

THE THREE BRONZE AGE FOOTPATHS XVI(Bou), XVII(Bou) and XVIII(Bou) IN THE RAISED BOG OF SOUTHEAST DRENTHÉ (THE NETHERLANDS)

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ABSTRACT: In the raised bog of Southeast Drenthé, a part of the Bourtanger Moor, 6 prehistoric wooden trackways have been found, of which three footpaths can be dated to the Middle Bronze Age. XVI(Bou) near Emmercompascuum is a plank footpath of oak, dated to 1160 ± 35 B.C.; XVII(Bou), the southern plank footpath near Bargerooterveld, also made of oak, is dated to 1170 ± 50 B.C. and 1195 ± 55 B.C.; XVIII(Bou) near Klazienaveen-North is made of roundwood of pine, and is dated to 1120 ± 50 B.C. The footpaths are built on an ombrogenous peat-bog surface with different types of hummock-hollow systems. On a plank of XVII(Bou) an iron punch has been found, indicating the use of iron in Southeast Drenthé as early as in the Middle Bronze Age. It is very probable that XVII(Bou) and XVIII(Bou) were used for the transport of bog iron-ore, present in the ombrogenous peat-bog at a distance of about 3 km from the bog margin, to MBA settlements on the higher sandy soils. Traces of habitation found in this area provide supporting evidence for the early production of iron in Southeast Drenthé. The dendrochronological dating of XVII(Bou) to 1372 B.C. indicates that the conventional C14 dates of the MBA are about 200 years too young.

KEYWORDS: The Netherlands, Southeast Drenthé, Bourtanger Moor, Middle Bronze Age, peat research, vegetation development, wooden footpaths, iron punch, bog iron-ore.

1. INTRODUCTION

1.1. Situation

From the time of the Late Glacial (c. 12,000 B.C.), in the ice-marginal valley of the Hunze in the Northeastern Netherlands a large peat-bog developed, that ultimately came to be known as the Bourtanger Moor (fig. 1). Up until c. 4500 B.C. the formation of fen peat predominated here, and thereafter mainly ombrogenous *Sphagnum* peat developed. Between 5200 and 3100 B.C., in part of this valley the formation of ferruginous seepage peat took place, and also this seepage peat finally became overgrown by *Sphagnum* peat. By Neolithic times already the peat complex measured up to c. 6 m in thickness, and about 12 km in width. This constituted an enormous barrier for the prehistoric inhabitation of the Plateau of Drenthé, the higher ridges of sand and boulder-clay, that had been deposited here during the Saalian glaciation. This plateau, of which the eastern, partly ice-pushed rim is known as the Hondsrug, is situated about 20 m above the bottom of the Late Glacial Hunze valley.

As early as the Neolithic, people belonging to the *Standvoetbeker* (Protruding-foot beaker) culture (PFB) tried to make a way of access through the peat-bog by means of building a wooden trackway across it (Casparie, 1982). Dating from the Middle Bronze Age (MBA) are the three wooden pathways that are the subject of this article: the southern

plank footpath XVII(Bou) near Bargerooterveld, the footpath XVIII(Bou) near Klazienaveen-North, and the footpath XVI(Bou) near Emmercompascuum (figs. 1 and 2).

1.2. The aim of the study and the framework of this paper

These three footpaths have been discussed at different times in various publications (including van Zeist, 1955a; van Zeist & Casparie, 1966; van der Waals & Butler, 1976; Casparie, 1972; 1978; Casparie & Smith, 1978), but in all of these previous publications an integral approach to the study of these footpaths has been lacking. The aim of this article is to provide an integral definitive report on the various excavations of the footpaths, and on the research that has been carried out on them (palynological and archaeological investigations, studies of the peat stratigraphy, metallurgical research), to enable us to explain more clearly the presence of the footpaths and their (possible) function. The results of this research can give further insight into the prehistoric inhabitation, particularly that of the MBA, in Southeast Drenthé. In the discussion of the paths emphasis will be laid on the southern plank footpath. Notably the relation between the MBA inhabitation and the use of iron is an important aspect of this report.

In section 2 an account is given, albeit on a fairly broad scale, of the vegetation development from the Neolithic (c. 1700 B.C.) until c. 800 B.C., on the

basis of pollen diagrams of *i.a.* van Zeist (1959; 1967) from this region (see also Casparie, 1982 and Casparie & Groenman-van Waateringe, 1980). Also discussed here are the geological situation, the peat stratigraphy and the character of the peat-bog sur-

face during the MBA. Particular attention is given to the formation of siderite, bog iron-ore in a seepage peat environment. The occurrence of siderite near Nieuw-Schoonebeek, in the southernmost part of the Bourtanger Moor, has been closely investigated in this connection (see also van der Straaten, 1981).

In section 3 an account is given of the inhabitation history of this region, in particular relating to the MBA, on the basis of the excavations and the research carried out by J.D. van der Waals, J.J. Butler and P.B. Kooi. The metallurgical investigation of an iron punch by J.A. Charles (Cambridge) is of direct relevance here. An important aspect of this investigation, that is published in this volume (Charles, 1984), is the production of 'sponge iron': a technological process that can explain how the punch was made.

Section 4 gives a detailed account of the actual footpaths, with emphasis on the southern plank footpath. The information presented is based on a number of excavations and reconnaissance surveys. The main points discussed include the method of construction and adaptations thereof, the course, aim and function of the footpaths. In the case of the Klazienaveen-North footpath the information obtained formerly by van Giffen is presented and discussed, and supplemented by data obtained from recent research. Finally, attention is devoted to Landweer's *schalmenweg* (batten pathway) (1902).

In section 5 an attempt is made to give a comprehensive picture of all the information, and of the

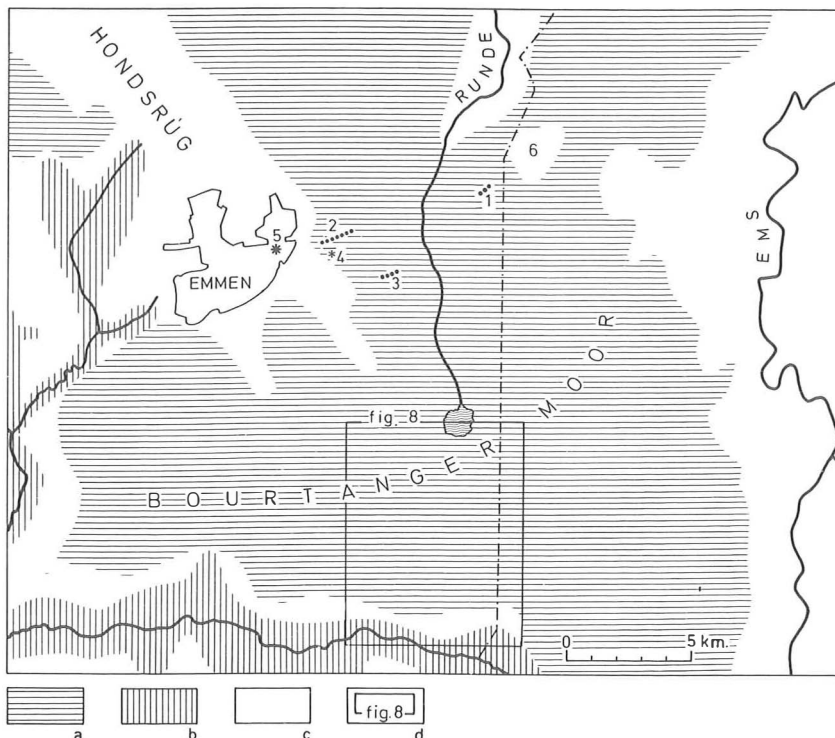


Fig. 1. The original peat-bog situation in Southeast Drenthe, indicating the footpaths. a. raised bog; b. fen peat; c. higher sandy soils (sand and boulder-clay); d. rectangle of fig. 8. 1. The footpath Emmercompascuum XVI(Bou), 2. The southern plank footpath XVII(Bou), 3. The footpath Klazienaveen-North XVIII(Bou), 4. The MBA ritual construction near Bargoosterveld, 5. The MBA settlement of Angelsloo, 6. The sandy areas Schwartenberg-Lindloh.

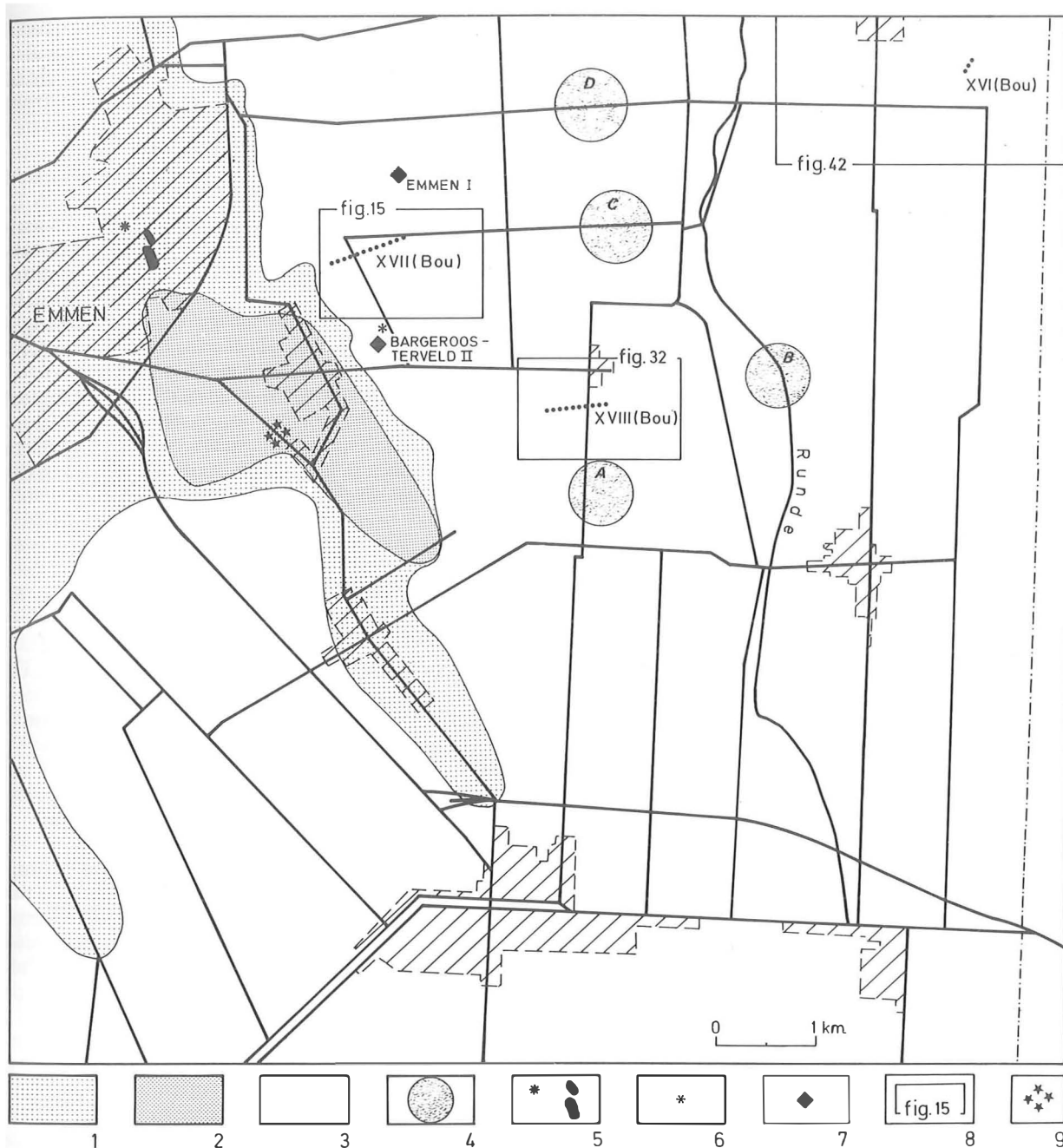


Fig. 2. The peat-bog region of Southeast Drenthe, showing the course of the footpaths. 1. sand; 2. boulder-clay (almost) up to the surface; 3. raised bog; 4. iron-ore areas (seepage centres A, B, C, D); 5. MBA settlement of Angelsloo, with house I3 indicated (asterisk); 6. MBA ritual construction near Bargerboosterveld; 7. sampling sites for pollen profiles Emmen I and Bargerboosterveld II; 8. rectangles of figs. 15, 32 and 42; 9. southernmost point of the Bargerboosterveld Celtic Field complex, where a group of cremation mounds has been found and where a Bronze Age settlement may also be present (3.1).

relationship between the various aspects of these three footpaths and their environmental situation.

1.3. The situation of the footpaths – broad overview

The southern plank footpath XVII(Bou) near

Bargerboosterveld, that can be dated in the MBA, had the function of providing a means of entering that part of the Bourtanger Moor in Southeast Drenthe (fig. 1). Various parts of this path were excavated between 1961 and 1967. This footpath would have been built by the local inhabitants who lived here roughly between 1300 and 1000 B.C.,

traces of whose occupation have been found near Angelsloo on the Hondsrug, near the margin of the peat-bog (B.A.I. excavations, between 1958 and 1967, pers. comm. P.B. Kooi). Presumably these inhabitants regularly visited the extensive area of raised bog. In 1957, in the course of peat-digging near Bargerosterveld, a ritual construction came to light, that can be dated in the MBA (Waterbolk & van Zeist, 1961; van Zeist & Waterbolk, 1960) (fig. 2). On the southern plank footpath an iron punch was found, indicating a very early iron technology (Charles, this volume, and 3.1.1. and 3.1.3.).

The footpath of Klazienaveen-North XVIII-(Bou), made of roundwood, was found in the peat about 2 km southeast of the southern plank footpath. After part of it had been exposed and photographed in 1923, A.E. van Giffen was able to ascertain its method of construction and its course, in 1930; since then this path has never been found again. On the basis of peat stratigraphy a dating between 1500 and 1000 B.C., *i.e.* broadly speaking MBA, seemed to us well possible; a C14-dating has confirmed this. This path too must have been built to give access to the peat-bog from the Hondsrug (fig. 2).

The (presumed) starting-points of both footpaths can be located (fig. 2) on the east flank of a large plate of boulder-clay, from where the Neolithic bog-trackway of Nieuw-Dordrecht (Casparie, 1982) was built a few kilometres to the south.

The higher soils of Southeast Drenthe, that are relatively isolated, were occupied fairly intensively from the Mesolithic onwards, but possibly as early as the Palaeolithic. From c. 3000 B.C. onwards agrarian activities are evident from the pollen record (van Zeist, 1959; 1967; Casparie, 1972; 1982; Casparie & Groenman-van Waateringe, 1980), indicating permanent occupation, that continued also after the Bronze Age.

In the Iron Age too attempts were made to provide access to the peat-bog by means of wooden trackways, undoubtedly for the purpose of exploitation (van Zeist & Casparie, 1966; Casparie, 1972; Casparie & Smith, 1978).

The large plate of boulder-clay, that extends as far as the ridge of Nieuw-Dordrecht (fig. 2) must have been particularly attractive as arable land, in view of the repeated clearances of the forests here since c. 3000 B.C. (Casparie, 1982). In contrast to the intensive occupation activities, the need for providing access to the peat-bog by means of wooden trackways or paths was only slight. During peat-digging operations in this region, since c. A.D. 1850, only five prehistoric trackways or paths have been found, spanning a period of c. 2000 years (between 2100 and 100 B.C.). The Bourtanger Moor was undoubtedly a formidable barrier.

Near Emmercompascuum, Landweer (1902) found a wooden footpath XVI(Bou), that can also be dated in the MBA (Casparie, 1978). This way of access into the bog was almost certainly built from another occupied region: the high sandy areas of Lindloh and Schwartenberg (fig. 1).

The C14-datings used here are non-calibrated values given in years B.P. (before present = A.D. 1950). The datings regularly mentioned in this article are derived from these values, and with the exception of the datings of the peat investigation in 2.3. they are expressed in years B.C. (before Christ). B.P.-datings have been used for the peat investigation so as to permit direct correlation with previously published basic data.

For footpath XVII(Bou) a dendrochronological dating is available; this shows that all the non-calibrated B.C. and B.P. values in the MBA given here are about 200 years too young compared to the absolute dendro-age (4.1.3.).

1.4. Abbreviations

PFB	Protruding-foot Beaker culture (<i>Standvoetbekercultuur</i>)
EBA	Early Bronze Age
MBA	Middle Bronze Age
LBA	Late Bronze Age
(Bou)	Bourtanger Moor (= Bog); used in the classification of prehistoric (wooden) trackways, according to Hayen (1958)

1.5. Acknowledgements

This publication is mainly the result of the peat-bog research and the excavations carried out by the author together with G. Delger and K. Klaassens; Dr. W.H. Zimmermann, of Wilhelmshaven, also participated in these activities. In addition the following staff-members and former staff-members of the Biologisch-Archaeologisch Instituut (B.A.I.) have contributed, often extensively, to the realization of this article: Dr. J.J. Butler, J. van Delden (†), Mrs. I. van Otterloo, H. Praamstra (†), H.R. Roelink, Prof. J.D. van der Waals, Prof. H.T. Waterbolk, Prof. W. van Zeist, J.H. Zwier. Assistance was also provided by G. de Leeuw, formerly of the Provincial Museum of Drenthe (P.M.D.) in Assen, now attached to the peat museum 't Aole Compas in Barger-Compascuum, Mrs. A.F. Smith of Exloo (who investigated reports of finds made), Prof. W.G. Mook of Groningen (C14-datings) and Prof. J.C. Vogel of Pretoria (C14-datings).

Dr. W.H. Zimmermann allowed us to make use of his catalogue of bog-finds. With H. Hayen, of Oldenburg, many aspects of the peat-bog research and the investigation of trackways were discussed.

Of great importance for our research is the work

of Dr. J.A. Charles, Department of Metallurgy and Materials Science, University of Cambridge (U.K.). This is also the case with the dendrochronological dating by Dr. B. Schmidt, Institut für Ur- und Frühgeschichte, Universität zu Köln. Dr. P.B. Kooi and Dr. J.J. Butler provided the text for 3.1. and 3.2., respectively, as well as part of the information presented in 3.3. Drs. M.W. ter Wee, Rijks Geologische Dienst (R.G.D., State Geological Service), Northern District, in Oosterwolde, Ing. W.J. Tonniss and Ir. P. Oosterlee, water-board of Bargerbeek at Klazienaveen, Ing. L. van Dijk and Ing. R.J. Zandstra, Staatsbosbeheer (S.B.B., State Forestry Service) in Emmen, Ing. J.G. Streefkerk, (S.B.B.) in Utrecht, made available partly unpublished information, which has been made use of in 2.3.

The excavations and much of the peat-bog research took place on terrain belonging to the 'Klazienaveen' firm of Klazienaveen, director Ir. K. Meinders, works supervisor G. Hekman (who also collected data concerning finds). The Koninklijke Nederlandse Heidemaatschappij provided technical assistance. The Arbeidsbureau in Emmen made it possible, on a number of occasions, for a few labourers to be recruited for the fieldwork.

The drawings have been made by G. Delger. Mrs. G. Entjes-Nieborg (B.A.I.) typed out the manuscript. Mrs. S.M. van Gelder-Ottway of Haren translated the text into English. Most of the photos were prepared by the Centrale Fotodienst (C.F.D.) of the State University of Groningen. The photos of figs. 31 and 39 are by F.W.J. Colly (B.A.I.).

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2. VEGETATION DEVELOPMENT, PEAT STRATIGRAPHY, GEOLOGICAL ASPECTS

2.1. Pollen analysis

2.1.1. Introduction

In the discussion of the wooden trackway of Nieuw-Dordrecht (Casparie, 1982) an account is given of the forest history of Southeast Drenthe in the Neolithic, from c. 3000-1700 B.C. The information thus presented was based mainly on the pollen diagrams of van Zeist (1959). In that period a number of *landnams* can be distinguished, that are not so much isolated instances of interference with the vegetation as rather accentuations of the clearance activities.

For the description of the forest history in the Bronze Age, roughly from 1700-800 B.C., use has been made of van Zeist's (1959) pollen diagram Emmen I (fig. 3) that is also shown in Casparie

(1982), and van Zeist's (Waterbolk & van Zeist, 1961) pollen diagram Bargerroosterveld II (fig. 4).

With these diagrams the *Quercetum mixtum s.l.* (van Zeist, 1959) has been taken as a basis for calculation; roughly speaking these are the components of the natural forest on the higher soils. The location of the sites for these diagrams is shown in fig. 2. Apart from these diagrams, also various diagrams of Casparie (1972) and a number of unpublished diagrams from this bog region have been consulted. In the pollen diagrams Emmen I (fig. 3) and Bargerroosterveld II (fig. 4) only the trees of the *Quercetum mixtum s.l.* and a few herbs are illustrated, as the discussion is mainly limited to the trees.

In our discussion of the Neolithic trackway of Nieuw-Dordrecht (Casparie, 1982) we have distinguished a number of types of forest, that were affected by human interference after c. 3000 B.C. The situation of these forests is shown in fig. 5. By the MBA these forests had already been interfered with to a considerable extent (Casparie, 1982). The bog was predominantly a treeless *Sphagnum* bog. Here and there small *Pinus* woods were present on dry spots (2.2.3.). Close to the bog margin an *Alnus* carr was present.

On the left side of the pollen diagrams (figs. 3 and 4) a division of these diagrams is given with the capital letters A-I, indicating the forest clearances that have been distinguished. The sections A-D refer to the Neolithic period; they are discussed in Casparie, 1982. The sections E-G refer to the Bronze Age; they are discussed in 2.1.2. Sections H and I can be dated in the Iron Age; these will not be dealt with here.

The forest clearances that have been distinguished have been given time limits. These are of course more approximations of the age of the clearances registered than exact datings.

The higher soils of Southeast Drenthe were continually occupied from c. 3000 B.C. on (Casparie, 1982 and 3.1.). In the MBA the bog was not occupied, but it was entered and exploited (3.3. and 3.4.). We assume that the developments on the higher soils prompted the construction of the footpaths. This article does not concentrate on the demographic development, however. We take the view that the Neolithic cultures and the Bronze Age occupation of this region should be regarded as successive generations of the same population groups.

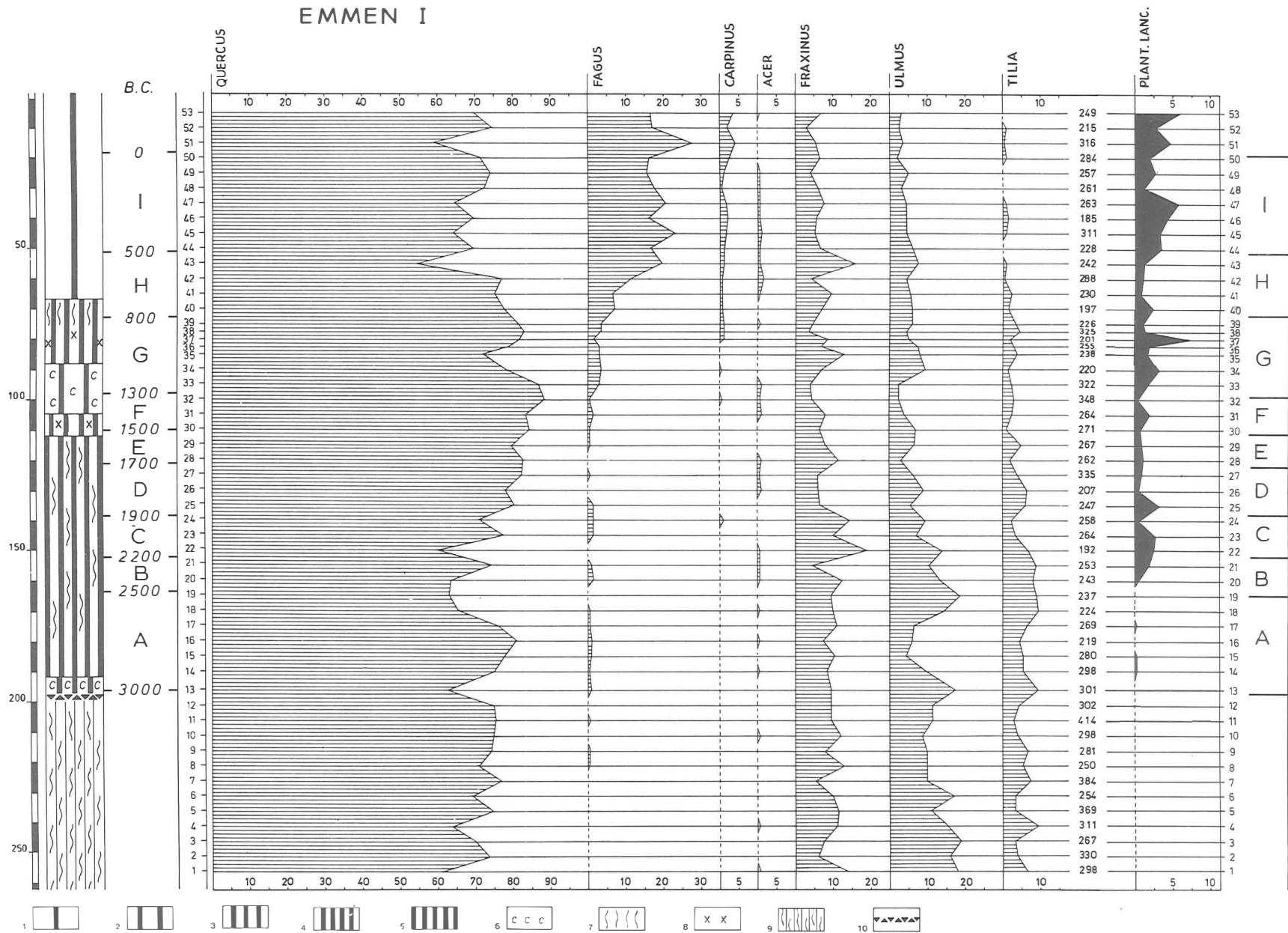
2.1.2.

c. 1700-800 B.C. (figs. 3 and 4)

E (c. 1700-1500 B.C.)

