1.1. THE HISTORY OF THE ARCHAEOLOGICAL ENQUIRY

1.1.1. Before 1940

As early as the 16th century remains of Roman settlements were discovered in the Western Netherlands and recognized as such. In 1520, 1552 and 1562 finds were made on the beach at Katwijk, where the Brittenburg must have been situated, and on the terrain of the Roman *castellum* near Leiden, the Roomburg [2]. In 1647 the Nehalennia temple near Domburg was exposed by the sea [3]. The first systematic excavation in this country concerned the Roman town of Arentsburg near Voorburg, where Roman finds had been made as early as about 1500. It was Reuvens who conducted large-scale excavations there between 1827 and 1833 [4].

On the other hand prehistoric finds in the low-lying western parts of the Netherlands were not yet recognized as such. Pleyte [5] was the first to make drawings of a few: two stone axes from Hoorn, a flint sickle from Venhuizen, an arrow-head from Katwijk, the Late Bronze Age hoard from the Veenenburg estate (Hillegom/Lisse), a socketed axe and a flint sickle from Herveld. More finds were known to Holwerda [6], namely more of the finds from Veenenburg, the hoard from Voorhout and the high-flanged axe from Wassenaar. He regards these finds in the Western Netherlands, however, as having been lost by chance travellers and not as a proof of prehistoric occupation. The discovery of the Late Neolithic settlement site at Zandwerven in 1928 by Butter was therefore a sensation of the first order: the proof of a real settlement in the Western Netherlands in the Neolithic! The year before Oppenheim had already stressed the importance of the prehistoric finds in the Older Dunes and the consequences for the age of the coastal barriers [7].

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[2] We will not discuss here the interesting problem as to what finds, said to be made at Katwijk beach, were in reality found there, and what finds at Roomburg, nor the question whether the foundations traditionally called "Brittenburg" really were observed at the beach or not. See Dijkstra and Ketelaar 1965, esp. 10 f.; Byvanck 1943, 430 f.

[3] As to Domburg, see Hondius-Crone 1955. As result of the discovery of the remains of a second Nehalennia sanctuary at the bottom of the sea-arm Eastern Scheldt near Colijnsplaat, the Domburg finds are again in the focus of interest. See Stuart 1971, 1972, Louwe Kooijmans 1971.

[4] Recently Bogaers (1971) gave a summary of the various interpretations and argued that Arentsburg might be *Forum Hadriani*, the capital of the *Cananefates*.

[5] Pleyte 1877-1903. As the first in Dutch archaeology Pleyte made archaeological distribution maps with a geological background.

[6] Holwerda 1924, 1925, 72. The maps by Holwerda also have the geology as background.

[7] Butter 1935, Oppenheim 1927/'28, Van Giffen 1927/'28.

1.1.2. After 1940

For a long time inhabitation seemed to have been limited to the coastal barriers ("the Older Dune Landscape"), separated from the high Pleistocene sands of Utrecht and Brabant by an extensive uninhabited and uninhabitable peat swamp. A sharp increase in finds and archaeological sites and consequently in our understanding of prehistoric settlement in the Western Netherlands occurred only after the second world war. This is due chiefly to the activities of two new organisations: the systematic soil survey led by Edelman since 1943 [8], later by the Soil Survey Institute (Stiboka), and the foundation of the Association of Amateur Archaeologists in the Western Netherlands (the AWWN, now AWN) in 1951.

Through the physiographic character of the surveys and through the interest of the pedologists the soil surveys, which were made primarily in the alluvial regions, were at the same time a kind of systematic archaeological exploration. In a large number of regions, the history of human occupation especially in relation to the transgression and regression phases, and particularly in the period during and after Roman times, could be described consecutively [9]. These studies increased our understanding of the occupation of alluvial landscapes unprotected by dikes: of the living places of the inhabitants, where we may expect prehistoric settlements, possibly at some depth under younger sediments, and where they will lack.

Due to the work of amateur archaeologists, together with the extensive digging and building activities of the last twenty years, numerous sites and finds were discovered which otherwise would have remained unnoticed. Witness of this is given in the journal *Westerheem*. Obvious objects such as stone axes and bronze implements would in many instances have come to the attention of archaeologists as they had done previously, but settlement sites, which are only identifiable by means of sherds (not easily recognized as such by a lay person) would certainly have remained undiscovered or might have been destroyed.

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[8] Hoeksema 1948.

[9] The most important comprehensive studies listed by district, are:

general	— Van Giffen 1954, J. P. Bakker 1958
Betuwe	— Modderman 1949[b]
Bommelerwaard	— Modderman 1947, 1949[c]
Heusden en Altena	— Modderman 1953[b], Voogd 1955
Maas en Waal	— Modderman 1951[b], Pons 1957
Maaskant	— Modderman 1950
Vijfheerenlanden	— Modderman 1951[a], Pons 1961
river area as a whole	— Modderman 1955[d], Pons 1957
Westland	— Modderman 1949[a], Van Liere 1947
Zeeland	— Van der Feen 1952, Van der Feen in Bennema & Van der Meer 1952, Trimpe Burger 1958, 1960, 1960/'61
West Frisia	— Wiese 1956
IJsselmeer district	— Braat 1932, Modderman 1945, Van der Heide 1955[a], [b], [c], 1962, 1965/'66
Older Dunes	— Van Regteren Altena in : Jelgersma *et al.* 1970

further a series of internal reports and find lists at the RMO, Leiden.

Since the discovery of the Neolithic settlements at Hekelingen [10] and Vlaardingen [11], and the Bronze Age barrows at Zwaagdijk [12], it was clear that occupation was also possible in the region behind the coast, along creeks and on deposits that were silted up to a high level, at least since the Late Neolithic. The peat area, however, seems to have been an uninhabited wilderness through which the courses of rivers and creeks formed the only communication with the high sand areas. It was only an occasional find which indicated that prehistoric man actually also lived along these rivers and on the sandy deposits of silted-up older systems [13]. In the river area the first Bronze Age settlement was discovered in 1954 at Kesteren, after a number of Iron Age sites had already been found during the soil surveys [14]. Thanks to the investigations of Havinga in recent years the number of Bronze Age sites has increased to some dozens [15], for the greater part in the surroundings of Opheusden and Dodewaard.

With increasing knowledge of the geological history of the Western Netherlands and recognition of the problems connected with this area, interest also increased in its prehistoric (and historic) inhabitation history, which is closely linked with them. In the modern geological surveys, conducted by the Netherlands Geological Survey, the superficial deposits as well as the whole deeper lying Holocene complex, are involved. They also contribute to a better understanding of the possibilities for inhabitation. The prehistorian is aware of the possibilities for research, while on the other hand the results of excavations are of importance for an accurate picture of the geological situation and for a correct dating system.

1.2. THE HOLOCENE OF THE WESTERN NETHERLANDS

1.2.1. A short Outline of its Structure (fig. 1)

A knowledge of the geomorphological development of the area is essential to full comprehension of the inhabitation history in the Western Netherlands. Thanks to the numerous soil surveys and the investigations of the Netherlands Geological Survey the structure of the Holocene deposits is well known at this moment. Numerous comprehensive studies have been published [16]. Here only a short summary is necessary for our purpose.

