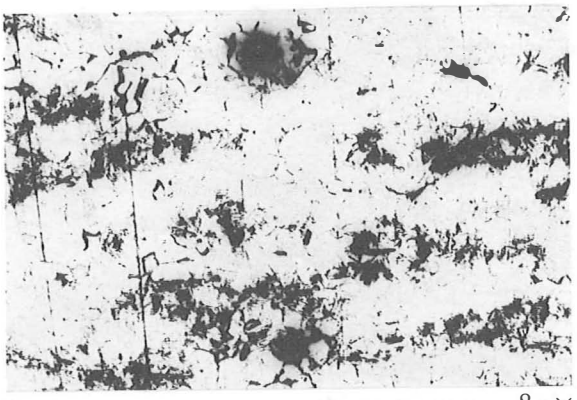


7 dendritic structure 80 ×



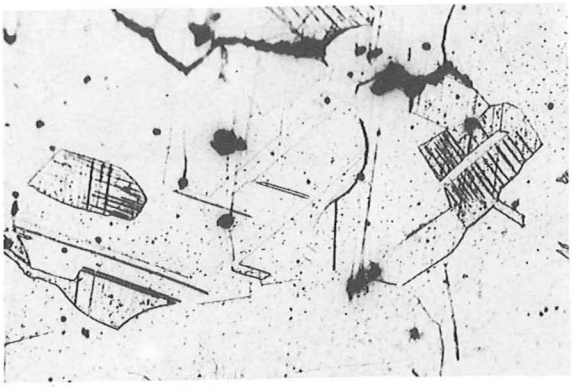
8 160 ×

Fig. 41.

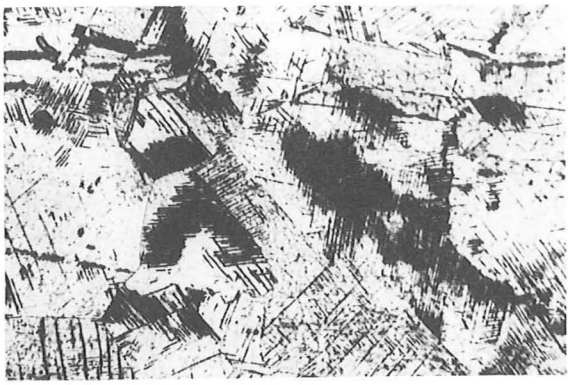


9 80 ×

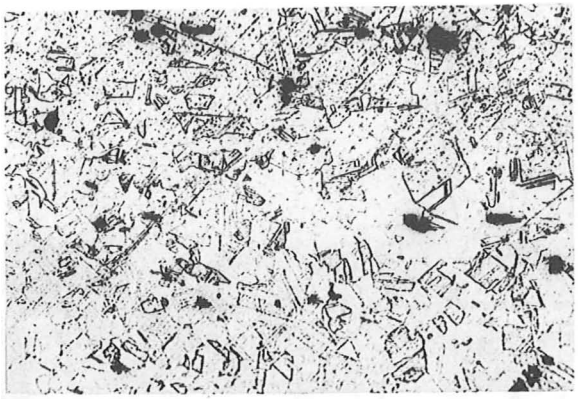
10 160 ×



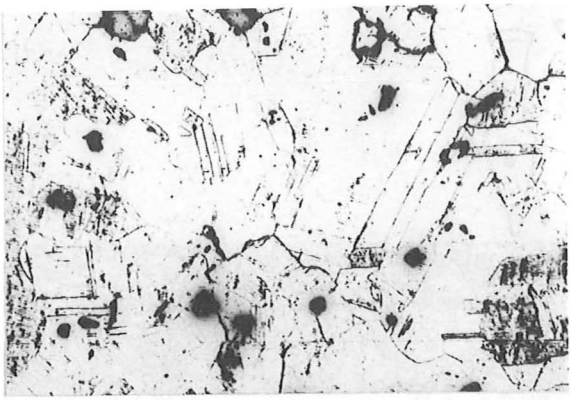
11 160 ×



12 160 ×



13 160 ×



14 160 ×

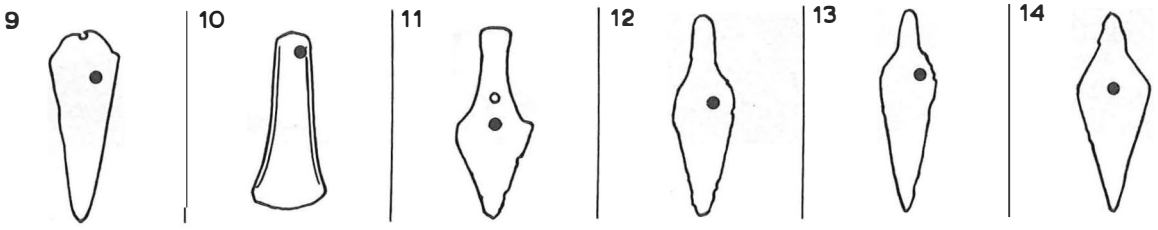
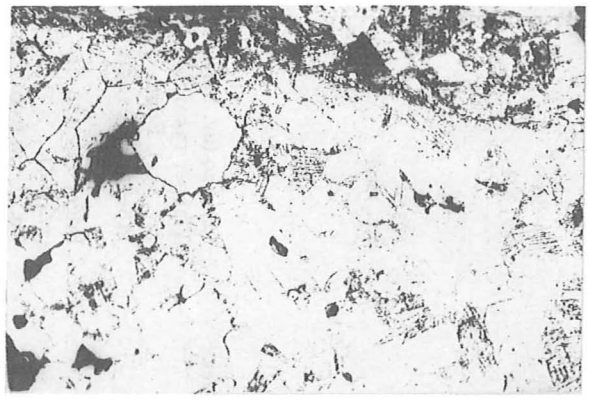
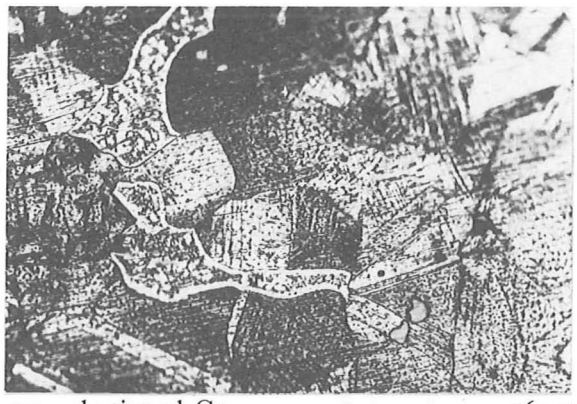


Fig. 42.

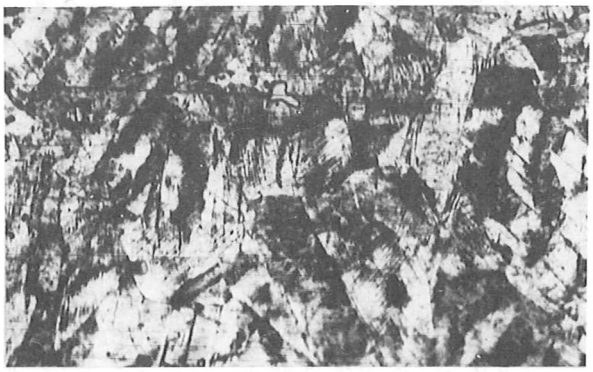


15 $\alpha + \delta\,\alpha$ 400 ×



15 de-tinned Cu 160 ×

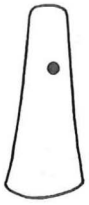
15

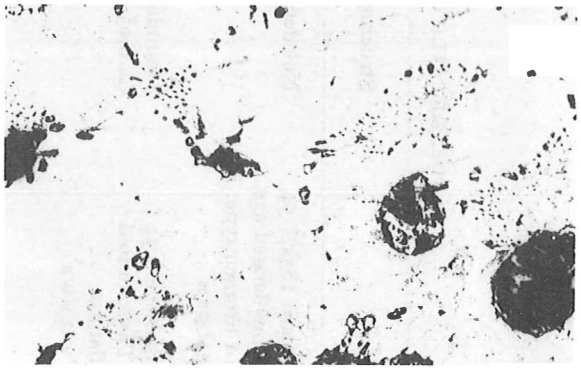


16 160 ×

16

17





17 160 ×

Fig. 43.