The decline of *Quercus*, combined with the (slight) increase of *Ulmus* and *Tilia* in Bargerroosterveld II

EMMEN I



BARGEROOOSTERVELD II

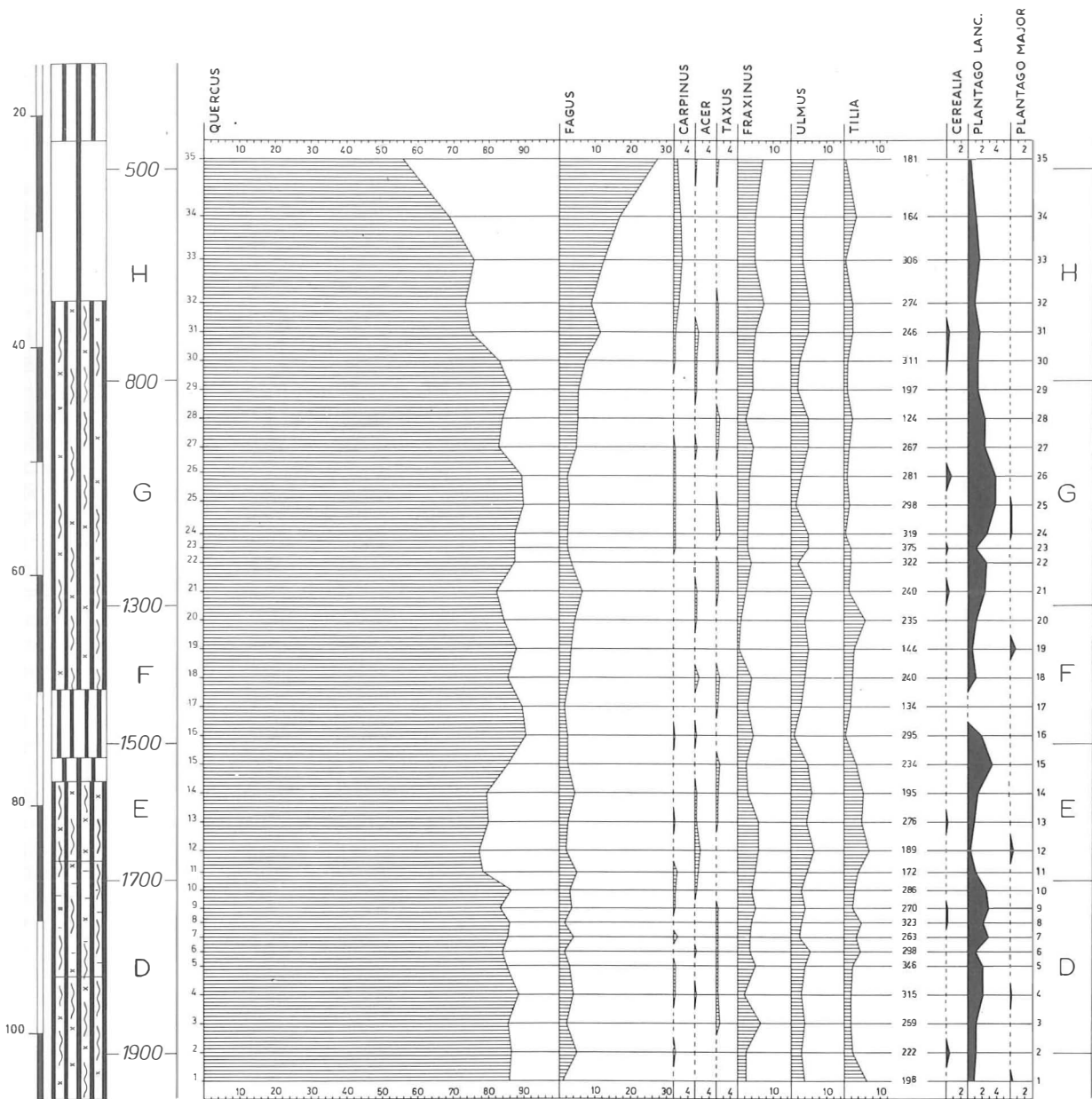


Fig. 4. Pollen diagram BARGEROOSTERVELD II, adapted after Waterbolk & van Zeist (1961: fig. 13). Key: see fig. 3.

(fig. 4) may be an indication of fairly extensive felling of the forest on the poorer cover-sand soils, without any interference with the forests on boulder-clay soil. The development of *Fagus* appears to have been slightly impeded. It is therefore almost certain that this tree was also felled. It would thus have been present on the cover-sand soils. There is a distinct decline of *Plantago lan-*

ceolata. It is possible that the deforested area was used so intensively that the distribution of *Plantago* was severely restricted. Towards the end of phase E *Quercus* increases, together with *Plantago lanceolata*. The area that had been cleared of forest, and that was probably situated close to the bog margin, appears to have been largely abandoned, as a result of which the forest was able to regenerate

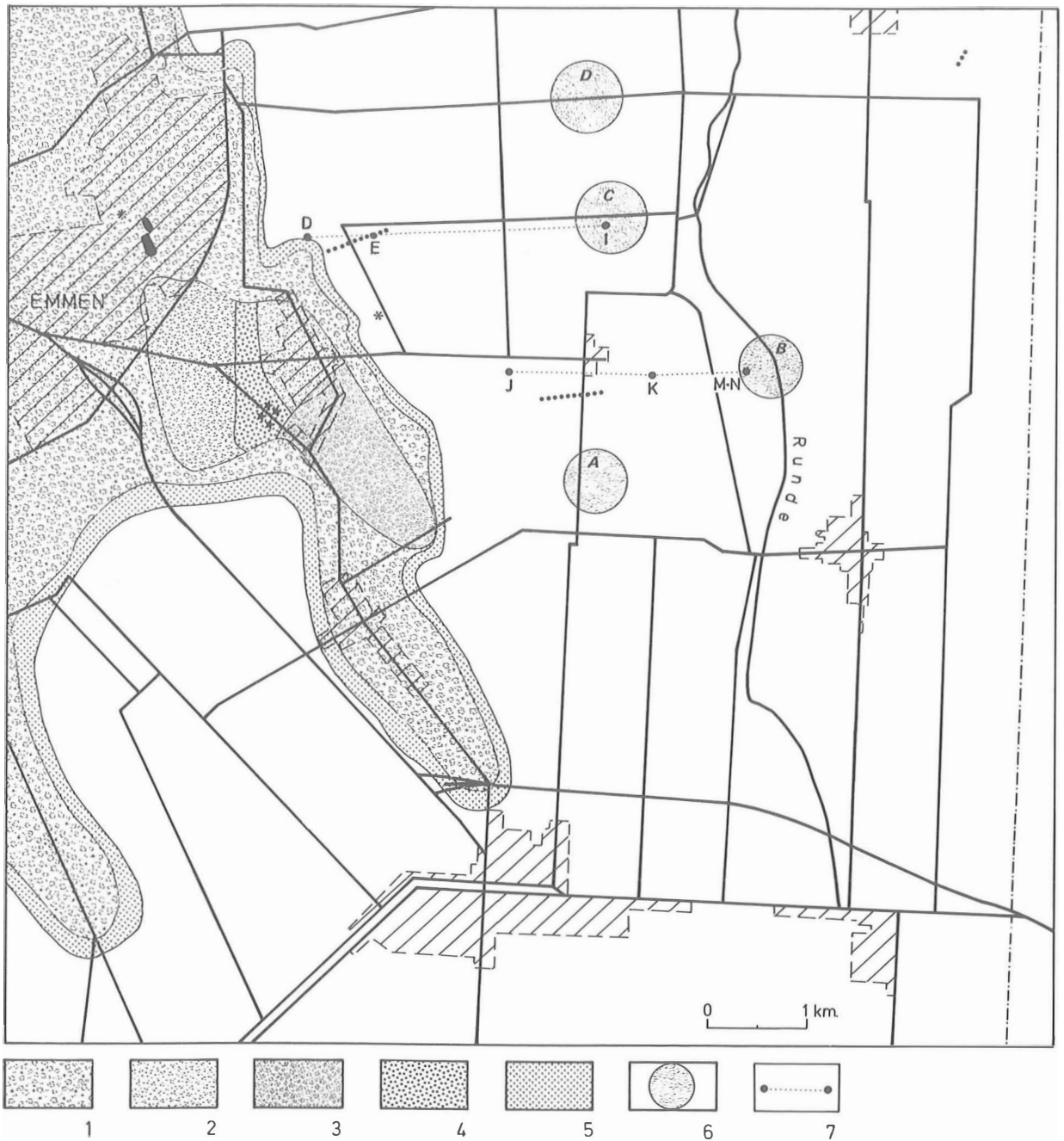


Fig. 5. The location of forest types on the Hondsdrug and of the footpaths in the bog. 1. oak (*Quercus*) forest on cover-sand soils; 2. lime-rich (*Tilia*) forest; 3. elm-rich (*Ulmus*) forest; 4. ash-rich (*Fraxinus*) forest; 5. bog marginal forest, predominantly alder (*Alnus*); 6. seepage centres; 7. sites of the peat sections close to the footpaths XVII(Bou) (upper line) and XVIII(Bou) (lower line).

on fallow ploughland. This is not confirmed, however, by the behaviour of *Betula* (not illustrated here), in contrast to the beginning of this phase, in which birch does react to the felling of the forest, as is evident from an increase in its pollen production.

In Emmen I (fig. 3) phase E is also characterized by a slight expansion of *Ulmus* and *Tilia*. This too can probably be ascribed to the felling of the oak-rich forest on cover-sand. *Quercus* shows a somewhat deviating behaviour. In Emmen I this tree shows a tendency to increase from c. 2500 until

1300 B.C. This pollen diagram is situated at a somewhat greater distance from the bog margin. It therefore records a regional development, in the form of repeated instances of clearance, slightly more than Bargerroosterveld II. In contrast to the situation in phase D, in which there is a distinct decline of *Fraxinus*, it appears that in phase E the ash-rich forest in the very moist to wet side-valley was interfered with only slightly or not at all. This side-valley is a lowland area on the boulder-clay ridge (fig. 2), that is drained towards the north. The side-valley opens out into the Hunze valley just to the west of the footpath XVII(Bou).

F (c. 1500-1300 B.C.)

The slight decrease of *Quercus* in Bargerroosterveld II (fig. 4) combined with an increase of *Ulmus* and *Tilia* indicates renewed felling of the oak-rich forest on cover-sand, while the elm-rich and lime-rich forests were affected much less, if at all. In this phase it is probable that also the *Fraxinus*-rich forest in the very moist side-valley was partly felled, shortly before c. 1300 B.C. The slight expansion of *Fagus* would mainly have taken place on fallow land, where the forest had already been felled previously. The rather low value for *Plantago lanceolata* in this phase deviates somewhat from what is found in many other pollen diagrams from this region (Casparie, 1972). In our opinion this cannot be regarded as an indication of a sharp decline in the population density.

In Emmen I (fig. 3) there is a slight increase of *Quercus* and *Tilia*, while *Ulmus* shows a distinct decline. This deviates from the picture in Bargerroosterveld II. It is possible that only the northern part of the elm-rich forest was felled. In view of the location of the sites for the pollen diagrams (fig. 5), this decline of *Ulmus* would then be well recorded only in Emmen I. Also the *Fraxinus*-rich forest in the very wet side-valley was partly felled in this phase. *Fagus* does not expand. Possibly the cleared area was used too intensively, so that forest regeneration, with expansion of *Fagus*, did not take place. The values for *Plantago lanceolata* are somewhat higher than in the previous phase. The local population may have become concentrated entirely on the north side of the boulder-clay ridge, on which *i.a.* the elm-rich forest developed.

G (c. 1300-800 B.C.)

In contrast to the previous phases this phase spans a relatively long period of time. In this phase, it is no longer possible to detect any distinct *landnams*, accentuated instances of clearance. The region was under cultivation, though the land was not used everywhere equally intensively, so that individual instances of interference with the vegetation are obscured in the pollen production.

In Bargerroosterveld II (fig. 4) *Quercus* initially expands, after which it shows a slight decline. *Fagus*, on the other hand, shows a decline at first, after which it increases. We assume that this indicates mainly some degree of expansion of the *Quercus* forests, and not the felling of *Fagus*. In the *Ulmus*-rich forest it appears that felling activities took place on different occasions. Undoubtedly most of the *Tilia*-rich forest had already disappeared by this time. *Fraxinus* appears to recover; it is possible that the area suitable for the growth of ash expanded as a result of the rise in ground water level in this region, caused by the increasing upward growth of the raised bog in the Hunze valley. The relatively high values for *Plantago lanceolata* and the occurrence of *Cerealia* can be attributed to the intensive MBA occupation of the nearby situated higher soils.

In Emmen I (fig. 3), the sharp decline of *Quercus*, shortly after the beginning of this phase, together with the distinct expansion of *Fagus*, *Fraxinus* and *Ulmus*, can be attributed to felling activities in the MBA, *i.a.* for the ritual wooden building (3.3.), the wooden footpath XVII(Bou) and of course for the construction of the large farmhouses of Angelsloo (3.1.) and for extending the area of ploughland. On the whole *Quercus* tends to decline, indicating a progressive deforestation of the region. *Tilia* is still present to only a limited extent. Evidently there was no regeneration of lime-rich forests. The high values for *Plantago lanceolata* fit in well with the picture of intensive occupation of this region indicated by other evidence.

The discussion of the phases H and I (Iron Age) will be presented in a subsequent study on the pre-historic trackways of this region (Casparie, in prep.).

2.2. The peat-bog: subsoil and stratigraphy

2.2.1. The peat-bog near XVII(Bou) and XVIII(Bou)

The peat stratigraphy of the region in which these footpaths are present is well known (Casparie, 1972). Of the vertical peat-faces we have studied a few sections are presented here for the sake of the discussion of the peat stratigraphy. These sections are illustrated in fig. 6. The locations of these sections are shown in fig. 5.

For the peat stratigraphy near the southern plank footpath parts of the vertical peat-faces D, E and H have been taken. The section from peat-face D shows the situation just outside the Hondsrug slope, in the actual Hunze valley, slightly north of where the side-valley opens out into the Hunze lowland area. The section from peat-face E inter-

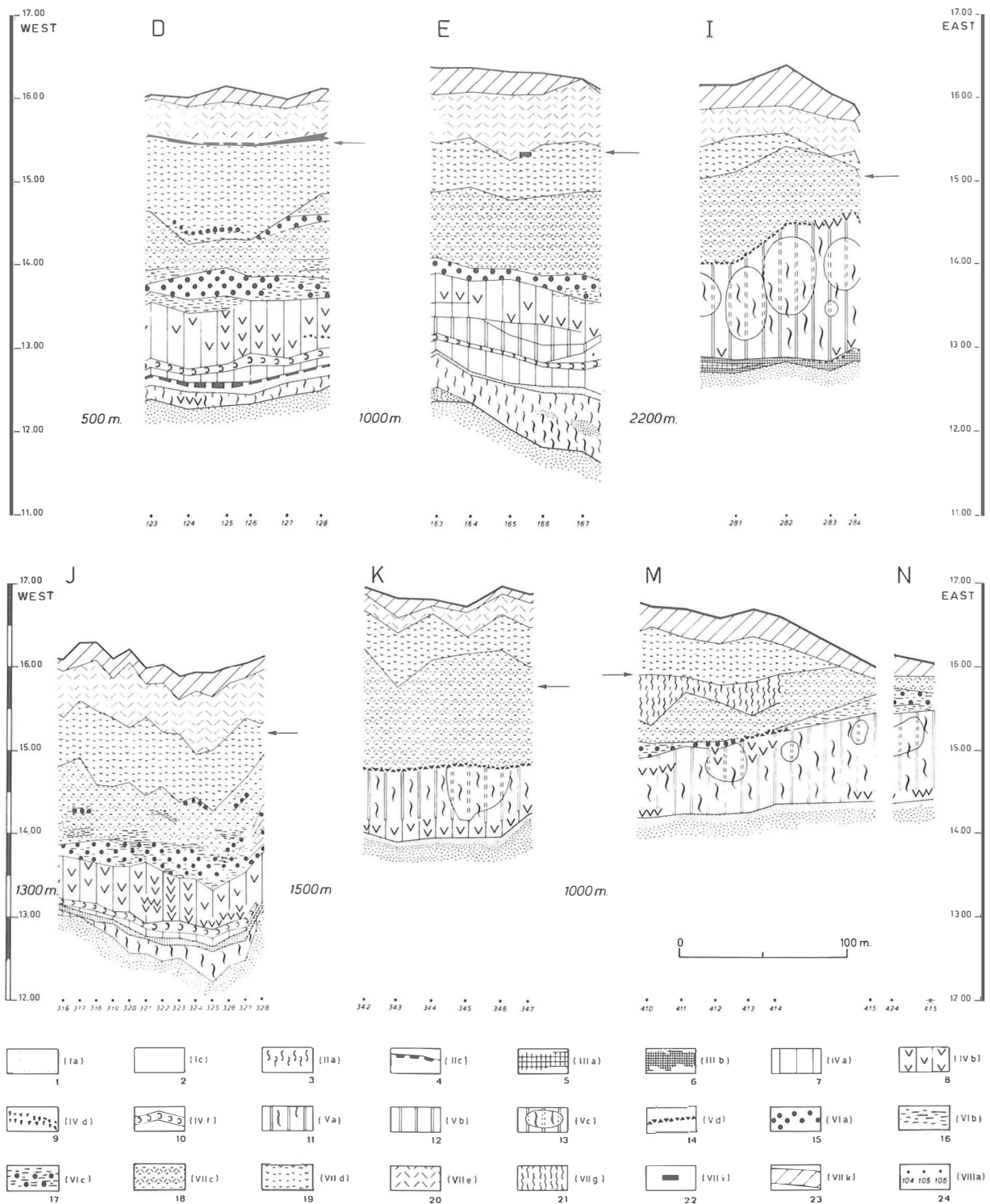


Fig. 6. Peat sections close to the footpath XVII(Bou)(above) and the footpath XVIII(Bou)(below), derived from the vertical peat-faces D, E, I, and J, K, M+N, respectively (Casparie, 1972). Key (the numbers g' fluvial loam; 3. *Braunmoorstorf*; 4. loess layer; 5. orange Boreal gyttja; 6. grey gyttja; 7. fen peat; 8. fen-wood peat; 9. charcoal layers; 10. early Atlantic charcoal layer; 11. seepage peat; 12. ferruginous fen peat; 13. siderite lenses; 14. seepage peat dopplerite layer; 15. pine stumps; 16. *Scheuchzeria* peat; 17. *Pinus-Scheuchzeria* peat; 18. highly humified *Sphagnum* peat; 19. intermediate deposits; 20. fresh *Sphagnum* peat; 21. *Eriophorum vaginatum* peat; 22. cross-section of footpath XVII(Bou); 23. secondary weathered layer; 24. points examined ('pits').

sects the footpath XVII(Bou). That of peat-face I is situated close to the presumed destination area, the seepage centre C.

For the peat stratigraphy near the footpath of Klazienaveen-North sections were taken from peat-face J in the actual Hunze valley, from peat-face K on the gradual east slope of the Hunze valley, and the peat-faces M and N, in the seepage centre B, that we regard as the destination area of the footpath XVIII(Bou).

The peat stratigraphy near the footpath of Emmer-Compascuum XVI(Bou) is known only very roughly, so there is no sense in discussing it here.

In the peat sections the level of c. 1200 B.C. can be clearly indicated. This is done by means of an arrow at this level next to each section. In fig. 6 the distance between the sections themselves is indicated, as well as the distance between the sections and the western margin of the peat-bog around 1200 B.C. (± 19.00 m +NAP). The heights given are in metres +NAP (= Dutch Ordnance Datum). The pit numbers (points examined) correspond to those of the vertical peat-faces studied. For a detailed description of the peat stratigraphy see Casparie, 1972. The distance from the sections chosen to the definite or most probable course of the footpaths concerned amounts to 500 m at most.

In evidence here is the general pattern of peat formation, i.e. first of all fen peat, then ombrogenous peat, with a development from highly humified *Sphagnum* peat via the 'intermediate deposits' with highly humified hummocks and poorly humified hollows, to homogenous poorly humified or fresh *Sphagnum* peat. Between the fen peat and the *Sphagnum* peat, in various places a transitional peat layer with mainly *Pinus* is present. The thickness of the fen-peat layers (including Late Glacial deposits and Boreal gyttja) can amount to about 3 m. The transitional peat layer is usually a few decimetres thick. By c. 1200 B.C. the ombrogenous peat had reached a thickness of about 3 m. As a result of the drainage of the raised bog since the 16th century A.D. the peat has shrunk considerably: the *Sphagnum* peat layer is less than half as thick as it was originally.

Vertical peat-faces D, E and I. The sandy subsoil of D and E is the fluvial base of the actual bed of the Hunze on which *Braunmoorstorf* developed (c. 11,000-9500 B.C.), covered by a layer of loess (9500-8800 B.C.). In the vertical face I the gradual east slope of the Hunze valley is exposed, covered by Boreal gyttja (c. 7000-5300 B.C.). This is still the west slope of the ridge known as the Berkenroderug (Casparie, 1982).

On top of the Late Glacial deposits in the vertical peat-faces D and E there lies non-ferruginous fen

peat (c. 8400-4500 B.C.), in which a number of desiccation layers are present. Locally this fen peat is ferruginous to some extent. On top of this there lies the Middle-Atlantic layer of *Pinus* stumps (4500-4000 B.C.): the base of the ombrogenous peat. This is the brown-black highly humified *Sphagnum* peat (4000-2000 B.C.), and the hummock-and-hollow peat of the intermediate deposits, with the formation of highly humified hummocks continuing until c. 200 B.C. From the poorly humified peat in the hollows there gradually develops from c. 1500 B.C. on the fresh *Sphagnum* peat deposits. The footpath XVII(Bou) is situated in the intermediate deposits.

On top of the Boreal gyttja in vertical peat-face I there lies the ferruginous seepage peat (5200-3100 B.C.), that is here very rich in siderite. At this point we are just on the edge of the seepage centre C (fig. 5), the domed surface of which is still just visible. On top of the seepage peat lies the blue-black highly humified *Sphagnum* peat (3100-c. 1200 B.C.). The intermediate deposits (c. 1200-500 B.C.) here consist mainly of *Sphagnum cuspidatum*-*Scheuchzeria* peat and a raised-bog lake, that emptied c. 500 B.C. (bog burst). Here too poorly humified to fresh *Sphagnum* peat constitutes the topmost peat-layer, after 500 B.C.

Vertical peat-faces J, K and M+N. The sandy subsoil of J is the fluvial base of the actual bed of the Hunze, that here too is overlain by *Braunmoorstorf* (11,000-9500 B.C.), followed by Boreal gyttja (c. 7000-c. 6000 B.C.), and non-ferruginous fen peat (c. 6000-4100 B.C.), in which several desiccation layers occur. On top of this fen peat there lies the Middle-Atlantic *Pinus*-stump layer (4100-3800 B.C.), in which a lot of *Scheuchzeria* is present. This peat is the base of the brown-black highly humified *Sphagnum* peat (3800-2000 B.C.), over which lies the hummock-and-hollow peat of the intermediate deposits (from c. 2000 B.C. on), with the formation of highly humified hummock peat continuing up until c. 200 B.C. The fresh to poorly humified *Sphagnum* peat, here formed out of hollows, originates from c. 1500 B.C. on.

In the vertical peat-faces K and M+N there lies the fluvial loam layer, that here forms the western flank of the Berkenroderug (Casparie, 1982), as base of the siderite-rich seepage peat (5200-3100 B.C.). The domed surface, locally covered by *Scheuchzeria*-rich peat (3100-3000 B.C.) indicates the seepage centre B (Casparie, 1982). The vertical peat-face N was especially rich in siderite.

On top of the seepage peat of the peat-faces K and M+N lies the blue-black highly humified *Sphagnum* peat (3100-c. 1200 B.C.), in which a lot of *Eriophorum vaginatum* occurs. Here too the intermediate deposits (c. 1200-c. 200 B.C.) consist of

highly humified hummocks and hollows, out of which the fresh to poorly humified *Sphagnum* peat (after c. 800 B.C.) forms.

The topmost part of the peat is absent, partly because of the cultivation of buckwheat and the associated burning of the uppermost layer, and partly because of peat-digging activities.

2.2.2. *The occurrence of seepage*

In the peat-bog region of Southeast Drenthe we have distinguished an area with ferruginous Hypnaceae peat, that developed under the influence of seepage. The seepage water came to the surface at four places in the mineral subsoil (Casparie, 1972; 1982; Casparie & Smith, 1978; van Heuveln, 1958). These seepage centres (fig. 5) are characterized by large numbers of lens-shaped concentrations of siderite or bog iron-ore, present in the Hypnaceae peat.

The bog mineral siderite is present in the Hypnaceae peat as ferrous iron oxide in amorphous form (FeO). Van Bemmelen (1895) analyzed the siderite: it consists (when free of water) for nearly 90% of ferrous carbonate, for a few percent of calcium carbonate and for 10% of plant remains. When exposed to the air siderite oxidizes from ferrous iron to ferric (Fe₂O₃). Its colour then changes from yellow-white to orange-red. As the ignition rest has an iron content of about 50%, siderite is a very rich iron ore, that can be relatively easily processed, on account of the absence of mineral components such as sand, loam and clay.

The beginning of the seepage can be dated to c. 5200 B.C., because it was then that the water pressure in this part of the Hunze valley almost certainly became reduced (Casparie, 1972). The seepage centres that we have distinguished (fig. 5) are characterized by the absence of water-sealing deposits such as Late-Glacial Hypnaceae peat and loam on top of the sandy subsoil.

From the time when seepage first began the seepage water was ferruginous. The iron compounds became dissolved in the water during the transport from the infiltration region through soils rich in boulder-clay in the Hondsrug.

All of the Hypnaceae peat in the seepage-peat region is ferruginous. From c. 4500 B.C. on separate lenses with siderite start to form, especially near the seepage centres and in the drainage courses of the seepage water over the mineral subsoil. The lenses are all roughly isodiametrical, from 0.5-10 m in cross-section. The thickness varies from 0.1-1.0 m, usually amounting to 20-50 cm. The seepage comes to an end fairly suddenly around 3100 B.C., possibly due to a catastrophic drainage of the infiltration region (Casparie, 1972). The water supply would generally have been abundant, but any varia-

tions in this are difficult to ascertain. The seepage-peat surface was not horizontal. The formation of peat in the depressions, that did not function as drainage channels of seepage water, was almost certainly very limited. In a dried-out state the thickness was only a few decimetres; siderite lenses are absent here. In the drainage channels the peat thickness was often up to c. 1 m. The seepage centres are characterized by large numbers of thick siderite lenses and a domed surface. The height of this surface was initially not well known to us (Casparie, 1972). Ultimately it became evident that this peat thickness was considerable (Casparie & Smith, 1978): possibly as much as 2 m in total. This means that the extremely siderite-rich peat became overgrown by ombrogenous peat only considerably later (possibly only after c. 1000 B.C.) than the end of the seepage, that is dated to c. 3100 B.C. Up until the date of c. 1000 B.C., the siderite-bearing peat would have been recognizable even from a distance, on account of vegetation that was distinctive or absent altogether. On the basis of the occurrence of peat-bog finds, it is evident that the siderite-bearing peat was recognized as such already in Neolithic times (Casparie, 1982). In any case it was exploited c. 500 B.C. already (Casparie & Smith, 1978). By the time the seepage ended the peat desiccated as a result of which many drying cracks developed (Casparie, 1972), that subsequently must have functioned as drainage channels. This would have facilitated the processing of the seepage peat.

