LATE NEOLITHIC OCCUPATION NEAR BORNWIRD (PROVINCE OF FRIESLAND)

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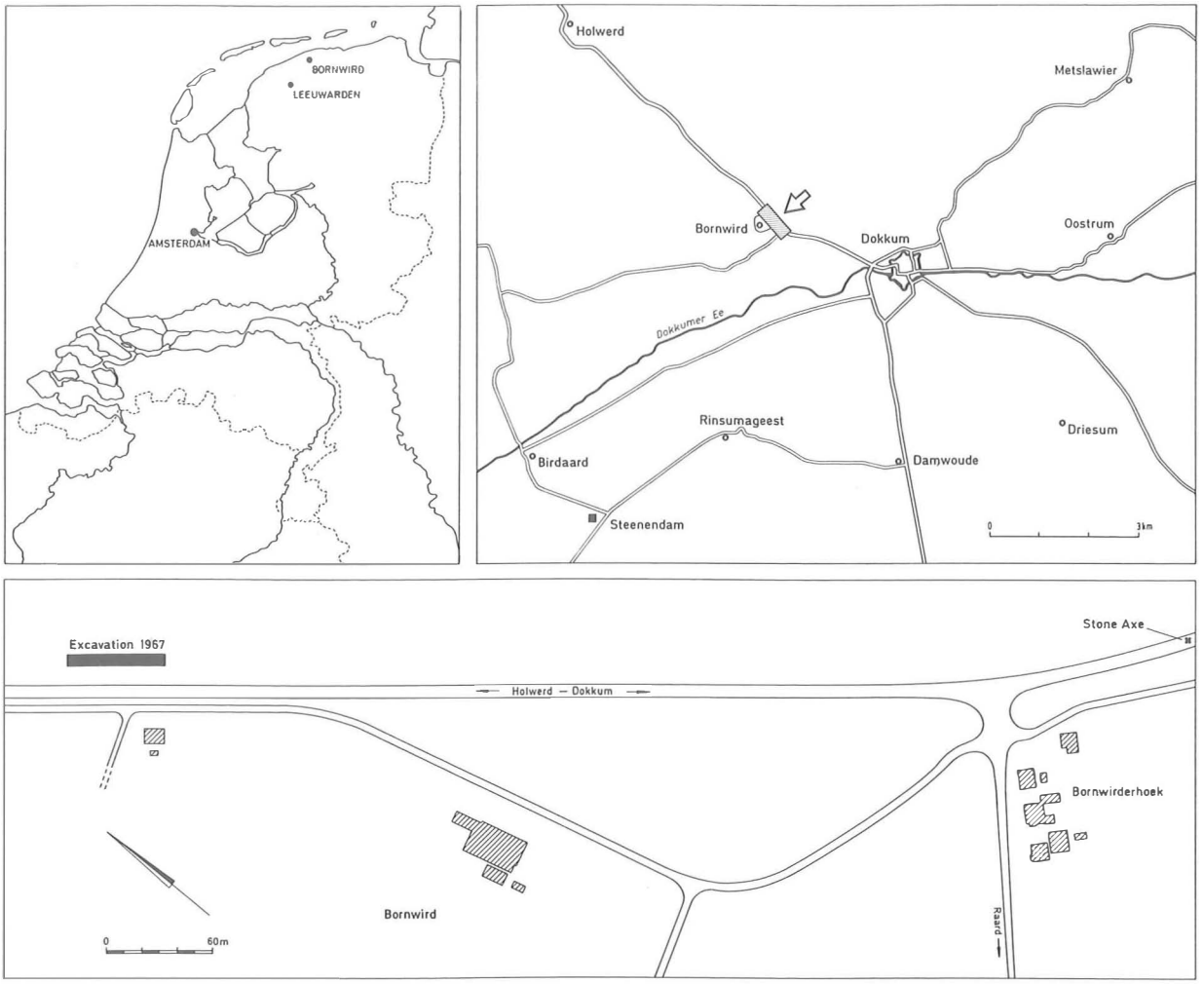

Fig. 1. Location of the site.

1. INTRODUCTION

During one of his reconnaissances in the field (in the autumn of 1966), J.K. Boschker (field assistant attached to the Frisian Museum in Leeuwarden) found near Bornwird (fig. 1) a small stone axe, some crudely worked flint artefacts and a few potsherds. The finds were made in upturned soil alongside the planned route of the new Holwerd-Dokkum road that was then under construction. In the course of sinking a trench for the road a sand-outcrop appeared, from which the artefacts originated. During a closer reconnaissance by members of the Biologisch-Archaeologisch Instituut (B.A.I.) in Groningen it became evident, moreover, that in the surface of the sand traces of prehistoric ploughland were visible.

The complex was dated–mainly on the basis of the coarsely tempered potsherds–to the Late Bronze Age (Elzinga, 1966). This dating fitted in well with an observation made by Van Giffen in 1910. During the levelling of the *terp* of Bornwird, Van Giffen discovered a few urns that must have come from the sandy subsoil of the terp (Van Giffen, 1920). It was notably the discovery of the ploughland that made this complex a unique find for the Netherlands, for here we had the oldest traces of prehistoric agriculture this far north. It was decided to carry out an excavation, that took place in the autumn of the following year (Sep. 4th–Oct. 4th, 1967). The excavation was carried out by labourers under the supervision of H. Praamstra and K. Klaassens, under the direction of G. Elzinga and H.T. Waterbolk.

The excavation provided a great deal of new information. The most noteworthy was the fact that the complex could, on the basis of the decorated pottery, now be dated in the Late Neolithic. Later this relative dating was confirmed by a C14-dating of peat that overlay the old ploughland (GrN-5295: 3930±50 B.P., Vogel & Waterbolk, 1972).

After 1967 Bornwird was regularly mentioned by various authors. The traces of inhabitation were attributed to different archaeological cultures[1] in turn. Elzinga (1967), Waterbolk (1967; 1968) and Van Zeist (1970) ascribed the ploughland and the finds to the PFB (Protruding foot beaker) culture. In addition Louwe Kooijmans (1974), Lanting and Mook (1977) and Waterbolk (1977) mentioned elements of the VL (Vlaardingen) culture. During a visit to the excavation in 1967 Bakker (pers. comm.) identified a few sherds as originating from the LHV (Late Havelte) phase of the TRB (*Trechterbeker*= Funnel beaker) culture. When questioned, the different authors avowed that they had based their statements (*i.e.* concerning cultural affinity) on their own observations of the 'show pieces' (pottery) or on oral and published communications by other authors. The present article can be regarded as a definitive report of the 1967 excavation, and as such can serve as a basis for discussion and comparison.

2. GEOLOGY AND PALAEOGEOGRAPHY

2.1. Geology

From a geological viewpoint Northeast Friesland forms part of the Fries-Drents boulder-clay plateau, of which it is an extension in a northwestern direction.[2] The plateau is intersected by a large number of streams that drain on the east side into the ancient valley of the Hunze, in the southwest into the ancient valley of the Vecht and in the west into the Boorne depression. During the Eemian and Weichselian these streams often cut deep into the boulder clay and formed so-called primary valleys (Zagwijn & Van Staalduinen, 1975). In the northern part these were the valley of the river Oude Ried, the river Zwemmer, a deep valley near Dokkum and the valley of the Kromme Ee river.

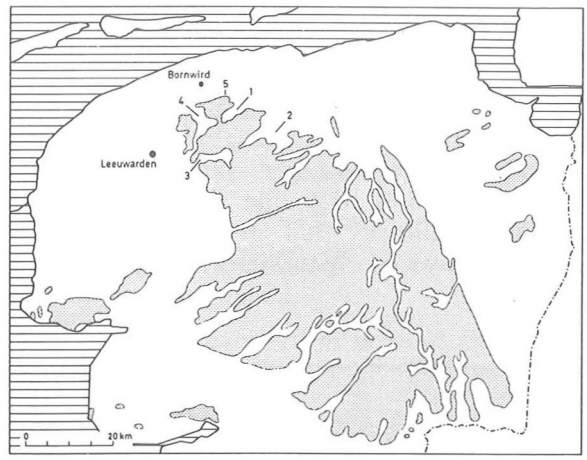

Fig. 2. The Fries-Drents boulder-clay area indicating a few important valleys of Pleistocene origin in N.E. Friesland (based on Griede, 1978). 1. valley of the river Zwemmer; 2. valley of the river Oude Ried; 3. valley of the river Kromme Ee; 4. valley east of Birdaard; 5. valley near Dokkum.

Moreover, under the influence of glacial and/or fluviatile processes there originated a northwest-southeast oriented valley that penetrated the boulder-clay area between Rinsumageest and Oenkerk as far as the Hardegarijp-Veenwouden line (Griede, 1978: fig. 2).

The developments since the Holocene are characterized by the gradual rise in sea level in a succession of transgressive and regressive periods.[3] Initially the influence of the sea was only noticeable on the northeast side of the boulder-clay plateau, where the water was able to penetrate via the primary valleys. As a result of this the cover-sand area acquired, especially in the north, a markedly dissected character. On the west side the coastline remained fairly stationary for a long time, and the sea penetrated only into the valley of the Boorne (Griede, 1978). This applies notably to the developments that occurred during the Atlantic and the first part of the Subboreal. About 4000 C14-years B.P. there occurred a great expansion of peat growth in the Holland IVa and IVb regression periods, only temporarily interrupted by the Calais IVb transgression period. There then followed from ±3400 C14-years B.P. (Griede, 1978) the Dunkerque transgression periods that determined the present-day extent of the clay region.

The actual situation that was consolidated when people first started to build dikes, presents in Northeast Friesland the picture of an extensive region of clay. Cover-sand is present at the surface to the south of the line between Rinsumageest and Westergeest. To the north of this line there are only a few sand hillocks that protrude above the clay (Bornwird, Wanswerd, Oostrum and Lichtaard). To the west there are a number of larger sand 'islands' that are separated from the 'mainland' by the valley between Rinsumageest and Oenkerk that is filled up with peat and clay.