As a consequence of the rapid rise in sea-level there occurred in what are now known as the Western Netherlands at about the end of the Boreal, marshy conditions which resulted in the formation of the "Basal Peat", an eastward extension of the earlier peat formation in what is now the North Sea (the *moorlog*) [17].

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[10] Modderman 1953[a].

[11] Van Regteren Altena *et al.* 1962/'63.

[12] Van Giffen 1944[a].

[13] See p. 98, note 62.

[14] Modderman 1955[d], 31.

[15] Pers. comm. Mr R. S. Hulst, Amersfoort; Havinga 1969.

[16] Edelman 1960, Pannekoek (ed.) 1956, J. D. de Jong 1960, Pons *et al.* 1963, Stichting voor Bodemkartering 1965, Brand *et al.* 1966, J. D. de Jong 1967, Hageman 1969, J. D. de Jong 1971.

[17] *Cf.* Florschütz 1944, Van Straaten 1954. In the Late Glacial Rhine/Meuse valley the peat formation started earlier (Preboreal). There, however, not the rise of sea-level but the changes in *regime* of the rivers determined the conditions.

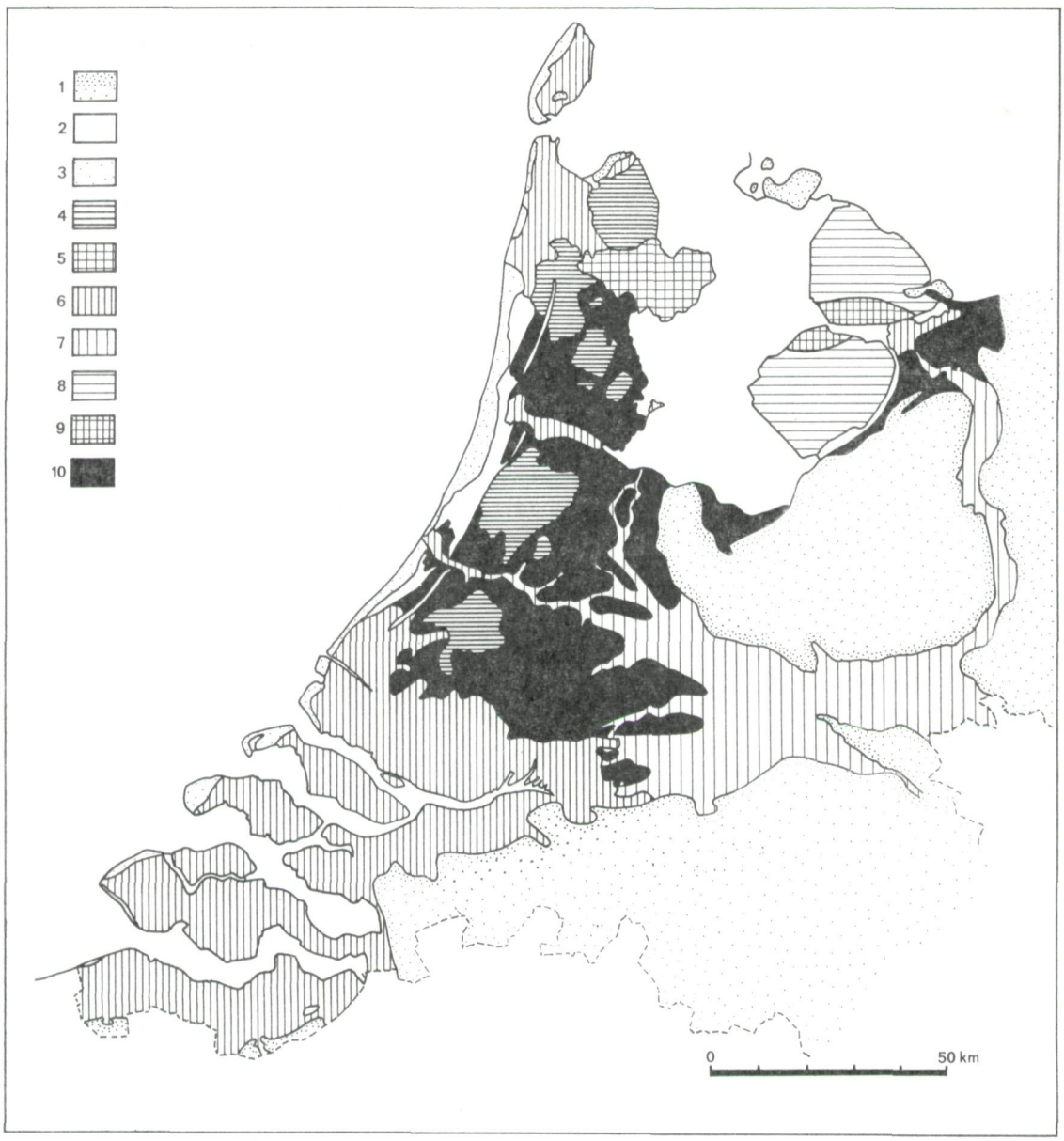

Fig. 1. Generalized map of the Holocene surface deposits in the Western Netherlands, used as background in the distribution maps figs. 2, 5, 7 and 8. A cover of recent or subrecent clay, if less than half a meter is left out of consideration. For the greater part after the generalized soil map scale 1:600,000 in the "Atlas van Nederland".

Legend :

1. Pleistocene (mainly ice-pushed hills and cover-sands, the "high sand area", well above NAP.
2. Coastal Barriers and Older Dunes.
3. Younger Dunes.
4. Calais deposits (5 and 9 excluded).
5. Westfrisian deposits (Calaix IV^b and Dunkirk 0).
6. Dunkirk deposits (5 and 8 excluded).
7. Tiel deposits.
8. IJsselmeer deposits (Dunkirk III).
9. Dunkirk deposits underlain by Calais deposits and Early Holocene dunes in the IJsselmeer Polder district.
10. Holland Peat, in the southern part with Gorkum river deposits (stream ridges) and outcropping Early Holocene dunes.

After the continuous rise in sea-level the sea passed the present day coast line in the beginning of the Atlantic. The Western Netherlands changed into a landscape of tidal flats, its inland boundaries formed by reed swamps and separated from the open sea by a coastal barrier which was broken by a number of tidal inlets [18]. These zones shifted more landward as the sea continued to rise, but as the rate of the rise in sea-level decreased the landward move of the coastal barrier became slower and slower, until in the beginning of the Subboreal a balance was achieved between erosion and the coastal sedimentation. From then on new coastal barriers were subsequently formed seaward of the old ones. So the oldest preserved coastal barriers [19], formed in the beginning of the Subboreal (3000-2700 B. C.), are the innermost of the present coastal barrier complex. Mainly after the formation of the second belt of coastal barriers which were covered soon after their formation with low dunes (the Older Dunes), the tidal flat area was more or less cut off from the sea.