The lowest seepage centre is D. The mineral subsoil was ± 12.40 m +NAP. According to reports the iron-rich peat would have been 2.25-2.50 m thick here (Casparie & Smith, 1978). The base of seepage centre C is at c. 12.60 m +NAP according to reports the iron-rich peat was more than 2 m thick. We have estimated the base of seepage centre A to have been at ± 13.20 m +NAP (Casparie, 1982). Concerning the thickness of the ferruginous peat here we have no data. The highest seepage centre (B) has its base at 14.35 m +NAP. Here the peat thickness was reportedly more than 1.50 m.

2.2.3. *The peat-bog surface c. 1200 B.C.*

The peat-bog surface of Southeast Drenthe, on which the footpaths XVII(Bou) and XVIII(Bou) were built, can be reconstructed reasonably well. The peat-bog types distinguished have been described and numbered previously (Casparie, 1972). The numbering given here below is according to the same system. On the basis of later research (Casparie, 1982; 1984), the information can be elaborated. In fig. 7 the spatial distribution of the peat types (especially hummock-hollow systems) are shown in broad outline.

We are concerned here with predominantly om-

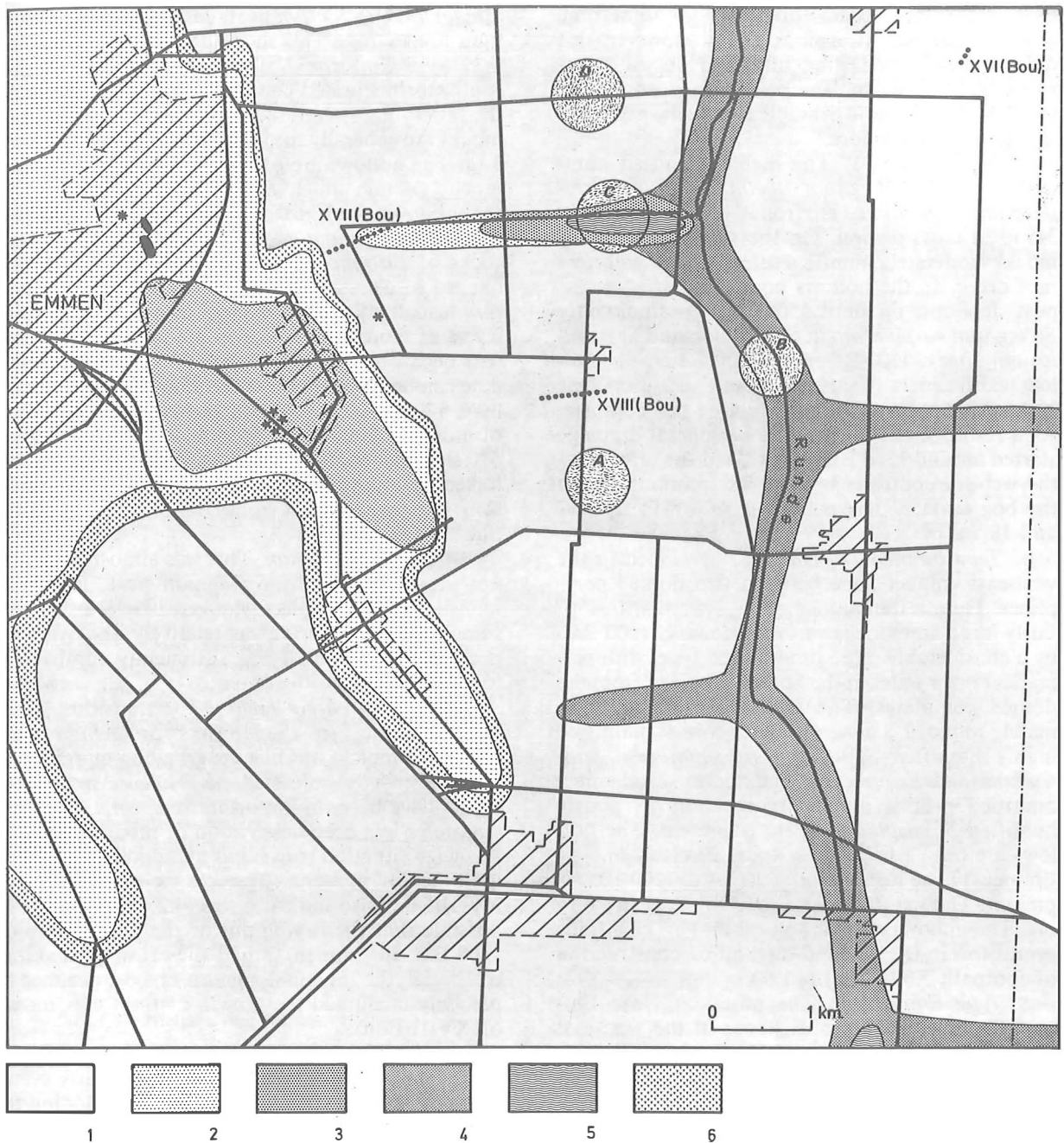


Fig. 7. Outline sketch of the peat surface 1200-800 B.C., indicating the hummock-hollow complexes distinguished, as described in Casparie (1972). 1. type Emmen 9; 2. type Emmen 17; 3. type Emmen 22+23; 4. type Emmen 32; 5. raised-bog lake Emmen 19; 6. bog marginal forest. For the meaning of the symbols on the Hondsrug (sand, boulder-clay and MBA occupation), see fig. 2: 1, 2, 5 and 9.

brogenous peat that started to form c. 4500-4000 B.C. and c. 3100 B.C.: highly humified *Sphagnum* peat, especially *S. rubellum*, with *i.a.* *Calluna*, *Eriophorum vaginatum*, *Rhynchospora alba*, *Scheuchzeria officinalis*. To some extent hummock-hollow systems are present here, although these

cannot be clearly distinguished. Around 2000 B.C. the formation begins of poorly humified moss peat, with *i.a.* *Sphagnum cuspidatum*, *S. imbricatum*, *S. papillosum*. At this stage different hummock-hollow-systems can be distinguished. In some parts of the region concerned it is evident that the

peat-bog surface became dried out for some time around 1200 B.C. (Casparie, 1972). However, this did not have any lasting influence on the hummock-hollow pattern. The peat-surface would certainly have been more passable during the period of drying-out than before.

a. *Type Emmen 9*. The highly humified hummocks, mainly *Sphagnum rubellum*, *Calluna*, *Eriophorum vaginatum*, are round to oval; mostly 3-6 m in cross-section. On the sides of the hummocks moderately humified tussocks of *S. imbricatum* occur. In the hollows poorly humified moss-peat develops: up until 1500 B.C. predominantly *Sphagnum cuspidatum* in open water, and *S. papillosum*; after c. 1500 B.C. mainly the latter. The hollow width generally varies from c. 1 to 7-8 m. This is the principal type of domed raised-bog complex. As a result of the doming the peripheral drainage started around 1500 B.C., which had the effect that the wet-dry contrasts became less pronounced on the bog surface. The pattern is shown in figs. 17 and 18.

b. *Type Emmen 17*. This type developed in the west-east contact zone between two domed complexes. Here a hummock-hollow system with low, fairly large hummocks was overgrown c. 1500 B.C. by a considerably more pronounced type, with permanent open water in the hollows, derived from the domed complexes. The hummocks are approximately round, 2-3 m across. They consist mainly of highly humified *Sphagnum rubellum* peat with *Calluna* and *Eriophorum vaginatum*. Moderately humified peat is absent. In the hollows poorly humified *S. cuspidatum* peat is present. The hollows are only a few metres wide. Precisely in type Emmen 17 the desiccation layer of c. 1200 B.C. is present. The wet-dry contrasts in this type are very big. The hollows were not passable. This also finds expression in the adapted method of construction of footpath XVII(Bou) (4.1.6.).

c. *Type Emmen 19*. The raised-bog lake Emmen 19, that came into existence in the west-east contact zone, was not yet fully developed at this time. Nevertheless, in view of the presence of *Sphagnum cuspidatum*/*Scheuchzeria palustris* deposits, that formed here from c. 1500 B.C. on, the region would have been so wet that it was impassable, even with the help of a plank footpath.

d. *Type Emmen 22/23*. This is the shore zone of the raised-bog lake. Here and there hummocks were present. The hummocks were rather irregular in shape, possibly 3-5 m across. The centre consisted of highly humified *Sphagnum rubellum* peat, with *Calluna* and *Eriophorum vaginatum*. The margin consisted of moderately humified peat, partly *S. rubellum*, partly *S. papillosum*, indicating very wet conditions. The hummocks were frequently visited by birds. The hollows, completely filled with

Sphagnum cuspidatum peat, could have been more than 10 m across. This shore area was not passable.

e. *Type Emmen 32*. This type developed in the south-north situated contact zones, through which the raised-bog stream the Runde flowed. The hummocks are generally round. Their diameter is about 5 m. The hollows are often 5-7 m wide. The hummocks contain much *Eriophorum vaginatum*. In the hollows fresh to poorly humified units of *Sphagnum cuspidatum* are present, as well as tussocks of *Eriophorum vaginatum*. On top is a sequence of *Sphagnum papillosum* and *S. imbricatum*, usually distinctly layered, in which many thin layers of more humified peat are present. The system began to develop after 1500 B.C. No precise date can be given, but it is certainly already present by c. 1200 B.C. The system shows a great number of erosion phenomena, generally slight, indicative of relatively intensive flowing water. This can be linked up with the more pronounced drainage function of these contact zones in comparison with those of Emmen 17.

f. *The siderite region*. This was almost certainly not yet overgrown by *Sphagnum* peat. It is not known what such places looked like. We can assume that the material was relatively dry. We suspect that the material was sufficiently compacted to allow people to dig it out.

g. *The bog-margin region*. The transition from the Hondsrug to the treeless *Sphagnum* bog (domed complex) was marked by a bog-margin forest, that partly consisted of *Alnus*. Also *Pinus* would have been an important tree, certainly after a more or less deep desiccation of the bog surface. In such a situation true *Pinus* marginal forests were undoubtedly present. The choice of wood for XVIII(Bou) also indicates this (4.2.6.). We think it possible that the drying-out of the bog surface c. 1200 B.C. in Emmen 17 had the effect of making the bog in the marginal zone so much drier that it precisely facilitated the growth of the *Pinus* forest of XVIII(Bou).

The surface relief was almost certainly fairly even. The bog-margin zone would have been sloping to some extent. The height of the slope would probably not have been very great, half a metre at most. The hummocks and hollows of the types Emmen 9, Emmen 17 and Emmen 22/23 had some relief, that was almost certainly less than 20 cm. For people crossing the bog the effective height difference would not have been constant, however, on account of the very different carrying capacity of hummock-peat compared to hollow-peat.

The difference in height between the bog margin and the higher centre of the domed complexes was undoubtedly a few metres. The doming here may have been acentric. The differences in height in the

Fig. 8. The peat-bog region close to the Meerstalblok and Nieuw-Schoonebeek; for the location see fig. 1. 1. boulder-clay plate (Hondsrug); the contour lines for 15.00, 16.00 and 17.00 m +NAP show the relief of the top of the boulder-clay. 2. Indication of gulleys/depressions below 15.50 m +NAP. The gulley-shaped depression on the right is the upper course of the Hunze, partly blocked by cover-sand. Below left there is a complex of gulley-shaped depressions, partly hollowed out in the large boulder-clay plate. This plate forms the watershed between the Hunze-Ems system to the north, and the Schoonebeker Diep/Vecht system to the southwest. 3. profile line 1-5 of the cross-section of fig. 11. At no. 1 is situated the profile of Nieuw-Schoonebeek; at no. 5 the profile of Meerstalblok (fig. 10).



region Emmen 19, Emmen 32 and the siderite area were presumably minimal.

As a result of variations in water content, changes in the relief would have occurred (*Mooratmung*). This aspect has been disregarded here.

2.3. The presence of siderite as an example of seepage near Nieuw-Schoonebeek

Near Nieuw-Schoonebeek, in the southernmost part of the Bourtanger Moor, a field-study was made, in June 1976, of a peat complex, in which numerous siderite lenses (bog iron-ore) occur

(fig. 8). The complex in its entirety showed close similarity to the ferruginous peat complex in the area of the footpaths XVII(Bou) and XVIII(Bou), the formation of which could be attributed to the occurrence of ferruginous seepage (Casparie, 1972). This has been discussed above (2.2.2.). The geological situation in the region around Nieuw-Schoonebeek is well known, as is also the peat stratigraphy. Closer study of this peat could provide further insight into the occurrence of (iron-rich) seepage. In this connection it is assumed that the presence of ferruginous peat in an environment otherwise poor in iron could only have occurred

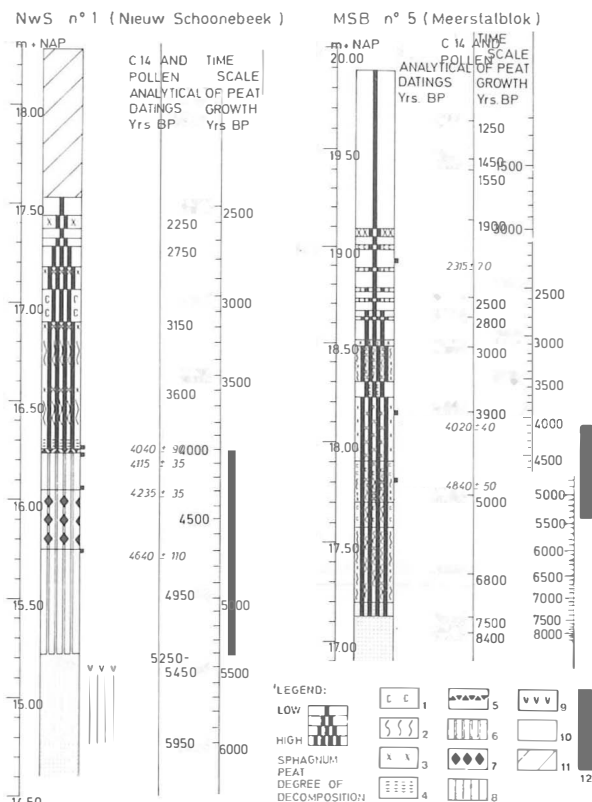


Fig. 9. Profiles of Nieuw-Schoonebeek and Meerstalblok, with time-scale, based on pollen analysis by E. Mook-Kamps (Nieuw-Schoonebeek) and D. Teunissen (Meerstalblok) and on C14-datings (C. van der Straaten, 1981). On the left the NAP heights are given. The synchronous levels of peat formation during the seepage (c. 5500-4000 B.P.) are indicated by a bar. Legend to peat stratigraphy: 1. *Sphagnum cuspidatum* peat; 2. *Eriophorum vaginatum*; 3. *Calluna*-rich peat; 4. *Scheuchzeria* peat; 5. dopplerite layer; 6. ferruginous fen peat; 7. siderite; 8. fen peat; 9. wood layers; 10. sand; 11. disturbed secondarily weathered layer; 12. thickness of peat grown between 5500 and 4000 B.P.

under the influence of seepage.

For this study we were able to make use of the pollen diagrams of Nieuw-Schoonebeek, made by Mrs. E. Mook-Kamps (B.A.I.) and Meerstalblok, made by D. Teunissen of Nijmegen. In particular the lithology column, the NAP heights and the time-scale of these diagrams have been used here, as previously published in van der Straaten (1981) (Casparie, van Geel & Teunissen, 1981). The information is given in fig. 9.

Also available for this study were the (as yet unpublished) data on the hydrological situation in this region, obtained from investigations by the R.G.D., the S.B.B. and the water-board 'Bargerbeek' at Klazienaveen. The area concerned is now largely the national nature reserve of Bargerveen. This study is intended to provide information on the hydrology of this region, specifically to facilitate the management of this nature reservation area (Streefkerk & Oosterlee, 1984).

In fig. 10 is shown a cross-section of the region concerned; the information of fig. 9, in reduced form, is included here too. The location of this cross-section is shown in fig. 8. From the relief maps of this region it can be deduced that the infiltration area must be looked for to the north of the Nieuw-Schoonebeek section, and more particularly to the north of the boulder-clay ridge present here: the NNW-SSE outlying end of the Hondsrug. This boulder-clay ridge here forms the watershed between the Hunze-Ems system on the northeast side and the Vecht-IJssel system on the south and west side. From the pollen analysis and the datings of the two sections it was evident that a distinct difference in height exists between the peat-forming levels in the two systems, which could explain the occurrence of seepage.

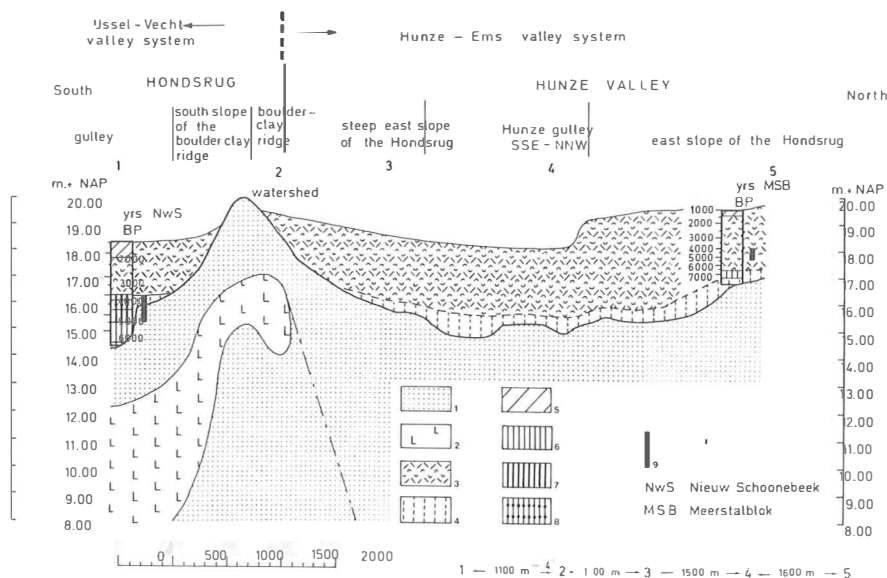


Fig. 10. Extremely simplified cross-section through the region of Nieuw-Schoonebeek (no. 1) - Meerstalblok (no. 5) showing the different areas that have been distinguished on the basis of their specific hydrodynamic conditions. The profiles of Nieuw-Schoonebeek (1) and Meerstalblok (5) are simplified, though they include the time-scale and an indication of the synchronous peat-forming levels 5500-4000 B.P. (occurrence of seepage). When the peat in the Hunze valley (nos. 3, 4, 5) had reached a height of c. 18 m +NAP, water flowed off over the boulder-clay ridge (2) in the much lower lying valley near Nieuw-Schoonebeek (1): 15-16 m +NAP. Key: 1. sand; 2. boulder-clay; 3. ombrogenous *Sphagnum* peat; 4. fen peat; 5-8: in sections NwS and MSB; 5. disturbed, secondarily weathered layer; 6. fen peat; 7. ferruginous fen peat; 8. siderite; 9. thickness of peat grown between 5500 and 4000 B.P.

2.3.1. Nieuw-Schoonebeek (NwS, fig. 9; fig. 8: no. 1 of the profile line)

On the southern flank of the NNW-SSE boulder-clay ridge a number of gulleys are present, in which between 15.00 and 16.30 m +NAP ferruginous Hypnaceae peat with siderite lenses is present, overlying fen peat or a thin layer of gyttja. The Nieuw-Schoonebeek profile comes from such gully. The formation of the ferruginous peat can be dated to between c. 5500 and 4000 B.P. The Hypnaceae peat is overgrown by ombrogenous *Sphagnum* peat. The transition between the two kinds of peat is very clear. It is therefore likely that this overgrowing process took place in a very short time, c. 4000 B.P. The ferruginous peat also covers the above-mentioned southern flank of the boulder-clay ridge, up to a height of c. 16.40 m +NAP. The gulleys filled with ferruginous peat, that all drain towards the SW, are situated so high in the Vecht-IJssel system that the supply of iron-rich water must have come from a higher lying system, so that the water passed alongside the boulder-clay ridge (fig. 8: 2). From the relief maps of this region it can be deduced that the most likely infiltration area lay 2-5 km north of the NwS profile. Here there is a channel-shaped depression, about 1 km across, blocked by a cover-sand plateau (fig. 8: 3, 4, 5).

2.3.2. Meerstalblok (MSB, fig. 9; fig. 8: no. 5 of the profile line)

This section is situated on the cover-sand plateau, that lies roughly between 15.50 and 17.00 m +NAP. The base of the channel (the Hunze bed) lies roughly at 14.80 m +NAP. The formation of peat began here c. 8000 B.P. Initially there was sedge-birch peat, later some alder peat. From c. 7500 B.P. on the formation of ombrogenous *Sphagnum* peat begins here. By about 1000 years later all the birch-, sedge- and alder-peat has become overgrown by ombrogenous peat (profile MSB, fig. 9). Against the slope of the Hondsrug a *lagg* zone develops, in which mainly *Scheuchzeria* is dominant (Casparie, 1972).

The formation of ombrogenous peat in this section is remarkably slow. Up until c. 4000 B.P. the rate of peat growth is less than 3 cm/100 years (Casparie, van Geel & Teunissen, 1981). Only after c. 3000 B.P., when poorly humified *Sphagnum* peat is mainly formed, does the rate of peat growth reach values that frequently occurred elsewhere in the bogs of Southeast Drenthe. All this applies to peat that has been found recently, in a considerably dried-out state.

If we compare the time-scales of the NwS and MSB (fig. 9), then a distinct difference in accumulation of organic material is evident; this is accentuated by

a black bar, that indicates the time span 5500-4000 B.P. The situation at Nieuw-Schoonebeek suggests that there was still plenty of water present here. Obviously there must have been plenty of water for the formation of seepage peat to have occurred. At Meerstalblok it seems as though only after 4000 B.P. the water supply was abundant enough for the optimal formation of ombrogenous peat; *i.e.* a situation of water surplus prevailed, with the surplus being discharged over the surface of the bog (Casparie, 1984).

2.3.3. Conclusions

Judging from the present-day dried-out situation, between 5500 and 4000 B.P. (the period of ferruginous peat formation in NwS) the peat forming level in NwS lay 2.40 to 1.70 m lower than in MSB (fig. 9). In this section (MSB) the peat accumulation was half as much as what was deposited in NwS (c. 50 cm, as compared to c. 100 cm). On the basis of the mineral composition and the topography of this region (fig. 10) it can be assumed that the watershed above c. 17 m +NAP (the top of the boulder-clay ridge in fig. 10, point 2) was no longer effective as such. The uppermost sand deposits in this region are readily permeable to water. We now assume that at that time (5500 B.P.) in the Hunze valley (fig. 8: 3, 4, 5) the peat-forming level had reached a certain height above 17 m +NAP, the boulder-clay ridge (fig. 8: 2) was no longer a barrier for the water, and the discharge of water began from the Hunze valley through the watershed towards the south; *i.e.* there was leakage through the watershed, in the direction of Nieuw-Schoonebeek (fig. 8: 1). In the water that thus flowed southwards, iron compounds from the boulder-clay undoubtedly became dissolved, so that in the gulleys on the south flank of the boulder-clay ridge there originated the iron-rich environment, in which Hypnaceae developed. Not only did the Hypnaceae build up a ferruginous peat unit between c. 5500 and 4000 B.P. Between c. 4600 and 4200 B.P. also siderite was deposited (fig. 9). The peat-forming levels between 5500 and 4000 B.P. lay higher than is shown in figs. 9 and 10. The original levels can be ascertained reasonably well by assuming a shrinkage of the peat of 50%, which broadly speaking is a realistic value for this region. The levels found by us (as given in figs. 9 and 10) are put between brackets here. This also applies to the height difference ascertained. The levels are expressed in metres +NAP.

	Nieuw-Schoonebeek	Meerstal-blok	Height difference
End of the seepage	17.70 m (16.27 m)	19.10 m (18.13 m)	1.40 m (1.86 m)
Beginning of the seepage	15.70 m (15.25 m)	18.15 m (17.62 m)	2.45 m (2.37 m)

A height difference of ± 2.50 m over a distance of 2-5 km appears to be sufficient to start off seepage and to maintain it for a considerable time. Around 4000 B.P. (the end of the seepage) the height difference has decreased to ± 1.40 m. This may have been too slight to maintain the seepage. Another factor that undoubtedly played a role here is that precisely after this time in MSB the large-leaved *Sphagna* of the section *Cymbifolia* started to expand, species that can hold considerably more water than the *Sphagnum rubellum* of the highly humified moss-peat.

The end of the seepage is therefore not necessarily linked only to a decrease in the height difference between the infiltration area (MSB) and the seepage area (NwS) to less than 1.40 m. The development of a peat-forming environment, that on the one hand requires more water and on the other hand can hold more water (fresh to poorly humified moss peat), can also have a great influence on the cessation of the seepage. From this information it is interesting to note that only a slight difference in height (probably less than 3 m) in suitable readily permeable layers can start off seepage and maintain it, over a distance of 2-5 km (and possibly even further).

In view of the height difference between the seepage peat deposits in the area close to the footpaths XVII(Bou) and XVIII(Bou) (possibly up to c. 17 m +NAP) and the boulder-clay deposits on the Hondsrug further to the west (up to c. 23 m +NAP) it is very likely that iron-rich seepage occurred from the Hondsrug over a distance of about 10 km (Casparie, 1972). The earlier occurrence (2000 to 1000 years earlier) is undoubtedly connected with the fact that the original situation here was different to that prevailing in the region of NwS and MSB.

3. HABITATION HISTORY

3.1. The Middle Bronze Age habitation of Angelsloo-Emmerhout (P.B. Kooi)

In the years 1958-1967 archaeological research was carried out on a wide scale on the site planned to be built up as the residential areas of Angelsloo and Emmerhout, immediately to the east of Emmen. In the course of this research, over a distance of about 1500 m in the main direction of the Hondsrug traces of habitation were found dating from the Palaeolithic, the Neolithic, the Bronze Age and the Iron Age.

On the whole, the traces that predominate are those of the Middle and Late Bronze Age, among which could be distinguished ground-plans of houses, barns, fencing-structures, burial mounds

and urn fields (van der Waals & Butler, 1976). Although the total surface cannot be thoroughly investigated everywhere, it is possible to deduce from the density of traces, the differences in house types and the C14-datings available that in the MBA three settlement nuclei were present situated 300 and 500 m apart, respectively, indicated in fig. 2: 5 as MBA settlement Angelsloo. The C14-datings range from 1370 ± 60 B.C. to 880 ± 35 B.C.

A feature that is of importance for the possible relation between the settlement of Angelsloo and other finds in the vicinity, notably the southern plank footpath XVII(Bou), is the ground-plan of house no. 13 in the northern nucleus (fig. 2). This house is oriented more or less north-south, and when it was first built it measured 18 m in length and 7 m in breadth. Later an extension was built on the north side. The wall consisted of wattle. The pattern of the wall traces shows that the house was rounded at each end. Furthermore the wall was interrupted by three entrances: one in the short south side, and two in the long walls of the northern part. In the wall itself there stood fairly heavy wall-posts. Two rows of post-holes indicate a supporting structure of cross-beams, while in the northern and southern part central posts were also present, that would have supported the weight of the roof ridge.