2.2. Palaeogeography

The previously mentioned C14-dating (3930

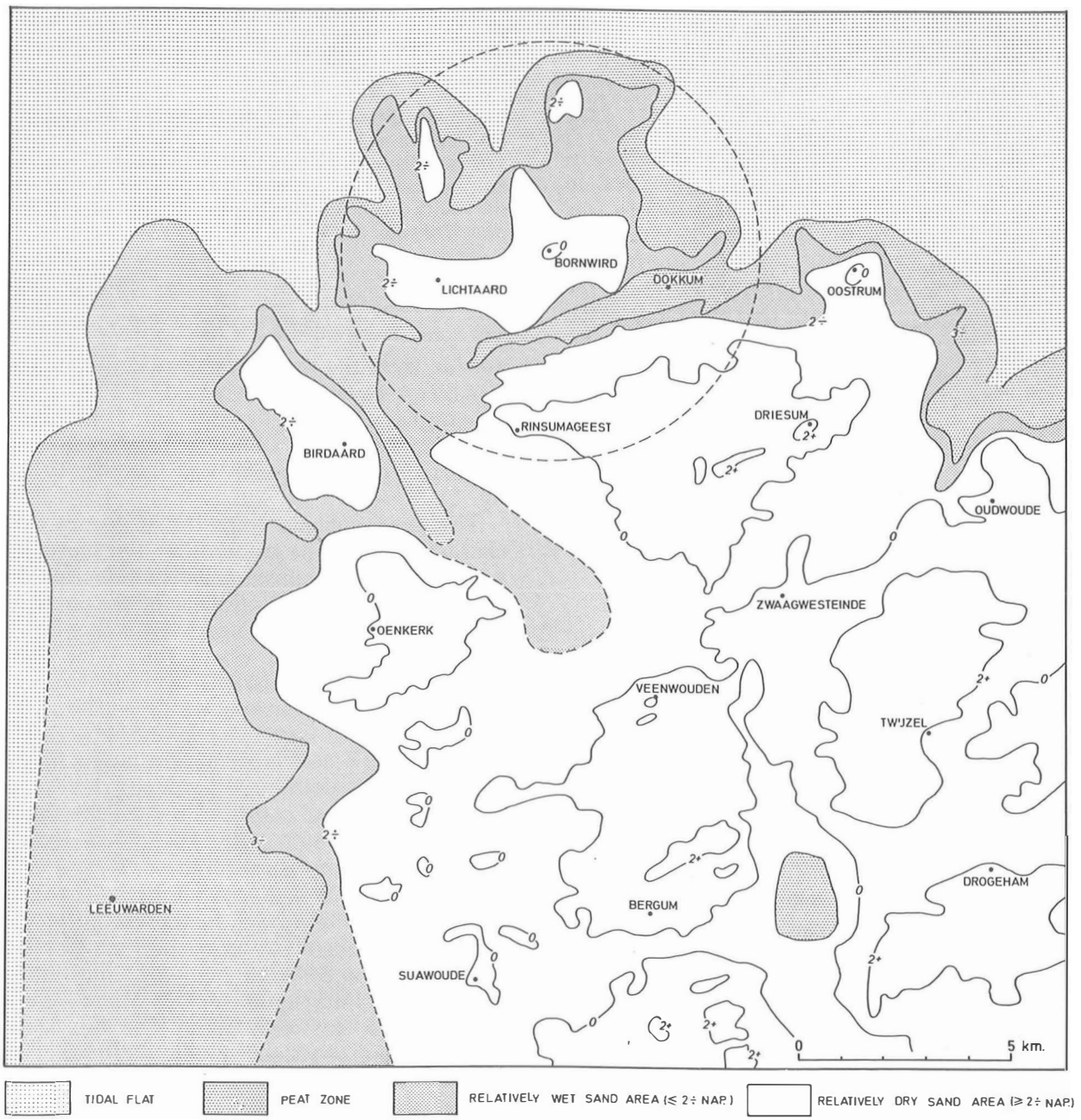

Fig. 3. Palaeogeographic reconstruction of Northeast Friesland ±4300 C14-year B.P. (after Griede, 1978).

±50 B.P.) of peat that covered the ploughland provides a *terminus ante quem* for permanent occupation in the region around Bornwird. From a chronostratigraphical viewpoint this peat belongs to the Holland IVA regression period that lasted in this region from 4150–3900 C14-years B.P. (Griede, 1978). The increasing wetness of the region meant that agriculture and stockbreeding were no longer possible, and consequently permanent inhabitation probably came to an end. Thus it is possible to limit the palaeogeographical description to the period from ±4400, when PFB pottery first made its appearance (Bakker & Van der Waals, 1973), until 4100 C14-years B.P. (fig. 3).

The site then was situated in the northernmost part of the cover-sand region that had not yet been overgrown by peat. Towards the north, the west and the east the coastal zone was nowhere further away than 5 km. Especially on the west side an extensive coastal peat bog formed a buffer zone between the region of tidal flats and the mainland, while in the north and east this belt was not so wide (fig. 3). Where the sea penetrated the peat-bog, a shallow, brackish, lagoon-like environment predominated, that towards the sea underwent a transition into a tidal flat region (Griede, 1978). In the period under discussion, during the Calais IVA transgression period (4300–4150 C14-years B.P.) the sea eroded the peat-bog zone especially in the west (Griede, 1978). The influence of the sea would have been mainly noticeable, however, by the increasingly wet state of the region as a result of the rising ground-water table. Various sea-level curves (Louwe Kooijmans, 1974; Roeleveld, 1974) show that the level of MHW (mean high water) in the period under discussion rose from ±3.5 to 2.5 m below datum level (N.A.P.). As a large part of the region around Bornwird lies at this level, the influence of the rising ground-water table must have been clearly noticeable. Especially in the lower lying areas the oligotrophic peat that was already present there will have greatly expanded. The higher sand region we can envisage as covered by a vegetation of predominantly tall trees, *i.a.* oaks and elms (Cleveringa, 1978). About 1.5 km south of the site lay the primary valley that extends inland from Dokkum. It must have been covered by a vegetation of phragmites fen-peat and along the edges by fenwood-peat. The marshy belt may have been up to 1 km wide (fig. 3). Owing to the presence of this valley the site in fact lay on a peninsula; at the same time the valley provided effective drainage of the area.

3. THE EXCAVATION

3.1. Location, excavation method and stratigraphy

When the excavation started in 1967, the new Holwerd-Dokkum road had already been completed. The excavation trench (57×7 m) was therefore planned to the east of the road and parallel to it (fig. 1). With the aid of a hydraulic crane the overlying clay layer of about one metre thickness was removed. In the southern part of the trench the sandy subsoil was reached in this way, in the north however the sand was still covered by a layer of peat. This peat was dug away by hand. The horizontal surface was drawn at two levels, with the ploughmarks being visible only at the first level. Of the profiles only the eastern face of the trench was drawn. A number of soil samples were taken for the purposes of palaeobotanical investigation (Van Zeist, 1970), as well as a sample for C14-dating (Vogel & Waterbolk, 1972). The finds were collected by sieving the topmost layer of sand (A1-horizon, see below) that had been removed manually. These finds were not localized. Also during the process of shovel cleaning the horizontal surface some finds were made, but the precise location of these was not recorded either. Hence it is not possible to make any statements about the distribution of the finds, nor about the layer in which they were found.

Only in the extreme southeast of the trench (fig. 4:C) the sand was not covered by peat. To the north a layer of allochthonous peat is present that gradually undergoes a transition into an increasingly thicker peat complex. At the extreme north end of the trench the peat is 50 cm thick (fig. 4:B); there it lies between 110 and 160 cm below datum level. Both in the horizontal level and in the profile a few large tree stumps are visible that characterize the peat as fenwood-peat (W.A. Casparie, pers. comm.).

On top of the peat (in the south on top of

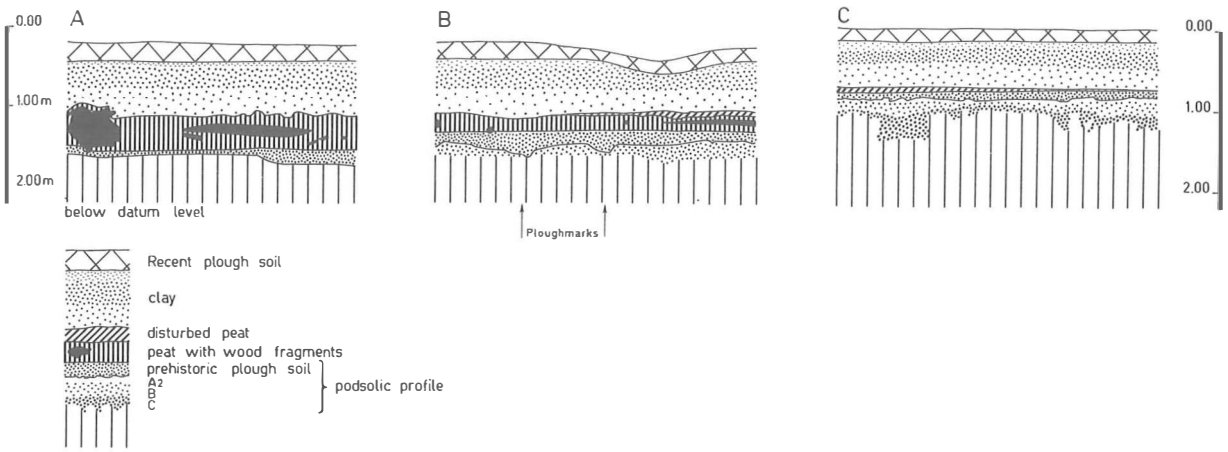

Fig. 4. Representative parts of the eastern profile of the excavation trench. For location see fig. 5: A.

the sand) we find a covering layer of clay about 100 cm thick. Lithostratigraphically two layers can be distinguished within this clay. The lower layer was sedimented on top of the peat following erosion of the peat surface; in the clay, which showed sandy laminations, lumps of peat are included. On top of this a greenish clay was deposited which shows features indicative of extreme desiccation while here and there patches of rust coloration can be observed. On account of the desiccation the boundary with the underlying clay layer is sharply defined, but is not erosive. The lower layer can probably be identified as the 'sandy layer', and the clay lying on top of it as the '*knip* layer' (Griede, 1978; dating 2500–2000 and from 1650 C14-years B.P., respectively). Both clay layers have a thickness of 35–40 cm. The top of the uppermost layer (approximately present day ground surface level) varies in height from 10 cm above datum level in the southeast to 20 cm below datum level in the northwest. The difference in height of the covering clay layer is of course connected with the topography of the underlying surface of sand and of the peat that developed over this. The sand surface level drops even more, namely from 80–150 cm below N.A.P. (from southeast to northwest).