The marine sediments were changing markedly from tidal flat deposits into salt marsh deposits at that time [20]. On the other hand already in Atlantic times there must have been short periods of non-deposition, during which the thin peat layers originated that separate the different Atlantic Tidal Flat Deposits. Especially by means of these peat layers it was possible to establish the subdivision into the various Calais phases.

Under the influence of the eutrophic river water flowing into the central salt marsh area from the east, it quickly became an extensive fresh water swamp. A swamp forest developed on the former tidal flats and salt marshes.

From the beginning of the Holocene the area of sedimentation of the main rivers was already situated in its present position. In the course of time the deposits were laid down there in various superimposed systems. In this process parts of the older sediments were eroded each time and replaced by new deposits.

Since the oldest preserved coastal barrier was formed the tidal inlets through the coastal barrier system (which were at the same time the estuaries of the main rivers) had little changed their places. We distinguish: the estuary of the Scheldt in the place of the present Eastern Scheldt, the estuary of the Meuse near Rotterdam, the estuary of the Rhine near Katwijk and an extensive inlet near Egmond. This was the estuary of a river, of which at least in the older stage of development the Utrecht-Vecht and probably also the river IJssel with the Oude IJssel and the Overijssel-Vecht formed the upper courses [21]. The most western courses of

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[18] For the Older Dunes and the coastal barriers see: Van Straaten 1965, Zagwijn 1965, Jelgersma & Van Regteren Altena 1969, Jelgersma *et al.* 1970.

[19] By "coastal barrier belt" we mean in this paper the units of several single coastal barriers, formed close together and separated from each other by small discontinuous shore flats or (mostly) not at all. The coastal barrier belts are separated from comparable units by broad, well recognizable shore flats, with which they form the units into which the coastal deposits below the Older Dunes can be divided in the first instance. See fig. 9. The small and older (Calais II ?) coastal barrier remains at Nootdorp (Schans & van der Knaap 1956) and near the IJpolders are left out of discussion here. We follow the conception of Jelgersma *et al.* 1970.

[20] Riezebos & du Saar 1969.

[21] The part of the river IJssel between Arnhem and Doesburg must be of very recent date, as appears from the absence of natural levee deposits in this reach. So the present IJssel was not yet one of the lower courses of the river Rhine, but the lower course of the many brooks of the Achterhoek, Twente and Salland, including the Overijssel-Vecht. *Cf.* Poelman & Harbers 1966, Zagwijn 1971, Pons 1957, fig. 38. Since the discovery of the remains of the Roman

the main rivers therefore appear to have been much more conservative, that is to say much less liable to deviations, than was thought until recently.

1.2.2. Transgression and Regression Phases (table 1)

Periods marked by a relatively strong marine influence can be distinguished as transgressions, or rather "transgression phases", which left their marks chiefly behind the tidal inlets. The transgression phases are followed by periods of rest, which are called the "regression phases". We can recognize a sequence or a cyclicity which can be described as follows: the transgression phase begins with erosion of the older sedimentation and/or peat areas and the forming of a network of creek systems. The next phase is that of marine sedimentation, followed by the gradually silting-up of the creeks. One of the results of the vanishing of the creeks is the blocking of the drainage of the sedimentation area. Finally in the regression phase peat growing spreads again over the whole area [22]. In this cycle the advanced state of the sedimentation phase and the beginning of the phase with general peat formation form the period in which the possibilities for occupation by men are most favourable. On the one hand drainage is still sufficient, and on the other hand the fully developed sediments provide terrains of sufficient height for permanent occupation.

The first (Atlantic) transgressions, occurring during a rapid rise in sea-level and an eastward shift of the narrow (*i.e.* much broken) coastal barrier, resulted in the formation of a coherent marine sedimentation area covering an extensive part of the Western Netherlands. In the Subboreal and Subatlantic when the sea-level rose slower and the coastal barrier system was well developed transgressions were limited regionally and more or less restricted to the regions behind the inlets; yet they generally appeared clearly in various places more or less simultaneously, and may therefore be grouped in well-defined periods of transgression activity.

Present-day Holland has always been well-protected by a broad and nearly continuous series of coastal barriers covered with low "Older Dunes". It was only through the above-mentioned inlets that the sea could invade the peat area. In Zeeland and the Northern Netherlands, on the other hand, the old peat landscape suffered considerable flooding. In the north it disappeared almost entirely and was replaced by young tidal flat and salt marsh deposits. In the region of the Zeeland and South Holland islands the peat was cut up by numerous young creeks. The remaining areas between these young deposits were preserved and now form a number of geological (and archaeological) "windows" [23].

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temple at Colijnsplaat (*cf.* note 3) the course of the Roman Scheldt is in the centre of interest. In addition to the old reconstruction through South Beveland (Steur & Ovaa 1960), a course through the Eastern Scheldt seems to be another possibility (pers. comm. Mr F.F.F.E. van Rummelen). In both models the mouth is situated north of Domburg.

[22] Pons in: Van Regteren Altena *et al.* 1962/'63, esp. 1962, 235 f.

[23] In the Dutch sedimentation areas we can name those districts "windows" where an older landscape is at or near the present-day surface, in an otherwise completely covered or destroyed region. So the "window" is surrounded by younger sediments or water. There a glance at the former situation is made possible, so that the landscape on a wider scale may sometimes be reconstructed. It must be borne it mind that this is a relative question: one can have

TABLE 1

Transgression phases in the Netherlands. Comparison of the different names used

Pollen zones	Transgression phases: Calais- and Dunkirk phases	Transgression phases: Older names	Transgression phases: "Tidal flat deposits"	Transgression phases: Conventional ^{14}C dates after Hageman 1969	Remarks
Subatlantic	D III^{c}	recent			
	D III^{b}	Late Mediaeval		800-recent	Younger Dunes
	D III^{a}	Ottonian post Carolingian			
	D II	post Roman Early Mediaeval		A.D. 250-600	beginning of coastal erosion
	D I^{b}	pre Roman (II)	Early subatlantic	600-100 B.C.	
	D I^{a}	pre Roman (I)			
Subboreal	D O	Cardium Westfrisian II	Late subboreal	1500-1000	widespread peat formation
	C IV^{b}	Unio Westfrisian I	Early subboreal	2600-1800	
	C IV^{a}	Wieringermeer Hellevoeter zand			
Atlantic	C III	Hoofddorp Beemster	Late atlantic	3300-2800	oldest preserved coastal barrier
	C II	Watergraafsmeer	Early atlantic	4300-3400	
	C I	Starnmeer		6000-4500	lower peat
	C I^{a}	layer of Velsen Hydrobia layer			
Boreal					*donken*

"Younger sea clay" / "Older sea clay"

We meet a comparable situation in the river area, where the prehistoric deposits have been eroded in the meander belt windings of later river courses. They are only preserved at places of exclusively back swamp clay sedimentation in later times [24]. Between the river clay area and the "younger sea clay" a great part of the South Holland peat area has been preserved. It can be conceived of as the largest of the geological or archaeological "windows". Besides former river courses a large number of Early Holocene dunes have been spared, the so-called *donken*, of which the tops have frequently not become overgrown with peat.