From traces of boxes for cattle it is evident that the animals were stalled in the middle part. The southern part contained a hearth-pit and would therefore have been the living area. As to the function of the northern part nothing can be said with certainty. In the hearth-pit charcoal and a lump of iron were found. A sample of this charcoal gave a C14-date of 3090 ± 60 B.P. (GrN-5775). Consequently it is evident that iron was processed or worked in the MBA. Unfortunately the lump of iron concerned has been mislaid, so it is not possible to carry out an analysis with regard to its place of origin.

Concerning the development of the settlement of Angelsloo (fig. 2: 5) in space and time, a number of conclusions can be drawn from various data. From the presence of three urnfields that were used contemporaneously it is evident that the situation assumed for the MBA also existed during the LBA: i.e. that in the Bronze Age too there were three settlements. Two of them have already been found in the excavation area.

The (early) Iron Age is represented by settlement traces to the north of MBA Angelsloo (fig. 2: 5) and furthermore by the occurrence of cremation mounds and arable complexes, Celtic Fields. These fields extend from at least 1100 m north of MBA Angelsloo to 2500 m to the south. At the southernmost extremity of the Celtic Field complex of Bargerosterveld (fig. 2: 9) lay one of the groups of cremation mounds, which when levelled yielded

pottery of the type Ruinen-Wommels I. By analogy with other observations, the associated settlement must have been situated in the immediate vicinity. The relationship with the settlement complex Angelsloo-Emmerhout (fig. 2: 5) can be regarded in two ways: either the settlement at Bargerboosterveld originated as an offshoot of the Angelsloo-Emmerhout settlement, or this settlement originated at this spot from a Bronze Age settlement.

In view of the Bronze Age finds from the adjacent peat-bog region, to be discussed under 3.3., the second possibility seems to be more likely. In that case this (fig. 2: 9) would appear to be the settlement from which XVIII(Bou) could have been built.

3.2. Indications of iron production in the Middle Bronze Age (J.J. Butler)

In the Netherlands, iron finds were hitherto unknown prior to around 700 B.C., when the Iron Age conventionally begins in this region. With the arrival of Hallstatt C influences, rich warriors' or chieftains' graves occur, if only in small numbers, in which iron weapons and accoutrements may be present.

But how do we account for the occurrence of an iron tool, however modest in size, on a plank of footpath XVII(Bou) in southeastern Drenthe, in use only briefly in the local MBA, some half a century earlier than the Hallstatt C *Fürstengräber*?

Although the iron punch or awl from this plank footpath now takes its place as one of the earliest well-dated iron objects in Europe, it is important to bear in mind that it is not the only, nor even the earliest European iron artifact in a pre-Iron Age milieu. Publication of the Third Symposium proceedings of the 'Comité pour la sidérurgie ancienne de l'UISPP' (1981), greatly facilitates the attainment of an overall perspective on the present state of knowledge on this question.

The survey of early iron finds in Greece by Varoufakis (1981), for example, reveals that while objects of meteoric iron occur in the 16th to 13th centuries B.C., one dated find of nickel-free, and thus presumably smelted iron is of the 13th century, and several others are of the 12th century. The 13th century find is a finger-ring from Mycenae, the 12th century finds are iron knives from the cemetery at Perati. The source of these objects is unknown.

In the South Russian region, objects generally similar to that from our footpath XVII(Bou) have been claimed from settlements of the Srubnaja Culture, dated to around 1500 B.C. From the site of Voronež there is even evidence for local production, in the form of a smelting hearth and slags (Shramko, 1981: p. 109, Taf. I: 2, 3; Pleiner, 1981: pp. 115-128, esp. Abb. 9: 2, 3, p. 126 n 19). In his

footnote last cited, Pleiner, however, suggests that the dating may not be quite certain.*

Well known by now is the iron dagger handle (Vlček & Háček, 1963) or dagger blade (Vlášar, 1973; 1974) with three bronze-capped rivets found in 1956, stratified together with abundant remains of the Otomani Culture, in a well in an EBA settlement at Ganovce near Poprad, in northeastern Slovakia.**

For this find there is, at any rate, no doubt as to the reliability of the dating. The stratigraphy of the well leaves no doubt as to its association with the material of the end of the EBA in that area. Through the kind mediation of Dr. B. Novotný (Prehistoric Seminar, Bratislava) a sample of wood (*Picea*) from the lining of the EBA well was dated in the Groningen C14-laboratory. The determination was 3415 ± 35 B.P. (GrN-7319) in conventional C14 years. This agrees well with C14 results from sites of the same period in, for example, Switzerland and the Netherlands.

The Ganovce iron object was examined metallurgically by J. Pelikán (Prague). The results have not been published in detail, but it is mentioned that there was a high content of cobalt, and that 'the iron is not of meteoric origin but was made metallurgically' (Vlček & Háček, 1963: p. 436). As to its origin, it is regarded as being an import object from the Near East. For this attribution there is, however, no direct evidence.

Of approximately the same age is an alleged iron finger-ring from Lower Saxony. In 1928, in the course of a rescue excavation of a series of tumuli at Vorwohlde, Kr. Sulingen (now Kr. Nord-Sulingen), Sprockhoff (1930) found, in the central grave at ground level under Tumulus B, an EBA 'Sögel' man's grave, with remains of a skeleton in a decayed coffin, fragments of a dagger, a *geknickte Randbeil*, a strike-a-light, and hollow-based arrowheads. Also in the grave, at waist level, was a fragment of what was reconstructed and published as an iron finger-ring. Analysis by Dr. Tüxen (Hannover) showed that the oxidized remains were of pure iron. Discussion of this find at various conferences has revealed that it is regarded with reserve by some German colleagues, who suggest that it could be the remains of an iron nodule; the combination

* An even earlier iron find, a leaf-shaped spearhead from the *kurgan* of Bickin-Buluk in the steppe region near Elisty, between the Volga and the Don, has been determined as a cold-forged object of meteoric iron (Shramko, 1981: p. 109, Pl. I: 1; Pleiner, 1981: p. 121, Abb. 9: 1, p. 126 n 19).

** Original publication: E. Vlček & L. Háček, 1963: pp. 427-439. Subsequent discussion in various works of J. Vlášar (1973: pp. 253-257, Abb. 35-6; 1974: p. 1, pp. 11-12, p. 40 (no. 96), p. 41 (no. 97), Taf. 12A; 1981: p. 221, Abb. 7). Colour photograph: Ozdání, 1983. Black-white photograph: Vlášar, 1976: Pl. 29. Drawing: Vlček & Háček, *op cit.*; Vlášar, 1973: Abb. 35; 1981: p. 221, Abb. 7; Pleiner, 1981: p. 115, Abb. 1.

strike-a-light and nodule commonly occurs in such graves.

Pleiner (1981: p. 115, p. 126 n 6) cites the presence of an iron rod enclosed in a bronze ingot in the hoard of Suchdol in Central Bohemia. This hoard gives its name to the Suchdol phase, which is equivalent to the Ha A1 of Müller-Karpe, conventionally 12th century B.C., and thus not too far off from the date of the southern plank footpath XVII(Bou).*

These finds show that the southern plank footpath iron find is by no means isolated in Europe, and that the occurrence of an iron object in a pre-Iron Age context is by no means an event that *per se* requires explaining away as an intrusion. Casparie shows in this paper that in the raised bog area of southeastern Drenthe all the prerequisites were present for early iron working, and Charles (this volume) suggests that small quantities of iron

could have been produced incidentally to bronze production through the use of bog iron as a flux. One shall have to wait with patience for further evidence as to occasional local iron-working in the Bronze Age, as such evidence can come to light only under very exceptional conditions.

3.3. Middle Bronze Age peat-bog finds

The sanctuary in the raised bog near Bargerooosterveld. In 1957, in the course of peat-digging operations fragments of wood and stones were found, these being the remains of a ritual construction, situated about 300 m from the western margin of the peat-bog, c. 650 m south of the footpath XVII(Bou) (Waterbolk & van Zeist, 1961). In that same year these authors carried out a more detailed investigation. Most of the information mentioned here is derived from their publication. The preserved fragments of wood and the stones are now kept in the P.M.D. in Assen. The construction, illustrated by the excavation photo of fig. 11 and the excavation drawing of fig. 12 (Waterbolk & van Zeist, 1961: figs. 2 and 3) is dated to 1290 ± 65 B.C.

* Jockenhövel, 1971: p. 94, also n 3; Von Brunn, 1968: p. 92, p. 96, p. 111, p. 269, p. 302; Kytlicova *et al.*, in *Acta Musei Reginae hradecensis* Ser. B 7, 1964, pp. 143-180, esp. p. 177-p. 179 (Tabelle). The iron object is not mentioned in any of these references.

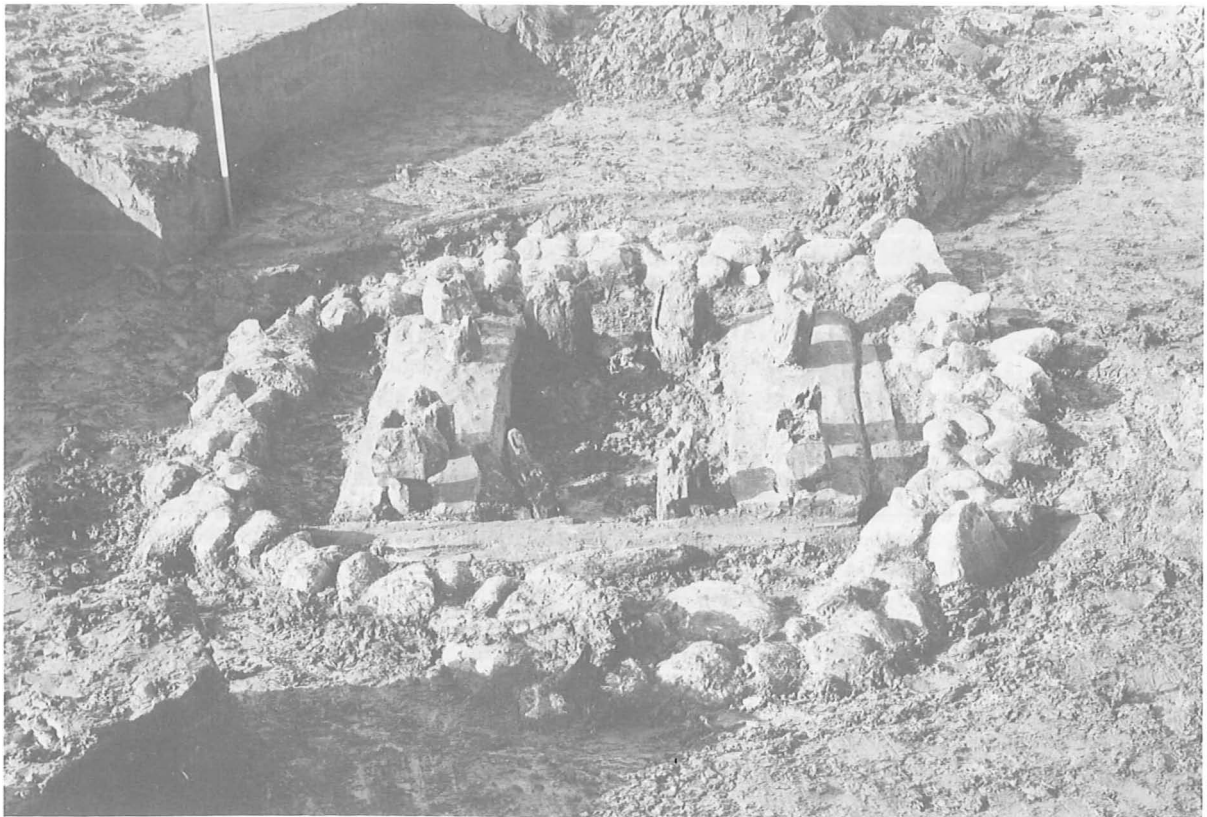


Fig. 11. The ritual construction in the peat-bog near Bargerooosterveld (Waterbolk & van Zeist, 1961). Photo B.A.I., J. Dijkstra.

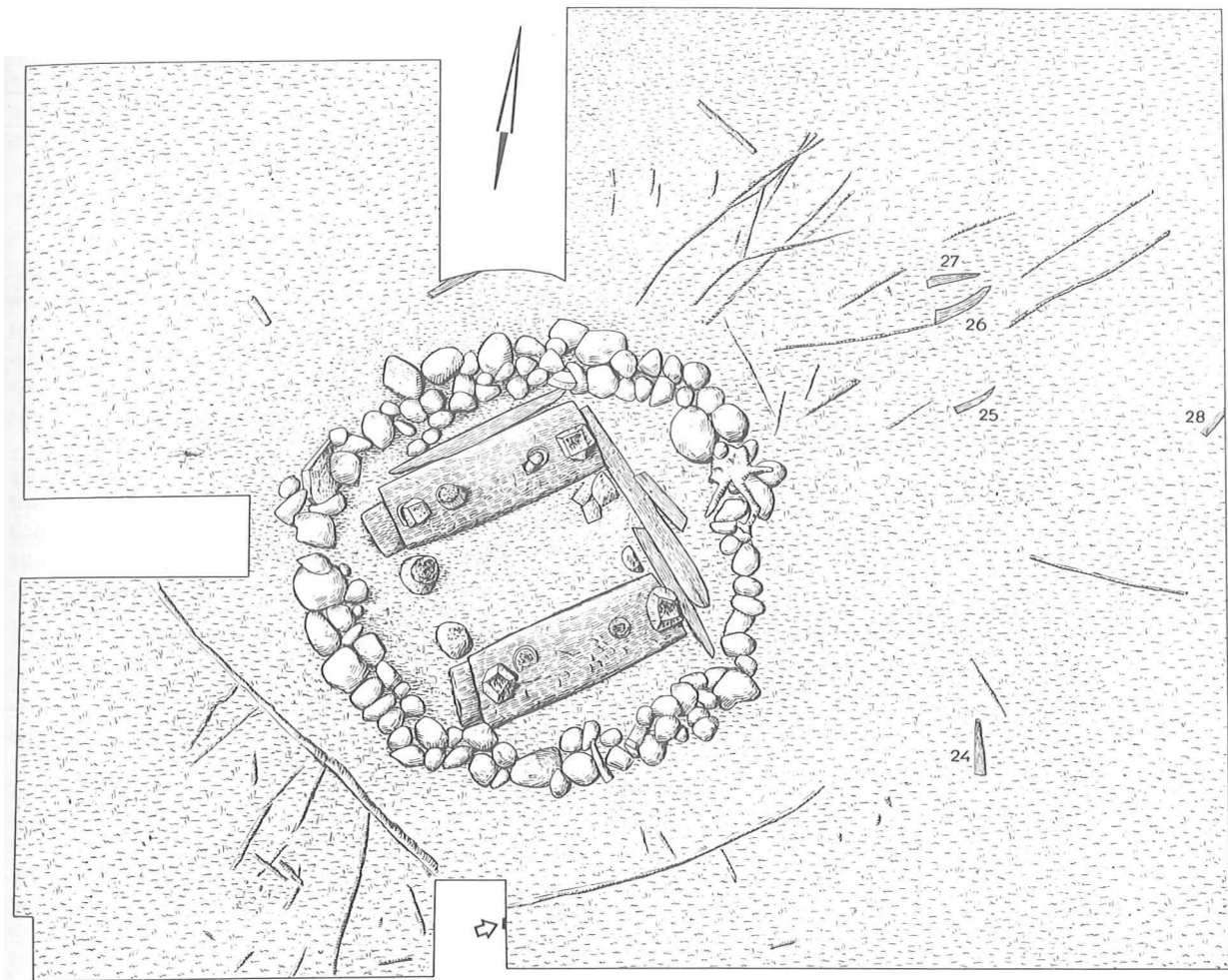


Fig. 12. Excavation drawing of the ritual construction near Bargerosterveld, 1957. Drawing B.A.I., B. Kuitert.

(GrN-1552) (Lanting & Mook, 1977). Broadly speaking it is situated mid-way between the footpaths XVII(Bou) and XVIII(Bou) (figs. 2 and 5). It is about 100-170 years older than these footpaths, therefore the construction and the footpaths cannot automatically be assumed to be of contemporary age. Nevertheless, the construction undoubtedly does represent a MBA activity in the bog. Its builders would almost certainly have lived in or close by the settlements, where (later) the builders of the footpaths lived. For a description of the construction elements and the method of building used see Waterbolk and van Zeist (1961).

The species of wood used (*Quercus*) indicates that the construction elements were made on the higher soils, the Hondsrug, as was also the case with the footpath XVII(Bou). In this region the boulder-clay is present in various places at very high levels. It can be assumed that the boulders of the stone ring also originated from this region. The

large quantity of wood chips, that have been found in the occupation layer, indicate that the construction elements were finished off at the building site. In the case of the footpath XVII(Bou) we have not been able to show this. The sand that was found by the excavators we do not regard as a floor that was laid down purposely. We are convinced rather that it was brought into the bog, unintentionally, merely clinging to the boulders, the wood, people's footwear, *etc.* It is notable that around the construction no traces whatsoever have been found of any settlement material or other extraneous objects.

The building method employed, in particular the 'foundation', appears to be more suitable for constructions on sand than in a peat-bog. This supposition is completely in agreement with the unique character of the construction.

We do not agree with the view of Waterbolk & van Zeist (1961) that from the way in which the posts have rotted it can be deduced that the con-

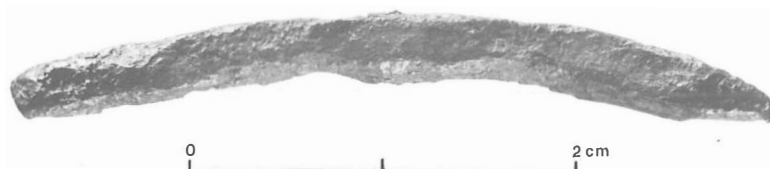


Fig. 13. Iron punch, found in trench 4 (fig. 18). Photo C.F.D.

struction was destroyed on purpose. Wood that has decayed naturally can show exactly the same rotting phenomena.

We can assume with certainty that no cremation took place at this spot. Any cremation remains (in particular charcoal) would undoubtedly have been recognized as such by the peat-diggers and the excavators. There is no evident connection with mortuary houses. In our view it is more likely that the construction had a ceremonial significance, related to the veneration of the bog, in whatever way this may have been carried out.

The iron punch. On March 28th 1961, in the course of cleaning the planking of trench 4 of footpath XVII(Bou), between 5 and 8 m (fig. 18), the author found under a tuft of cotton-grass the iron punch (fig. 13). It had left behind a black impression on the brown oak timber. During the excavation it was presumed that this footpath dated from the Iron Age (van Zeist, 1955a: pp. 47-48; fig. 18), and consequently the punch was regarded as a 'normal find'. The C14-datings of the footpath (4.1.3.) indicated that it dated from the MBA, and accordingly the punch became a special find. It was mainly for this reason that the punch was sent for closer metallurgical investigation, through the intermediary of Dr. J.J. Butler, to Dr. J.A. Charles.

The fact that the punch has been preserved in the acidic, ombrogenous peat can be attributed mainly to the preservative action of the tannin from the oak timber (*Quercus*), that inhibited rusting and

oxidation, and to the undoubtedly fairly rapid covering over of this spot by cotton-grass (*Eriophorum vaginatum*), that forms a very compact, somewhat less acidic peat. As a result of this the punch became hardly accessible any more for H^+ and OH^- ions. It is possible that also the way in which it was made contributed to its preservation.

For a description of this punch, that is nearly 4 cm long and is slightly curved, see Charles (this volume). Until it has been decided where the punch should finally go, it is being kept for the meantime at the B.A.I.

The wooden mallet. On June 13th 1967, while trench 2 of footpath XVII(Bou) was being dug, at 2.80-2.90 m (fig. 17) a wooden object was found, that has been interpreted as a mallet for knocking the pegs into the peat (fig. 14).

The object is 70.6 cm long. The handle and the striking head each measure about 35 cm in length. The handle is, somewhat faceted, round in cross-section, its diameter decreases from 6.0 to 4.3 cm. The extremity is slightly rounded. The striking head is semicircular in shape. Its width varies from 12.3 through 9.6 to 12.0 cm. The middle part has been severely affected, supposedly as a result of use, in such a way that the wood has mouldered over a length of c. 10 cm. This is the case over the entire width, but on the side edges it is very clearly visible. The wood that was shattered has not been preserved.

The mallet was made out of a lengthwise cleft

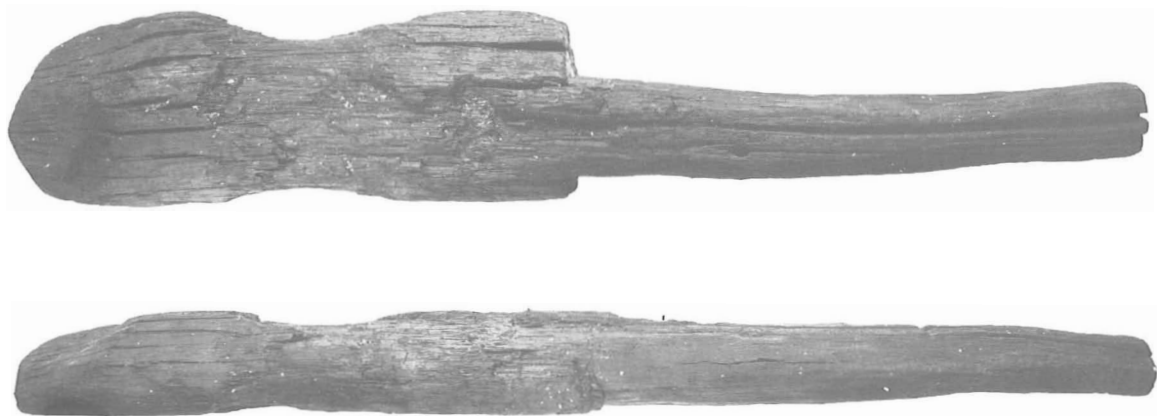


Fig. 14. Wooden mallet, found in trench 3 (fig. 17). Photo B.A.I., F.W. Colly.

trunk of *Quercus* with a diameter of at least 13 cm. The tree was more than 25 years old. This piece of trunk-wood was apparently cut into the required shape fairly roughly. As a result of the weathering of the object only a few traces of wood-cutting have remained visible. The most conspicuous traces of wood-cutting are at the somewhat rounded broad extremity of the striking head.

The mallet is preserved at the B.A.I. by J.N. Lanting.

Two stones. In trench 3 of footpath XVII(Bou) at 14.60 m (fig. 17) two large pebbles were found. They measure 9.5×6.2×5.3 cm and 7.8×6.4×3.2 cm, respectively. They are pale in colour (almost white) due to the effect of the acidic peat on the type of rock: fairly coarse granite. Owing to the effects of weathering on the crumbling rock it is not possible to see any traces of working or of use that may originally have been present. The two stones lay only a slight distance away from a foot-plank, one on each side, at the spot where there once lay a transverse timber that has since disappeared. Although the use of stones does not belong to the 'normal' construction method of the footpath, it is not impossible that these two were used for example to support such a transverse timber. In any case we can assume with certainty that the two stones belong to the footpath XVII(Bou).

Other finds. In the peat-bog of Southeast Drenthe various Bronze Age finds have been made that indicate that the bog was entered, without there being any apparent connection with the MBA footpaths. In comparison with e.g. the Neolithic (Casparie, 1982) these finds are rather few in number. Some of the finds mentioned in that article could also date from the Bronze Age, for example the necklage of amber beads from Emmercompascuum (P.M.D., inventory no. 1923/VI-1). In addition a few bronze spearheads are known from this region. We have not made any investigation as to the occurrence of specific MBA finds.

3.4. Conclusions

The production of iron in small quantities is a technique that is as it were an extension of those techniques that were mastered by the bronze-smiths, as is made clear by the investigation of Charles (this volume). From the information provided by Butler (3.2.) it follows that in the MBA the necessary knowledge was present in different places in Europe. The intensive occupation of the higher soils in Southeast Drenthe in the MBA (as a continuation of the occupation present here in the Neolithic) had wide contacts over great distances, as is indicated by Butler (3.2.). As to the frequency of these contacts little is known. In the locality the raw material

(bog iron-ore) was in plentiful supply, although it was not readily accessible (2.2.3.). We must assume that the occurrence of this material was well known, at least in the well developed and probably also well organized MBA inhabitation of Angelsloo, as described by Kooi (3.1.) That the peat-bog was difficult to enter is evident from the small number of peat-bog finds dating from the MBA in this region (3.3.), and from the construction of wooden footpaths.

The likelihood that the occupants of MBA Angelsloo were familiar with iron production is evident from, among other things, the presence of iron-slag in house 13 of this settlement (3.1.), of which the charcoal has been dated to 1140±60 B.C. (GrN-5775) (Lanting & Mook, 1977). Conclusive evidence is provided by the iron punch (3.3.). We may not assume that we have demonstrated here the only and the oldest incidence of iron-ore processing in this region. We presume that in this locality more indications of MBA iron-processing will be forthcoming, because siderite or other iron-ore of good quality occurs at various places in the Bourtanger Moor. We can state that the basic conditions necessary for the early processing of iron were indeed present in Southeast Drenthe. The information presented here indicates that these opportunities were actually exploited.

4. THE FOOTPATHS – BUILDING METHOD AND CONSTRUCTION ELEMENTS

4.1. The southern plank footpath XVII(Bou)

4.1.1. Overview of the field research

The path has been investigated a number of times in different places, mainly in connection with the stratigraphical peat research in this region (Casparie, 1972). Below a chronological summary of this research is presented, with details of noteworthy information. The location of the excavation trenches is shown in fig. 15. The excavation trenches are numbered from west to east. This numbering system is maintained consistently further on. The parts of the path that have been excavated are illustrated in figs. 16, 17 and 18.

When this article was almost completed, two additional reconnaissances were made. The details of these are included in this article. For practical reasons the two trenches have been given a different nomenclature: A and B. In this way it was possible to include the supplementary information with the minimal adaptation of text and drawings.

The excavated parts of the footpath were exposed by digging away the uppermost peat, with the aid of a shovel, until the path was almost reached. Subsequently the remaining peat was removed using a trowel and by hand, and then the elements of the



Fig. 15. Southern plank footpath XVII(Bou). Location of the excavation trenches. The definite, unexcavated part of the course of the path is indicated by a broken line; the path presumably continues further to the west, as indicated by a dotted line. 1. peat remains; 2. water. Drawing B.A.I., G. Delger.

footpath were cleaned with a paint-scraper and brush. After the elements had been measured and drawn, samples were taken where necessary, and then the wood was removed to make it possible for the underlying peat to be dug over to a depth of a further 30 cm. In the meantime various photographs were taken of the path.

In the case of trenches 5-8 the uppermost peat had already been removed by the Maatschappij Klazienaveen (to whom the peat area concerned belongs), as a result of which the wood of the footpath was already severely damaged in many places.

1961, trench 4. Excavation from March 26th-29th 1961 by H.R. Roelink, J.H. Zwier and W.A. Casparie.