In the top of the sand a podsol profile has developed with a distinct A1-horizon (topsoil), A2-horizon (leached sand) and B2-horizon (iron pan). The ploughmarks were visible at the transition from topsoil to leached sand (fig. 4: B). In the lower parts of the slope the B-horizon was much softer than in the highest part, where it had developed into a hard layer (Bornwird excavation field notes). In the northwestern part the leached sand was almost absent (fig. 4: A).

3.2. Features

3.2.1. *Ploughmarks*

Apart from a few post-holes and pits (see below), the features mainly consisted of ploughmarks. In a Neolithic context we mean by ploughmarks the marks made by an ard. The ard, which can be regarded as a predecessor of the plough proper, does not turn the earth, but merely makes a furrow in the soil surface (Rees, 1979).

Ploughmarks made by ards show a number of characteristic features: (1) a fairly consistent distance between adjacent furrows of 30–40 cm (Kjaerum, 1954; Fowler & Evans, 1967; Rees, 1979), (2) a relatively great furrow length (as compared to the plough proper) (Fowler & Evans, 1967), and (3) evidence of cross-ploughing, *i.e.* the occurrence of ploughmarks crossing one another at right angles.

The distance of 30–40 cm between two furrows is also the average for Bornwird (fig. 5: D). Experimental research has shown that this is the minimum distance necessary to prevent the ard from slipping back into the previously made furrow (Rees, 1979; P. Reynolds, pers. comm.). The length of the furrows in Bornwird is difficult to determine. The longest furrow measures 8.5 m, but this

was interrupted by the vertical face of the trench. Fowler and Evans (1967) found a maximum length of 14 m for Neolithic ploughmarks.

Also the third characteristic feature of ard marks, namely the occurrence of ploughmarks crossing one another at right angles, has been ascertained in the ploughland of Bornwird. The survey of all ploughmarks (fig. 5: A) shows that a number of directions occur repeatedly (with or without a corresponding ploughmark at right angles). A total number of four different main directions could be distinguished (fig. 5: B-E). The relative age of the different phases was determined by the analysis of intersections and interruptions of the ploughmarks that had been drawn very accurately by H. Praamstra. It is assumed that when the marks running in one particular main direction break off at the point where they are crossed by furrows running in another main direction, the latter ploughmarks are the younger ones.

The analysis provides the following picture (fig. 5: B–E and 6). Direction 1 is concentrated in the northwestern part of the excavated area and is only fragmentarily present. For this reason ploughmarks belonging to this direction have not have extricated separately. The average compass direction is 42° and 138° respectively (fig. 6). Direction 2 can clearly be seen in the northern and central part of the trench (fig. 5: B). In the southeastern part of the trench, however, this system has largely been overploughed in later phases. Direction 3 can only be distinguished in the southeastern part of the surface-area (fig. 5: C). No corresponding ploughmarks at right angles could be discovered. It must therefore be assumed that during this cultivation phase cross-ploughing was not applied. Direction 4 represents the youngest phase. The ploughmarks of this system are the most abundant and at the same time the most complete. As a result of this it was possible, on the assumption of an average distance between furrows of 30 cm, to extricate the system of one phase of activity (fig. 5: D). This has only been done for the southernmost 20 m of the trench where the ploughmarks were clearest. Fig. 5: E shows what remains after the traces of direction 4 have been extricated.

For an interpretation of the ploughmarks in Bornwird it is necessary to ascertain the probable type of agriculture practised during

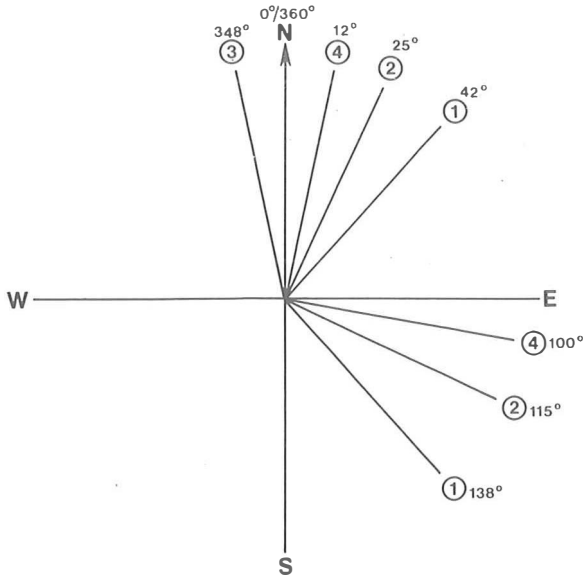

Fig. 6. Compass-card showing the (estimated) means of the 4 main directions of ploughmarks.

the Late Neolithic. Since the work of Iversen many authors have assumed that in the Neolithic and later slash-and-burn agriculture was practised. Ethnological parallels from tropical rain-forest situations are often cited by way of comparison (*i.a.* Harris, 1972). Recently however doubts have increasingly been raised as to how far this analogy is directly applicable in the temperate climate of Western Europe (*i.a.* Rowely-Conwy, 1981). Certainly on clay and loess soils annual burning would not have been necessary and the fields could have been cultivated for a fairly long period without interruption (Bakels, 1978). The actual presence of ploughmarks is regarded by Rowley-Conwy (1981) as a confirmation of this proposal: when after 3–5 years of cultivation fields lie fallow for 10–15 years, the ground becomes penetrated by roots to such an extent that a plough cannot break up the soil. If cultivation is continued over a long period, however, then ploughing is indeed useful.

Experiments with replicas of prehistoric ards certainly make it clear that the ard has hardly any turning action and can probably rather be classified as an instrument for making seed drills (Rees, 1979; Reynolds, 1981). Good arguments for this are the small, regular inter-furrow distance, the fact that the

direction often remains constant for a long time, and the fact that the ploughmarks are distinct–in contrast to the 'self-cancelling ploughmarks' (Reynolds, 1981). Moreover experimental research has shown that sowing in seed drills produces the maximum yield (Reynolds, 1981; Steensberg, 1979). For the ploughland investigated at Bornwird I will assume that a form of shifting cultivation took place, with the plough-furrows largely functioning as seed drills.

The length of time during which a field is kept under cultivation still remains difficult to estimate. On the (poor) sandy soils of northern Friesland permanent cultivation without manuring is out of the question. Although continual cultivation for 1–3 years (Welinder, 1975; Harris, 1972) is probably too low an estimate, uninterrupted cultivation for longer than 5–10 years would not have been possible. For the intermediate period one should think in terms of a fallow period of 10–15 years (bush fallow). With such a system the working of the soil after a fallow period is