We need only refer to the problem of the causes of transgression and regression cycles, as it falls outside the scope of this study [25]. Of especial importance in this connection are the correlations of the marine transgression phenomena themselves with the information about cyclicity outside the marine sedimentation area. Thus, it seems possible to correlate a number of periods with marine sedimentation with sedimentation phases in the river clay area [26]. Moreover, a succession of aeolic sedimentation phases and phases in which humic or peaty layers were formed in the coastal dunes appears to run parallel with the regression and transgression phases respectively in the marine sedimentation area. It is suggested that the blocking of the tidal inlets by wind-blown sands during the periods with a low ground water table in the Older Dunes, might be one of the causes of the origin of the regression phases [27]. Later we shall deal further with these matters (p. 100).

For the present classification and nomenclature of the most important deposits and transgression phases in the Dutch Holocene we refer to table 1 and to the listed literature [28].

1.3. THE DETERMINATION OF INHABITATION AND ITS PERIODICITY

1.3.1. Introduction

The determination of the presence of inhabitation and forming of ideas about the (relative) density of inhabitation is a matter of relationships between the distribution patterns of the finds and the original pattern of inhabitation. In which way and to what extent does a map showing the distribution of finds reflect inhabitation during a given period?

In an enquiry into the occupation of the Western Netherlands the same questions must be asked as in any similar enquiry elsewhere: when (if at all), where and how was the region used for inhabitation? What is exceptional in the Western Netherlands is that the whole problem of inhabitation is governed by the drainage conditions: the average height of floods,

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a Roman window within a Mediaeval sedimentation area, or a Neolithic window within a region with pre-Roman sediments and Roman occupation. The lake bottom reclamations (*droogmakerijen*) may for instance be regarded as windows too.

[24] Havinga 1969.

[25] See lit. mentioned in note 16.

[26] Pons & Modderman 1951, Pons 1957, Hageman 1969, Havinga 1969, Verbraeck 1970.

[27] Jelgersma *et al.* 1970.

[28] *Cf.* note 16, also S. van der Heide & Zagwijn 1967.

extreme water-levels, the general rise of sea-level or of the groundwater table and its fluctuations, the availability of well-drained terrains (that is, relatively sandy and high) their size and accessibility. An ultimate purpose of this part of the enquiry is the determination of periods of more or less intensive inhabitation as opposed to periods without or with only slight inhabitation and the relationship of such inhabitation periodicity to the changes in the environment. These last data may be represented by the geologically established transgression and regression phases.

The history of inhabitation will not be the same for the different physiographic regions of the Western Netherlands. The distribution of inhabitation, the concentrations in special parts of these regions and the choice of the settlement sites in these regions reflect the suitability for inhabitation and so give a picture of its circumstances.

1.3.2. Some critical Remarks on the Interpretation of the Finds

Certainly in the Western Netherlands we must make a sharp distinction in the different levels of our knowledge of inhabitation, as we could also conclude from the history of the enquiry. We must distinguish between establishing:

— human presence

— actual inhabitation

— the density of occupation.

In the ideal case these questions must be answered for each landscape unit (physiographic region) and for each culture or phase within these units.

Human presence is proved already by one reliable and well-documented find. Actual inhabitation appears from at least one settlement site, from grave finds or from clear indications of human activity in a pollen diagram. The character of the settlements reflects the nature of the inhabitation. This knowledge can only be acquired by excavation. Especially in the wet Western Netherlands it is possible to make a detailed picture of a prehistoric society because organic material often has been preserved at the settlement sites.

It is much more difficult to determine the intensity of the inhabitation, or its absence. As is the case also outside the Western Netherlands a number of factors play a role in this, which we can summarize as the "chance of discovery". This includes, for example:

— The absolute rarity of the relevant material. This can be the result of, for example, the short duration of its use; one thinks in this connection of the Maritime Bell Beakers, which in the higher parts of the Netherlands, moreover, are mainly grave finds from barrows.

— The nature of the relevant material can be such that it is only identified by laymen with difficulty; for example, tanged and barbed arrow-heads are much easier to identify than transverse arrow-heads, Roman pottery easier than that of the Bronze Age, and bronze axes easier again than those of stone.

— The way the material is found. Of certain groups, particularly the beaker cultures, the finds occur predominantly in barrows. As these hardly ever appear in the Western Nether-

lands, the distribution picture is determined by settlement finds, which have never attracted much attention outside the Western Netherlands. The same applies to the Late Bronze Age, although it must be remembered that until a few years ago no well-defined domestic assemblages were known at all either in the west or in the south. The dimensions of the settlement terrains are also of importance: a Roman site is easier to find than a Beaker settlement.

— The intensity of the enquiry. Also in the Western Netherlands this is of importance. In the districts of active AWN groups the number of known find spots can increase rapidly in a short time, as was the case, for example, in the Alblasserwaard. The extra attention which has been given to those relief units on which experience teaches that finds are to be expected, can also lead to an incorrect picture. With our present knowledge of the possibilities of inhabitation it seems to us, however, that this factor is not of much significance.

An entirely different aspect is the variable degree of typological differentiation and the possibility of dating in that way. Such datings of the Beaker Cultures for example, can be established fairly closely; in the Bronze Age and often also in the Iron Age settlements can only be dated roughly. Bronze axes can be closely dated, but dating of stone axes is often almost impossible. Naturally all this plays a part in the determination of possible periodicity of inhabitation. Thanks to the ^{14}C-dates these difficulties can now be partly surmounted.

Peculiar to the Western Netherlands finally, besides the above-mentioned generally valid factors, is the influence of geological conditions. Old landscapes are often covered with later deposits, so that the opportunity of discovering archaeological terrains is reduced with increasing thickness of the deposits. This applies particularly to former creek systems and the river courses. In large parts of the Western Netherlands old deposits have been considerably affected by later erosion, or have even completely disappeared and replaced by younger sediments. Good examples of this are Zeeland and the present IJsselmeer district, and also the Atlantic coastal barriers. All information for a given period of time has thus disappeared from such an area, sometimes with the exception of a few small districts, which for this reason we called "archaeological windows". In establishing inhabitation and its periodicity these are important factors.

1.4. THE SEQUENCE OF INHABITATION IN THE WESTERN NETHERLANDS BEFORE THE IRON AGE

1.4.1. The Maps

Prehistoric finds in the Western Netherlands have not yet been the object of a comprehensive publication. There are some regional surveys [29] and summaries for a few cultures [30]. Recent finds have been listed in the "Chronicles" of the journal *Helinium*. In view of our invest-

[29] *Cf.* note 9.

[30] Van Regteren Altena *et al.* 1962/'63 (VL-Culture), Verwers 1968 (BB-Culture).

igations in the river clay/wood peat area we were most interested in the period before the Iron Age. So this period will be discussed here in detail, while the later times will be dealt with more comprehensively in the next paragraph.