The presence of a prehistoric footpath in this peat region was already known (Wesselink, 1924; van Zeist, 1955a), but only during the peat-bog investigation did it become evident that two footpaths are concerned (Casparie, 1972), namely this MBA footpath and the Iron Age footpath XV(Bou), that lies

about 90 m further north. When in March 1961 part of the MBA footpath was threatened by destruction in the course of peat-digging operations, it was decided to excavate this part. The length of the trench is c. 12 m (figs. 18 and 19).

Aim: to establish the construction method, and to take samples for the peat research. The construction method could not be established with certainty.

Dating: see 4.1.3.

Finds: on the longitudinal plank between 5 and 8 m, under a tuft of *Eriophorum vaginatum* peat, an iron punch was found (for further details see 3.3.). The C14-sample was taken from this plank. Illustrated in fig. 20 is part of the longitudinal plank between 2.70 and 4 m, with distinct traces of cutting.

Casparie, 1972; van der Waals & Butler, 1976.

1963, trenches 5, 6, 7, 8. Excavations in May and June 1963 by G. Delger, K. Klaassens, W.H. Zimmermann (Wilhelmshaven) & W.A. Casparie.

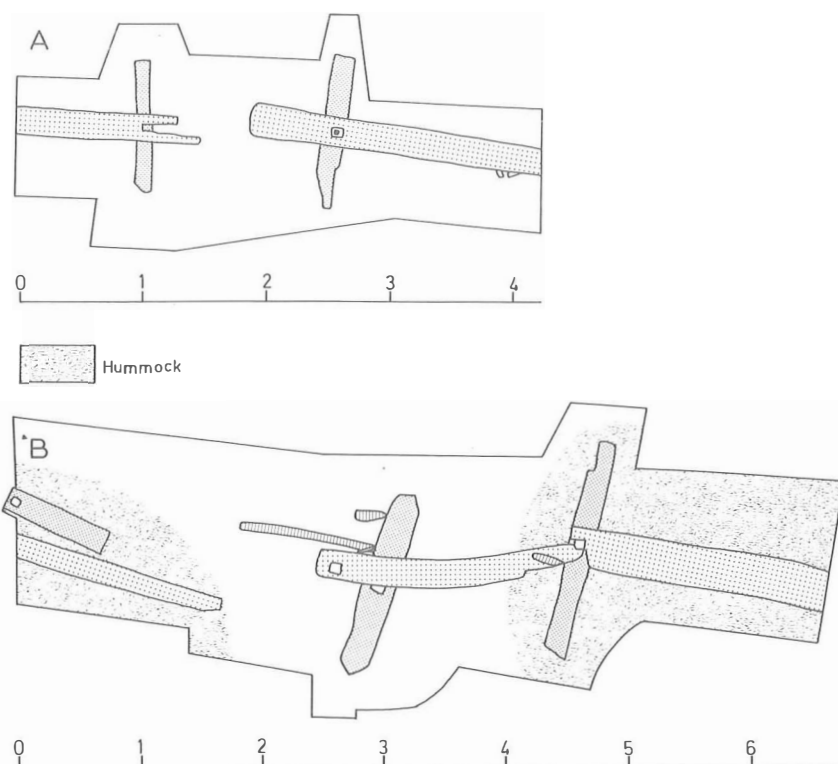


Fig. 16. Southern plank footpath XVII(Bou). Excavation trenches A and B. Drawing B.A.I., G. Delger.

The area of peat in which these parts of the footpath lay was dug out in the course of 1963. In the course of these operations, pieces of the path that had not been destroyed during peat-digging were measured and drawn. Trench length measurements: trench 5, 14.10 m; trench 6, 17.10 m; trench 7, 11.60 m; trench 8, 18.50 m (figs. 18 and 21). The distances between the trenches is shown in fig. 18. Trench 8 is the easternmost occurrence of this footpath that has been ascertained.

Aim: to establish the construction method, documentation, tree species represented.

Van Zeist & Casparie, 1966; Casparie, 1972.

1967, trenches 1, 2, 3. Excavations from June 6th-19th 1967 by K. Klaassens, H.R. Roelink & W.A. Casparie.

Trench length measurements: trench 1, 2.90 m; trench 2, 44.60 m; trench 3, 51 m (figs. 18, 22 and 23).

Aim: to gain insight into the hummock-hollow systems of the fossil peat surface, the construction method, traces of use.

Finds: in trench 2 at 2.80 m a wooden mallet was found (3.3.), that had undoubtedly been used to drive the pegs into the peat (figs. 14 and 18). In trench 3 two pebbles were found, measuring about 8 cm in diameter, at 14.70 m, on either side of the

longitudinal plank (fig. 18).

Dating: in 1963 a C14-sample was taken from the easternmost longitudinal plank of trench 3 (50.20-50.90 m) (4.1.3.).

Casparie, 1972.

1984, trenches A and B. Reconnaissances made on November 6th and 7th 1984 and on December 19th and 20th 1984 by G. Delger, K. Klaassens, L. van Dijk & W.A. Casparie. Trench length measurements: trench A, 4.40 m; trench B, 6.65 m. Trench A is the westernmost excavated part of the footpath (fig. 16).

Aim: to gain insight into the state of preservation of the wood and the peat so as to facilitate control measures by S.B.B. for this archaeological monument.

Dating: from the plank in trench A between 2.00 and 4.40 m and from the transverse timber between 2.40 and 2.60 m wood was taken for a dendrochronological dating (4.1.3.).

4.1.2. Description of the excavation trenches

In most of the trenches the footpath shows a fairly pronounced relief. The height difference between the longitudinal planks measured at most 80 cm, usually 40 cm, in any one trench. The hummock

and hollow system of the peat surface accounted for about 30 cm of this difference in height. This relief would have been present originally to some extent, but it would have developed to a great extent as a result of the shrinkage of the peat after the systematic drainage of the raised bog from the 16th century A.D. on. In trench 3 this relief must have been greater originally, as now it was about 50 cm. This can be attributed to the different kind of peat-bog surface (see under trench 3). The remaining height difference that has been ascertained is mainly the result of (local) subsidence of the peat, e.g. due to extreme drying-out of old peat-faces. In the descriptions that follow below, the differences in peat thickness between the trenches is not indicated in any further detail. The value given for the thickness of the peat above the path is always the average of the observations made per trench.

Trench A, fig. 16. The main reason for digging this trench was to enable us to establish the exact position of the path within the protected archaeological monument. Here the path lay c. 50 cm under the present-day peat surface. The peat that lay over the path had not been disturbed though it had dried out to a serious extent. As a result, the roots of the forest of *Pinus strobus* present on this peat reached down as far as the level of the path. The state of preservation of the wood was still fairly good. The control measures that are to be taken here will result in this peat becoming completely wet again.

Trench B, fig. 16. The trench, that is immediately adjacent to trench 1 (see below), was dug because the part of the footpath that is present here cannot be well conserved as it lies just outside the peat area destined to be made wet again in order to protect the archaeological monument. Here the path lay c. 1 m below the peat surface. The state of preservation of the wood was good. Wood was taken from the construction elements for the purpose of dendrochronological research.

Trench 1, fig. 17. This trench was dug mainly to enable us to establish the presence of the footpath on the west side of the Veldweg, a deep cutting in the peat down to the level of the sandy subsoil. Here the path lay c. 1 m below the present-day peat surface. This peat that overlay the path had not been disturbed. The underlying peat was hummock-peat. The state of preservation of the wood was fairly good.

Trench 2, fig. 17. Here the path lay about 1 m below the peat surface. Between 5.90 and 10.20 m, and between 31.10 and 35.70 m there are traces of disturbance, where (recent) cuttings had been made in the peat that subsequently became refilled. Con-

sequently the longitudinal planks are absent at these disturbed spots. In the disturbed peat wood remains were indeed found, though these have not been recorded in the drawings. The hummock-hollow system was clearly in evidence. The wood presence on the hummocks was in a poorer state of preservation than the wood in the hollows.

Trench 3, fig. 17. The peat thickness above the path was on average slightly more than 1 m. There is no evidence of any deep cuttings that could have disturbed the path. On the north vertical face at c. 3 m a peat section was sampled for palynological research. This material is not included in the palynological investigation (2.1.). The state of preservation of the wood was generally good. The hummock-hollow system, on which the path was laid out, could be clearly discerned. A few hollows appeared to have been trodden down at the margins.

Trench 4, fig. 18. The presence of the footpath was evident from the occurrence of wood remains in the peat-face (Casparie, 1972: fig. 24, peat-face E, pit 165). The exact location and the peat stratigraphy at this spot are also given there. The depth of the path under the peat surface was c. 1 m. The peat-digger K. Rengers (Roswinkel) who was working here (fig. 19) dug away the uppermost peat, after which the remaining peat was removed using a shovel. Subsequently the wood was cleaned up using paint-scrapers and brushes. While doing this the author found the iron punch (see above, 1961, trench 4, and 3.3.). The overlying peat had not been disturbed. The state of preservation of the wood was partly very poor (on a hummock), and partly good (in a hollow).

Trench 5, fig. 18. In those places where the footpath had come into contact with the peat-digging machine, the wood had disappeared for the most part, as between 9.20 and 12.10 m. Between 12.10 and 14.00 m the wood was severely damaged. In general these spots were the hummock-parts of the path. The other part of the footpath lay under a peat layer c. 10 cm thick, that had just escaped being dug away. The state of preservation of the undamaged wood was very good.

Trench 6, fig. 18. Here the footpath had been damaged or even destroyed by the recent digging operations, namely between 0-0.60 m, between 10-12 m, and between 14.50-17.00 m. The other parts of the path lay under a thin layer of remaining peat, usually not more than 10 cm thick. The state of preservation of the undamaged wood was fairly good.

Trench 7, fig. 18. Here the footpath had been de-



Fig. 19. Southern plank footpath, trench 4, with K. Rengers. March 28th 1961, towards the west. Photo B.A.I., J.D. van der Waals.

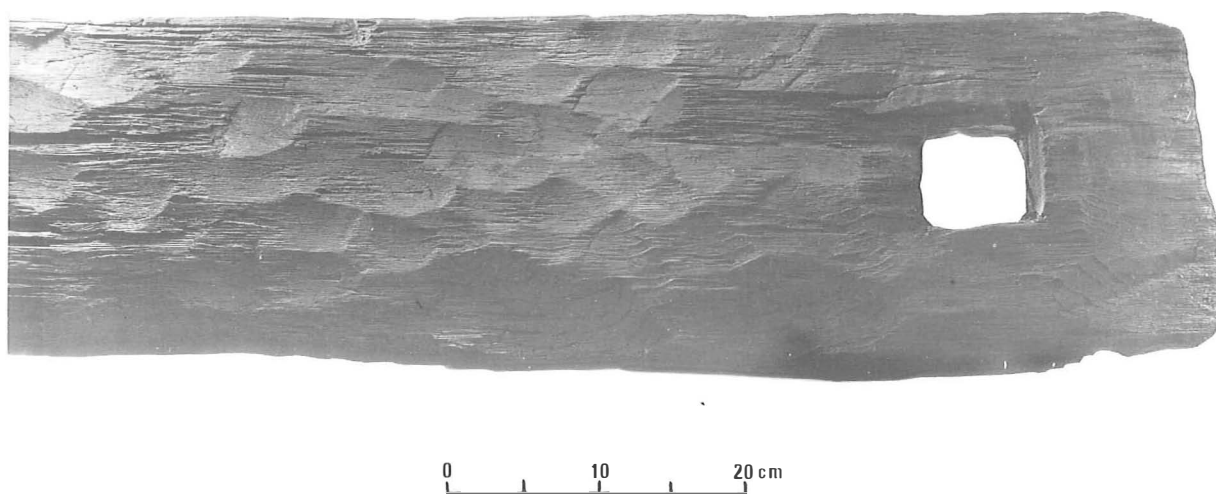


Fig. 20. Plank showing adze marks, from trench 4. *Quercus*. Photo C.F.D.



Fig. 21. Southern plank footpath, trench 5, towards the east, June 1963. The footpath has been damaged by peat-cutting. Photo C.F.D.

stroyed between 0 and 4.50 m. The rest of the footpath lay under a thin peat layer measuring c. 10 cm in thickness. The state of preservation of the undamaged wood was fairly good.

Trench 8, fig. 18. Here the footpath had been severely damaged over the whole length of the trench.

4.1.3. The dating

From the part excavated in 1961 (trench 4), the plank between 5 and 8 m, on which the iron punch was found, was subjected to C14-dating. For the youngest annual rings (± 10 years) of this plank Prof. J.C. Vogel (Pretoria, formerly Groningen) obtained a C14-dating: 1170 ± 50 B.C. (GrN-4179). The wood (*Quercus*) that was dated was partly sapwood. Initially an age of some 500 years younger had been expected on account of the find of the iron punch, and because of this another C14-dating

was performed already in 1963, this time for the youngest annual rings of the easternmost plank of trench 3. The dating obtained for the 10 youngest annual rings (with no sapwood visible) of the *Quercus* plank is: 1195 ± 55 B.C. (GrN-4342). In this way it became sufficiently clear that the footpath dated from MBA times. The peat-bog research in this region has fully confirmed this age (Casparie, 1972).

Of the two pieces of *Quercus* wood taken for dendrochronological dating from trench A (4.1.1.), the transverse timber turned out to be a piece of tangentially cut sapwood, semicircular in cross-section, i.e. a plank of slab-wood. It contained 24 annual rings, and therefore could not be dated. The longitudinal plank sampled from trench A was a plank that had been cleft through the heart of the tree. Dr. B. Schmidt informed me in his letter of 4.12.1984 that the plank has 78 annual rings. The youngest ring measured belongs to the year 1372 B.C. This dating is based on the oak tree-ring chro-

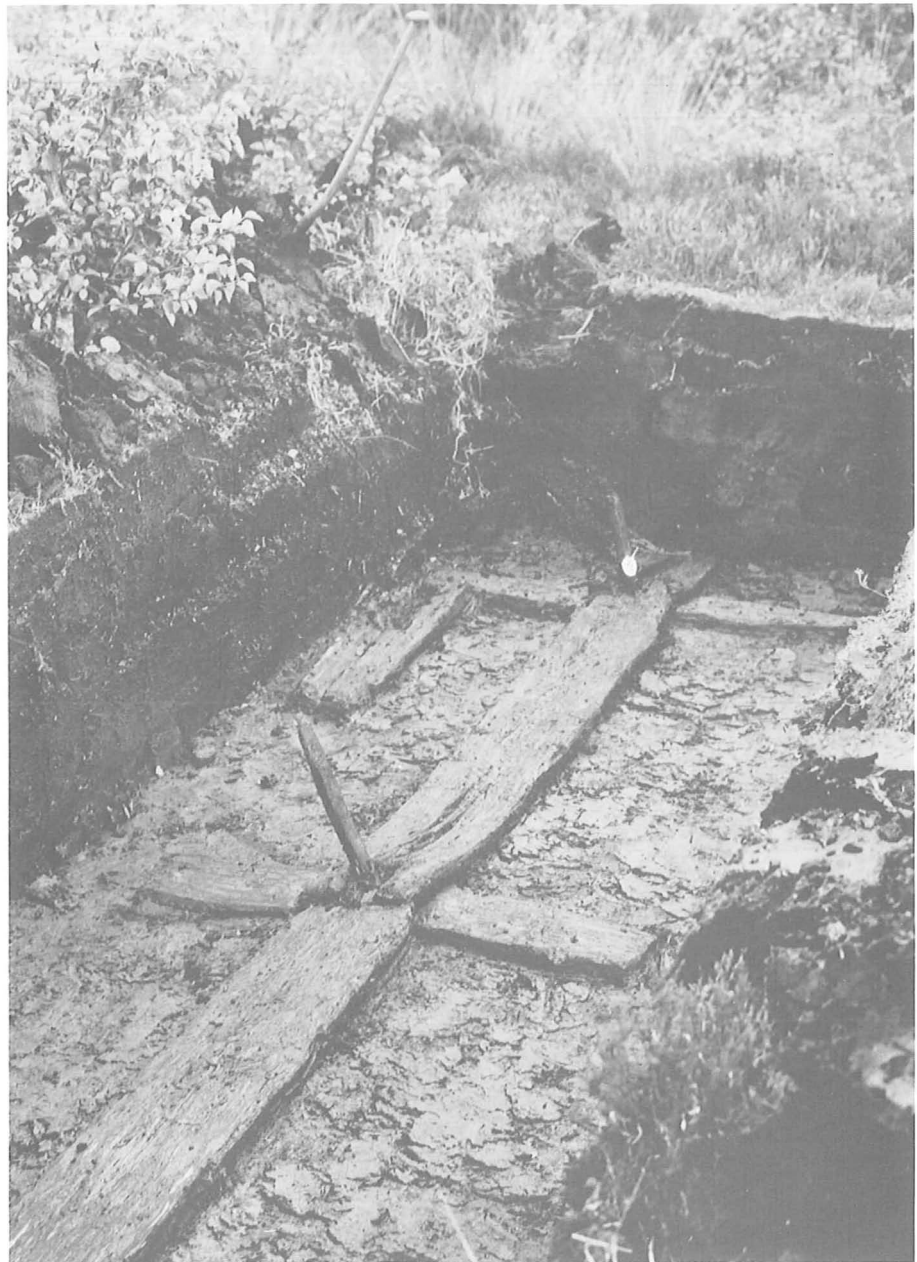


Fig. 22. Southern plank footpath, trench 2, towards the east, July 1967. Here most of the construction units are still lying in the original position. Photo C.F.D.

nology, that has been established by Dr. Schmidt for the plank-trackway Varel 36, excavated by H. Hayen. Sapwood is lacking in the plank dated, so it is not possible to give the precise year in which the tree was felled. With various planks it has been observed that sapwood was partly or altogether absent (4.1.5.). Evidently the sapwood was removed intentionally and used for the transverse timbers. We have reason to assume that the transition from heartwood to sapwood is not much younger than

the youngest ring measured by Schmidt (4.1.5.). Taking for oak a value of 20-25 years for sapwood, we arrive at an absolute dating for this footpath XVII(Bou) of 1345-1350 B.C. The C14-datings that have been obtained are about 200 years younger. In this article we shall however stick to the conventional C14-datings, while mentioning that the actual age in the MBA is about two centuries older.

This is the first dendrochronological dating for a prehistoric peat-bog trackway in the Netherlands.



Fig. 23. Southern plank footpath, trench 3, towards the east, June 1967. The construction elements here have been partly moved from the hummocks to the hollows. Photo C.F.D.

4.1.4. *Method of construction*

We are concerned here with a footpath only one plank wide, with transverse timbers serving to increase stability. Planks and transverse timbers were fixed to each other and into the bog by means of pegs driven vertically into the peat, through square holes made near the ends of the planks and in the middle of the transverse timbers (figs. 22 and 24). The thick heads of the pegs were projected above the trackway surface, so the people who used the

footpath would have had to contend with a small obstacle after every few paces. The heads of the pegs almost certainly stuck out 20-30 cm above the trackway surface.

The western end of each longitudinal plank always lay over the eastern end of the plank lying to the west of it. This indicates that the path was laid out from west to east, *i.e.* from the Hondsrug eastwards into the bog (fig. 5). Here and there the path appeared to have been built in a different way. In 4.1.6. an adaptation of the construction method

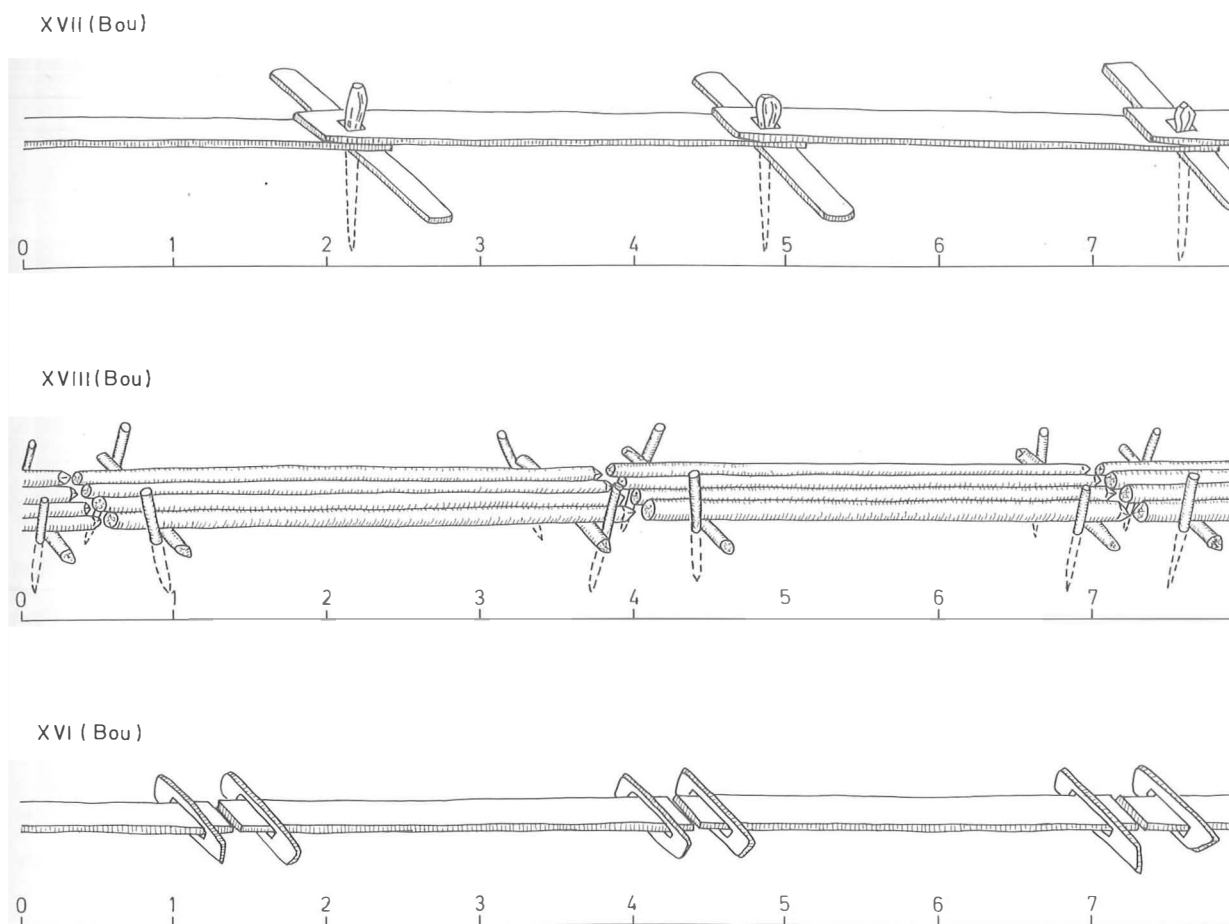


Fig. 24. Method of construction of the three MBA footpaths. Drawing B.A.I., G. Delger.

will be discussed in more detail. In a few places there were (usually insignificant) variations on the construction method illustrated in fig. 24. In trench A (fig. 16) two plank-ends were not laid down one on top of the other with the peg then driven in, but each plank was fixed separately in the peat with a peg and a cross-timber. In this case the square holes were not made near the ends of the plank. This variation may have something to do with a local unevenness of the peat-bog surface: a conspicuously large hummock, that was somewhat higher. This would almost certainly have made it impossible to keep to the construction method as shown in fig. 24. In trench 2 (fig. 17) two pegs were used at 3.05 m, undoubtedly because the longitudinal plank was already split. In the same trench there is an identical situation at 13.00 m, and in this case a third (short) peg has been driven under the transverse timber, next to the large peg on the south side.

In some places a few branches of *Betula* or *Alnus*

were found under longitudinal planks, as in trench 2, from 43.20–44.0 m, and in trench 3, between 16.80 and 17.20 m. We do not know whether this wood ended up here quite by chance, or whether it was laid down on purpose to provide some kind of (minimal) substructure.

In trench 2 at 14.60 m two pegs were present in one hole. The one on the east side was only 20 cm long, and had undoubtedly been added to provide extra structural support, because the long peg had no head or a head that was too short.

The functional width of the pathway varied from c. 20 to 35 cm.

4.1.5. Construction elements

Longitudinal planks and transverse timbers are all made out of cleft wood of *Quercus*. After the wood had been cleft, the resulting planks were hewn into shape where necessary with the aid of an axe or adze (fig. 20). The ends of the planks were almost



Fig. 25. Southern plank footpath. Parts of the footplanks of the trenches 5-8. The planks that were cracked lengthwise were cleft through the pit of the tree. Photo C.F.D.

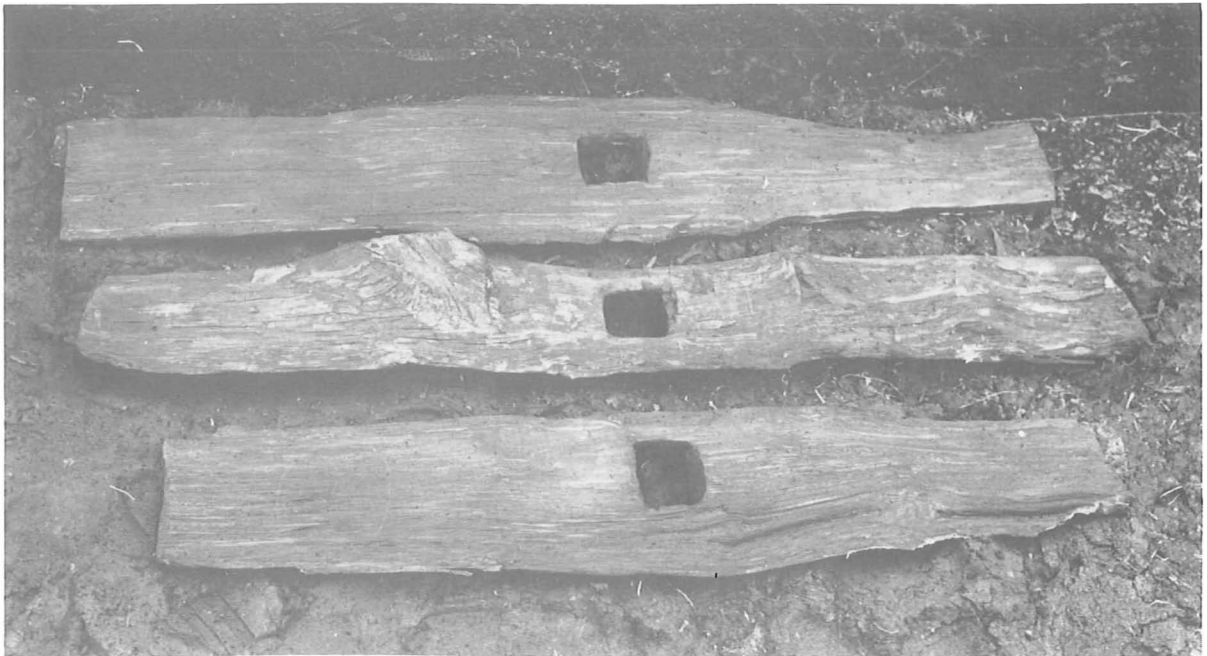


Fig. 26. Southern plank footpath. Transverse timbers. Photo C.F.D.