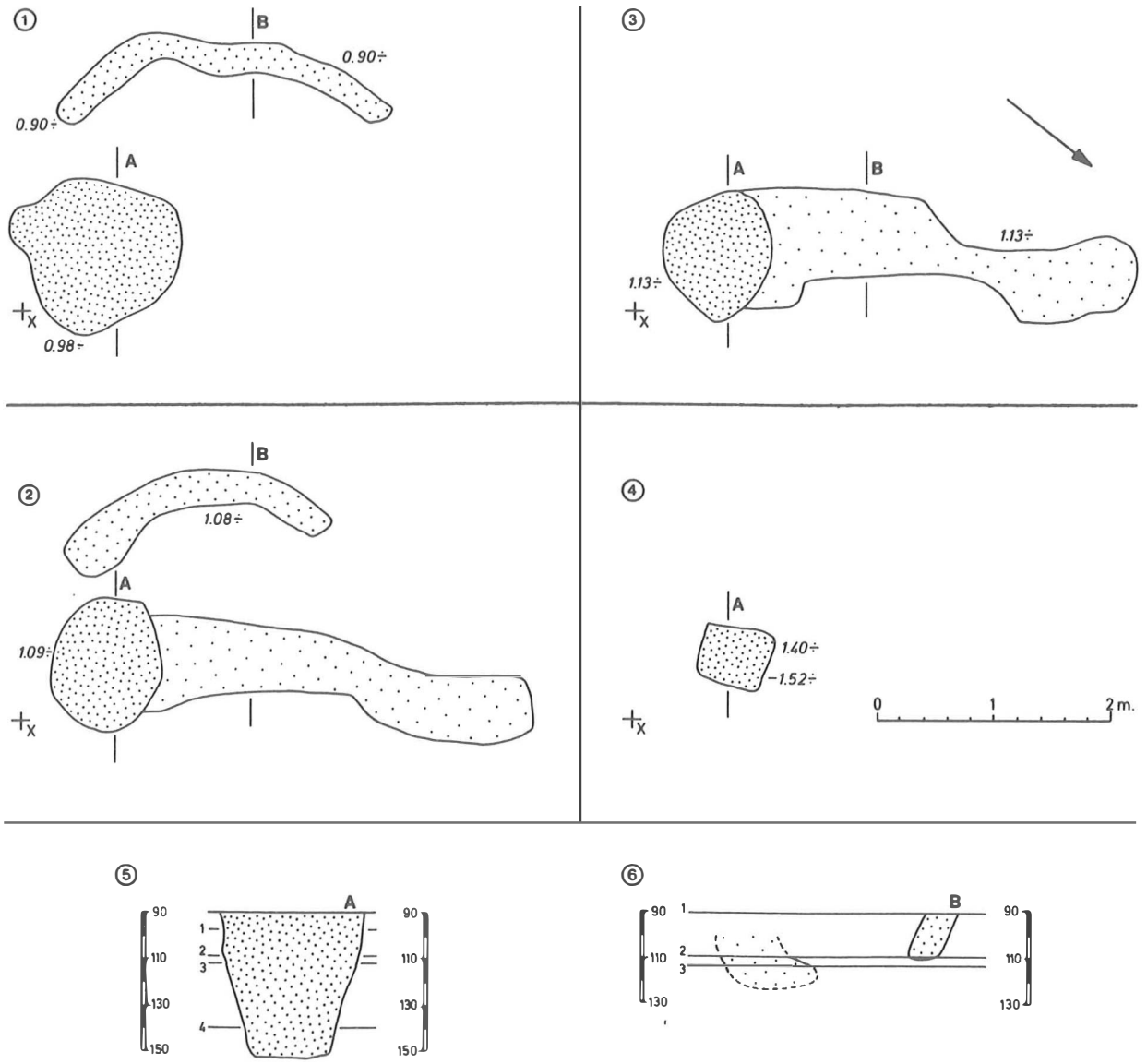

Fig. 7. Two intersecting pits in the northern part of the excavation trench, drawn at different levels (fig. 7: 1-4); constructed cross sections of the same pits (fig. 7: 5, 6).

relatively easy and therefore attractive (Conklin, 1969). The straightness of the plough-furrows supports this presumption.

On the basis of these figures, and assuming that the different main directions of the ploughmarks represent four phases of continuous cultivation, the total duration of use of this land can be estimated at 70–95 years. However, a number of alternative estimates can be defended as well.

3.2.2. *Crop remains*

Van Zeist (1970) analyzed one sample from the topsoil (±0.5 m^3) and found in it 13 grains of naked barley (*Hordeum vulgare* var. *nudum*). Van Zeist's study shows that this was the kind of grain that was cultivated most in the late Neolithic. Also *Triticum dicoccum* (emmer) and *Triticum aestivum* (club wheat) were known, but these were not found in Bornwird (Van Zeist, 1970). The fact that the grains were carbonized could be the result of burning the field after harvesting or before sowing. In the same sample two carbonized hazelnut shells were found (*Corylus avellana*) (Van Zeist, 1970).

3.2.3. *Other features*

Under the cultivation level a small number of pits and post-holes were found. Only one pit could be recognized at the level on which ploughmarks were visible (fig. 7). In the horizontal surface drawings it is clearly indicated that this pit was cut into by the ploughmarks (fig. 5: A). The feature was excavated in successive layers, so a profile had to be reconstructed on the basis of the four horizontal-surface drawings (fig. 7). From this it is evident that in fact two pits are concerned here. The larger of the two, that is also older (fig. 7: 1–3, 6) seems to be the result of a tree having fallen down in a NE direction (Kooi, 1974). The second pit (fig. 7: 1–5) has been dug through the first, possibly with the aim of removing a more deeply lying tree root. This activity could thus be connected with the primary reclamation phase of the ploughland.

In the NW part of the trench some patches of discoloration were found, of which three were evidently post-holes; no profile drawings were made. Despite close investigation in the periphery of the trench (fig. 8) no fourth post-hole could be found. On the basis of these data it is not possible to interpret this configuration as some kind of construction. The three post-holes and the two larger pits (fig. 8) are all older than the ploughland.

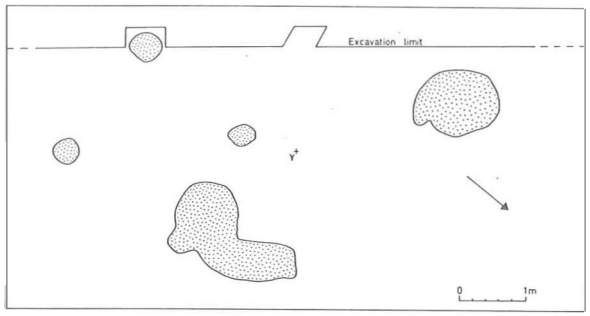

Fig. 8. Post-holes and pits in the northern part of the excavation trench.

3.3. The finds

3.3.1. *Stone*

The finds consist of worked or unworked stone and flint, as well as potsherds.

The excavation provided 21.7 kg of stone material. Only a small proportion (in total 10 specimens, 2.1 kg) shows signs of use. With regard to rock type three main groups can be distinguished: granite (65%), sandstone (27%) and quartzite (8%). Granite and sandstone occur naturally on the boulder-clay plateau in the form of moraine material. Both are to be found in the arable land near Bornwird. The greater part of the stone material that was collected during the excavation will therefore not have been brought to the spot by man. With the quartzites the situation is different. These are always small rolled stones, sometimes distinctly affected by vigorous breakers action, like stones that one would find along a coastline where cliffs are present (identification G.J. Boekschoten). In view of the fact that all the hammerstones (n=7) are rolled stones of this kind (fig. 9: d), it is reasonable to conclude that the stones were specially brought from the coast. They will have been used notably for the working of flint.

The granite stones are almost all severely weathered and could therefore readily be crushed into small pieces suitable for tempering pottery. The TRB pottery (see

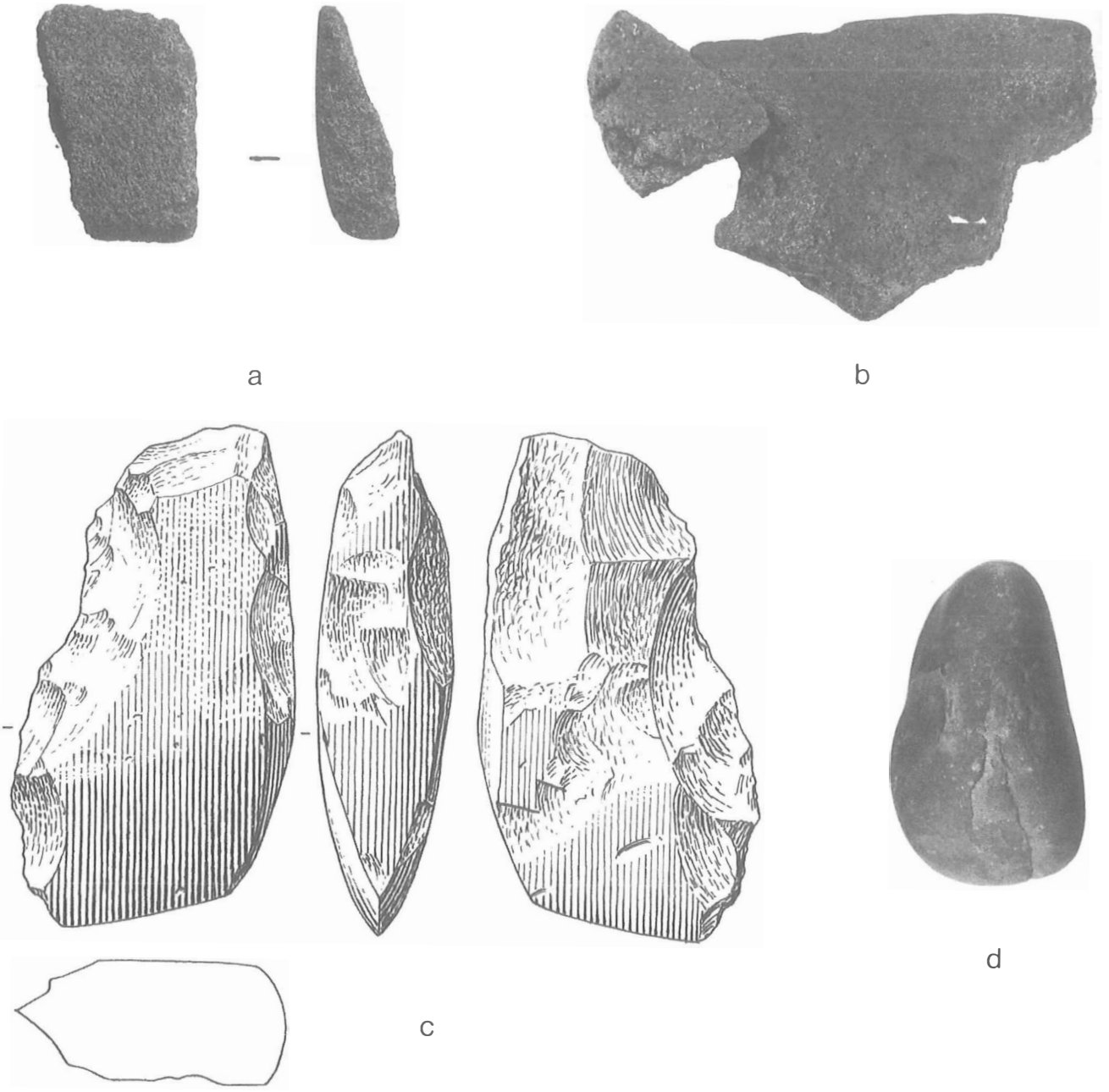

Fig. 9. Characteristic stone artifacts. a) fragment of a stone axe; b) fragment of grindstone; c) large fragment of a flint axe; d) hammerstone. Scale 1:1.

below) has been tempered almost exclusively with weathered granite. Only in a small number of cases (only coarsely tempered potsherds) less weathered granite was used (red feldspars).

One piece of sandstone was used as a grindstone (fig. 9: b). The fragment is too small to permit any closer typological identification.