TABLE. DETAILS OF OBJECTS EXAMINED PARALLEL TO SURFACE (//) AND IN SECTION (⊥)

Object	Structure //	Structure ⊥	Inclusions	Hardness Hv (// surface)	Hardness Hv (section)
1. Assen 1855/I 54 Low-flanged axe of Emmen type: EMMEN	Not determined	Granular (grain size 0.05–0.1 mm) Segregation bands Side: slip bands	Much; coarse	91	79–85 (av. 82) Side: 93–97 (Av. 94)
2. Barneveld 52 Thick-butted flat axe 'VELUWE'	Granular; twinning (d. 0.05–0.1 mm)	Fine granular structure, twinning (d. 0.01–0.05 mm), segregation bands spherical precipitation Edge: elongated grains, segregation bands converging towards edge.	Much; coarse	Not det.	82–89 (av. 86) Edge: 95–99 (av. 97)
3. RMOL e. 1940/1.107 Riveted knife DRIE	Granular; twinning (d. 0.05–0.08 mm)	Granular, twinning (d. 0.04–0.1 mm). Segregation. Edges of grains not always sharp.	Coarse, somewhat elongated	96	80–89 (av. 85)
4. RMOL e. 1945/8.17 Tanged knife VAASSEN	Indeterminate. Traces of slip bands	Fine granular; twinning (d. 0.02–0 05 mm) Segregation (bands parallel even at point) Edge of grains not always sharp	Much, fine, rather elongated	111	103–4 (av. 104)
5 Assen 1872/I 15 Low-flanged axe of Emmen type GIETEN	Granular; little twinning (d. 0.1–0.2 mm)	Granular; little twinning (d. 0.03–0.1 mm). Flange: slip bands	Little, elongated	Not det.	127–129 (av. 128) Flange: 135–172 (av. 151). Edge: 118–130 (av. 125)
6. Assen 1929/IX.1 Tanged knife EXLOO	Hardly perceptible; presumably fine granular structure; traces of slip bands	General picture: no sample. Presumably recrystallized structure. Slip bands increase strongly towards the edge	Predominantly fine, elongated	119	Edge; 153–172 (av. 164). Ca. $^1/_2$ cm from cutting edge; 144–150 (av. 147)

Riveted knife BARGEROOSTERVELD		
8. RMOL RW 2 Halberd WAGENINGEN	Coarse granular (d. c. 0.15 mm)	110
9. RMOL RW 3 Riveted knife WAGENINGEN	Granular (d. c. 0.05 mm)	127
10. Assen 1921/XII.12 Low-flanged axe of Emmen type VALTHERSPAAN	Granular (d. c. 0.1 mm)	111
11. RMOL e. 1936/1.91 Tanged knife LETTENSE BERG	Granular; twinning (d. c. 0.08 mm)	109
12. RMOL e. 1936/1.3 Tanged knife LUNTERSE HEIDE	Granular; twinning (d.c. 0.07 mm)	104
13. RMOL e. 1936/1.63 Tanged knife EDE	Fine granular; twinning (d.c. 0.015 mm)	98
14. RMOL e. 1929/3.18 Tanged knife STROEËRZAND	Granular; twinning (d. c. 0.05 mm)	107
15. RMOL e. 99/6.1 Low-flanged axe, Emmen type 'S-HEERENBERG	Fine granular; twinning (d. c. 0.02–0.05 mm); $\alpha + \delta$ eutectic present	112
16. RMOL RW 4 'Thin-butted faceted' flat axe WAGENINGEN	Granular; twinning (d. c. 0.08 mm)	118

APPENDIX III

NOTES ON THE CIRCUMSTANCES AND DOCUMENTATION OF THE FINDS

Associations of tanged knives in the Bellen Collection

Four of the copper knives from the Ede area (Appendix I, nos. 2, 4–5, 9) were excavated by the late Captain H. J. Bellen. When still in the possession of his extremely rich collection, Bellen wrote a preciese account of his excavations with descriptions of the finds. This report is preserved at the B.A.I., Groningen, along with a series of photographs of the objects, arranged according to the find groups. In 1936, the Bellen collection was purchased by the Rijksmuseum van Oudheden at Leiden. One finds repeatedly that the information contained in the Accessions Register of the Leiden museum is not in correspondence with the original Bellen manuscript. There is reason to believe that the original report is the more reliable source of information: whenever, in cases of ambiguity as to which find group an object belongs, these objects still bear the code-numbers of Bellen, these numbers confirm the correctness of the Bellen ms., which always refers to these code-numbers (no mention being made of these numbers in the Leiden museum register). Shortly before his death in 1961, Captain Bellen presented the "Gelderse Archaeologische Stichting" at Arnhem with his diaries of the period of his excavations on the Veluwe (1923–1931). The notes in this diary generally confirm the correctness of the Bellen ms. As to the find groups relevant to this paper, the following should be mentioned:

1. *Grave find Ede, „de Kweekerij"* (Fig. 3; App. I no. 4).
The knife was excavated by Bellen (30–V–1924) from a barrow and published in *Revue Anthropologique*, 1925. In the vicinity of the knife, fragments of an early PF Beaker (type 1*a*) had also been found. From the Bellen ms. and the diary we learn that in 1929 the barrow was heavily damaged by military activities, after which occasion "an S-profiled Bell Beaker" was excavated by children living in the vicinity. Upon investigation (6–XI–1929) Bellen believed that this Bell Beaker had been lying underneath the knife, and could establish that both had been contained within a ring-shaped colour-trace of 4 m. diameter, within which had also been found the fragmentary PF Beaker (Leiden, e. 1936/1.62). Presumably Bell Beaker and knife were the grave goods of a secondary interment, which had destroyed a primary PF Beaker grave. Only recently, Modderman (1962–63, p. 20) was able to identify a Beaker of which a cast was made in the Leiden museum in 1943 (e. 1943/1.1), as the "S-profiled Bell Beaker" acquired by the children of the neighbourhood. This identification is confirmed by an entry in the Bellen diary (24–X–1929).

2. *Grave find from the Ginkelse Heide, gem. Ede* (Fig. 4; App. I no. 9).
On 19–VIII–1927 Captain Bellen found at a depth of 0.90 m., just underneath the top of a barrow, an undamaged "slender S-shaped Bell Beaker" standing in oblique position.