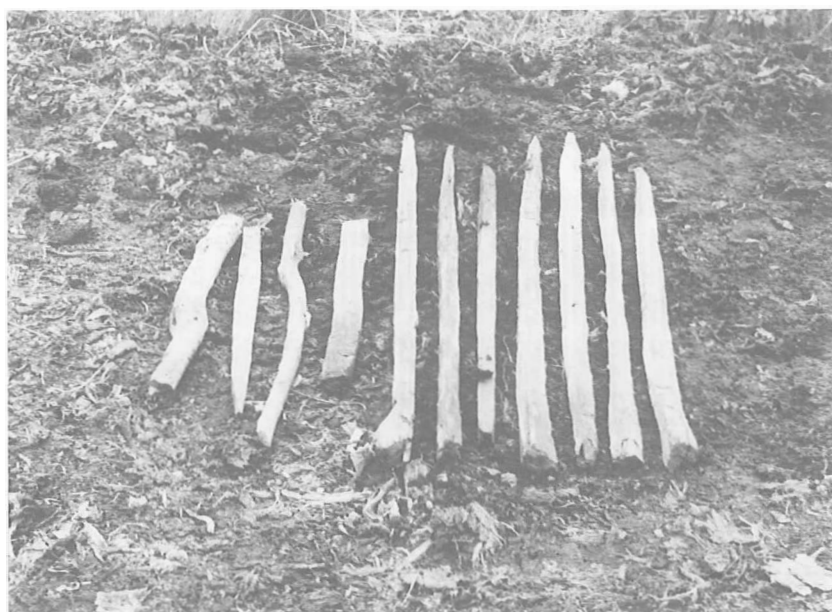


Fig. 27. Southern plank footpath. Pegs, some with the thick head still present. Photo C.F.D.

Trenches 1-3

4-8

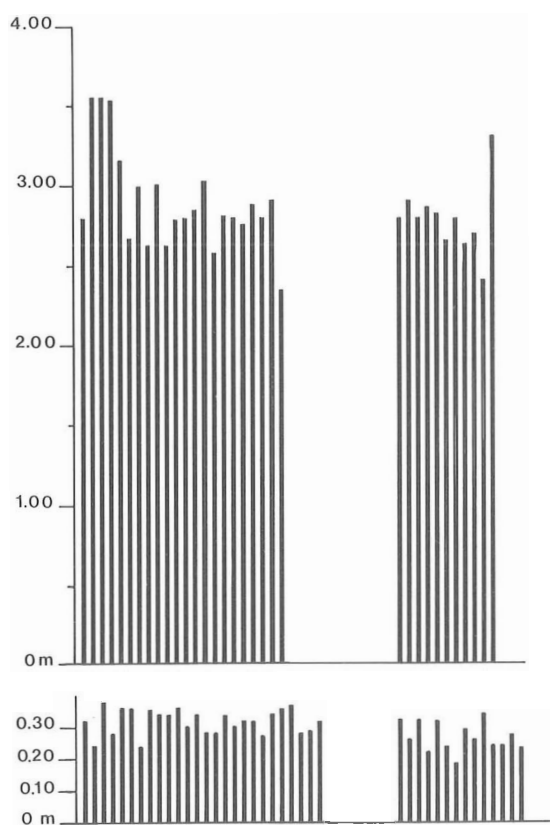


Fig. 28. Southern plank footpath. Length, width and thickness of footplanks. Drawing B.A.I.

all straight (fig. 25). The shape of the transverse timbers was more variable, particularly the shape of the ends (fig. 26). The pegs were mainly of *Quercus*, often cut into shape so as to be 4-, 5- or 6-sided, with a point and, as mentioned above, a thick head (fig. 27). A few pegs were of *Alnus*; these were always pointed roundwood. With the pegs of *Alnus* the presence of a head could no longer be ascertained. The points had always been made using an axe.

In figs. 28 and 29, and in tables 1 and 2, various measurements are given of longitudinal planks, transverse timbers and pegs. The planks and transverse timbers are divided into two groups: a western group (trenches 1-3) and an eastern group (trenches 4-8). Differences in terms of size between these two groups may be indicative of differences in construction phases or origin of the wood.

The length of the planks was often between 2.60 and 2.90 m. In a few cases considerable longer planks were used, up to about 3.50 m (fig. 28). There is evidently no real difference in length between the 'western' and the 'eastern' planks.

The width of the planks was usually between 24 and 34 cm (fig. 28). We have the impression that in the western trenches the planks are on average somewhat wider than in the eastern trenches. In the western trenches 16 out of the 26 planks were wider than 30 cm, in the eastern trenches this was the case with 4 out of 14 planks. In particular trench 5 was conspicuous, as it contained a number of narrow planks.

In many cases the planks were not of the same thickness from one side-edge to the other. This is

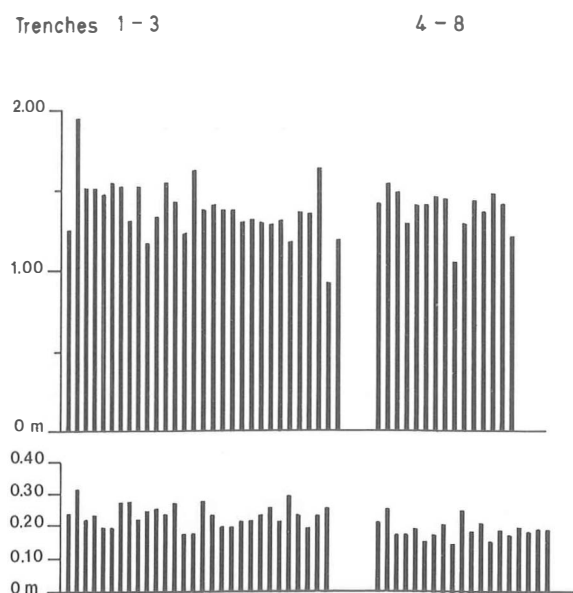


Fig. 29. Southern plank footpath. Length, width and thickness of transverse timbers. Drawing B.A.I.

the result of the way in which the planks were prepared: only cleft wood was used. In table 2 a few measurements are given. The minimum thickness was on average 2 cm, the maximum thickness on average 3.5 cm. Generally speaking the planks were well formed, smooth and fairly thin.

The length of the transverse timbers was often between 120 and 153 cm (fig. 29). There is no clear difference in their length between the western and eastern trenches. The width of the transverse timbers was mainly between 15 and 26 cm. The transverse timbers of the eastern trenches appear to be somewhat narrower than those of the western trenches (fig. 29). The two long side-edges of the transverse timbers were not always equally thick, although slabwood was frequently used (see below). The thin side-edge was on average 2.6 cm thick. The thick side-edge on average about 4.0 cm (table 2). If both side-edges were equally thick, then only one thickness measurement is given in table 2. The transverse timbers are usually made out of somewhat thicker and narrower wood than the longitudinal planks.

The difference in size and proportion between the longitudinal planks and the transverse timbers can be simply explained. A great many longitudinal planks contain hardly any or no sapwood; this softer wood had evidently been removed. All the longitudinal planks were cleft wood. In a lot of these planks the heart of the trunk was present. Many transverse timbers had been made out of the outermost sapwood, often slabs but without any

Table 1. Southern plank footpath XVII (Bou). Thicknesses of longitudinal planks and transverse timbers, listed not according to excavation trenches, but according to minimum and maximum thickness. In all cases the wood concerned has been cleft, and consists partly of cleft heartwood (mainly the longitudinal planks), and partly of slabwood (transverse timbers). The planks are mostly 2-3.5 cm thick; the transverse timbers 2.6-c.4 cm. The heartwood was used to make thinner planks than the sapwood.

cm	Longitudinal planks			Transverse timbers		
	Thin side-edge	Thick side-edge	Both side-edges equally thick	Thin side-edge	Thick side-edge	Both side-edges equally thick
	n	n	n	n	n	n
1	4	—	—	1	—	—
2	26	1	2	17	1	—
3	7	19	3	12	10	4
4	15	11	4	2	9	7
5	—	5	—	1	7	2
6	—	1	—	—	3	—
7	—	—	1	—	1	—

Table 2. Southern plank footpath XVII (Bou). Lengths and diameters of the pegs. The lengths are divided into the groups 'west' (trenches 1-3) and 'east' (trenches 4-8), and are listed in classes of 10 cm. Only complete pegs are included here, *i.e.* pegs with the point still present, but in many cases the head had (largely) disappeared. The diameter was measured as high as possible, usually at the level where the peg fitted through the hole of the accompanying longitudinal plank. The pegs are often 80-120 cm long (25 out of the 45); in the west trenches pegs occur that are considerably longer, mainly 140-150 cm (10 out of the 28). The diameters are mainly between 4 and 7 cm. In those cases where the diameter is greater than 7 cm, this concerns the head of the peg or the transition from the peg to the head (22 out of the 56).

Length in cm	Lengths		Diameters	
	Trenches 1-3 (west)	Trenches 4-8 (east)	Diameter in cm	n
141-150	10	—	11.1-12.0	2
131-140	3	1	10.1-11.0	—
121-130	1	1	9.1-10.0	3
111-120	3	4	8.1-9.0	7
101-110	4	3	7.1-8.0	10
91-100	3	4	6.1-7.0	20
81-90	3	1	5.1-6.0	7
71-80	—	—	4.1-5.0	6
61-70	—	2	3.1-4.0	1
51-60	1	1		
Total	28	17		56

bark. Freshly cut wood was used for the planks and the transverse timbers as well as for the pegs (see below). Of the trees that were felled for the purpose of building this path the sapwood was cleft of and then shaped into transverse timbers. The heartwood was used to make the longitudinal planks.

From the transverse timbers made of lengthwise-cleft roundwood it can be deduced that the trees were about 40 cm thick. This corresponds to the width of the longitudinal planks that still contained some sapwood. It would appear that gradually in the course of time of building the footpath somewhat thinner trees came to be used. On the basis of these observations we assume that from the dendrochronologically dated plank (4.1.3.), in which the sapwood was absent, (almost) no heartwood has disappeared. For this reason we consider that a very realistic dating for the path is some 20-25 years (the average number of sapwood years of the oak) younger than 1372 B.C.

As mentioned previously, the pegs were cut into a particular shape with 4 or more sides, and that at

the same time they were provided with a point and usually also a thick head. Length measurements of less than 0.80 m hardly occur (table 2). Most of the pegs are between 0.90 and 1.20 m long, although lengths of 1.40-1.50 m are by no means rare. The very long pegs are mainly restricted to the western trenches. This may be connected with the more sparing use of the construction material in the course of the building process. The pegs mostly measure 4-7 cm in cross-section (table 2). Thickness measurements exceeding 7 cm usually mean that we are concerned with the head (usually thicker than 8 cm) or with the part adjacent to the head (7-8 cm). It was not possible in all cases to show the presence of a head, but in view of the construction method used in building the path it is most likely



Fig. 30. Southern plank footpath, trench 2. A footplank that was cracked already when the path was built, and the wooden mallet (3.3., fig. 14). Photo C.F.D.

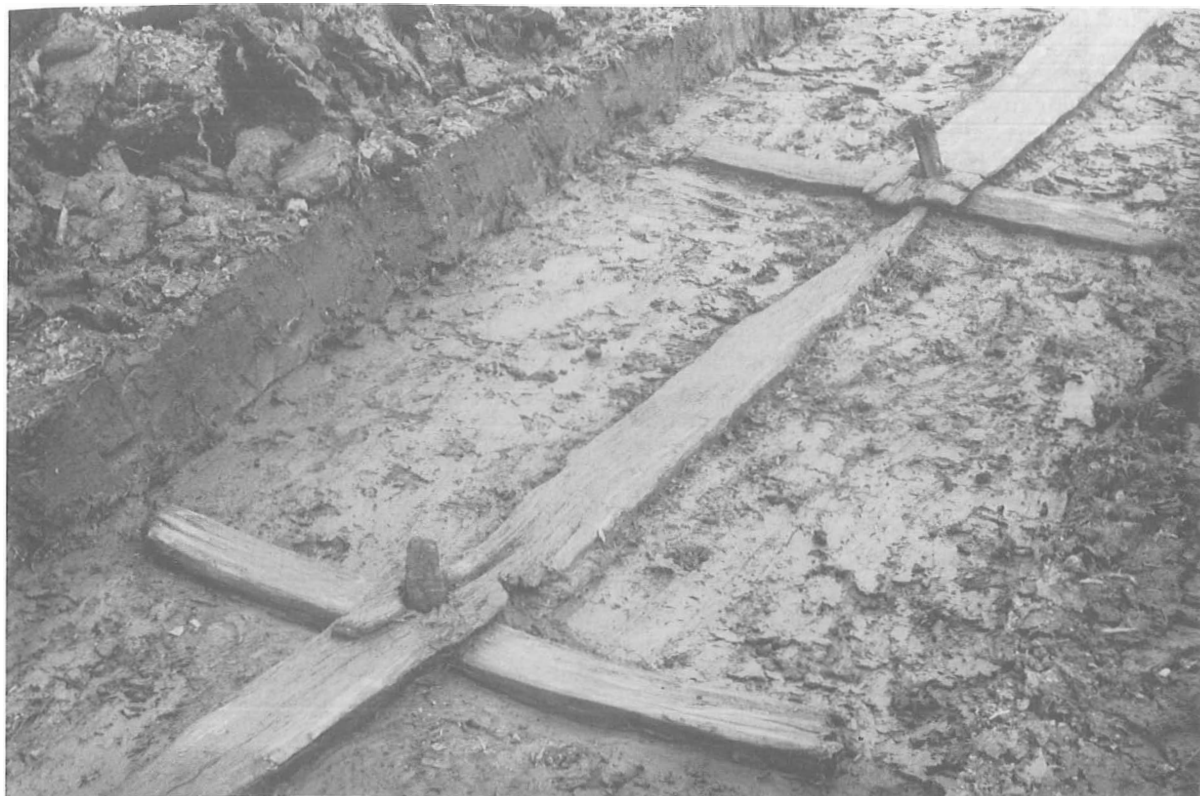


Fig. 31. Southern plank footpath. Footplanks with partly rotted ends. Photo C.F.D.

that all the heads must have been made thick.

The pegs were not made out of planks with the same dimensions as the longitudinals and transverse timbers. They were made separately of sapwood for this footpath. The part of the pegs that had been driven into the bog usually looked like fresh oak timber. Like the longitudinals and transverse timbers the wood of the pegs showed no signs of having been eaten by insects, or any other characteristic features of 'old wood'.

The wood of the planks was rather susceptible to splitting. This can be seen in many places, especially around the holes that were cut through the wood. These holes were square in shape, about 8×8 cm. They were made on both sides of the plank. In view of the almost vertical cutting strokes, the holes could not have been made using an adze. With the planks the distance from the hole to the end of the plank was usually 8-10 cm. It is obvious that these perforations have resulted in a considerable weakening of the plank ends. This part of the plank was usually rotten, often split and sometimes it had disappeared altogether, as can be seen in different places in figs. 30 and 31. From the cutting marks on the plank shown in fig. 20 it can be deduced that

the cutting edge of the axes was 4-5 cm wide. We have too few data at our disposal to enable us to determine the exact size. Most of the planks showed no cutting marks. The path-builders were able to produce very smooth planks exclusively by cleaving.

To summarize, it can be said that fresh oak timber was used for building the footpath. The felled tree-trunks were cleft into pieces of varying sizes, according to the function of the construction elements required. Especially the longitudinal planks were made with great care. Heartwood was particularly used for the longitudinal planks. As for the shape of the transverse timbers there were no strict requirements. Moreover these were made of sapwood. The pegs were mostly cut into shape: a fairly rough cutting technique was applied to produce the pointed end and the thick head. No wood chips were found near the footpath. It can be assumed that the construction elements were made elsewhere (4.1.8.). It looks as though timber was used more sparingly in the course of time: narrower planks and transverse timbers, no extremely long pegs in the eastern trenches.

4.1.6. Adaptations of the construction

On the footpath there are no evident traces of use in the form of wear. This does not necessarily mean that the path was not used, since the top part of the surface elements of wooden peat-bog trackways always show a certain degree of weathering, which has resulted in the disappearance of various surface features of the wood. If the pathway was indeed used, then how can this be demonstrated?

The trenches 3 and 4 appear to show a different, much less regular construction method. Yet here the building elements are of the same type and the same order of size as in the other trenches. Also the distances between the pegs, as far as can be ascertained, do not differ from those in the other trenches. We are therefore concerned with a part of the trackway that originally was built in the same way, in which adaptations were (later) made. In fact it is evident, especially from the situation in trench 3, that a few of the construction elements present on the hummocks were transferred to the hollows (trench 3, 8-11 m, 16-19 m, 21-23 m). Also the wood in trench 4, 2-5 m, is situated in a hollow. We regard this as adaptations of the building method, designed to raise the footpath level at these spots. The planks and transverse timbers that were shifted were clearly intended to raise the level of the originally longitudinal plank, under which they were shoved.

The hollows contain a lot of *Sphagnum cuspidatum* peat and *Scheuchzeria* peat, which must have started to form long before the path was built, and which continued to form for many centuries thereafter. This indicates the presence of open water in the hollows over a long period of time; see also 2.2.3., where the situation of the peat-bog in this region is discussed. In contrast to the peat surface to the west of trench 3 and to the east of trench 4, it was exceptionally wet there, so that the initial building method was not sufficiently effective. Evidently the adaptations that we have noticed were made in order to keep the path in a usable condition in this bog region.

We are convinced that the entire stretch of the track between trenches 3 and 4 was situated in this exceptionally wet peat-bog region, that we have described as the contact zone between two domed raised-bog complexes (Casparie, 1972). After c. 1500 B.C. the raised-bog lake Emmen 19 without any drainage outlet developed within this zone (2.2.3.). Thus the hollows in this contact zone were part of the permanently inundated shore-region of this raised-bog lake (fig. 7).

We can therefore conclude that there were distinct differences in the wetness of the peat-bog surface, and that the path was indeed used. After the path had been in use for some time the original construction method turned out to be insufficiently

effective in the contact zone. It is evident that building elements of the footpath that were already present on the spot were used exclusively to make the adaptations that we have observed. No extra wood was brought from the higher soils. We presume that the adaptation was made fairly soon after the path had been built. We have found no indications that the contact zone became much less easily passable only after the path had been built.

In trench B (fig. 16), between 1.80 and 3.20 m, a peg was found that had not been driven into the bog. Lying next to it, between 2.75 and 3.05 m, is its head, that probably broke off. We have not been able to ascertain whether this is a peg that had been driven in and pulled out again. If that was the case then the situation of trench B could indicate an intended adaptation of the building method, that had not yet been completed. It is possible however that the peg was broken before it could be driven into the bog, and that no-one fixed the transverse timber and the longitudinal planks between 2 and 3 m into the bog with a new peg.

4.1.7. Direction, starting-point, destination, length and function

The course of the path is known to us over a distance of about 1000 m in length (fig. 15). There are no bends in the path. We therefore assume that it was built as a direct connection, from the Hondsrug. The starting-point was therefore probably c. 350 m west of the westernmost observation (trench A) (fig. 7), on the east side of the side-valley of the Hunze depression, notably on the northern point of this sand-hill.

On this sand-hill no MBA occupation has been found. We assume that the MBA inhabitation that was excavated by the B.A.I. in the years 1958-1967, situated about 1500 m west of the presumed starting-point of the wooden path, was the actual beginning of the route for entering the bog (van der Waals, 1967; pers. comm. B. Huiskes & P.B. Kooi, B.A.I.; see also 3.1.). We do not know anything about the building method used to make this exactly eastward-running trackway, or in particular how the depression of the side-valley was bridged.

We are certain that the destination of the path was not the other side of the Bourtanger Moor, c. 12 km away. In the extended line east of the footpath XVII(Bou) no remains of a wooden trackway or path have been found in the bog. We assume (2.2.3.) that the straight path was built along the northern shore of the raised-bog lake Emmen 1' (fig. 7), and that it did not extend any further than this area. The path almost certainly did not reach as far as the Runde, otherwise we would undoubtedly have come across it in the bog due east of the raised-bog stream, as indeed was the case with the nearby situated 'northern plank footpath'.

XV(Bou) (Wesselink, 1924; Casparie & Smith, 1978).

We assume that the path ran to the iron-ore area near this raised-bog lake (fig. 7), that must have been visible from a distance at that time (Casparie, 1972; Casparie & Smith, 1978). The assumption that this iron-ore area was the destination of the path is supported by the direction, the associated find of the iron punch (3.3.) and the occurrence of iron-slag in the northernmost house nr. 13 of the MBA settlement Angelsloo (3.1.). The length of the path over the bog was then probably c. 3000 m (fig. 7). The trackway length from the MBA settlement to the bog margin at the spot where the wooden path supposedly begins, is c. 1500 m. The above-mentioned house with iron-slag lies c. 800 m westnorthwest of the central part of the MBA settlement.

If the iron-ore area was the destination of the wooden path, then to get there from house nr. 13 with the iron-slag a distance of 5300 m would have to be covered. From the central part of the MBA settlement the corresponding distance was c. 4500 m, and from the bog-margin it was c. 3000 m, as already mentioned (fig. 7).

It is therefore most probably that the footpath was used to transport the bog iron-ore from the iron-ore area C to the MBA settlement near Angelsloo. From the research carried out by J.A. Charles (this volume) it is clear that this material could be processed only in small quantities. There would therefore have been no need to transport the ore in large quantities, *e.g.* in a wagon over a wider trackway.

4.1.8. *The use made of the wood*

The wood used for the footpath XVII(Bou) almost certainly came from the Hondsrug, the higher sandy and boulder-clay soils near the MBA inhabitation of Angelsloo. We have the impression that oak-trees were felled specially for building this path, of which the trunks, measuring c. 40 cm in thickness, were cut up to provide the building elements. No depot wood was used, nor was any scrap timber or any other kind of building timber reused to make this path. There is no indication whatsoever that the construction of this path XVII(Bou) was accompanied by other building activities, in contrast to the situation with the trackway of Nieuw-Dordrecht XXI(Bou) (Casparie, 1982).

H. Hayen (1979) has estimated that for the Iron Age peat-bog track VI(Pr), that is made out of planks c. 3 m long, laid transversely, an area of 42 ha of forest was required per 1000 m length of trackway. If we apply his method of estimation to the southern plank footpath, that contained about one-sixth as much timber, then for 3000 m of path-

way an area of c. 21 ha of oak forest would have been required. A few points should be made clear with regard to these calculations. Hayen's trackway was not made exclusively of *Quercus*, but this was the most important tree species represented. This trackway had on average somewhat thicker planks than the southern plank footpath XVII(Bou), undoubtedly because it was intended to take much heavier, wheeled traffic.

We should therefore regard the figure of about 20 ha, given here as the area of forest used, as being rather approximate. The region concerned was undoubtedly deforested to a considerable extent, as a result of the permanent occupation that had long been established here. Thus the area of woodland that was used to provide timber was probably considerably larger than the estimated 21 ha. However, the felling of the requisite number of trees would not have resulted in any great expanse of treeless landscape.

4.2. The path of Klazienaveen-North XVIII(Bou)

4.2.1. *Overview of the field research*

Concerning this path only a limited amount of information is available. There are hardly any written records of the field research, that was of only limited extent. We have at our disposal a photo dating from 1923, the excavation drawing and a few photos dating from 1930, the location and nine logs, constituting a 'construction unit' of the path, transferred by the excavator of 1930, Prof. A.E. van Giffen, to the P.M.D. in Assen (catalogue no. 1930/X-3). A.F. Smith, who has been active in collecting data on the peat-bog trackways of Southeast Drenthe, has also provided information concerning this footpath (4.2.7.). J. Bruggink (P.M.D.) has looked through the depot and archives of the museum in search of any additional data that may be available.

In the region concerned (fig. 32), the existence of the path was already known long before 1923, probably by the beginning of the 20th century.

1923, trench 1. A photo dated May 30th 1923 (fig. 33) shows the trackway towards the west. It looks as though the overlying layers of peat have been dug away in order to make the path visible. We assume that the path was thus exposed for the purpose of finding out how it was built. The photo was taken by G. Blöte of Sappemeer, by order of the Klazienaveen Company, who owned the peat-land.

1930, trench 2. Excavation by Prof. A.E. van Giffen on September 29th 1930 in the Smeulveen (Klazienaveen-North), *veenplaats* (parcel of peat) no. 52. The part of the pathway that was found here was

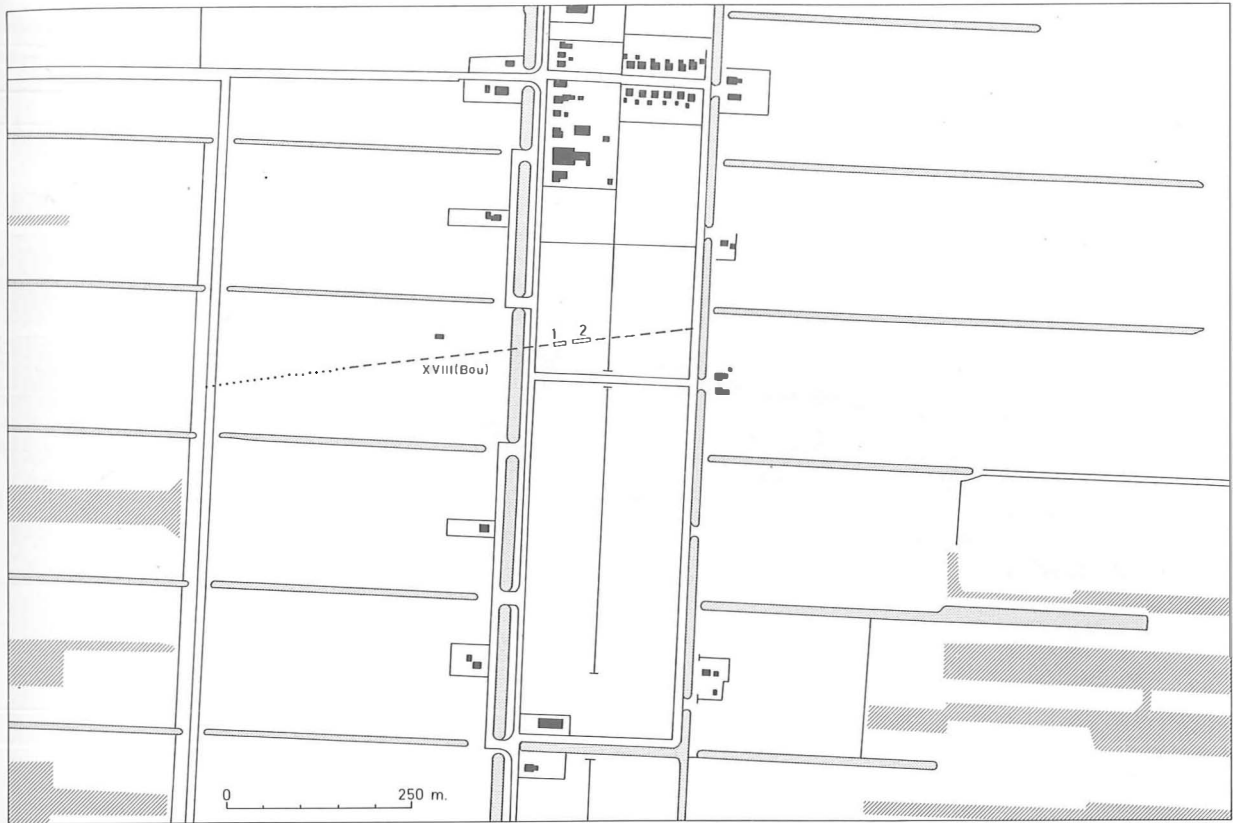


Fig. 32. Klazienaveen-North, footpath XVIII(Bou). Location of the excavation trenches. That part of the path that was almost certainly (but not excavated) is indicated by a broken line. The path presumably continued further towards the west, as indicated by a dotted line. Drawing B.A.I., G. Delger. Legend: see fig. 15.

probably exposed by employees of the Klazienaveen Company, after which it was photographed and drawn by van Giffen and his assistants (figs. 34-36). The length of the path exposed measured 28 m.