3.3.2. *Axes*

Two axe fragments came to light during the excavation, while a third (complete) axe had already been found in the course of the first reconnaissance (fig. 1, mus. no. FM 1966-IX-2). This axe lay at a distance of ±500 m from the excavation trench and strictly speaking it cannot be ascribed to the

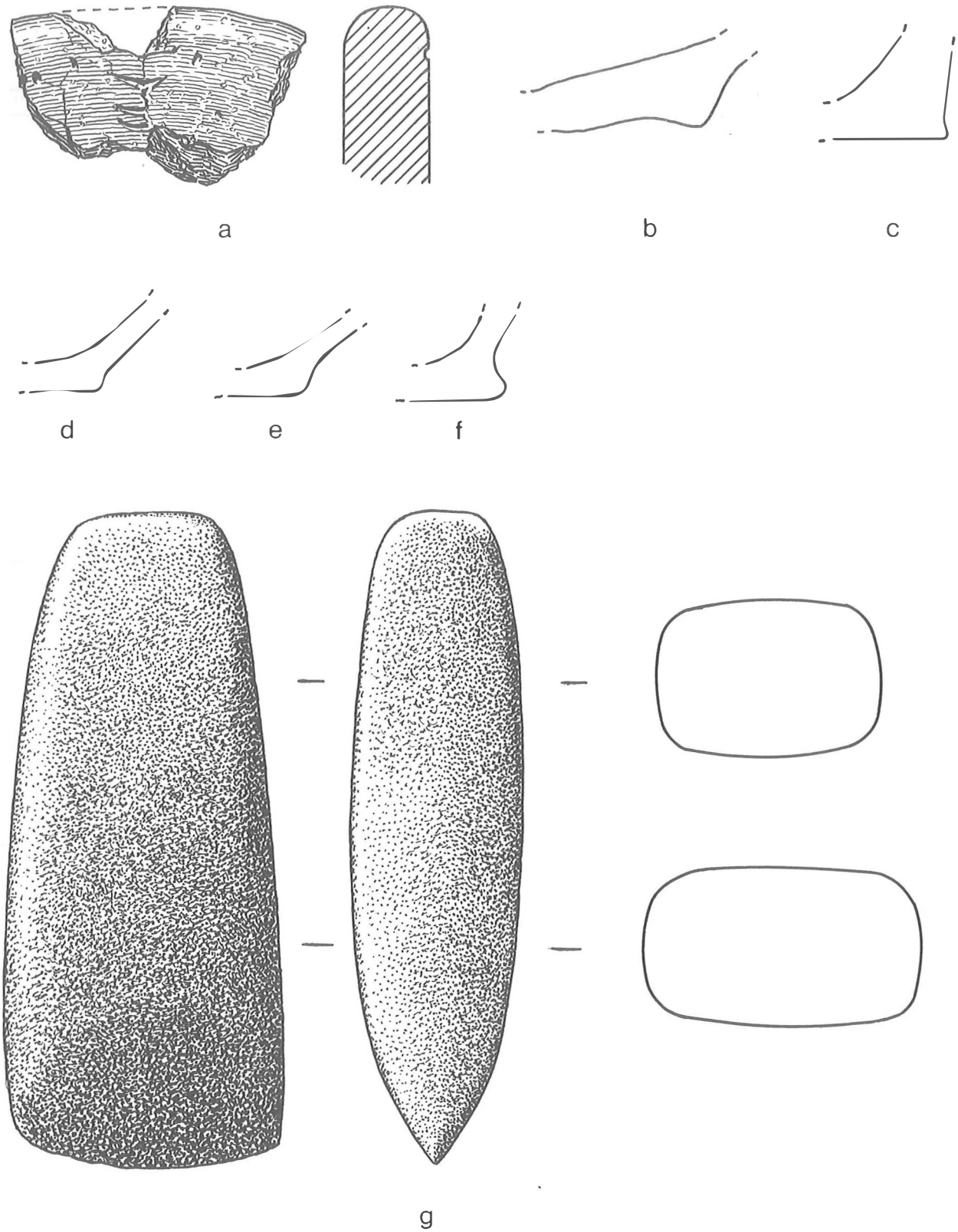

Fig. 10. Various artifacts. a) fragment of a clay disc; b-f) bottom fragments of pottery vessels; g) stone axe (FM1966-IX-2). Scale 1:1.

find complex from the excavation. For further discussion see 4.1.; the description follows below.

The axe (fig. 10: g) is made of gabbro, a rock that occurs on the boulder-clay plateau and that is to be found near the site (identification G.J. Boekschoten). In the typology of Brandt (1967) it is a *Felsrechteckbeil* (type A2b). This type is considered by Brandt to be common in the Neolithic, notably often associated with *Schnurkeramik* (Brandt, 1967). It is regularly found in a TRB context (Davidsen, 1978).

Of the two axe fragments that were found during the excavation, one (fig. 9: c) probably is part of a *dünnblattige Flintrechteckbeil* (Brandt, 1967; type 7b). The raw material is coarse-grained flint, most probably having originated from terminal moraine (identification D. Stapert). A conspicuous feature is pronounced curvature of the sides towards the cutting edge, unusual for this type. Regarding the typechronology the same remarks apply as for the *Felsrechteckbeil* (Brandt, 1967; Davidson, 1978). The second fragment (fig. 9: a) consists of a part of the flat surface and side of an axe. The fragment is too small to permit typological classification of the axe of which it formed part. The rock type is diorite, that also occurs locally in the form of erratics.

3.3.3. *Flint*

The very large quantity of flint (33 kg) that was collected during the investigation can be characterized as terminal-moraine flint of local origin. The complex includes many weathered specimens, stones showing wind gloss and frost-split faces. Out of the total number of flints 32% still have all natural surfaces; probably we are concerned here with flint that occurred naturally in the ploughland. Of the remaining proportion (68%) of flints that have been worked by man, 99% consists of waste material while only 1% had been used or further worked (n=201)[5]. Twelve specimens had been in contact with fire.

In the analysis of the flint material a distinction has been made between intentional retouch and use retouch.[6] Both forms of retouch can of course be present on one specimen. In view of the fact that the complex includes few typologically diagnostic tools, a classification based on morphology has mainly been used. On the basis of the shape of the used edge the following distinctive categories have been established (between brackets the presumed function):

1. Blades or flakes with convex retouch and/or use retouch (scraping, cutting);
2. Blades, flakes and blocks with a notch or concave retouch and/or use retouch (planing, scraping).
3. Blades (and flakes) with straight retouch and/or use retouch (cutting);
4. Flakes (and blades) with a pointed projection that has been retouched and/or shows use retouch (drilling);
5. Flakes and blades that have been retouched in such a way that a tool has been made that is characterized according to established typologies as an arrow-head.

A conspicuous feature of the whole complex is the small number of blades, in total not more than 10. Most of the specimens can be described as irregular flakes and blocks. Most of the artefacts appear to have been used for scraping and/or planing activities (table 1): categories 1 and 2 (used edge convex, concave or with notches) together include 94% of the total number of worked and/or used artefacts.

Characteristic for the complex is also the large number of artefacts that show only use retouch (*i.a.* fig. 11: g). In these cases the used

Table 1. Flint; frequencies of the types, based on shape of the used edges

Shape of the used edge	Kind of retouch			
	Intentional retouch	Use retouch	Both	Total
Convex (edge partly used)	30	53	60	143
Convex (edge completely used)	16	–	16	32
With notches or concave	2	11	2	15
Straight	–	2	–	2
With a used pointed projection	2	1	–	3
Combination of forms (functionally different)	–	–	4	4
Arrowhead-shaped (transversal)	1	–	–	1
Arrowhead-shaped (leaf-shaped)	1	–	–	1
	52	67	82	n=201