In a list (appendix I) and a number of maps the finds dating from before the Iron Age are here brought together. Included have been only the finds which are in some degree datable: all settlement terrains, pottery finds, shaft-hole axes, flint axes, bronze implements and a number of "other artifacts". Excluded are all stone axes and the majority of antler implements, since these generally can be dated only very roughly. Further we have not included unreliable finds, such as all finds dredged up from the main rivers (especially those "near Nijmegen") which have mostly reached the museums via the art-dealers. The list of finds (appendix I) now consists of 261 items, namely 198 find-spots and 63 references.

The material is divided over four distribution maps. The time limits of the periods covered by the maps coincide as far as possible with divisions in the archaeological material, but they are primarily moments when large parts of the region appear to be relatively thinly inhabited.

Considerations of classification have led us in each case to show groups of similar isolated finds on one map. The flint axes and battle axes have thus been shown on map II, the flint arrow-heads on map III and the hammer axes on map IV. A number of late battle axes certainly falls, however, in the period of map III; flint axes were certainly in use as late as 1700 B.C. The Sögel arrow-heads fall in the beginning of the period of map IV and the dating of the hammer axes is still a considerable problem. As long as the above points are borne in mind, all this — certainly since we are concerned with isolated finds — has little influence on the interpretations and the conclusions. Stone axes of round or oval cross-section form a special problem, which will be discussed in its appropriate context.

1.4.2. Palaeolithic-Middle Neolithic (fig. 2)

1.4.2.1. *The Palaeolithic*

A few finds originating from the Middle Palaeolithic were made in the area of the river Scheldt, apparently washed out of deeper deposits, in the subsoil. We must, however, be on our guard against objects, thrown overboard from modern ships on their way to the harbour of Antwerp, such as tropical shells and a tooth of an African elephant, recently dredged up, does show.

Moreover, only two Late Palaeolithic implements from the subsoil of the Western Netherlands are known. Both have been described as Lyngby axes, which appears to us to be a somewhat daring interpretation. We prefer to call them worked reindeer antlers. Together with the finds of Late Palaeolithic implements in the coastal regions of the Western Netherlands, at Aardenburg and Axel in Zeeland Flanders, near Schokland in the North-east Polder and on the island of Texel for example, they do in fact show that the cover-sand landscape and the Late Glacial river system in the subsoil of the Western Netherlands were inhabited. Cultural similarities between the finds in Great Britain and the Netherlands, especially in the Allerød period, point indeed indirectly to inhabitation of the intermediate part of the North Sea basin. But the chance of finding direct proof of this in the form of flint implements is very small.

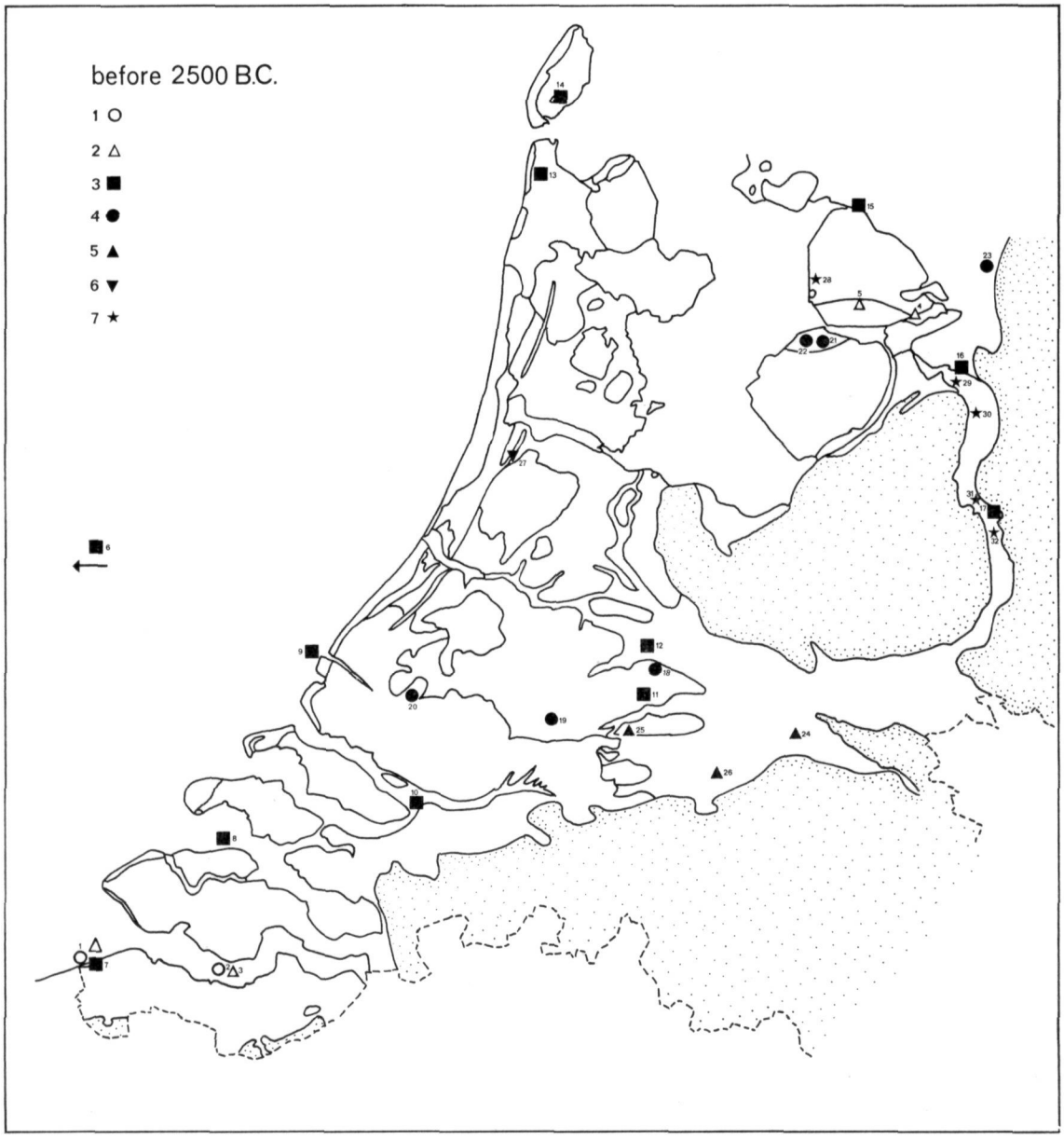

Fig. 2. Prehistoric finds in the Western Netherlands, dated :

— before 2500 B.C.
— before the VL Culture
— before the transgression phase Calais IV

The numbers refer to the documentation of the mapped sites in Appendix I, section I.

Legend :

1. Middle Palaeolithic.
2. Late Palaeolithic.
3. Mesolithic.
4. Early and Middle Neolithic.
5. shaft-hole axes of *Breitkeil* type.
6. stone axes.
7. antler T-shaped axes.

1.4.2.2. *The Early Mesolithic.*

The similarity of the Early Mesolithic cultures on both sides of the North Sea is proof of inhabitation of the North Sea basin at that time [31]. A marshy zone with peat (the *moorlog*) will have been attractive, as is shown by the finds and as can be accepted by extrapolation of the Danish finds to the comparable landscape in the North Sea region.