Aim: to ascertain the method of construction, documentation, sampling for peat-bog research.

Dating: see 4.2.4.

Finds: none.

Casparie & Smith, 1978.

1957. Reconnaissance on September 18th 1957 by W. van Zeist, A. Meijer and W.A. Casparie, with the aim of finding the path again in the peat-bog region concerned. The only result of this reconnaissance was the find of a (pointed) stick of *Betula* in the peat. The path itself was not found.

4.2.2. Description of the excavation trenches

The path showed some relief, as can be deduced from the photos of 1930 (figs. 34 and 35). This can be attributed to the situation of the path on the hummock-hollow surface of the peat-bog. From a

few figures noted on the field drawing it is evident that the relief measured c. 30 cm at most. The original relief would have been less than this (4.1.2).

The description of trench 1 is based on the picture that is presented by fig. 33 and on the information collected by Mrs. A.F. Smith. Also the description of trench 2 is not based on field observations made by the author, but rather on photos, the field drawing and close inspection of the wood.

Trench 1. This is the westernmost point of the footpath that has been recorded in a photo. From the photo (fig. 33) it is evident that the path came to light in the course of peat-digging operations. Subsequently the overlying peat was dug away towards the east, evidently in order to expose the footpath. The part of the path that is thus visible is probably c. 15 m long, and consists of 4 'construction units' (4.2.3.), of which the two western ones were damaged, presumably by the peat-digging. The thickness of the peat above the path is c. 1 m, to give a rough estimate. The state of preservation of the wood seems to be fairly good.

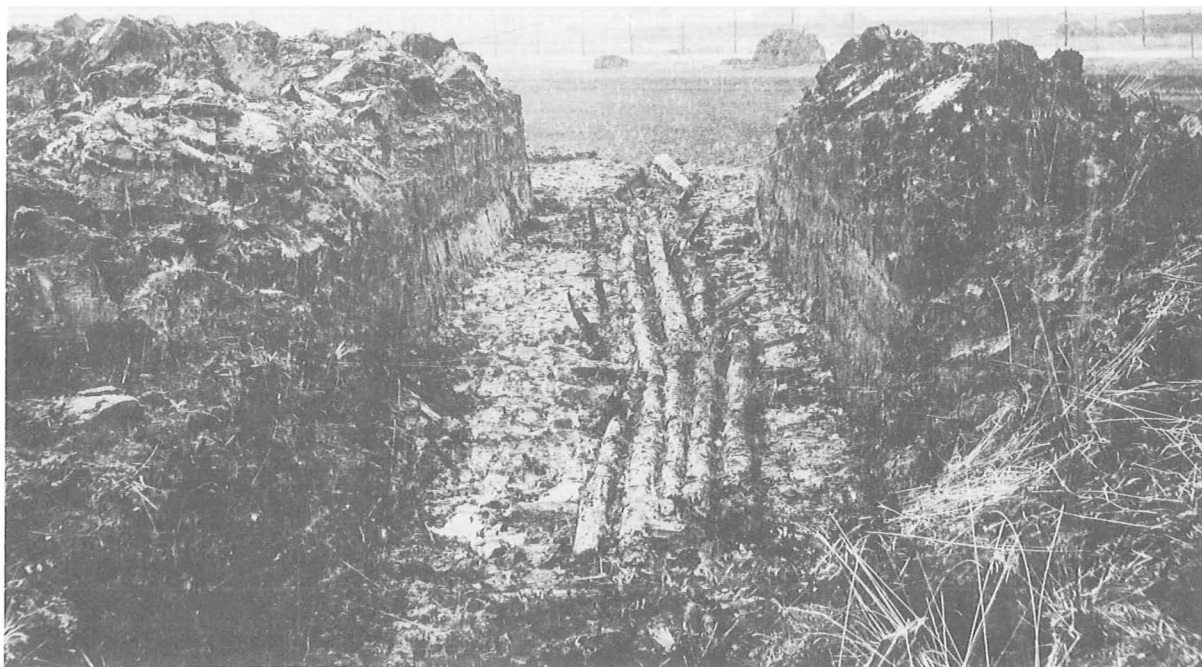


Fig. 33. Footpath of Klazienaveen-North. Trench 1. General view of the exposed stretch of pathway, May 30th 1923. Photo G. Blöte.

Trench 2, fig. 36. Also this part of the path was found in the course of peat-digging operations during the process of removing the topmost peat layer (Dutch: *bolsterveen*), after which it was exposed over a greater length. The thickness of the peat above the path varied considerably, as a result of the continuing peat-digging activities, see also the photos of figs. 34 and 35. In the description of the wood remains in the P.M.D. a depth of 1.00 to 1.10 m below the peat-bog surface is mentioned. This can also be deduced from fig. 34, for the eastern part of the trench, from 19-29 m. In the trench the hummock-hollow system was clearly visible. The wood that was found did not lie in the fresh to poorly humified *Sphagnum*-peat (*bolsterveen*), but in the *Eriophoretum*, that was present here from 0.60-1.60 m below the surface. These are the so-called intermediate deposits (Casparie, 1972). The westernmost part (fig. 35) appears to be situated in a thick *Sphagnum cuspidatum* layer. This explains the good state of preservation of this wood, in contrast to some of the rest of the timber (4.2.5.). The wood illustrated in this photo was transferred by van Giffen to the P.M.D. (0-3.15 m). The absence of all or almost all the wood between 4 and 10 m is

probably the result of peat-digging operations at the time when this area was being reclaimed. From the photo it can be seen that the logs having their western end between 10.00 and 10.20 m have been broken off. In any case they are not supported by a transverse timber. At this spot there was only very little peat present overlying the path.

4.2.3. Method of construction

This footpath consists of construction units of 4 or sometimes 5 thin tree-trunks, laid lengthwise, held together by 4 thin, pointed stakes or sticks, driven obliquely into the bog, and lying on top of 2 transversely laid thin tree-trunks (fig. 24). The timber used is exclusively roundwood, that has been hardly processed any further. It is a very simple method of construction, that provided a walking surface ± 50 cm wide. The path was clearly constructed per unit, with tree-trunks of about the same length being used each time, as can be seen in the photos and the field drawing. The construction units varied considerably in length. Units of c. 2.70 m and of c. 4 m occur (4.2.4.).

From the construction method it cannot be de-



Fig. 34. Footpath of Klazienaveen-North. General view of the eastern part of trench 2, September 1930. Photo B.A.I.



Fig. 35. Footpath of Klazienaveen-North. General view of the western part of trench 2, September 1930. Photo B.A.I.

duced whether the path was built from the west of the east. We may assume that it was built from the west, because the path definitely did not extend as far as the opposite side of the raised bog, almost 12 km away (4.2.7.).

The function of the pointed stakes or sticks that were driven obliquely into the bog was not to hold in place the transverse timbers, but only the longitudinal trunks. The weight of the longitudinal trunks was sufficient to press the transverse timbers down far enough into the soft peat-bog surface.

The longitudinal elements are not fixed to the peat-bog surface or to the other trackway elements. At times when the water level was high (when the peat-bog surface was partly flooded), this footpath would therefore have been in a state of disrepair. We may assume that the builders of the path did not regard the possibility of the wood floating away as a risk.

The somewhat indistinct part of the path in trench 2, between 24 and 26 m, seems to us to be a matter of a few tree-trunks slipping down the slope of the hummock in the direction of the hollow immediately to the west.

There are no indications that the path was covered with sods or turves. Also in those parts of the path that are present in the P.M.D., inventory no. 1930/X-3, there are no traces of any (sandy) turves. There were still only some remains of peat on the wood. This is indicative rather of the absence of any covering of turves. In view of the construction method it appears that the builders of the path did not aim at providing a pathway as comfortable for walking along as a level trackway surface.

4.2.4. *The construction elements*

The 9 elements that are present in the P.M.D., the construction unit in trench 1, 0-3.20 m, consisting of 4 longitudinal tree-trunks, 2 transverse logs and 3 pegs, all consist of *Pinus sylvestris*. The irregular growth of the wood, corresponding to what we were able to ascertain at the time (Casparie, 1972), indicates that the pines used for the path grew on peat (4.2.5.).

The wood, inventory no. 1930/X-3 has been preserved in the P.M.D. by the application of an oily substance, probably linseed oil, so as to impregnate

the wood or to cover the exposed surfaces. Consequently the material has remained in an excellent condition, and lends itself to investigation (4.2.5.).

The longitudinal wood, *i.e.* the logs that constituted the walking surface, usually consists of straight, well-formed tree-trunks. The log lengths in trench 2 are c. 2.70 m, c. 4.00 m and c. 4.35 m. The diameter at the thick end of the logs varies from 11-15 cm, and at the thin end from 8-11 cm. There is only a gradual tapering of the tree-trunks: a decrease in thickness of c. 1 cm per m. The trees of the westernmost construction unit of trench 2 were felled at the age of c. 75 years (4.2.6.). The thick end of the trunks has been fairly roughly cut from one or two sides (fig. 37: a, c). The thin end has usually been cut straight across (fig. 37: b, d). One of the trunks that has been preserved showed a considerable development of curl wood. This could be attributable to the gnawing activities of wild deer (pers. comm. L. van Dijk).

The transverse timbers measure 1.00-1.30 m in length, and 8-10 cm in diameter. The ends of the transverses resemble those of the longitudinal logs inasmuch as they have been cut from one side at the thick end (fig. 38: a, b) and straight across at the thin end. The side-branches have been cut off less carefully on the transverses than on the longitudinal logs.

The stakes ('pegs') were driven with their thin pointed ends into the peat-bog. They measured 5-7 cm in diameter. Their thick ends (that initially projected above the bog surface) had generally rotted to a considerable extent, so it was not possible to see how they had been cut.

The gradual decrease in tree-trunk thickness, see above, indicates that the trees used with diameters of 11-15 cm provided, from just above the roots, a usable tree-trunk that was much longer than c. 2.70 or even 4 m. Investigation of the wood that has been preserved of this path makes it clear that the pegs must have originated from the top of the tree-trunks. Also the transverse timbers had distinct side-branches, that had been cut off. We can therefore assume that from the tree-trunks that were felled the topmost part of c. 1 m was cut off for use as a peg. From the remaining part of the tree-trunk the top 1-1.50 m provided the transverse timber, and the rest was used as a walking-surface element. As only half as many transverse timbers as longitudinal logs were needed, for 50% of the tree-trunks it was not necessary to cut off transverse timbers.

It now seems to us very likely that the longitudinal logs of c. 2.70 m came from trunks that provided the peg as well as a transverse timber. In the case of the longitudinal elements of c. 4 m or more it was not necessary to produce a transverse timber.

Taking into account loss in length as a result of cutting, we arrive at a figure of about 6 m for the usable length of trunk.

The walking-surface logs had partly rotted to a considerable extent (fig. 34), but the wood that had remained preserved, that had lain in a very wet hollow, still appeared to be intact and in very good condition. The damage that has been suffered by the wood is in our opinion not the result of wear due to (frequent) use. Those parts of the path that lay on the hummocks initially remained less wet and consequently they rotted to a greater extent.

The path gives the impression that the aim of its builders was to provide an efficient wooden track-way over the bog with the expenditure of as little labour as possible, using wood that was presumably not very valuable and available on the spot or in the close vicinity. In view of the straight, well-formed tree-trunks, this pine forest did not grow on the wettest bog surfaces (4.2.6.). The trees had side-branches at a remarkable low level on the trunk, typically for pines growing on bog. These side-branches have usually been cut off fairly carefully from that part of the trunk that provided the longitudinal logs for the walking-surface. The length measurements of the construction elements are not necessarily standard measurements, but were mainly determined by the optimal utilization of the usable trunk length. As mentioned previously, this was probably about 6 m. Pines with trunk lengths of this order and a diameter of 11-15 cm just above the roots come from rather dense stands of forest. Free-standing pines never grow to be as tall as this (pers. comm. L. van Dijk).

4.2.5. The dating

During the excavation of 1930 not a single find was made that could provide a dating. On the basis of the peat stratigraphy (the path lies in the 'intermediate deposits' (Casparie, 1972)) we dated the path to between 1500 and 1000 B.C. (Casparie, 1978). From one of the logs that has been preserved (P.M.D., 1930/X-3), that has been sawn in half for some unknown reason, a C14 dating was carried out on part of the heart of the trunk, by Prof. W.G. Mook, Laboratory of General Physics in Groningen. The heart of the trunk was chosen for this dating because the wood surface had been impregnated with an oily substance, probably linseed oil (4.2.4.), that had not penetrated right into the middle of the timber. The material was also given an extra pre-treatment to get rid of the linseed oil-like smell, that is difficult to distinguish from resin (pers. comm. W.G. Mook). The dating obtained is: 3070 ± 50 B.P., *i.e.* 1120 ± 50 B.C. (GrN-11785). The construction of the path can be dated some 40-50 years later, in view of the position of the annual rings dated. The path is undeniably of MBA age, seeing that it was built between 1100 and 1050 B.C.



Fig. 37. Footpath of Klazienaveen-North. Cutting marks at the thick end (a and c) and at the thin end (b and d) of two longitudinal logs (a+b, c+d). Photo C.F.D.

4.2.6. The use of the wood

After the exposed surface of the sawn-through log (4.2.5.) had been planed smooth, the cross-section of the tree-trunk (fig. 39) was studied more closely. In the course of our peat research we have already devoted rather a lot of attention to the growth of *Pinus* on peat (Munaut & Casparie, 1971; Casparie, 1972).

The tree was felled at the age of about 75 years. The total number of annual rings could not be determined exactly. With regard to the life history of the tree given below it should be borne in mind that where the age in years is mentioned some slight deviations are possible.

The annual rings were to some extent not clearly visible, as is apparent from the photo (fig. 39), as a result of poor growth (see below) and some local rotting. The excentric heart, the irregular growth, the partial doubling of rings, the local absence or invisibility of annual boundaries all clearly indicate that the tree grew on peat.

This peat environment would have been a more or less dried-out raised bog. The tree almost certainly grew close to the bog margin. Some of the rings were very narrow with late-wood being almost absent. In this phase the growth of the tree must almost have come to a complete standstill.

On the basis of the picture presented by the annual rings, the following can be said about the life history of the tree. During the first ten years of its life the pine had a normal growth for trees growing on peat-bog, showing characteristic features of ger-

mination on a fairly dry raised-bog surface. From 10-15 years of age growth was slow. The surface of the bog had probably become wetter. From 15-21 years the trunk cross-section shows a slight recovery in growth, although this growth is relatively slow. From 21-31 years growth is again slow. From 31-47 years there is very little growth, and almost no formation of late-wood. This pronounced stagnation or standstill in growth can probably be ascribed to an excessively wet bog surface. The quality of the wood is very poor here (much rotting, loose wood). From 48 to about 73 years there is growth typical of a pine on a moderately dry raised-bog surface. The last years (2-5) cannot be seen clearly as a result of the rotting process and the action of the substance used to impregnate the wood.

We may assume that all the pines used for this path grew on the bog. For pine forests growing on raised bog the bog surface is almost always suitable for tree growth only a relative short time, usually after a period of (slight) drying-out. Therefore a lot of wood from this c. 75-year-old forest would have been suitable for the construction of the path. It must have been a fairly dense stand of forest (4.2.4.). Furthermore it can be deduced that for each 'construction unit' of c. 3 or 4 m four pines were required, each measuring at least 6 m in trunk length and 10-15 cm in diameter. For a stretch of footpath measuring 3300 m in length (4.2.7.), about 3300 trees would be necessary. If we assume that the mutual distance between the trees was 4-5 m (pers. comm. L. van Dijk), then the area of forest



Fig. 38. Footpath of Klazienaveen-North. Cutting marks at the thick end of two transverse logs (a and b) and at the top end of a peg (c). Photo C.F.D.

that was felled for the construction of this path would have been 5-6 ha.

4.2.7. Direction, starting-point, destination, length and function

Thanks to the efforts of Mrs. A.F. Smith (4.2.1.) and the cooperation of G. Hekman, it was possible to obtain important information from Jan Bijl of Klazienaveen-North, who in his youth lived at *veenplaats* no. 51, close by the footpath. He was familiar with the remnants of this path from his youth. In addition information was available from H.G. Trip, the predecessor of G. Hekman. This information was given by Trip at the end of 1956 and at the beginning of 1957, to W. van Zeist. J. Bijl was able to confirm this information.

The path was in any case some hundreds of metres long. It ran from west to east, slightly towards the north, see fig. 32 which shows its course as far as this is known for certain. The excavation trenches 1 (1923) and 2 (1930) could not be indicated precisely.

The path had a few gradual bends (see also the excavation drawing, fig. 36, and figs. 34 and 35). We think nevertheless that a straight path was intended, of which the western starting-point would almost certainly have been situated on the edge of the Hondsrug. In this case too the aim of building the path would have been to provide access to the bog from a settlement on the Hondsrug (4.1.7.).

Just 1300 m west of the probable starting-point of the wooden pathway there lies a settlement that was excavated by the B.A.I. between 1958 and 1965

(fig. 2), that can be dated roughly to between 800 and 500 B.C., and that is covered by a Celtic Field complex (van der Waals, 1968; pers. comm. P.B. Kooi & B. Huiskes). The presence of MBA occupation on this spot is quite probable (3.1.).

The southern plank footpath XVII(Bou) runs approximately parallel to the footpath of Klazienaveen-North XVIII(Bou), only 2 km to the north of it (fig. 2). From the Hondsrug towards the east the two paths diverge slightly. This could mean that within a distance of 2 km from the MBA settlement of Angelsloo (the presumed starting-point of the southern plank footpath) another MBA settlement was present, which had its own wooden pathway extending into the bog (fig. 7). No such settlement is known. Therefore no clear starting-point can be indicated for this footpath.

The destination would undoubtedly have lain in the eastern extension of the (known) course of the pathway. The path certainly did not reach as far as the other side of the bog about 12 km away, as we have stated already. It seems much more likely to us that the destination-point was the iron-ore area B (fig. 5), towards which the path ran directly. We do not, however, have any direct indications, e.g. in the form of any wood remains, that this iron-ore area was exploited in the MBA. In this iron-ore area a battle axe, possible PFB, has in fact been found (P.M.D. inventory no. 1959/XI-3) (Casparie, 1982). From the EBA and MBA a few peat-bog finds are known from this region. It is therefore well possible that the iron-ore was indeed exploited.

If this iron-ore area B was the destination of this path, then the stretch of pathway over the bog

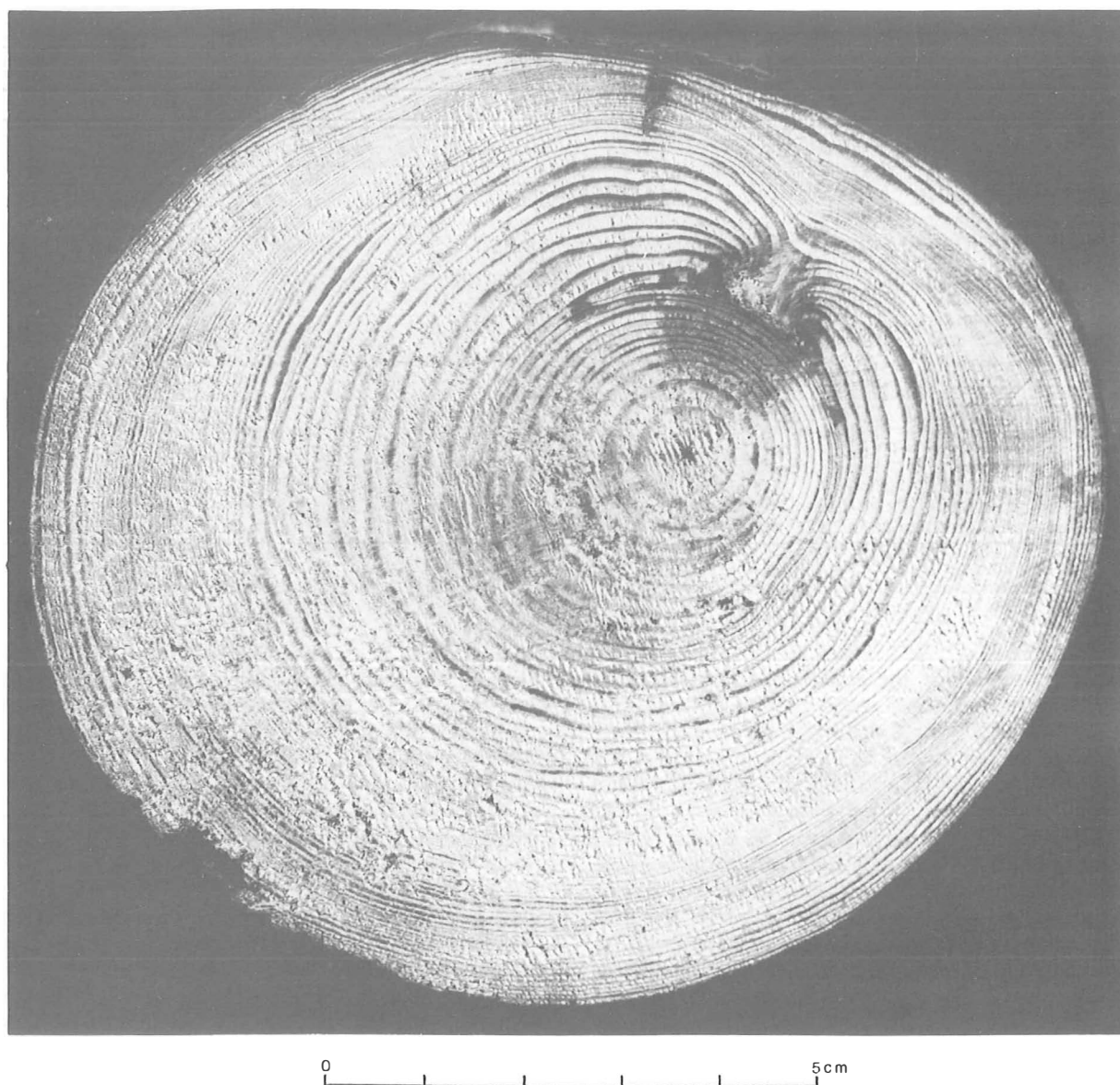


Fig. 39. Footpath of Klazienaveen-North. Cross-section through a longitudinal log. Photo B.A.I., F.W. Colly.

would have been c. 3300 m long. We do not know whether the entire trajet over the bog consisted of a wooden pathway, but in view of the wetness of the bog it is possible that this was the case. The length of the route over the higher soils (the Hondsrug) is not known.

If the path was indeed intended to provide access to the iron-ore area, then it is reasonably certain that the path served to facilitate transport of the ore to the Hondsrug, as we have been able to demonstrate for the southern plank footpath (4.1.7.). It could then be regarded as an 'imitation' of the southern plank footpath. The presence of an iron

industry in this area in the Iron Age is well known (Modderkolk, 1970; Casparie & Smith, 1978).

4.3. The footpath of Emmercompascuum XVI(Bou)

4.3.1. *The field research*

For this footpath too very little information is available. Hardly any measurements have been recorded and no excavation drawing is available. The path came to light at the end of the 19th century, in the course of peat-digging operations. This

has been mentioned by several persons in written records. An important part of the information given below is derived from Joosting (1901) and Landweer (1902).

1899. Communication by J. Oostinjer, director of the peat-digging company Emmercompascuum, in a letter in reply to another letter (of which nothing is known) of July 14th 1899 (Joosting, 1901). The path was found (and subsequently destroyed) during peat-digging operations in 1899, and possible also in the preceding years. The length exposed in 1899 was c. 70 m. Although strictly speaking no field research was carried out, we have nevertheless included this observation as field-work. Oostinjer took the opportunity provided by his presence at the site (almost certainly due to peat-digging activities) to collect information concerning the building technique and the local stratigraphy. This is dealt with in further detail in 4.3.2.

The footpath was one plank wide; it lay about 1.50 m below the surface. The underlying peat thickness was c. 2 m. No finds were made at this part of the footpath. Joosting, 1901.

1900. Reconnaissance by G.J. Landweer Jz. (1901; 1902) on April 21st 1900, when once again a considerable part of the path was exposed, after which it disappeared. Landweer himself saw only a very small part, measuring a few metres in length. Apart from the method of construction Landweer mentions the approximate location where the path was found, its direction, its depth in the peat and its possible starting-point. In his communication he gives a sketch of the construction method. He arranged for a (damaged) transverse timber to be sent to the Provincial Museum of Drenthe in Assen (inventory no. 1901/I-23). No finds were made along this part of the path.

Aim: to establish the method of construction, the direction, the location in the peat.

Landweer, 1901; 1902; Casparie, 1978.

4.3.2. *The method of construction and the construction elements*

The path is one plank wide. The longitudinal foot-planks lie in one straight line. Near the ends of the planks are plank-like transverse timbers, one on each side. These have a rectangular opening, through which the longitudinal planks are fixed. Each longitudinal plank has two transverse timbers. Very occasionally a supporting plank was found under a longitudinal foot-plank. Landweer (1901; 1902) made a sketch of what he saw (fig. 40). On the basis of this a reconstruction drawing has been made (fig. 24).

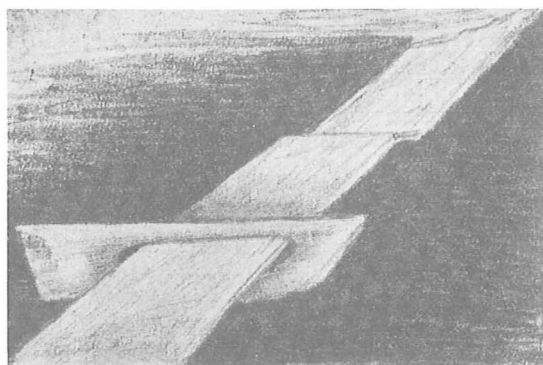


Fig. 40. Footpath of Emmercompascuum XVI(Bou). Sketch of the building method made by G.J. Landweer Jz. (1902).