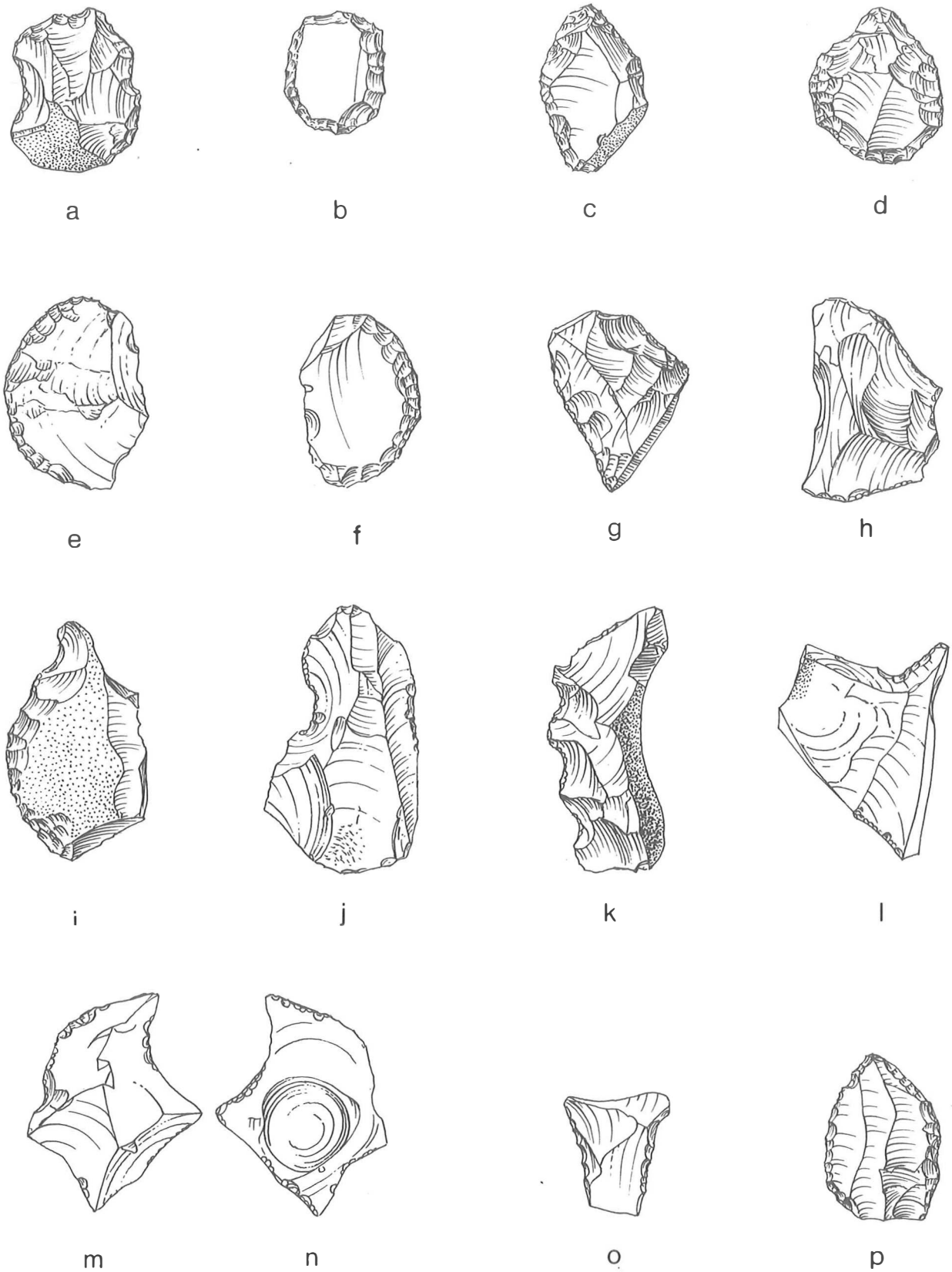

Fig. 11. Characteristic flint artefacts (for explanation see text). Scale 1:1.

edges evidently already had the right shape for the required function. Also retouched specimens give the impression that no exacting demands were made as to the shape of the tool as such (fig. 11: a, d, h). Only an occasional specimen has been carefully worked into an impressive-looking 'scraper' (fig. 11: b, e, f).

With respect to the shape of the other tools the same remarks are applicable. Thus a block with a projection has been used as a drill after minimal retouching (fig. 11: l). Also among the specimens with notches there are irregularly shaped flakes and blocks (fig. 11: j-k). Fig. 11: m shows a frost-split specimen with four projections, all of which show intensive use retouch, caused by a turning movement in a clockwise direction.

Two artefacts were classified as arrowheads (fig. 11: n, o). The one shown in fig. 11: n is generally described as a trapezoidal arrowhead (Bakker, 1979) and is considered to be diagnostic for the west group of the TRB culture (Bakker, 1979). The specimen of fig. 11: o is also referred to as an arrowhead, albeit only on morphological grounds. Parallels have been pointed out in Vlaardingen context (Van Regteren Altena *et al.*, 1962). Comparable forms also occur however in a LHV connection (Bakker & Van der Waals, 1971) and in the Danish Store Valby group (Davidsen, 1978: fig. 104.0). In many respects Store Valby (MNV) is similar to LHV (Davidsen, 1977; Bakker, 1979). In view of the fact that LHV is represented also among the pottery (see below), it seems reasonable to regard the leaf-shaped point also as an LHV element.

In its entirety the complex appears to resemble to a number of vaguely described TRB assemblages. Among the characteristic features of these complexes are particularly the casual working of the flint material (no remarkably fine tools), the large number of scrapers, and the relatively small number of blades. These characteristic features are typical for Anlo (Waterbolk, 1960), Anlo 'De Schipborg' (Van der Waals, 1962), Angelsloo (Bakker & Van der Waals, 1971) and the Beekhuizerzand (Modderman *et al.*, 1976). The two arrowheads described here also are indicative of TRB, and then possibly the LHV phase.

Caution is necessary however because the flints found all come from ploughland. With regard to chronological and cultural aspects, it is therefore not possible to consider the complex without further preface as a homogeneous entity. Moreover we must bear in mind that the composition of a flint complex says more about the activities of the people who used it than about their 'cultural' identity.

3.3.4. *Pottery: technology*

From detailed examination of the pottery it became evident that the 'show-piece finds', on which a number of authors based their opinion (see under 1), were a small and unrepresentative sample of the whole. Table 2 makes this clear. The show-collection consisted almost exclusively of decorated sherds that had been tempered with sand.

Seeing that 97% of the pottery is undecorated and represents hardly any characteristic shapes, the emphasis of the research had to lie on the technological aspects. For each sherd data were recorded concerning *i.a.* the variable tempering, mode of construction, colour, wall thickness and decoration. As is evident from table 2 two categories of temper can be distinguished: sand and granite-grit. Within the category of granite grit a distinction can be made between a fine-grained component (<2 mm) and a coarse-grained component (2–5 mm). Most of the sherds contain the fine-grained fraction (64%).

The structural composition of the sherds has only been investigated on the basis of the fracture pattern. Especially when a vessel is built up from bands or coils of clay, this can clearly be seen from the fracture: the pot breaks along the zone of attachment of the coils. This pattern was present in 99 sherds, all

Table 2. Pottery; quantitative data.

Part of the pot	:	81 rim-sherds
		1 054 body-sherds
		7 bottom-sherds
Total number of sherds	:	1 142
Temper	:	123 sand (11 %)
		1 019 granite grit (89 %)
Other aspects	:	30 decorated
		1 handle
		7 secondarily drilled holes
		1 clay disc

of which had been tempered with granite. The zone of attachment of the coils was always oblique, which indicates that they were attached to one another by pushing the inner surface downwards with the thumb and the outer surface upwards with the index finger. Van der Leeuw (1976) mentions that this technique was used to prevent the pot from becoming wider than desired in the course of its fabrication.

The colour of pottery is generally related to the method of firing used: in an oxidizing environment colours become light, in a reducing environment dark. The difficulty in this respect is that on a single pot big differences in colour can often be seen. In spite of this problem, in all cases the colour has been described and 'translated' in terms of oxidation and reduction (table 3).

Because that it is unlikely that a pot was fired on the inside in oxidizing conditions and on the outside in reducing conditions, the last category in table 3 gives an indication of the interpretation error that arises because one pot has a different gradation of colours.

On the basis of the colour differences, the sand-tempered pottery can be characterized as predominantly fired in reducing conditions on the inside and in oxidizing conditions on the outside. This would seem to indicate that these pots were fired standing upside-down in an open or poorly covered fire. Of the granite-tempered sherds 35.5% show the same colour distribution, yet the majority show reduction colours on both sides (61.7%). Statistically the two distributions differ significantly when the last category (too small expected values) is left out of consideration ($\chi^2=6.93$, $\alpha=0.05$).

For the wall thickness of pots the same remarks apply as for the colour that is connected with the firing process: over an entire pot substantial differences are often evident. Moreover, weathering is an important disturbing factor with this variable. Caution is therefore necessary in drawing any general conclusions. The width variation of the sand-tempered pottery is 3–14 mm, and of the granite-tempered pottery 3–15 mm (with fine tempering 3–11 mm). The two distributions have an average and median value of a thickness of 7 mm (6 mm for the fine tempering). Both the granite-tempered and the sand-tempered pottery contains a thin-walled as well as a distinct thick-walled component. The material is, however, too fragmentary to permit any percentage figures to be given, which might be suggestive of a distinct differentiation.

To summarize the technological analysis, it seems possible to distinguish two groups of pottery, mainly on the basis of the variable tempering.

1. The sand-tempered pottery. Fired for the most part under oxidizing conditions. The inner surface often shows reduction colours however (table 3). The wall thickness varies from 3–14 mm, the fracture pattern gave no indication of the structural composition.

2. The granite-tempered pottery. For the most part fired under reducing conditions, both on the inner and outer surface. The wall thickness varies from 3 to 15 mm. The pottery tempered with fine grit is generally slightly thinner than that tempered with the coarser grit. About 10% was seen to have been built up from band or coils of clay.

Table 3. Pottery; distribution of the color patterns

Color of the sherd	Temper granite grit	sand
Inner- and outer surface light	27 (2.6%)	23 (18.7%)
Inner- and outer surface dark	629 (61.7%)	18 (14.6%)
Inner surface dark, outer surface light	360 (35.5%)	80 (65.0%)
Inner surface light, outer surface dark	3 (0.2%)	2 (1.6%)
	1019	123

3.4.5. *Pottery: typology*

The pottery of Bornwird is too fragmentary to permit anything much to be said about the shape of the pots. One sherd shows a distinctly carinated neck profile (fig. 12:b). The rims have consistently been more or less symmetrically flattened out by kneading, or have been rounded off. Neither are the few bottom fragments very useful for establishing a typology. Three pieces have the shape of a small protruding foot (fig. 10: d-f); these are sand-tempered. The other four bottom sherds have been tempered with granite; three of them have a flat bottom that joins the wall almost at a right angle (fig. 10: c). A fourth has a rounded bottom and may represent a form of dish (fig. 10: b).