Immediately south of the Beaker six arrowheads were found: three of triangular shape with slightly convex sides (Fig. 4, nos. 4–5, = Bellen ms. T, S; his U now missing) and three barbed-and-tanged examples (Fig. 4, nos. 6–7, = Bellen ms. B? and X; his C now missing). With these arrowheads occurred "a number of more or less worked pieces of flint" (which almost certainly comprise the strike-a-lights and flakes Fig. 4, nos. 9–17), a copper knife, and the four-holed arched wristguard (of a similar type of stone as those described by Bursch, 1933, p. 47, as being probably of *Pisolithtuff*). Immediately adjoining these finds to the south-

west a concentration of cremated bones was found, which according to Prof. H. F. Nierstrasz of Utrecht University were from a grown-up and an infant of the age of c. 35 and c. 3 years respectively. With these cremated bones a seventh flint arrowhead of barbed-and-tanged type was found (Fig. 4, no. 8, = Bellen ms. D), which is burnt. No soil colour-traces were observed. This account, composed after the Bellen ms., strongly suggests that we have to do with one of the few known Bell Beaker cremation graves in the Netherlands (*cf.* van der Waals, 1964a)

In the Leiden museum, the finds from this barrow are accessioned as no. e 1936/1.1–23. No. 18–21 are Beaker sherds, a piece of stone, and a fragment of iron which according to the Bellen ms. were found in different parts of the barrow. The identification of the Beaker (no. 1), the wrist-guard (no. 2), and of four arrowheads (nos. 4–5, 7–8) is not problematical. The arrowhead indicated by Bellen as B and described as barbed-and-tanged, but not figuring on his photographs, may well be the arrowhead accessioned in Leiden as no. 6. The arrowheads figuring in the Bellen ms. and on the photographs as C and U are not accessioned in Leiden with this find group; on Fig. 4 they are drawn in outline after the photograph. The two strike-a-lights, accessioned in Leiden as no. 9–10, are the pieces described by Bellen as F–G, and the flakes accessioned as nos. 11–17 are no doubt identical with the Bellen flakes J–N, P–Q, and R (one piece apparently missing in Leiden). Strike-a-lights and flakes almost certainly represent the worked pieces of flint mentioned by the ms. as part of the grave group, but this is not stated for each of them individually in the description of the finds in the ms. As we have seen already, and as was realized by Prof. Glasbergen when studying the Bellen ms. in 1954, the knife which in the Leiden museum is accessioned as no. 3 with this find, does not belong to this find; there can be no doubt that this knife formed part of the Lunterse Heide grave find (see below). The knife described by the Bellen ms. as belonging to the Ginkelse Heide grave find is not in the Leiden museum. According to the original photographs it was a small knife of c. 9.5 cm. length with hammered-up flanges; on Fig. 4 and 10 it is drawn in outline after the photograph. What happened to the knife is unknown. When interrogated by the second of us shortly before his death in 1961, Captain Bellen could not offer any suggestion as to its fate.

3. *Grave group from the Lunterse Heide, gem. Ede* (Fig. 7, App. I no. 5).
According to his report, Bellen found (on 8–XII–1928) c. 1 m. southeast of the top of a barrow, at a depth of c. 0.40 m. below the surface and lying closely together, the copper knife, two flint arrowheads and the two wristguards (the fracture of the fragmentary example looks recent, but it is described already by Bellen as being only half a wristguard). C. 1.50 m. south of the top (*i.e.* at a distance of c. 1 m. from the other finds), he found, at a depth of only 0.10 m. below the surface, the (rim of the upright standing) Bell Beaker of Veluwe type. Accordingly there can be doubt as to the association of this Beaker with the other objects. However, bearing in mind that more often Bell Beaker graves are situated eccentrically in the tumulus, and that the seeming difference in depth can be accounted for by the greater distance to the top of the barrow and by the fact that the Beaker was standing upright, there is to our mind a fair chance that Beaker and other objects are from the same grave: the Beaker could have stood at the bottom end of the grave, the other objects almost certainly lying near the head of the deceased. As to the finds belonging to this grave group, the two wristguards, the coarse flint arrowhead, and the Beaker offer no problems, as they are mentioned both by the Bellen ms. and the Leiden register as belonging together. On the other hand, no copper knife is mentioned in the Leiden register as forming part of this find. But from the Bellen ms. it is clear that the copper knife which in Leiden is inventorized with the finds from the Ginkelse Heide tumulus (see above) in reality belongs to this grave group, as has been pointed out by Prof. Glasbergen (oral communication). Furthermore, a hollow-based flint arrowhead (indicated on Fig. 7 in outline only), mentioned by Bellen and figuring on his photograph of the find group, is missing in Leiden. Three arrowheads which are inventorized in Leiden with this find (e 1936/1. 53–55; not pictured on our Fig. 7) are mentioned in the Bellen ms. as forming part of another grave group, excavated by Bellen on 12–X–1927.

4. *Grave find from the Lettense Berg, gem. Ede* (Fig. 10; App. I no. 2).
On 5–IX–1929 Captain Bellen uncovered at a depth of c. 1.70 m. below the top of a barrow, a copper knife with one rivet in a hole in the tang. At a distance of 0.30 m. north of the knife, and on the same level, two V-bored amber buttons were found, which no doubt belong to the same grave find. The finds accessioned in the Leiden museum as from the Lettense Berg (e 1936/1.91–95) are identical to those described by the Bellen ms.; the only descrepancy is that the Leiden register makes mention of fragments of at least one more V-bored button. The rivet, which is mentioned in the Leiden register, is at present not with the knife and could not therefore, be drawn.

Associations of tanged knives in the Westendorp Collection

In the same years that Captain Bellen dug out his rich collection from barrows in the Ede area, Police Ajdutant H. Westendorp, then stationed at Nieuw-Millingen, was active more to the north in the vicinity of the Uddelermeer. His collection, which rivals the Bellen collection in its wealth of grave goods from Beaker barrows, was acquired by the Rijksmuseum van Oudheden at Leiden in March, 1929. Mr. Westendorp did not keep a diary of his findings as did Captain Bellen, but he made careful observations, and thanks to his excellent memory he could repeatedly provide valuable information as to the find circumstances and the locations of the grave finds he excavated. Information given on different occasions concerning the same finds agreed, and there are no major discrepancies as to the associations between the information provided by Mr. Westendorp and the Leiden accessions register. The following was recorded by one of us (J. D. v. d. W.) when visiting Mr. Westendorp (now at Elspeet) on 1 November 1966.

5. *Grave find from the Stroeërzand, gem. Barneveld, ,,Korte Struiken''* (Fig. 10; App. 1: 3; II: 14). Some time between 1926 and 1929 Mr. Westendorp excavated one of a group of nine barrows near ,,de Konijnenkolken'' in the ,,Korte Struiken'' of the Stroeërzand. The centre of the barrow proved to have been completely disturbed owing to excavations in these barrows in the 1870's by Mr. W. Pleyte (then curator of the Leiden museum) and Burgomaster C. A. Nairac of Barneveld, and owing to the fact that still later a heavy pole bearing a sign reserving the hunting privileges of King Willem III in the area had been planted deep in the mound. Slightly underneath a tile, which had supported this pole, Mr. Westendorp found, lying immediately together, a copper tanged knife and a 4-holed curved wristguard (according to Bursch, 1933, p. 85, of *Pisolithtuff*). These finds were accessioned in Leiden as e 1929/3. 18–19. As e 1929/3.17 was accessioned with these finds a Bell Beaker of Veluwe type (2^{1e}; Bursch, 1933, Taf. III: 2). But according to Mr. Westendorp this Beaker was found at some horizontal distance from wristguard and knife, and at a much higher level (*c.* 0.50 m.), just outside the disturbed central part of the barrow. Thus Mr. Westendorp is probably right in supposing that this Beaker belongs to a later interment in the same barrow. This is not clear from references to this grave group in the literature (Bursch, 1933, p. 85, Tabelle Veluwe no. 1, Taf. II: 2; VI: 5, 44; Modderman, 1962–63, p. 17).