In this peat was found the Maglemose barbed point of Leman and Ower Banks [32]. Some years ago, moreover, among the numerous bones of a Pleniglacial fauna which were fished up from the surroundings of the Brown Bank (half way between Lowestoft and Katwijk) some implements were found [33]. These are, however, not of Pleniglacial age, but must be dated for typological reasons to the Early Mesolithic, especially the Late Preboreal and Early Boreal. All of the implements are made from aurochs bones. The most characteristic pieces are a shaft-hole pick and a socketed axe. They were dredged up from depths between 35 and 45 m. and they originate very probably from the *moorlog* deposit, which is dated there in the very beginning of the Boreal [34]. The finds offer worthy additional data for the construction of the Early Holocene part of the curve of the relative rise of sea-level.

The Brown Bank finds made it very likely that the marshy Basal Peat landscape in the subsoil of the Western Netherlands was also inhabited by small groups of hunter-fishers during Boreal times. Another argument supporting this assumption is the distribution of (Early) Mesolithic bone implements, and especially the barbed points, all around the southern North Sea. In a recent paper we mapped these finds [35].

In the end of 1972 the above supposition was confirmed by some extraordinary finds on the artificial sand plain called "Maasvlakte", the most westerly part of the Europoort harbour of Rotterdam. The finds comprise until now four barbed points, one of them fragmentary, an antler sleeve, a bone needle, a wild boar's tusk chisel and some worked pieces of bone and antler (fig. 3) [36]. The implements must have been derived from the thin peaty clay (part of the Basal Peat) that overlies there the sandy and gravelly Late Glacial river beds at a depth of -26 to -22 m. NAP. We must imagine that the chance of making finds from this depth is extremely small. The deep and extensive sand dredging works in Europoort offered such a possibility.

1.4.2.3. *The Late Mesolithic*

We can name three possibly Late Mesolithic finds from the Western Netherlands.

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[31] Clark 1936, Schwabedissen 1951, Louwe Kooijmans 1970/'71, 64.

[32] Clark & Godwin 1956, esp. fig. 5 and Pl. I, 6; Clark 1932, Appendix VII, Louwe Kooijmans 1970/'71, 32.

[33] Louwe Kooijmans 1968[a], 1969[a] (preliminary notes), 1970/'71.

[34] *Cf.* Jelgersma 1961, 70-72. The centre of the localized finds is near "Location B". It is rumoured that also on the Dogger Bank Mesolithic worked bones have been fished up. According our information this seems, however, not to be the case.

[35] Louwe Kooijmans 1970/'71. In addition to the finds listed there we must mention the three barbed points found at Dinslaken, Stampfuss & Schütrumpf, 1970. I discovered this publication too late, to include its information. To our opinion the dating of these barbed points to the Allerød period is not very sound and is still open to discussion. A later date, more in agreement with all other evidence (Preboreal-Early Boreal) cannot be excluded.

[36] Louwe Kooijmans 1970/'71, 50-53.

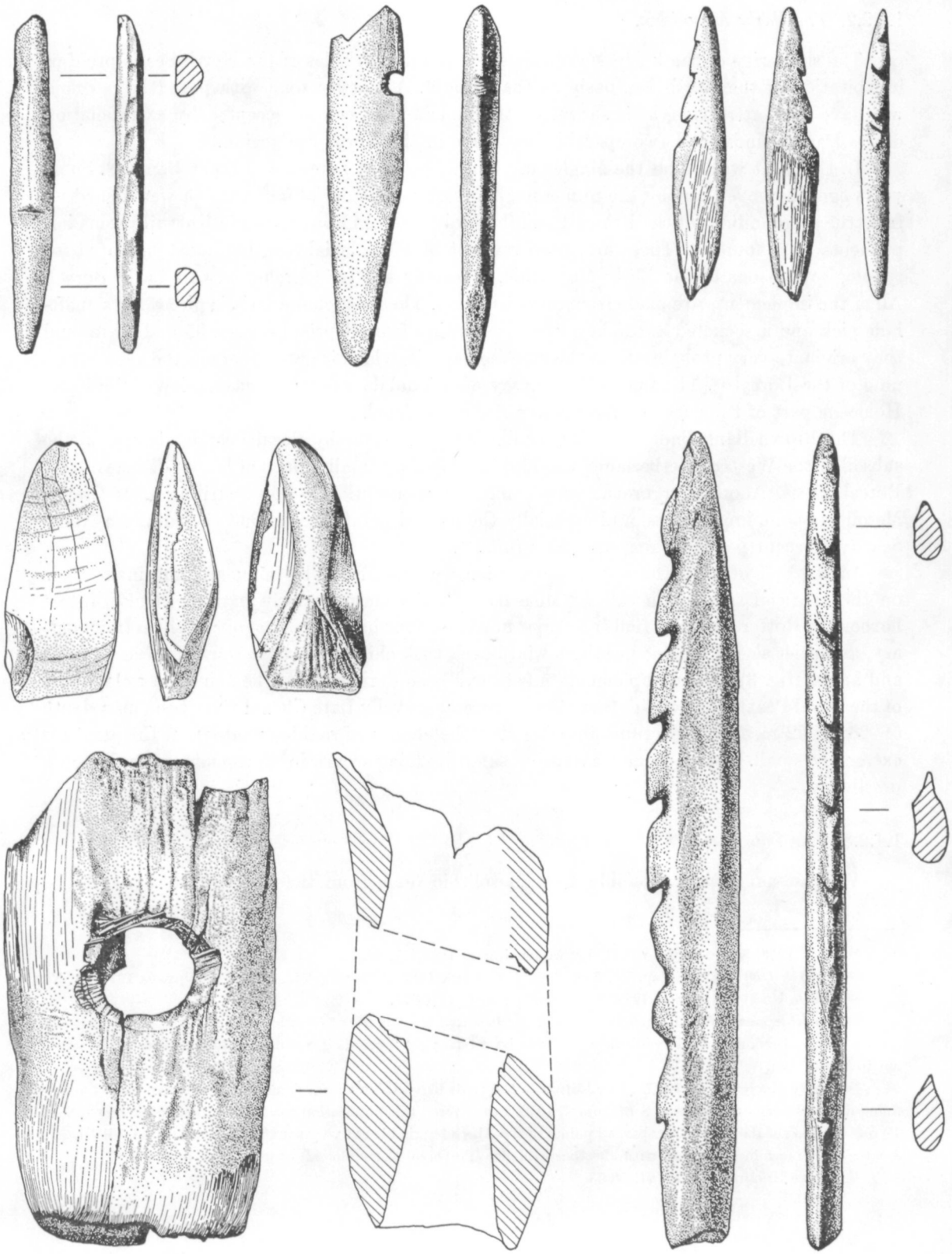

Fig. 3. Early Mesolithic implements, found in 1971-'72 on the Maasvlakte of Europoort, Rotterdam. Dredged up from a depth of —26 to —22 m. NAP. Scale 1:1.