For the purposes of ascertaining a typology

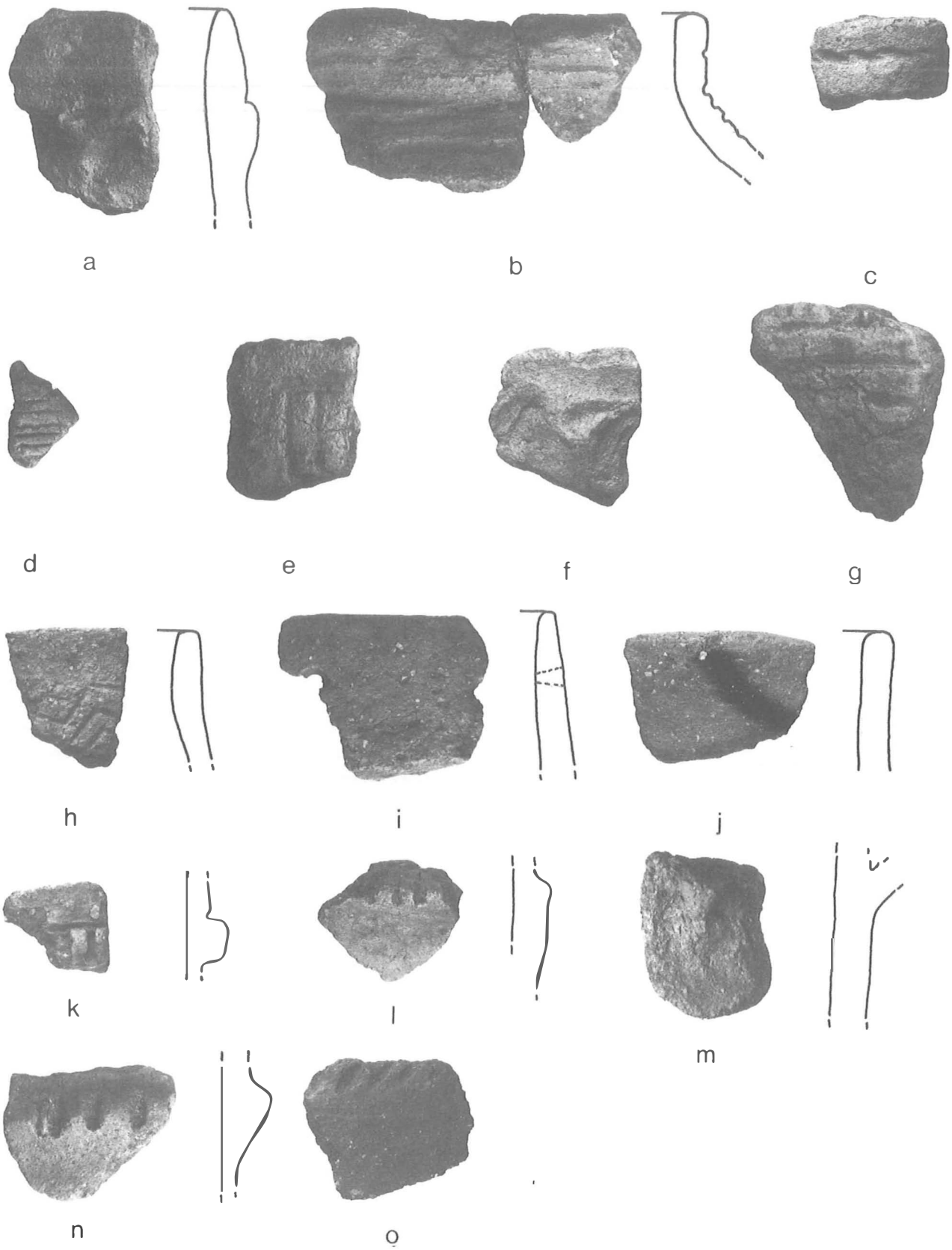

Fig. 12. Diagnostic pottery sherds (for explanation see text). Scale 1:1.

Table 4. Pottery; decoration forms; between () the typological determination. (PFB = Protruding Foot Beaker; LHV = Late Havelte; MHV = Mid-Havelte).

Type of ornamentation	Temper sand	Granite grit
Grooved lines (PFB)	4	–
'Short-wave molding' (PFB)	11	–
Fingernail impressions (PFB)	4	–
String impressions (PFB)	2	–
Grooved ridge (LHV)	–	4
Row of grooves (without ridge) (LHV)	–	4
Grooved lines (zigzag pattern) (MHV)	–	1
	21	9

the decoration provides us with more information. Table 4 shows that we are concerned with two groups; TRB and PFB decoration patterns.

With the PFB decoration no differentiation according to subtypes is possible (1a-1f, Van der Waals & Glasbergen, 1959; Lanting & Van der Waals, 1976). Clearly present in any case is the 'short wave moulding' decoration (*Wellenband* decoration) that is generally considered to belong to settlement pottery (Becker, 1955; Van Giffen *et al.*, 1971) (fig. 12: a, f).

Especially noteworthy are two sherds of a PFB amphora (fig. 12: b, e). In the Netherlands amphorae are a regularly though scarcely occurring phenomenon (Van der Waals, 1964b). Apart from the amphorae mentioned by Van der Waals (Zeijen, Ruinen and Rhee from burial mounds; Beilen, Rhee and Hankenberg possibly from flat graves), one is known from the settlement of the Vlaardingen culture in Vlaardingen (Glasbergen *et al.*, 1967). Unpublished finds are known from the megalithic tomb D26 (Bakker, 1983 in press), the megalithic tombs on the Glimmeres, Odoorn and possibly the PFB settlement at Kolhorn (J.N. Lanting, pers. comm.). In Bornwird we are probably concerned with sherds of an early (*Strichbündel*) amphora (fig. 12: b-e). Owing to the lack of good find-associations it is hardly possible to give a reliable dating for these amphorae.

The decoration in the form of a row of notches, sometimes on a plastic band (fig. 12: k, l, n, o), is characteristic for the LHV phase of the TRB culture (Bakker, 1979). The grooves in a zigzag pattern are ascribed by Bakker to the MHV (Mid Havelte) phase (1979).

It is noteworthy that the PFB decoration only occurs on sand-tempered pottery, and the TRB decoration only on the pottery tempered with granite grit. Although the humber of decorated sherds constitutes only a small percentage total, it is tempting to conclude that in Bornwird also the undecorated, sand-tempered pottery must be ascribed to the PFB group and the granite-tempered sherds to the TRB group (Havelte phase). On the basis of such a conclusion it is hardly permissible to generalize about the TRB pottery and the PFB pottery as distinct categories of uniform composition. The raw material used for making the pots must vary from one region to another, and also the material used for tempering, but probably not the way of shaping vessels and firing them. Nevertheless also Van der Waals noted a difference in tempering that is determined by the archeological culture: 'TRB pottery is tempered with stone grit: PF beakers sometimes are tempered with a little sand; Bell Beakers have grog tempering' (Van der Waals, 1965: p. 125). It is worthwhile investigating whether such a correlation does indeed appear to be consistently present.[7] In practice this means that the technological data will (also) have to be quantified.

A few additional attributes of the pottery have not yet been discussed. First of all the secondary perforations must be mentioned. These occur only on granite-tempered pottery and are always within 3 cm below the rim (fig. 12: i). As the perforations are secondary, they do not have to be regarded as decoration, as is indeed the case in a VL context. With VL pottery the small holes were made below the rim already before firing (Louwe Kooijmans, 1976). In most cases an interpretation as holes made to repair vessels can be excluded. Perhaps these holes should rather be regarded as points of attachment for a skin or lid covering the opening of the pot.

The complex included one body sherd with just the beginning of a handle (fig. 12: m). The fragment is too small to give any clear impression of the shape. The tempering consists of granite grit.

The final element to be discussed is the fragment of a clay disc (fig. 10: a). The thickness of the specimen is 16 mm, and the circumference of the whole disc must have

measured ±200 mm. There are no traces of a hole on the part that has remained preserved; the decoration consists of small holes and nail-prints. According to Davidsen (1974) the thickness is an indication of age (they were made increasingly thicker in the course of time), but so far this has only been demonstrated for the Danish discs. Fragments of clay discs occur both in VL settlements as well as in the TRB culture, although never in large numbers (Bakker, 1979).

To return to the identification of the pottery of Bornwird by other authors (see chapter 1) a number of points are now clear. Firstly, table 4 shows that the sherds with PFB decoration are the most numerous, in an absolute sense. Almost all of them were represented in the display collection, while the sherds with TRB decoration were absent from this. It is therefore easy to understand how the entire complex was labelled 'PFB culture'. The VL aspect that was introduced by some authors must be attributed to the plethora of discoveries of VL sites with PFB pottery (Glasbergen *et al.*, 1967; Van Regteren Altena *et al.*, 1961; 1962). Also the superficial similarity of the pottery (tempering with stone grit, grey colours) and the occurrence of a clay-disc fragment may have contributed towards such a designation. An initial identification in 1966 as pottery dating from the late Bronze Age becomes understandable in the light of a remark made by Bakker and Van der Waals (1971, p. 28): '... on superficial examination, undecorated LHV sherds could be confused with those from the Late Bronze or Early Iron Age,...'.

4. INTERPRETATION

4.1. The site in its setting

A site can be studied at a number of different levels. Unfortunately, the ploughland excavated at Bornwird does not lend itself to analysis at the intra-site level, on account of the absence of structures and the way in which the finds were collected. The artefacts found in the arable land (settlement pottery, flint, *etc.*) indicate that a settlement must be looked for in the immediate vicinity. The obvious place is slightly higher on the local eminence, on which the *terp* of Bornwird now lies.

For analysis at the second level, the site in its immediate surroundings, use is often made of the model of Vita-Finzi and Higgs (1970). There has been a lot of criticism of this method as site locational analysis, *i.a.* because it ignores the importance of non-subsistence factors for the settlement site (Clarke, 1978). Nevertheless the concept of site territory, that forms part of site catchment analysis, is used a great deal as an aid to description. Vita-Finzi and Higgs define it as follows: '...the territory surrounding a site which is exploited habitually by the inhabitants of a site' (1970: p. 7). The site territory of agrarian communities is designated as a circle around the settlement with a radius equal to the distance which can be covered on foot in one hour (or 5 km on level terrain).

The concept mentioned immediately above has also been applied for the description of the district around the presumed location of the settlement near Bornwird (fig. 3). Within its territory the settlement forms the centre of a peninsula surrounded by the coastal peat-bog zone in the west, north and east, and a valley with marsh vegetation and (semi-) permanent open water in the south. The only connection with the Pleistocene 'mainland' lying further south is in the southwest of the region. The situation on a local eminence probably means that the site was well drained, while in view of the deep position of the boulder-clay on either side it is unlikely that the site was suffering from a surplus of water. This last mentioned point is of special importance with regard to the arable land.