6. *Grave find from Nieuw-Millingen, gem. Apeldoorn, near ,,de Mottenkuil''* (Fig. 8; App. I: 10). About 1930 Mr. J. Bezaan, a collector from Putten, had dug a trench from the western side in a barrow at some distance to the south of ,,de Mottenkuil'', and had uncovered a ''Beaker and a flint knife''. Subsequently, Mr. Westendorp dug a trench from the opposite side into the same barrow, and hit upon a small, much corroded copper knife, a flint barbed and tanged arrowhead, a flint slug-knife and a lunate amber pendant, all lying closely together. Immedia-

tely surrounding these finds, on the same level, he found the scattered sherds of a Bell Beaker of Veluwe type 2^{Ie}), which must have been deposited in fragments. There is no reason to doubt that these finds represent one grave deposit.

We have not yet been able to identify the Beaker and the flint knife excavated by Mr. Bezaan. One might suppose that Mr. Bezaan had excavated a primary grave with a PF Beaker (which often are associated with flint knives) and that the Bell Beaker grave, the contents of which are still in the possession of Mr. Westendorp, represents a secondary interment.

Bell Beaker associated finds excavated by Dr. F. C. Bursch

7. *Grave find from Vaassen, gem. Epe, tumulus III* (Fig. 6; App. I: 1; II: 4).
In June, 1941, Dr. F. C. Bursch, director of the then existing "Rijksbureau voor Oudheidkundig Bodemonderzoek" at Leiden, excavated a group of three barrows near the gravel road from Vaassen to Elspeet (Veluwe). The remarkable finds from these excavations were accessioned in the Rijksmuseum van Oudheden at Leiden in 1945; the plans are also kept in the Leiden museum. It is impossible to give a complete discussion of the complicated stratigraphy (by no means clear from the plans) of these barrows, or even of the one barrow which concerns us here; this must await final publication of these excavations as a whole. Suffice it here that the grave find relevant in the present context was in all probability from a deep secondary grave, which had destroyed a primary PF Beaker grave, of which the contents were found at a higher level in the barrow (on the talud of the primary barrow, underneath the capping of the second phase of construction?). In this secondary grave were found, lying closely together on the same level of 1.84–1.90 m. below the centre-top of the barrow, the finds pictured on our Fig. 6. These finds are accessioned in Leiden as nos. e 1945/8. 15–17, and comprise: (15) the Bell Beaker of Veluwe type (2^{Id}), (16) the box-shaped/quadrangular V-bored amber button and the central part of a lunula-shaped perforated amber pendant, and (17) the remnant of a copper knife. A number of small amber fragments from the same grave are preserved in a small box; in part these may have belonged to the amber pendant. As these finds are also mentioned on the plan of the barrow as belonging to this grave, one need not doubt as to their belonging together as finds from one and the same grave.

8. *Grave find from "de Valk", Lunteren, gem. Ede* (Fig. 11–13, 44–46, App. I: 12).
In 1939, H. Ruyter brought to the light a Bell Beaker and some associated finds, while scavenging in the southern most of two barrows on the estate "de Valk" near Lunteren, gem. Ede (Veluwe; Fig. 44). Having produced these genuine finds, he also 'found' in the barrow a number of faked pots of a type well known from many a collection on the Veluwe the owner of which purchased finds from H. Ruyter. Upon being informed about these doubtful finds, Dr. F. C. Bursch, then keeper at the Rijksmuseum van Oudheden at Leiden, undertook the regular excavation of the barrow (August, 1939), eventually uncovering some highly remarkable genuine grave goods, among which were three "cushion stones" and a whetstone, in association with a second Bell Beaker of Veluwe type.

The finds and the records were preserved in the museum at Leiden, but owing to war circumstances the excavation and the finds were never published. One Beaker was sent back to Lunteren, where it was destroyed in the war. In the Leiden museum, the finds were not numbered or entered in the Accessions Register, and of the records of the excavation only the plan and some sections survive, with photographs of the objects uncovered. Photographs and written description of the excavation are lacking. In 1958, one of us (J. D. v. d. W.) with the never-failing help of Prof. Dr. H. Brunsting, traced all but one of the objects in the museum,

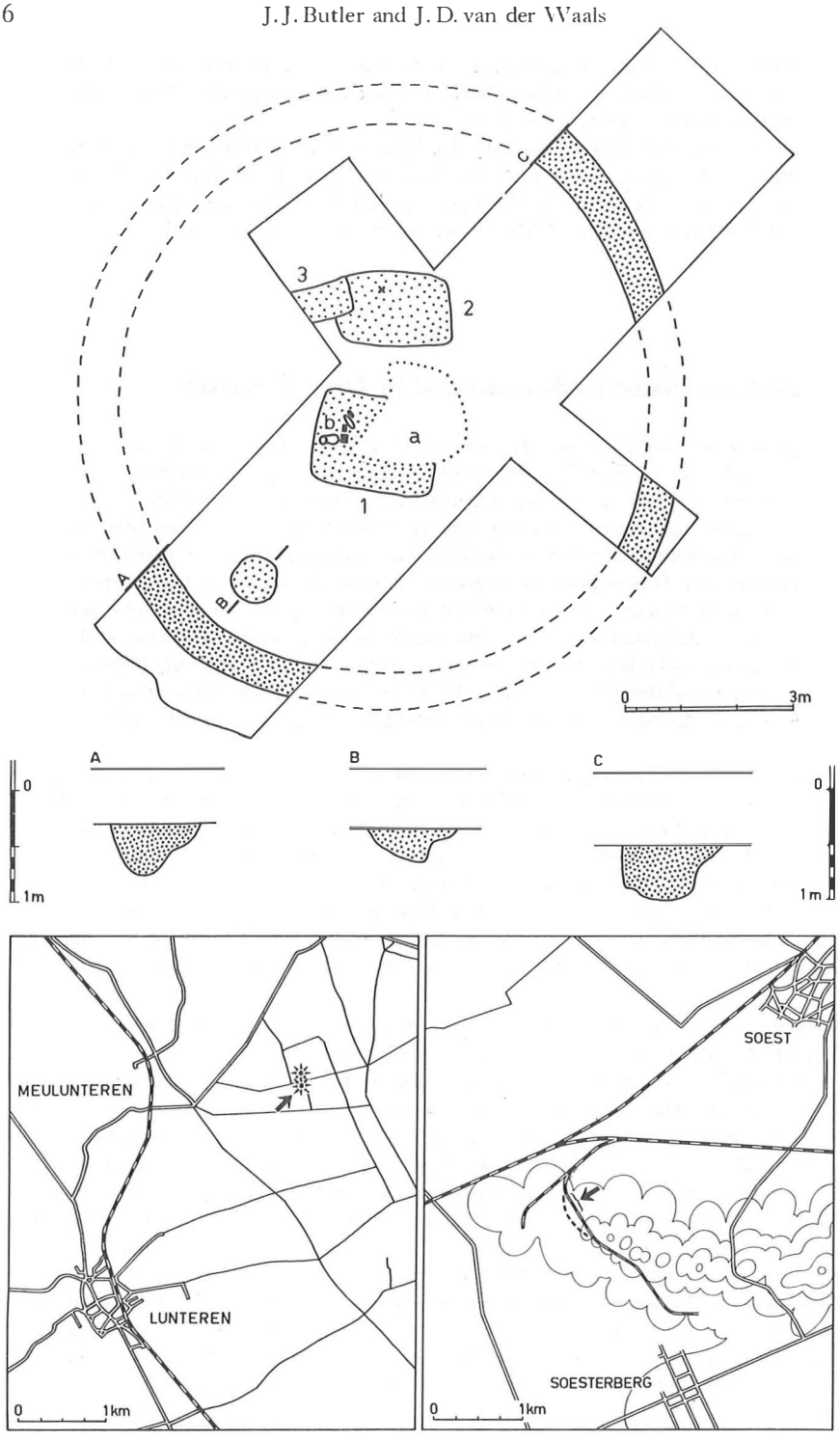


Fig. 44. Lunteren (Veluwe), Bell Beaker tumulus. Plan (above, after field drawing by Bursch) and location map (below left); Soesterberg (Utrecht), location map (below right).

and they were then accessioned. With the help of the surviving records and a newspaper article (from the *Rotterdamsche Courant* for 19 August 1939) the following account can be given.