The longitudinal planks were 28-30 cm wide. They were remarkably smooth. They had clearly not been sawn but cut. The thickness was 2-3 cm; this is remarkably thin. Joosting mentions that the planks are thinner at the ends. Landweer gives no information about this. What he does say is that the ends have been cut remarkably neatly so as to make a straight edge at right angles to the long sides. As to the length of the planks no measurements are given. In view of the fact that Landweer was familiar with the planks of the peat-bog track-way of Valthe, we think it probable that also those of Emmercompascuum were about 3 m in length.

The transverse timber kept in the P.M.D. (inventory no. 1901/I-23) had dried out completely and had therefore changed considerably in shape. Also, a lot of it was clearly missing. We have nevertheless been able to ascertain the original shape and measurements satisfactorily (Casparie, 1978) (fig. 41). It would have been c. 69 cm long. Its width varied from 13-15 cm. It was slightly more than 3 cm thick. The rectangular opening would have measured c. 33 × 4 cm. On the wood there were no longer any traces of cutting visible. Therefore the width of the cutting edge of the axe cannot be determined. To make the rectangular hole an axe or chisel with a cutting edge of at most 3 cm must have been used.

The remaining fragment of a transverse timber that has been preserved is made of *Quercus*. The path would probably have been made completely out of oak timber. Landweer gives no information as to the kind of wood used. Joosting thinks that it may be *Pinus* wood. In fact he says that the kind of wood used to make the path is the same as that of the (*Pinus*) stumps found in the bog. We think that he was wrong. Oak timber is not infrequently mistaken for pine, in a bog environment.

If the path was made completely or at least for the most part out of oak timber, then wood from

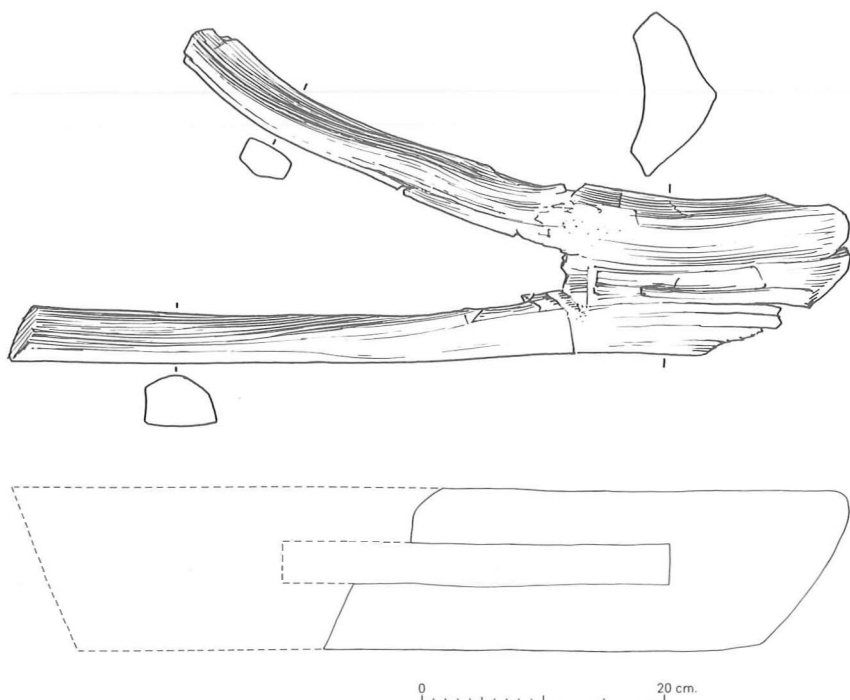


Fig. 41. Footpath of Emmercompascuum. The part of a transverse plank brought by Landweer to the P.M.D. (inventory no. 1901/I-23) (above), and a reconstruction sketch of the original form (below). The missing part is indicated by a broken line. Drawing B.A.I., H.R. Roelink.

the higher sandy soils must have been used. *Quercus* did not grow on the bog.

4.3.3. The dating

Landweer found the path at a depth of c. 1.50 m below the peat-surface level of that time. This suggested that the path could have been built long before the beginning of the Christian Era. Also Landweer's additional stratigraphical information (2.2.3.) points to the same conclusion (Casparie, 1978). Of the fragment of the transverse timber that has been preserved in the P.M.D. the youngest 5-10 annual rings were C14-dated in 1976: 3110 ± 35 B.P., i.e. 1160 ± 35 B.C.(GrN-7900). This puts footpath XVI(Bou) in the MBA, almost contemporary with XVII(Bou) and slightly older than XVIII(Bou).

4.3.4. Direction, starting-point, destination, length and function

The footpath was found in *veenplaats* no. 16 of the *Oostelijke Dwarsplaatsen* at Emmercompascuum. Landweer mentions that it ran in a NNE-SSW direction. On the basis of this information the most likely course of the pathway is shown in fig. 42, assuming that the path was straight. Wesselink (1924), in his discussion of the direction and course of the pathway, has confused this path with the footpath XV(Bou), that can be dated in the Iron Age (Casparie, 1972). Consequently he gives erro-

neous information regarding the direction and course.

Having established the direction and course of the pathway, we can roughly locate its starting-point: the southernmost point of Westerwolde, the complex of higher soils, that projects as it were like a peninsula into the Bourtanger Moor. Situated here, just on the east side of the Dutch-German border are Lindloh and Schwartenberg, that in the Bronze Age were higher sandy areas not overgrown with peat (Landweer, 1901; 1902). It was probably here that the oaks were felled to provide the timber for building the path. At the presumed starting-point, c. 1800 m NNE of the point where the path was observed, the peat has long since disappeared. No information at all has been preserved concerning the possible presence of a path here.

Both the (probable) starting-point and the direction suggest that the trackway may have served to extend the route that ran over the sandy part of Westerwolde. We know nothing whatsoever about the end of the pathway. It is unlikely that the end is to be found on the other side of the bog, on the Hondsrug. In fact no observations at all have been made of the presence of this path further south in the bog. We are therefore convinced that the end of this path was in the bog itself, although we have no idea where.

The definitely known length is c. 70 m (Joosting, 1901). If we assume that the starting-point lay on the higher soils near Lindloh and Schwartenberg,

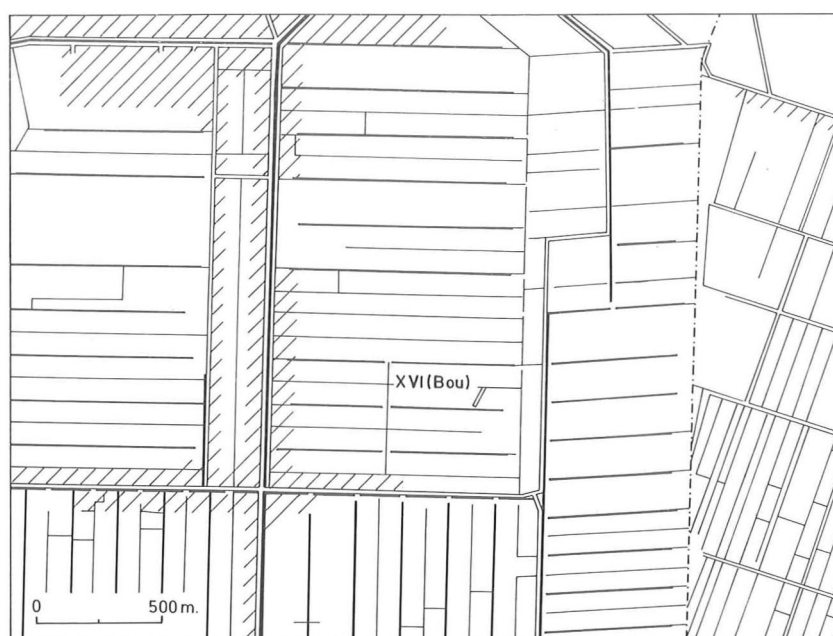


Fig. 42. Footpath of Emmercompascuum XVI(Bou). The most probable location of that part of the path investigated by G.J. Landweer in 1900. Drawing B.A.I., G. Delger.

then the footpath was at least 1800 m long. We suspect that the path was not much longer than this, as there has been no further mention of any finds made.

As the destination of the pathway cannot be indicated at all, it is not possible to clearly explain its function. Of course it is tempting to presume that this path too served to give access to places where iron-ore was present in the bog. This is by no means impossible (the iron-ore centre B could well have been the destination in this case) but such an explanation remains speculative.

In view of its light construction, we think it likely that the path was of limited length, and therefore not part of a through-going route, and, moreover, that it was used for a relatively short period of time.

5. INTEGRATION AND DISCUSSION

5.1. The accessibility of the peat-bog area

From as early as Neolithic times the peat-bog region of Southeast Drenthe was repeatedly entered, as can be deduced from peat-bog finds (Casparie, 1982). This also occurred during the MBA (3.3.). It is usually not clear what the destination was of the people who entered the bog, but as a general rule no artificial pathway was necessary. It is not known in which season the bog was entered, but it would probably have been during the dry summer period. Although a peat-bog region is never easily accessible, artificial pathways are in fact exceptions. The

presence of three MBA footpaths could be indicative of a rapid deterioration of the accessibility of the bog, but it could also indicate a new interest in the bog.

It is clear that the peat-bog surface became more difficult to pass over in certain places after c. 1500 B.C. This was notably the case in the contact zones of the domed peat-bog surface (2.2.3.), with the hummock-hollow systems of the type Emmen 17 and type Emmen 32, the raised bog lake of type Emmen 19, and the shore zone of this lake, type Emmen 22/23. Around 1200 B.C. the lake and shore-zone were impassable. The adaptation of the construction method of XVII(Bou) in the contact-zone region (figs. 17 and 18; 2.2.3 and 4.1.6.) illustrates the problematical situation there. The domed complexes themselves (hummock-hollow system type Emmen 9) were, relatively speaking, still reasonably passable. They were almost certainly not much more difficult to pass through than before c. 1500 B.C.

The region of the seepage centres is not so well known. We assume that these iron-ore areas were not yet overgrown by raised bog (Casparie & Smith, 1978). The doming of this seepage peat was probably visible from a distance. Also the exact shape of the seepage areas is not known, possibly they were not round. We presume that the marginal zones were very wet. The raised-bog lake Emmen 19 may have originated as a result of the closing-off effect of the iron-ore area C in the contact zone (fig. 7).

In addition to the worsening accessibility it is most likely that there was a new or renewed interest

in the bog. The ritual building (3.3.; fig. 11), for example, may be indicative of this. The new exploitation would then have necessitated the construction of the footpaths. These artificial pathways would certainly have facilitated the transport of heavy loads, in view of the limited carrying capacity of the soft bog surface, that would have hindered exploitation. However, we have no evidence that around 1200 B.C. the peat-bog surface became considerably wetter and thus more impassable within a short period of time. In fact we can demonstrate a (slight) desiccation of parts of the bog surface around that time (Casparie, 1972). Perhaps it was this that stimulated (renewed) penetration of the bog.

The forest along the bog margin (fig. 5), consisting mainly of *Pinus*, would almost certainly have been entered regularly. In view of the occurrence of *Scheuchzeria* remains in many places in the *Pinus* wood-peat near the bog margin, this must have been a fairly wet zone (Casparie, 1972), that was probably less than 100 m wide. The choice of wood for the footpath XVIII(Bou) indicates that this *Pinus* forest was exploited (4.2.6.). Locally *Betula* was present in this forest. In places where side-valleys opened out into the Hunze depression, where water richer in nutrients, from the Hondsrug, flowed into the bog, *Alnus* would have been present. We have not found any remains of this *Alnus* forest. On account of the stronger roothold of the peat in the marginal zone the carrying capacity of the bog margin would have been increased, though it seems unlikely that anyone could have simply passed through here dry-shod. For this reason, it is most probable that the footpaths were constructed from the higher sandy soils, right through the bog-margin forest.

5.2. Ferruginous fen peat and siderite; Bronze Age iron technology

One could imagine that the presence of a very large raised bog in Southeast Drenthe would be a serious handicap for the development of prehistoric occupation. A considerable part of the land close to the settlements cannot be reclaimed. Yet it is not possible to demonstrate that prehistoric occupation here was scanty or poorly developed. On the contrary, what we see here is remarkably intensive occupation in this region, not only in the MBA (see section 3.) but also as early as the Neolithic (Casparie, 1982). Apart from sufficient arable land, good pastures and an ample wood supply the region may have had other attractions, namely something provided by the bog. This could not possibly have been the ombrogenous *Sphagnum* peat. There is no evidence of any peat-digging activities or any other kind of reclamation of the highly humified or fresh to poorly humified *Sphagnum* peat. An attempt to

convert an area of *Sphagnum* peat near the bog margin into arable land can be dated in the LBA at the earliest (Casparie, 1972; Emmen 5). That attempt did not succeed.

The ferruginous seepage peat was almost certainly known in the MBA. The iron content is so low, however, that this peat could not possibly have served as raw material for the production of iron. The bog iron-ore, siderite, was well known in the Iron Age in any case (Modderkolk, 1970; Casparie & Smith, 1978). We are convinced that it was also well known in the MBA already, and possibly even in the Neolithic (Casparie, 1982). Indeed it was the only attractive material in this peat-bog region.

The process of formation of bog iron-ore is not known in detail. In particular it is not clear which micro-organisms play a role in this process (van Bemmelen, 1895; van Heuveln, 1958; Reinders, 1896; 1902). What is remarkable, and therefore worthy of mention here, is that this material, a ferro-carbonate, is present in peat in a non-oxidized state. The formation of this compound from the iron-rich seepage water would therefore have taken place at some depth below the peat-forming vegetation cover, mainly Hypnaceae (Casparie, 1972).

In the western marginal region of the Bourtanger Moor seepage is a well known phenomenon. Usually the Hondsrug functions as an infiltration region. In those cases where the ground-water courses come into contact with boulder-clay, the seepage is iron-rich. The occurrence of ferruginous seepage peat and siderite in the Bourtanger Moor is well known in many places. To some extent the seepage was as described in 2.2.2. and 2.2.3. (Casparie, 1972). In some cases the seepage water entered the Hunze valley via glacial side-valleys. The seepage described by us in 2.3. (leakage through the watershed) is in fact not essentially different. The most important difference with respect to the other types of seepage mentioned is the smaller difference in height. In Nieuw-Schoonebeek this was ± 2.50 m. Along the Hondsrug this can be as much as 8 m.

In the case of Nieuw-Schoonebeek we were able to describe the seepage process with much greater accuracy than in 2.2.2. and 2.2.3. The material formed, bog iron-ore (siderite), is very similar in both cases. For the prehistoric people who were familiar with this ore and how they could use it, it must have been very attractive. We therefore think it probable that iron was produced in a number of places during the MBA.

The analysis by J.A. Charles (this volume) of the iron punch, illustrated in fig. 13, that was found on a plank in trench 4 of the footpath XVII(Bou) (3.3.) shows convincingly that the bog iron-ore that served as raw material was of very high quality. There is no possibility that the iron was released as a by-product of e.g. smelting copper. In fact the raw material could only have been siderite. The MBA

occupation near Angelsloo (3.1.) would be the most obvious site of production.

With regard to the technology (resulting in a kind of spongy iron) Charles does not mention at which temperature the bog iron-ore yields malleable iron. This is about 600°C. Much Late Neolithic pottery was fired at a temperature of at least 700°C. The smiths of the Bronze Age were certainly able to produce a temperature of c. 600°C. The matrix of the bog iron-ore (*Hypnaceae* peat) ignites in a dry state at c. 300°C (pers. comm. G. Hekman).

Charles mentions the remarkable hardness of the punch, and of its point in particular. We are convinced that a metal object as hard as this must have been a marvel of technical expertise in the context of the MBA. A certain part of the technique required to produce it, namely cold hammering, would already have been well known at that time. It is questionable whether this technique had already been developed for the working of bronze, in which case it could have been applied quite by chance to the working of spongy iron, or whether it was developed specifically for this iron production. The latter possibility is suggested by the fact that the makers of the punch knew a lot about the process of preparing iron. Evidently they knew at which concentrations additives like manganese and carbon had a positive effect on the required quality (*i.e.* great hardness) of the end-product.

In that case the iron technology of Southeast Drenthe could be considerably older than the MBA as we have described it, *i.e.* c. 1200-1100 B.C. We may not presume that with this punch we have found the first iron product of this region.

What purpose could such a punch have served in the MBA economy? The hardness achieved could have made it very suitable for engraving bronze and copper (Charles, this volume). If that was indeed its function then it is hard to explain why this punch was found on the footpath in the bog. It is more likely that the punch had something to do with activities in the bog, notably digging for iron-ore, *e.g.* as part of a tool.

5.3. Methods of construction of the MBA footpaths in the peat-bog

The clear differences in the method of construction of these approximately contemporary footpaths illustrate the ability of the MBA population to find distinctly different solutions to overcome the various obstacles that hindered traffic over the bog. This corresponds to the findings of Hayen in Northwest Germany and Coles *et al.* in the Somerset Levels (see further below). In addition we can also speak of differences in terms of organization.

The southern plank footpath XVII(Bou) (fig. 22), had clearly been designed before it was built.

In view of the consistent method of construction it must have been made according to specific instructions. The method of construction and choice of material were probably dictated by a local squire. The wood came from the forest on the higher soils. Only oak timber was used. The construction elements were probably made in the settlement. They were of course put together in the bog at the place where the path was found. The mallet (fig. 14; 3.3.) must have been one of the tools used for this purpose.

It is almost certain that trees were felled specially for the construction of this path (4.1.8.). These trees were mainly oaks, c. 40 cm thick. The heartwood was used for the longitudinal planks, whereas the sapwood was used for the transverse timbers (and possibly also the pegs). It is possible that while the path was being built, eventually somewhat thinner trees were used (resulting in narrower planks and transverse timbers). The path is the work of woodworkers, possibly special carpenters. The condition of the wood (it has a fresh appearance, and has been attacked by insects hardly or not at all) indicates that it was used immediately after being felled. It seems as though no secondary material was used.

The construction method of XVII(Bou) (fig. 24) provides very great stability. The way in which the planks and transverse timbers are fixed with pegs into the bog indicates that the builders of the path were well familiar with the bog, at least with the problems involved in maximizing carrying capacity. Walking along this path could not have been very comfortable. The path was narrow, and anyone walking along it would have had to keep stepping over the pegs, that sometimes stuck out considerably from the planks. The greatest problem with the path was undoubtedly the low walking level, only a few centimetres above the bog surface (*i.e.* the thickness of the plank). As the weight of the wood and the people walking over it would have exerted pressure on the bog surface, this means that it would often have been impossible for anyone to walk along the path dry-shod (see also the adaptation to the construction method in the trenches 3-5 (4.1.6.)).

The way in which the path was constructed (with all the building elements fixed into the bog) makes it suitable for providing access through various types of raised-bog surface (domed complexes, contact zones, wide hollows), but with an increasingly wet bog surface it would have been much less satisfactory. This could indicate that the bog was temporarily drier, c. 1170 B.C. The contact zone remained too wet, however (4.1.6.), as previously shown by the peat research (Casparie, 1972).

The footpath of Klazienaveen-North XVIII(Bou) (fig. 34) is also the product of a clear design, although this is much simpler and more obvious than

that of the path XVII(Bou). The wood, *Pinus*, comes from a pine forest on ombrogenous peat (4.2.4.), that dried out c. 1120 B.C. This may have been the same drying-out period as that demonstrated for the path XVII(Bou) (Casparie, 1972). The timber was prepared in a simple way. The branches were removed from the felled trunks, and these trunks were then cut into two or three pieces. The top parts provided the pegs. The lowest part formed the pathway surface – 4 or 5 logs laid down lengthwise. Depending on whether the tree-trunks were cut into two or three pieces (in the latter case to provide transverse timbers), there were two types of building unit. The traces of felling were still clearly visible. The wood was used efficiently, the tree-trunks were fully made use of. The construction method is distinctly different from XVII(Bou) (fig. 24). The construction method provides fairly good stability, but less than XVII(Bou). The path would have been only moderately comfortable: people would have had to walk along roundwood laid lengthwise. Such a surface would not have been easy to walk along, but it was reasonably wide, about 50 cm. The walking level was sufficiently high above the bog surface to enable people using the path to remain dry-shod.

In terms of construction the path is inferior to XVII(Bou). At times when the water level in the bog was high (with inundated hollows) and in contact zones the pathway surface elements could have simply floated away. The path was therefore unsuitable for giving access through flooded hollows and contact zones. The situation of the path (fig. 7) also indicates this. To reach the presumed destination of the pathway no contact zone had to be passed through.

The footpath of Emmercompascuum XVI(Bou) (fig. 40) has a very special construction. This path too was designed beforehand, and it was almost certainly built by special woodworkers, according to instructions. The construction method (fig. 24) and the choice of material (oak timber) were probably enforced by a local squire too.

The wood comes from the higher sandy soils, not the Hondsrug but the sandy areas of Lindloh and Schwartenberg (Landweer, 1902). The building elements were made with great care. Well smoothened planks and the rectangular openings in the transverse timbers indicate that the axe was used skilfully.

On a bog surface with a pronounced hummock-hollow pattern the stability of the path is slight. The path was not suitable for giving passage through wet hollows and contact zones. The building elements easily float away if the bog surface is completely waterlogged. This suggests that in this locality the bog surface was fairly dry c. 1160 B.C. In such a situation the very slight difference in level between the walking surface and the bog surface

(only a few centimetres) would not have been a real disadvantage.

5.4. Comparison with other Bronze Age trackways

Of the 20 or so prehistoric trackways in the peats of the Somerset Levels, England (Coles *et al.*, 1975-1982), only two date from the MBA: Meare Heath track and Tinney's multiple trackways. These two paths are approximately contemporary. They date from c. 1250 B.C. Meare Heath track is a footpath two planks wide, laid down on top of transverse planks, some of which are fixed into the bog by means of pegs. It consists completely of oak timber. The construction method is somewhat less careful than for the footpaths XVI(Bou) and XVII(Bou). There is some correspondence to the construction method of XVIII(Bou), although the latter consists entirely of roundwood. Meare Heath track does not have a consistently solid construction. On drier peat-bog there is much less constructive timber.

Tinney's multiple trackways are in fact brushwood tracks, consisting of bunches of alder twigs laid down lengthwise and a number of oaken planks, also laid down lengthwise. The bunches of twigs were laid down in some cases rather carefully, and in some cases much less carefully. In terms of their construction the tracks cannot be compared with the footpaths of Southeast Drenthe.

Of the many peat-bog trackways of Northwest Germany that have been investigated by Hayen (1963a; 1963b; 1965; 1978; 1979; 1980), a few wooden footpaths of the find-region Ipweger Moor B can be mentioned here, that date partly from the EBA, and partly from the MBA. In his study on the building technique and the typology Hayen (1958) outlines the construction methods encountered. To build these footpaths, planks, roundwood and bunches of twigs were used. The trackway surface elements usually lie in the longitudinal direction of the track. A substructure of wood laid down transversely is present to some extent, to increase stability. Also pegs were used. The construction method of the footpath of Klazienaveen-North XVIII(Bou) can easily be fitted into Hayen's typology. Hayen's classification does not include systems with trackway-surface wood and transverse timbers fixed to each other and into the bog, like the southern plank footpath XVII(Bou), or systems with the longitudinal planks fixed through openings in the transverse timbers, like the footpath of Emmercompascuum XVI(Bou). However, the diversity of construction methods ascertained by Hayen shows that these two constructions should by no means be regarded as very exceptional.

A most remarkable footpath is one studied by Hayen (1970) in the peat-bog near Verden, that consists of stepping stones, and that dates from the

MBA. Wide peat-bog trackways dating from the MBA hardly occur at all, although the disc wheels from Glum from the EBA/MBA (Hayen, 1972) indicate the use of wagons.

5.5. Final remarks

The footpaths that form the subject of this article were not built to provide a means of contact. They were intended to provide access to specific places in the bog, so that people could go to and from on foot unimpeded. In view of the slight difference in age between these three MBA footpaths (50-75 years) it is justifiable to assume that all three pathways were intended to make accessible one particular material, that had (suddenly?) become recognized as being of great potential value. Here we are thinking primarily of iron-ore. There are clear indications that this assumption is correct.

It is possible that changes in the hydrological system of the peat-bog surface, that could have been climatologically induced, had the effect of making the bog more easily passable. Nevertheless wooden paths or trackways for giving access through the bog of Southeast Drenthe are rather the exception than the rule, as is evident from the distribution of peat-bog finds, dating from approximately the same period, that are not concentrated along these pathways. With these footpaths we see well thought-out methods of construction. Here we are concerned with carefully planned activities. In contrast the footpaths in the peat-bogs of the Somerset Levels, for example, that were precisely intended to reach ploughland and other settlements, were built very simply: they are merely brushwood paths rather than well designed constructions. The material that was to be found in the Bourtangier Moor must have been highly valued. Also the building of the ritual construction near Bargerosterveld (3.3.) suggests that the bog had something valuable to offer.

There almost certainly existed a wide range of possibilities for the construction of wooden pathways. Naturally knowledge of woodworking techniques was present in all settlements. It is not completely certain whether very much was known about the special nature of the bog surface. In any case the bog was known to be hardly passable.

From the path constructions that have been found it is possible to deduce various technical information, in particular concerning the woodworking. Thus a length of c. 2.80 m could have been a standard measurement for planks and logs. In addition it was known how to use the wood to maximal advantage, without the restriction of a standard measurement.

From the presence of these three almost contemporary footpaths it can be concluded that there was a certain increasing need for exploitation of a larger

region, from the home-base of the MBA settlements. This suggests that we are concerned here with a well structured form of society, in which a considerable skill in metal working had been established, and in which it was possible for the footpaths to be built according to specific instructions.

Nevertheless these footpaths give us nothing more than a momentary glimpse, as it were, of one particular situation during the entire span of the prehistoric occupation of this region. The paths were in use for only a relatively short period, the state of preservation of the wood found during the excavations indicates that they were used for a period of less than ten years rather than several decades. It is possible that only shortly after the paths had been built the bog became wetter once again, so that the exploitation of iron-ore became less attractive or even impossible. Perhaps we should not even exclude the possibility that after a short period there was no longer any need for this bog iron-ore, so that the footpaths fell into disuse not long after they had been built. In Southeast Drenthe so far no indications have been found of the use of iron between c. 1100 and 700 B.C.

The overall picture that we have presented in this article actually indicates a normal state of affairs, namely the exploitation of natural resources using adequate technical means. What is remarkable is that in this case the material concerned is bog iron-ore, while it has long been thought that the local population was able to process this material only c. 500 years later.

Thanks to the dendrochronological dating of XVII(Bou) it is now possible to ascertain the absolute age. The entire phase of activities described in this article we can thus date to between 1350 and 1300 B.C. in dendro-years.

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Figs. 17, 18 and 36 are to be found in the fold at the back of this volume.