If we consider the areas that do indeed lie within the site territory but outside the peninsula just mentioned, then it is evident that the site lies in a central position and gives equal access to a number of different environments:

1. The relatively high-lying wooded area immediately around the assumed settlement site. This is the potential arable land; estimated surface area 700–1000 ha.

2. The relatively low-lying wooded area. Probably more open and with local peat-bog depressions. Regarded as too wet for agriculture; estimated surface area 800–1200 ha. As an arbitrary borderline between these two environments the contour line of 2 m below datum level has been taken (= ±1 m above the sea-level of late Neolithic times).

3. The coastal peat-bog zone; notably in the west quite high and wide.

4. The tidal flat area; probably only accessible in places where the peat-bog zone was eroded away by lagoons or draining rivers. Such a lagoon was certainly present immediately NNW of the site (Griede, 1978, fig. 35).

Such a gradient-rich region is known as an ecotone. These are considered to be rich areas and certainly the peripheral zone of a forest region is eminently suitable for human inhabitation (Odum, 1971). Seen in this light, the location of the settlement at Bornwird is thus ideal rather than marginal.

The above-described naturally bordered peninsula can be considered as the territory of one settlement at most. A second, contemporary settlement cannot be expected in this small area, but the extent of the potential ploughland is large enough to maintain a group of 50–100 persons permanently.[8]

In fact there are indications that other parts of the site territory were used as ploughland. Van Zeist (1955) has discussed three pollen diagrams from the region to the west of Bornwird (Jislum, Lichtaard and Klaarkamp). At various levels in these diagrams low values are present for *Plantago lanceolata* and Cerealia. Notably the diagram for Lichtaard, where the first values for plantain and grain occur at a depth of 155 cm under the surface (in the top of the sand substrate), is of interest for our research. From a stratigraphical viewpoint this occurrence must be dated in the (late) Neolithic. The values higher in the diagram must originate from Bronze Age and Iron Age inhabitation. Van Zeist attributes these traces of human activity to inhabitation of the higher-lying sandy areas to the south of the region (Van Zeist, 1955). In 1955 it was thought that inhabitation was not possible so low on the flanks of the boulder-clay plateau, let alone that agriculture could be practised. As late as 1966 Waterbolk designated the 1 m above datum level contour-line as the extreme limit for both the TRB and the PFB culture. In the light of the present finds, however, the traces of human habitation–in any case the lowest level of the Lichtaard diagram–can perhaps better be explained as indication of the presence of local ploughland.

Although little or nothing is known about the role of stockbreeding for the subsistence of late Neolithic farmers, it can be assumed that stockbreeding was practised alongside agriculture (*cf.* Molenaarsgraaf, Louwe Kooijmans, 1974). In the surroundings of Bornwird the lower lying areas of open woodland probably formed the most suitable natural pastures. Bakels (1982) gives a figure of 1.5 ha per head of cattle as a very rough minimum estimate for the area of pasture required. Yet even if we double this figure, with an estimated surface area of potential pasture of 800–1200 ha this still leaves room for a few hundred head of cattle. Of course such estimates serve merely as guidelines for ascertaining the situation in former times. They are intended primarily to indicate that there was ample opportunity for permanent inhabitation.

At the third level of analysis, the inter-site or regional level, a problem is posed by the small amount and uneven quality of the data currently available. Nevertheless a general pattern can indeed be outlined. Contemporaneous and probably comparable traces of inhabitation have been excavated near Birdaard (Steenendam, Elzinga, 1971; 1972). Investigation of a sample of the pottery showed that here too we are concerned with a mixed LHV-PFB complex (Fokkens, 1980). The location of this site (fig. 3) right next to a deep valley filled with peat is very interesting from the point of view of preservation of any organic remains. In the course of the excavation the 'wet' part of the site was not reached, however. The immediate surroundings closely resemble the territory of the Bornwird settlement. The same environments are within reach, while also the extent of the area that is likewise enclosed by natural boundaries shows great similarity.

A similar environmental situation is also present around Oostrum where LHV pottery has been found. This find presumably concerns a flat grave, while a settlement was possibly present in the neighbourhood. A number of other isolated finds, mainly axes, PFB battle axes, flat graves and small flint complexes are homogeneously distributed over the region. These finds are not registered in fig. 3 because a separate study is to be devoted to their distribution and the interpretation of the settlement pattern.[9]

It is in any case no longer possible to regard the finds in this region as occasional isolated finds outside the actual distribution area. Rather we are confronted with what appears

to be a settlement pattern of farmstead settlements distributed regularly over the region, each with its own territory.

The natural compartmentalization of the landscape has in a number of cases evidently been the point of departure for the division into territories.

4.2. Concluding remarks

A problem that has not yet been discussed concerns the presence of two typologically different pottery complexes that are ascribed to different prehistoric cultures, both in Bornwird and Steenendam. The transition from TRB to PFB culture is still regarded by many archaeologists as an example of ethnic discontinuity. Various arguments seem to support this view: from an archaeological viewpoint there is a conspicuous change in burial ritual and pottery style, while on the basis of palynological evidence two different, apparently culturally linked *landnam* phases were distinguished (Iversen, 1973; Waterbolk, 1954; Van Zeist, 1967).

Those who prefer to consider the TRB–PFB transition in the light of ethnic continuity argue that the observed differences mainly concern burial ritual (Malmer, 1962; Haüsler, 1978). Discontinuity in one sector of culture, however, cannot automatically be implicated in other sectors (Van der Waals, 1976). Since so little is known about the other aspects of late Neolithic cultures, particularly settlement and economy, direct comparisons remain yet impossible. In this respect it is much to be desired that renewed (large scale) research be carried out on the Bornwird and Steenendam settlements.

With respect to the cultural link between the *landnam* phases that was previously assumed to exist, Casparie and Groenman-Van Waateringe (1980) have recently demonstrated that, as far as the Netherlands are concerned, this was an artifact of the archaeological sampling method involved. Therefore neither in palynological data evidence can be found for discontinuity.

In contrast it can be argued that much of the culture change that indeed marks the late Neolithic developments, is due to internal changes within the TRB culture. Already in the Havelte phase the emphasis changes from collective burial in megalithic tombs to individual interments in flatgraves. Besides, with the onset of the Havelte phase form and decoration of the pottery undergo a marked alteration. Seen in this light the TRB–PFB transition is incorporated in larger processes of change, and is less sudden and strict.

As to the factors that triggered those processes, they will have been related to various sectors of the culture system. However, indications are present that the main causes have to be looked for in the realms of the economical subsystem. In this respect Sherrat (1981) showed the importance of the concept 'secondary products revolution' for the explanation of processes of culture change. In our region at least two innovations in economic context can be demonstrated for the late Neolithic. Van der Waals (1964a) showed that the wheel was introduced in connection with the PFB culture. Secondly we might add the introduction of the ard of which the first traces in our region can be dated to the later part of the Neolithic.

The innovations mentioned above may have caused an improvement of existing farming methods, and may even have brought new areas for cultivation within reach. The presence of the Bornwird and Steenendam settlements, both situated in regions previously without (Neolithic) inhabitation, might point in this direction. The observed change in burial practices too, when seen as a change from the use of formal disposal areas (megalithic tombs; Chapman, 1981) to dispersed individual graves (burial mounds, flatgraves), might support this hypothesis.[10] In Chapman's view the abandonment of formal disposal areas would indicate a diminishing pressure on (scarce) resources of arable land.

It is beyond the scope of this article to discuss all the problems that are involved with processes of late Neolithic culture change. Nevertheless I hope to have contributed to the acceptance of the thesis that the TRB–PFB transition is to be explained in terms of ethnic continuity rather than discontinuity.

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6. NOTES

1. In this article the concept of culture is used in the sense of archaeological culture, as defined by Childe (1929, pp. v-vi): 'certain types of remains–pots, implements, oranaments, burial sites, house forms–that are constantly recurring together'. However, the original assumption made by Childe, namely that archaeological cultures by definition coincide with peoples, cannot be automatically included within this concept.

2. For a detailed overview of the origin of the boulder-clay plateau and the development into a cover-sand landscape see Zagwijn and Van Staalduinen, 1975.

3. The doctoral dissertation of Griede (1978) gives an extensive analysis of the Holocene developments in North Friesland.

4. Here it should be noted that no special attention has been devoted to the presence of any gloss produced as a result of use. All the flint has been observed macroscopically, with the aid of only a x10 magnifying glass. It is very probable that closer inspection will show that some specimens classified as waste material do in fact show traces of use.

5. In connection with the lack of data on the spatial distribution of the finds no further study has been made of the waste material.

6. Intentional retouch is meant to describe small flake–or pressure negatives that served to give a tool its shape or to make it sharp. Use retouch is meant to describe the traces of damage (often hardly visible with the naked eye) that arose as a result of the tool being used.

7. Superficial investigation of the late Neolithic settlement pottery of Steenendam and the pottery from the megalithic tomb of Valthe does not contradict this provisional conclusion.

8. The application of Bakels' estimate model for the loess exemplifies this (Bakels, 1978; 1982). Even if one takes 50 ha–taking into consideration the impoverished state of the sandy soils–as the required amount of arable land for 50–100 persons per year, the region is still big enough. With uninterrupted cultivation for 5 years and a fallow period of 15 years a minimum area of 200 ha of ploughland is necessary before the first field can be cultivated over again.

9. The author is occupied with a regional investigation of the western part of the Fries-Drents boulder-clay plateau with respect to the period from Neolithic times until the Early Middle Ages.

10. The idea of using this concept in the explanation of ethnic continuity between TRB and PFB was proposed by J.D. van der Waals in his Rhind lectures in Edinburgh (spring 1983).

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Figs. 4, 5, 6, 8, 9, 16, 17 and 27 are to be found in the fold at the back of this volume.