From the plan (Fig. 44) it is clear that we are dealing with a ringditch barrow, a type of barrow frequently associated with the Bell Beaker Culture in the Centre of the Netherlands. Apart from the graves to be discussed hereafter, there was found eccentrically under the south-western part of the barrow, a round shallow pit possibly of a ritual character and belonging to a group of phenomena repeatedly met with in this country. On the plan, three grave pits of sub-rectangular shape can be seen; these are also mentioned in the newspaper account. The smallest grave intersects one of the larger pits. The former is certainly a secondary grave, and as it did not yield grave goods, it can be left out of consideration for the present purpose.

Of the remaining two grave pits, one is of remarkable width, and could possibly represent a double grave, a suggestion by Dr. Bursch which is reinforced by the fact that two Beakers, each apparently with its concentration of associated finds, were recovered from this grave.

As to the stratigraphical relation of this large grave to the second grave, no direct evidence is available. As both graves are oriented parallel in E–W direction and do not intersect, and since neither of these graves is quite at the centre of the barrow (if the centre of the ringditch may be taken to represent the centre of the barrow), one might be tempted to conclude that both graves, and therewith all finds uncovered, represent the primary phase of the barrow and thereby are contemporary. It must, however, not be overlooked that the larger grave is essentially closer to the centre, and was also observed to be significantly deeper. Therefore, it is more likely that the larger grave is the slightly eccentric primary grave of the barrow, and that the smaller grave only belongs to a secondary phase. This second interment could have taken place only shortly after the first, when the exact position of the first grave was still known. Typologically the finds by no means suggest that much time could have past between the two interments. It is in any case certain that all finds from the larger grave pit are contemporary and must belong to the initial phase of the barrow, whereas those from the second grave pit probably date to a secondary phase.

For the identification of the finds, the following indications are available: *a*. the marginal notes on the plan, which only mention part of the finds; *b*. information in the newspaper article; *c*. the arrangement of the smaller objects in two groups on the original photographs of the objects found in the Leiden museum (Fig. 45).

From the newspaper article and the notes on the plan we learn that H. Ruyter found a Bell Beaker of Veluwe type in fragments, a copper awl, two flint arrowheads, a bracer, and a small flint axe. The Beaker is the one now in the Leiden museum (Fig. 13*a*); the smaller objects are almost certainly represented on one of the Leiden photographs, together with four arrowheads found subsequently by Dr. Bursch (Fig. 45, top). These finds represent the first concentration in the large primary grave; they must have been found in the part of this grave indicated on the plan as "recently disturbed", the disturbance evidently representing de Ruyter's activities.

The finds that Dr. Bursch recovered from the part of the same primary grave not touched by H. Ruyter, are also mentioned in the newspaper article, where they, moreover, appear to be illustrated. They comprise a second Bell Beaker of Veluwe type (the one now lost, Fig. 37*d*), four flint arrowheads (according to the newspaper photo; the text mentions five exx.), the three cushion stones and the whetstone. The arrowheads figure in all probability on the Leiden photograph together with those found by Ruyter (Fig. 45, top). This photograph thus appears to represent the smaller objects from the large grave. The newspaper photograph is not sufficiently clear to allow for the identification of the four arrowheads found by Bursch as part of the second concentration, but they could be those figuring in the bottom row of the Leiden photograph.

In the smaller grave pit, Dr. Bursch found, according to the newspaper-account, seven flint arrowheads, a small flint axe, and a bracer. These objects are clearly those pictured on the

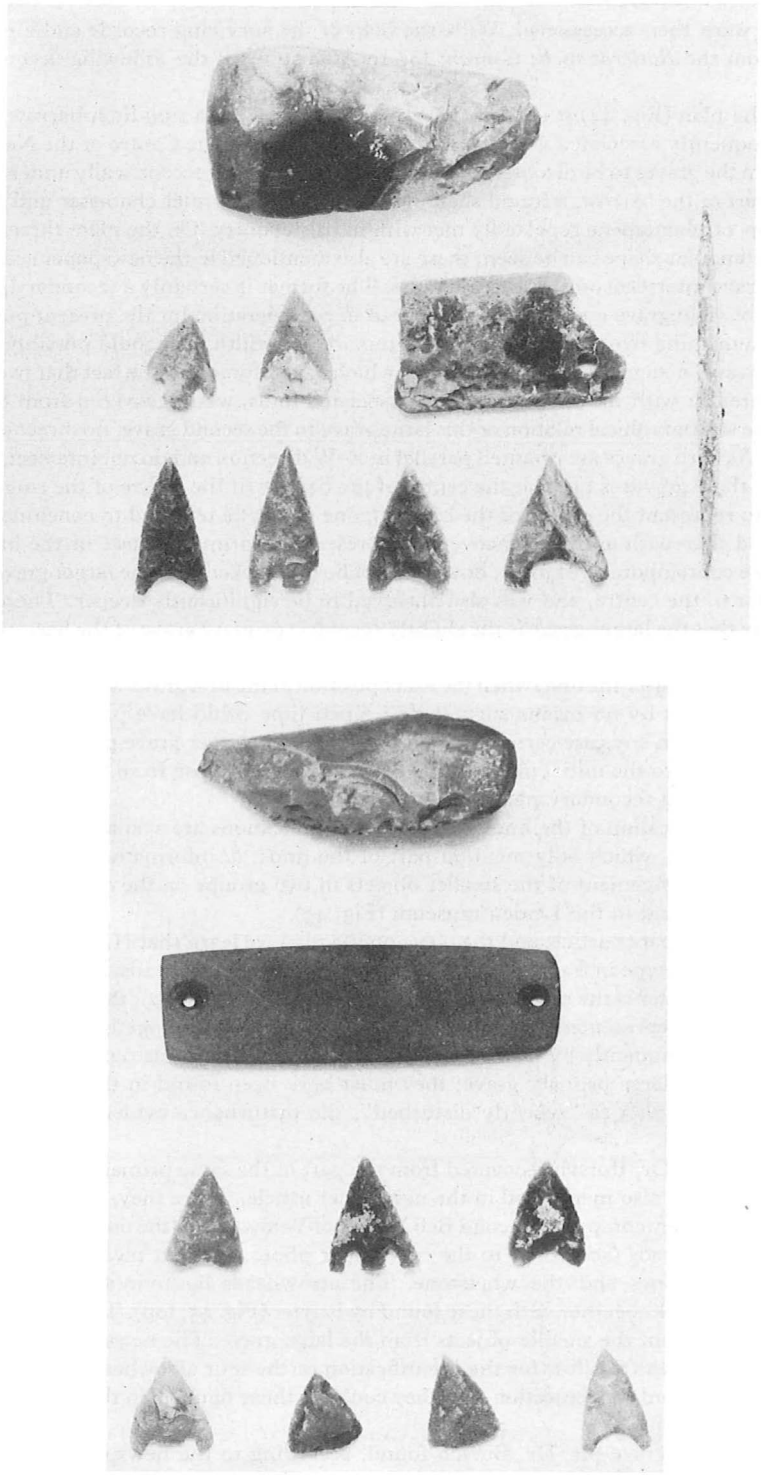


Fig. 45. Lunteren (Veluwe), Bell Beaker tumulus. Photographs of 1939 in the Rijksmuseum van Oudheden at Leiden, showing the smaller objects from in all probability grave 1 (top) and grave 2 (bottom).