First, the small wooden figure which was found in 1966 during the building of a lock in the Volkerak [37]. It was lying in a thin layer of peat at about — 8 m. NAP, between the roots of a tree stump directly above a gradual rise in the cover-sand. A ^{14}C dating gave an age of *c.* 4450 B.C.

At Koegras in 1950 a few flint flakes were found, also on the top of a sizeable rise (up to —4.25 m. NAP) of the cover-sand landscape. The base of the overlying peat is dated at about 3000 B.C., which is the latest possible date for the finds [38].

The third find is a human skull of apparently Mesolithic age, which was dredged up near Vianen [39].

The *donken* seem to offer the best chances of making more finds from the Late Mesolithic. Up to the present time, however, only a few flint implements have been found there. One piece, a trapeze, found on a *donk* near Leerdam, is perhaps Mesolithic [40]. In the pollen diagram of the Hazendonk, mun. Molenaarsgraaf, it appears that there are some traces of human activity at about 4100 B.C. [41]. In an identical situation Mesolithic finds were made in the English Fen district in 1935 [42].

Late Mesolithic finds are thus only known from the former peat regions. No inhabitation and so no finds are to be expected in the tidal flat landscape further to the west, with the exception perhaps of the short phases, during which a thin peat layer was formed there.

1.4.2.4. *The Early and Middle Neolithic* [43]

It is also valid to the Early and Middle Neolithic that the level of inhabitation is so deep that finds can only be of an incidental character. Moreover, at that time the largest part of the Western Netherlands consisted still of a tidal flat landscape of which the possible coastal barriers, with the exception of the latest series had disappeared.

Of the greatest importance is the discovery in 1963 of some Early Neolithic settlements with a number of graves near Swifterbant in the East Flevoland Polder, situated on outcrops of the Pleistocene/Early Holocene sandy subsoil and on the natural levees of Early Holocene water courses in a former peat area, which has since completely disappeared by marine erosion[44]. These sites and the finds made there are discussed in some detail at p. 163 in our comment on the Hazendonk pottery and we will mention here only some special characteristics. The depth of the inhabited surface is —5 to —5.75 m. NAP. Three ^{14}C dates give a date in the middle

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[37] Van Es & Casparie 1969, Van Es 1968.

[38] Du Burck 1959, Jelgersma 1961, 29.

[39] Huizinga 1959, 52 and figs. 12, 13. The skull is very similar to those from Téviec, Brittany. The skulls from Swifterbant seem to be of the same type. A skull, recently dredged up at Avezaath near Tiel, is perhaps a second specimen from the river area. See also Constandse-Westermann 1968, Louwe Kooijmans 1970/'71 and lit. cited there.

[40] De Kok 1965. "Chronicles" in "Helinium" for district B: 1964, 136, no. 13; 1969, 75, no. 1; since similar trapezes occur at Swifterbant, the artifact might be Early Neolithic as well.

[41] In Part III of this paper our investigations at this site are discussed in full detail.

[42] See p. 73 f.

[43] Most of the finds mentioned here will be discussed in more detail in Part III of this paper, where we deal with the cultural relations of the "Hazendonk pottery".

[44] Ente 1971.

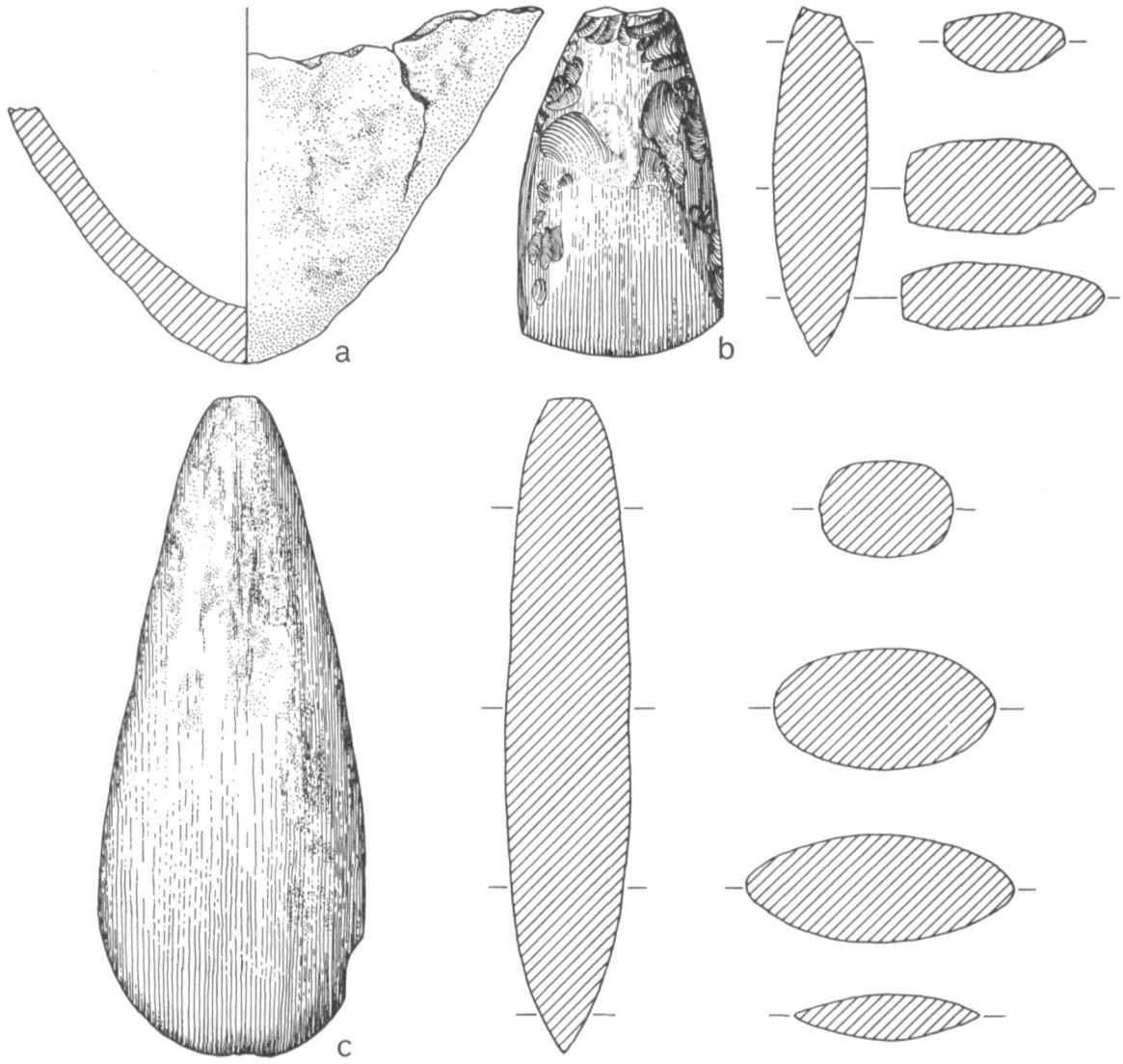

Fig. 4. Some recent Early/Middle Neolithic finds from the Western Netherlands. Scale 1:2

a) round pot base, Schiedam (fig. 2, no. 15)
b) flint axe, Abbenes (fig. 5. no. 43[a])
c) stone axe, Schalkwijk-Heemstede (fig. 2, no. 24)

of the fourth millennium. The recent excavations by the BAI, Groningen revealed that the organic material is preserved very well on the settlement sites. These investigations will give us a very complete picture of the communities (and their way of life), which inhabited the low lying regions in the Early Neolithic [45].