second Leiden photograph (Fig. 45, bottom). The finds, accessioned in the Leiden museum under nos. e 1958/6. 1–22, comprise:

Contents of large primary grave (Figs. 11–13, 45 top):

5. Bell Beaker of Veluwe type (2^{Id}) with "3"-shaped profile, slightly concave base and internally bevelled rim. Height slightly greater than rim-diam. Surface carefully smoothed and decorated with impressions of a short and narrow delicately dentated and a longer and broader, only slightly dentated spatula. Contracted narrow zones of decoration around neck (five, of which two filled with vertical impressions, two with two- and threefold horizontal zigzag-lines, and one with horizontal herringbone impressions) and body (four: two with four- and threefold horizontal zigzag-lines, two with vertical lines) and, in much degenerated form, near the base (two: with vertical lines). On upper and lower part of body large metopes with bordering vertical and horizontal fringes or zigzag-lines but otherwise undecorated, each time separated by three vertical strips with the same decoration as the horizontal zones. Height max. 18.1 cm., diam. rim 17.0–17.6 cm. Restored from fragments.

6. Copper awl of rectangular cross-section, gradually tapering towards both pointed ends. (App. I: 12). Length 7.8 cm., thickness max. 0.32 cm., width max. 0.56 cm.

7. Roughly flaked and only partially polished axe of speckled light grey opaque flint, of irregular sub-triangular cross-section. Length 7.4 cm., max. thickness 2.13 cm., width cutting edge 3.05 cm.

8. The half of an originally four-holed rectangular bracer of plano-convex cross-section of much corroded yellowish stone (Sangmeister, 1964, form 1 with four holes). Length of fragment 5.08 cm., width 2.87 cm., thickness 0.79 cm.

9. Irregular triangular arrowhead with straight base and one curved edge of translucent yellowish white flint. Height 2.36 cm.

14. Irregular triangular arrowhead with small barbs and heavy tang of opaque yellowish white fint. Height 2.07 cm.

The numbers e 1958/6. 5–8 belong to the first concentration, uncovered by H. Ruyter. The arrowheads e 1958/6. 9 and 14 in all probability also belong to this concentration.

(Now lost) Bell Beaker of Veluwe type with "3"-shaped profile and internally bevelled rim; height slightly greater than rim-diam. Decoration applied with dentated spatula. Contracted decorated zones around the neck (three: one with standing filled triangles and two with fourfold horizontal zigzag-lines), just underneath the neck constriction (one, with standing filled triangles), around the belly (two, with fourfold horizontal zigzaglines) and, in much degenerated form, near the base (two, cross-wise diagonally hatched). Upper and lower part of body undecorated but for the vertical fringes attached to the bordering decorated zones. Dimensions unknown.

1. Large cushion-stone; honey-coloured block mainly rectangular in shape of *Zement-Quartzit* (in all probability made from an erratic stone). One main face consisting of the mostly irregular natural surface, except for a highly polished strip along one edge which also is more

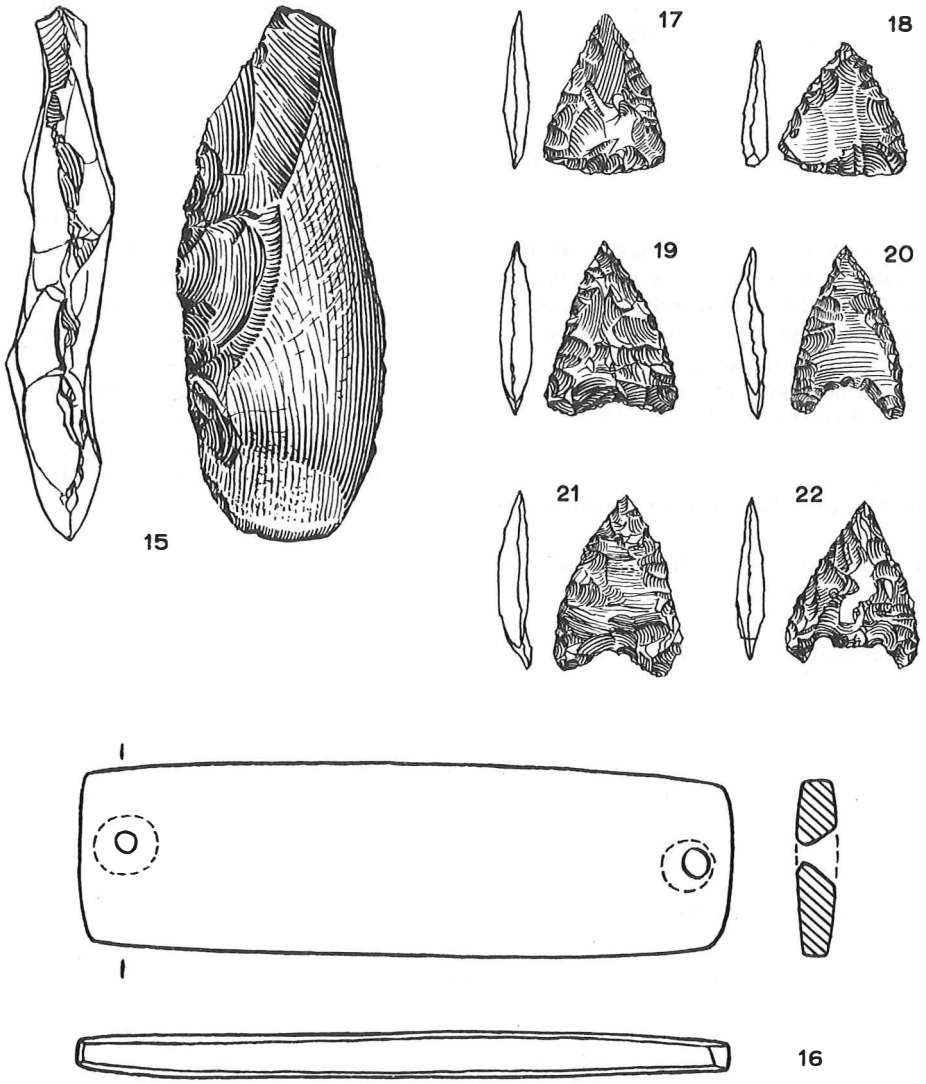


Fig. 46. Lunteren (Veluwe), Bell Beaker tumulus. The contents of grave 2 (App. III: 8 Drawing G. de Weerd. Scale 1: 1).

reddish in colour. The opposite face polished with an extremely broad and shallow groove across the centre. Of the other four faces, one has a rough pecked surface, the others being polished (one slightly concave with respect to its long axis, the others slightly convex). Dimensions: 12–13 × 14–14.5 × 7–8 cm. Weight 3480 gr.

2. Small cushion-stone; block of the same stone and type as the preceding one, but smaller. The six faces slightly convex and all polished. Dim.: 9.5 × 8 × 4.5 cm. Weight 750 gr.

3. Stone-hammer; elongated pebble of the same type of stone as the preceding ones, but slightly lighter in colour and of less regular shape, with irregular rectangular cross-section. The smaller subrectangular faces at the ends carefully polished to slightly convex surfaces, two of the other faces partly flattened and polished. The other faces represent the natural surface. Dimensions ca 9.5 × 4.7 × 3.5 cm. Weight 290 gr.

4. Whetstone of bluish fine-grained micaceous quartzite, flat and roughly rectangular in shape, in all probability an erratic stone. One face flat but rough, apparently a natural fracture surface. The other face has in general a smoothened (water-worn?) surface and rounded-off edges. The central portion is polished, though not so much as to create a really smooth and shiny surface. There are shallow slightly arc-shaped grooves running slightly diagonally cross-wise across the face. These are deepest near the edges.

10–12. Three triangular arrowheads with barbs and hollow base of grey and grey-brown flint of greater and less transparancy, all showing fine surface flaking. No. 10 of slender proportions, no. 12 broad, no. 11 intermediate. Resp. heights 2.90, 2.70 and 2.83 cm.

13. Slender triangular arrowhead of opaque grey flint with barbs (one of which is now missing) and tang; ends of barb and tang in one line, edges convex near the base.
Fine and regular surface flaking. Height 3.07 cm.

The lost Bell Beaker and the numbers e 1958/6. 1–4 belong with four arrowheads, in all probability the numbers e 1958/6. 10–13, to the second concentration, uncovered by Dr. F. C. Bursch.

Contents of secondary grave, uncovered by Dr. F. C. Bursch (Fig. 45 bottom, 46):

15. Chisel consisting of a heavy oblong flake of opaque grey flint with part of the cortex preserved on one surface. One of the edges retouched from both sides in order to obtain a teardropshaped implement; the broad end ground on both faces to form a cutting edge. Length 6.98 cm, width cutting edge 1.40 cm., max. thickness 1.19 cm.

16. Narrow rectangular bracer with two holes (one of which hour-glass shaped) of brown-grey stone with rectangular cross-section. The main faces and the sides slightly convex in all directions (Sangmeister, 1964, form 1 with two holes). Length 8.63 cm., width 2.55 cm., thickness 0.60 cm.

17–18. Two triangular arrowheads of resp. grey opaque and yellowish-white translucent flint. All edges slightly convex. The base of no. 17 c. 4/5th the length of the sides; no. 18 equilateral. The faces only partially flaked, near the edges. Height resp. 2.05 and 1.73 cm.

19–21. Three triangular arrowheads with barbs and hollow base, resp. of opaque grey flint, of slightly translucent yellowish-white flint, and of translucent grey flint. The faces of nos. 20–21 only partially flaked, near the adges; no. 19 flaked all over the surface. Height resp. 2.25 cm., 2.30 cm., and 2.36 cm.

22. Triangular arrowhead with barbs and tang of partially translucent yellow-white flint. Surface almost entirely flaked. Height 2.13 cm.

(now missing) According to the photograph (Pl. XV bottom, top row, in the middle) triangular arrowhead with barbs and tang, the ends of which are on one straight line.

Finds of Cushion Stones (see also no. 5, pp. 125 ff.)

9. *Grave find from the military aerodrome of Soesterberg, gem. Soest* (Figs. 14–15, 44).
In July, 1942, Mr. Kr. Drenth handed to the museum of the Utrecht Society of Arts and Sciences a remarkable find, including a cushion-stone, two other stone implements, and a bracer, which he had found earlier that summer when employed in the construction of a railway track for the *Luftwaffe* at the military airfield of Soesterberg, gemeente Soest, province of Utrecht. As the find had to be concealed from the German authorities, and as the airfield was out of bound, it was not possible at the time to carry out an investigation as to the character and exact location of the findspot. A visit was planned for after the war, but when the war was over traces of Mr. Drenth had been lost and no more investigations were carried out. According to the statements of Mr. Drenth recorded by the museum authorites when the find was purchased, a large stone (diam. ca 1 m.) was found underneath a sandhill of 10 to 12 m. in height (possibly a dune of recent formation, as there are many in this area) on the level of the surrounding terrain. At a depth of 1.25 m. underneath this stone the objects were found lying in the sand. According to the records, these objects are those inventorized under the numbers 7505–7509 (*vide infra*), no mention being made of the two boars' tusks which according to the oral tradition in the museum should also belong to this find, and which bear in fact the numbers 7508*a–b*.

However, in connection with the present study, and thanks to the population registry office, it proved possible to trace the whereabouts of Mr. Drenth, who was then interviewed by one of us (J. D. v. d. W., on 9 July, 1966). It thus became clear that Mr. Drenthhad been digging a deep hole at the side of the stone mentioned, in order to bury it as it formed an obstacle for the railroad, when he found the objects. It now also was possible to locate the findspot as indicated on Fig.44.

Comparison of the topographical maps of immediate pre- and post-war date, based on surveys of 1940 and 1948 respectively, shows that a bend has been cut off in an existing railroad track. This is evidently the work which was carried out in 1942. An aerial photograph made early in 1945 by an allied aircraft shows the new track, but the original course is still clearly visible. According to Mr. Drenth, the objects were found just past the second fork in the beginning of the straight section which runs towards the south-east. Accordingly, the grave must have been situated exactly on the crest of the Soesterberg sand ridge, but at its western end, where it slopes downward toward the northwest. This ridge, which stretches in a slight arc for over 7 km. from east to west, was crowned in its central part by a group of Neolithic to Bronze Age barrows, in which excavations have been repeatedly conducted (lastly by Bursch, 1934); its eastern end is marked by the two barrows of the Gallows Mound of Amersfoort (*cf.* top. map, sheets 427–428, editions of 1897–1902).

Most important was Mr. Drenth's spontaneous communication that along with the objects recorded in the museum were found "many fragments of a pot, finely decorated with strokes and lines" – no doubt a Bell Beaker. Though Mr. Drenth stated definitely to have handed these fragments along with the other objects to the museum, no traces whatsoever of this pot have as yet been found in the museum or the museum records, and Prof. Dr. J. H. Jongkees states that no sherds accompanied the find when he first saw it, shortly after the find was turned in.

There can be little doubt that Mr. Drenth hit upon a Bell Beaker grave; whether a flatgrave or a grave under a tumulus can no longer be established. The finds comprise (Figs. 14–15):

(7505) Cushion-stone; rectangular block of quartzite, probably made from an erratic stone. The stone is layered parallel with the main faces. The faces of the block show different stages of working: one narrow side-face and one small end-face display a rough pecked surface, with only highly superficial traces of subsequent polishing; the other side- and end-face also show

pecking marks, but polished to a greater degree, and also shallow polishing grooves, best visibles near the edges, these grooves being slightly arc-shaped and transversal on the small endface and lenthwise on the narrow slightly convex side-face; the main faces are the most completely polished ones, one being practically flat, the other flat in the centre but convex along the edges. All corners and edges are slightly rounded by pecking. Dimensions: 14.25 × 10.35 × 7.50 cm. Weight 2470 gr.

(7506) Double-headed-Hammerstone of *Zement-Quartzit* or very dense quartzite of truncated conical shape, oval in cross-section, with a broad groove girding its sides for the fastening of a shaft. The sides of the stone shaped by pecking and superficial polishing. The top slightly convex completely smooth with rounded edges; the base, also with rounded edges, somewhat more convex with slight depressions, but also quite smooth. Height 9.8 cm., max. diam. 6.65–8.75 cm. Weight 930 gr.

(7507) Stone hammer; top half of a point-–butted axe of oval cross-section of extremely fine-grained dark sandstone with numerous mica and felspar fragments (graywacke), not made out of an erratic stone, shaped by pecking and, possibly subsequent polishing. The fracture flaked and rounded at the edges, apparently to afford a better grip for the hand. The top ground down to a small oval surface plane, extremely smooth. Height 8.25; max. diam. 5.85–3.9; diam. top 1–2 cm. Weight 250 gr.

(7508) Rough lump of granite, not showing any traces of human working, probably not belonging to the original deposit.
(7508*a*, *b*) A pair of boar's tusks without traces of working. Length 7.9 and 7.7 cm.

(7509) Now unfindable, but still seen about 1956–1957 by the second author and by Mr. J. A. Bakker, to whom we are very grateful for the sketch then made. Wristguard of irregular shape and rectangular cross-section, probably the larger fragment of an once narrow rectangular wrist-guard with four hourglass-shaped perforations (Sangmeister, 1964, form 1 with four holes), broken parallel to one of its diagonals, and then made up into a bracer of sub-triangular shape with one perforation near one end and three holes at the other end (the two original ones, plus a third hole near the edge). Length c. 9 cm.

(*Pro memoria*) Fragments of a "pot decorated with stripes and lines".

10. *Cushion stone from the Roekelse Bos near Roekel, gem. Ede* (Fig. 15–16. Leiden, Rijks museum van Oudheden R. I. 5–I. 41).
According to the records of the Leiden museum acquired for the museum in July, 1855, by Dr. L. J. F. Janssen and found at a depth of 2 feet under the surface. (*c.f.* Pleyte, 1889, p. 54, Pl. XIV: 3).

Small cushion stone: rectangular block of *Zement-Quartzit* of perfect regularity, all faces slightly convex, completely smoothly polished and of great evenness: the edges scarcely rounded. One of the end-faces only convex longitudonally but flat cross-wise, and polished to a shiny gloss.

Length 8.95 cm., width 6.9 cm., thickness 4.05 cm. Weight 500 gr.

11. *Cushion stone from Speulde, gem. Ermelo* (Figs. 15–16, Leiden, Rijksmuseum van Oudheden e 1940/1.51).
From the collection of the late J. Bezaan. No further information available.

Small cushion stone: sub-rectangular block of *Zement-Quartzit*, probably made from an erratic stone. One of the smaller side-faces entirely rounded, showing battering marks pointing to the use of the stone as a mallet-stone. One of the main faces chiefly flat, rounded only

near the edges, but uneven, only the projections of the stone having been ground down. The other main face convex, also showing to a lesser degree depressions which have not been ground out. The remaining three side-faces flat and smooth-polished, partly even glossy, though also showing some smaller depressions which have not been ground out.

Length 7.45 cm., width 6.4 cm., thickness 3.65 cm. Weight 310 gr.

The Wageningen hoard

12. *The Wageningen hoard* (Fig. 21, App. I: 21–28). The find circumstances are described in a letter of G.P.Versteegh dated Wageningen, 9 March 1841, to L.J.F.Janssen in the Rijksmuseum van Oudheden, Leiden, accompanied by drawings of all the objects. Versteegh writes that they were "found in a piece of heath ground, which lies at a half hour's distance northeast of this town (Wageningen), belonging to Mr.J.van Rijn, Alderman here, on the occasion of the trenching or draining of that piece of ground to the depth of one Dutch el (= 0.688 Meters-ed.) for the planting of oak trees; at approximately the half of that depth, and all lying close together". The date of the find is stated by Versteegh to be the beginning of the previous December, *i.e.* 1840.

This letter is preserved not in the RMO, but in the Janssen correspondence in the Manuscripts Room of the University Library, Leiden (reference B.P.L. 944 III/V–Z, in the file "Wageningen"). The same information was noted in the Leiden museum accessions register when the hoard was acquired by the museum in June 1841. But the museum cataloger failed to take over the phrase "all lying close together", which has occasionally given rise to needless uncertainty on this point. Further confusion has arisen from the coupling on one plate by Pleyte (1889, p.49, Pl.XI: 5–9) of the hoard with a beaker-like vessel, which was also found at Wageningen, but not at the same time or as part of the same find. This vessel does not seem to have reached the museum and its fate is unknown; in any case, it has nothing to do with the hoard.

Cadastral records show that Alderman Van Rijn owned a number of parcels of heath and woods northeast of Wageningen at the time; of these, two parcels lie at a distance from the town of c. 2.5 km., and could accordingly have been described as having been "half an hour" away; the other parcels are at a greater distance. It is likely, therefore, that the actual find-spot lies on one of these two parcels, both of which are shown as wooded on the 1: 50,000 topographical map of 1850, surveyed in 1847. The two parcels are some 300 m. distant from one another. The actual find-spot can, therefore, be approximately located.

APPENDIX IV

COPPERS USED FOR BELL BEAKER OBJECTS IN VARIOUS PROVINCES

(*cf.* Graphs, Figs. 26–36)

In order to determine whether the Dutch Bell Beaker objects could be imports from other Bell Beaker provinces, it was necessary to collate and compare all published spectrographic analyses pertaining to objects associated with the Bell Beaker culture. The list of Bell Beaker analysed objects in SAM I (p. 150) made a convenient starting-point; a few further examples were found in more recent publications. Reckoning all Beaker-type tanged knives as Bell Beaker objects, whether or not found in association, but counting objects of other types (awls, etc.) only if actually found in Bell Beaker closed finds, a total of 67 analyses were found to be available. A graph of the entire group of Bell Beaker objects demonstrated only extreme heterogeneity, and no point would be served by reproducing it. Grouping the objects according to province in which found gave, however, a useful basis for comparisons; despite the small numbers of objects represented in each province, reasonably homogeneous copper types could be recognized in Iberia-South France, Bohemia-Moravia-Austria, Ireland, and the Netherlands. In Germany, two quite distinct sub-groupings emerged; whilst England and Sardinia-Italy proved to have somwehat heterogeneous metal. The copper types used in the various regions are briefly characterized below. When larger numbers of analyses become available, the patterns will undoubtedly be somewhat changed; but it is perhaps useful to have an impression of the present state of knowledge.

Iberia–South France. Seven analyses; of which four or five fairly homogeneous (arsenical copper, with high to very high As). Deviants: JSS 783 has high Pb; JSS 492 has high Ag and Sb, low Pb. The metal is that of Waterbolk and Butler, 1965, Graph 4.

Bohemia–Moravia–Austria: Seven analyses, of which five homogeneous (copper with some silver, otherwise pure). Deviants: JSS 3240 has moderate As, OW 257 has high As (Fig. 32).

Ireland. Five analyses, homogeneous; "Irish" (CC Group I) metal, high As, moderate to high Sb, moderate Ag (Fig. 33).

Netherlands. Nine analyses, of which six homogeneous (high As, moderate Ni). Deviants; JSS 691 is of arsenical copper, without Ni; JSS 686 is of "Singen metal", JSS 685 has high As and Ni, moderate Pb, Sb and Fe (Fig. 29).

Germany and Austria. Seventeen analyses; divisible into two sub-groups:
a. high-impurity group: nine ex. with moderate to high Pb, As, Sb, Ag, moderate Ni; o to moderate Sn, but one ex. (OW 990, *cf.* Dorchester in England) has very high Sn (Fig. 31).
b. five ex. with moderate Ag, low to high Pb. (Fig. 32).
Deviants: OW 367 has high As; JSS 311 has high Sb, moderate Sn, As low Pb, Ag, Ni; JSS 211 has mod. Pb, Ag, low Sb, Ni, no As.

England. Ten analyses; of which six fairly homogeneous (moderate to high As, low to moderate Sb, Ag, very low to moderate Ni, tr. to very low Pb and Bi; two specimens are of bronze). Deviants: CC 96 and 97, perhaps 83 resemble Dutch Bell Beaker – Breton flat axe metal. West Overton is of very pure Cu with high Sn; Dorchester has high Sn alloyed with copper resembling the German high-impurity group. CC 93 (also from the Dorchester grave) has moderate As, Sb, Ag, Ni (Fig. 33) (Case, 1965; Smith & Simpson, 1964; and correspondence).

Sardinia and Italy. 14 analyses. Rather heterogeneous metal.

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