A second important site is the Hazendonk, mun. Molenaarsgraaf, also on an Early Holocene outcrop, but situated in the river clay/wood peat area of South Holland. In the pollen diagram at this site, human influences (esp. *Cerealia* pollen) are present at levels which are ^{14}C dated about 3400 B.C. and 3000 B.C. The levels correspond with former peat surfaces at —4.30 m. and —3.70 m. NAP respectively. The older dated level corresponds very well with the date of Swifterbant, the younger date can be brought in connection with the "Hazendonk pottery", found on the top of the *donk*. This pottery is a new group for this country [46]. We refer the reader to Part III for full details on this site.

Other finds supplement the inhabitation pattern. First the recently rediscovered round pot base from Schiedam, which is clearly related to the pottery found at Swifterbant [47]. Next we mention the indications of inhabitation since about 3000 B.C. which were found in the pollen diagram of the infilling of the stream channel at Zijderveld [48]. The "Zijderveld stream ridge", a Late Atlantic/Early Boreal river course, must therefore have been inhabited as early as in the Middle Neolithic. At the boundaries of the area are the Michelsberg Culture finds, made near Antwerp [49] and the occupation remains found at De Gaste near Meppel [50].

Some of the isolated finds can be dated to this period. First, three shaft-hole axes of *Breitkeil* type, of which two were found at the perimeter of the area, apparently below the Holocene deposits and on the cover-sand surface. Only one (no. 25) comes from the Holocene deposits themselves. Second, some T-shaped antler axes. Both types of implements are studied by Van der Waals [51].

Although Brandt placed all his *felsrund* and *felsoval* axes in the Early Neolithic (pre-TRB), we did not follow him here. The find circumstances of most of these axes, the locations and the over-all picture on the map make it likely that these axes, or at least some of them, are later [52].

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[45] Preliminary reports on the sites: Van der Heide 1964, 1965, 1965/'66 and esp. Van der Waals 1972.

[46] Renewed study of the finds from the *donk* at Waardhuizen, mun. Almkerk (fig. 5 no. 41; predominantly VL Culture, *cf.* fig. 6) yielded one sherd with deep reed impressions, very probably "Swifterbant" ware, and one rim sherd that might be "Hazendonk" ware. Both finds are not indicated on the map at fig. 2.

[47] Van Regteren Altena *et al.* 1962/'63, esp. 1962, 19-20. This paper: p. 164.

[48] Pers. comm. Mr R. S. Hulst, Amersfoort; J. de Jong 1970/'71.

[49] De Laet 1966, 1958, 31 and fig. 22; Lüning 1967, *Taf.* 1-4.

[50] Pers. comm. Mr O. H. Harsema, Groningen.

[51] We thank Prof. Dr. J. D. van der Waals, who gave us the manuscript of his article on these artifacts (Van der Waals, 1972) to read. The *Tüllengeweih-äxte* are in the collections of the RMO, Leiden and the Museum voor de IJsselmeerpolders, Schokland. The elk antler axe has its parallels among the finds from the Dümmer See (Deichmüller 1963, 80 and *Taf.* 1, 2), and at Star Carr (Clark 1954). Mr G. Elzinga, Leeuwarden, kindly informed us of the T-shaped axes found in the Holocene sedimentation area.

[52] Brandt 1967. Axes with oval or round cross-sections were found on the coastal barriers, in West Frisia, the Wieringermeer Polder and the southern part of the North-east Polder, *i.e.* in the blank regions of the Early/Middle Neolithic map (fig. 2). We think that not only the form, but also the stone used, the working technique and minor details in the form are determinative characteristics.

A dating before the VL Culture for the axe from Heemstede (fig. 4 c), seems, however, very probable on geological grounds. The axe was found on one of the oldest coastal barriers, that of Spaarnewoude, and must come from below the covering peat [53].

To summarize it appears clear that the Western Netherlands were inhabited in the Early and Middle Neolithic. Settlements were made in any case on the tops of sandy outcrops and on the stream ridges in the peat zone between the coast and the relatively high hinterland. Almost all the coastal barriers of these periods have, however, disappeared or are reworked by dune formation, so that it is a pure guess whether dwelling places also existed there of the kitchen-midden type such as are met with in the Danish Ertebølle Culture and in Brittany. To us it seems probable. From the region between the coastal barriers and the peat area the Schiedam pot base is the only find. It is dated now in a regression phase (CII/III), when in this predominantly estuarine region relatively quiet circumstances prevailed and peat formation took place so far to the west. In our view, occupation of the tidal flats themselves may have been as improbable as in the foregoing Mesolithic.

1.4.3. The Vlaardingen Culture (fig. 5)

1.4.3.1. *Dating, distribution, cultural relations*

It is not until the Late Neolithic that information becomes so detailed that we can form a picture of inhabitation which is more than a summary of incidental observations.

The Vlaardingen Culture (VL Culture)[54] is one of the best known cultures in the Netherlands, for which a fairly large number of ^{14}C dates is available (table 2). The dates of Leidschendam seem to be a few centuries too late, like that of the lowest layers of Voorschoten. On the basis of all dates we may place the VL Culture in the Western Netherlands between 2450 and 2000 B.C.

The distribution map of the archaeological remains of the VL Culture has undergone a number of changes in the course of time. The site which was first discovered (Zandwerven) occupies an exceptional position. The discoveries of Hekelingen and Vlaardingen increased the significance of the estuarine area, and Voorburg, Leidschendam and Voorschoten then made it clear that the coastal barrier area between the river Meuse and the mouth of the Rhine had been intensively inhabited.

As a result of the investigations in the river clay/wood peat area, the map has undergone a new and fairly drastic change. One findspot is known there on a stream ridge (Zijderveld)

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[53] It concerns a drop-shaped axe with oval cross-section, made from a compact sandstone with a beating technique. Only the cutting-edge has been ground. The axe probably originates from a southern Neolithic group. A few comparable pieces belong to the Michelsberg Culture (Lüning 1967, *Beilage* 9: *Beile Typ* 3). Of the other axes only those from Hoorn and Monster, made with the same technique, are axes of the true *Walzenbeil* type.

[54] Van Regteren Altena *et al.* 1962/'63, 101-103 for the definition of the VL Culture. For the natural circumstances in relation to the inhabitation see esp. Pons in the same paper, 97-111.

TABLE 2

Vlaardingen Culture. Radiocarbon dates

		Coastal barriers			
Zandwerven	GrN 2221	2050 ± 65	charcoal	Vogel & Waterbolk	1972, 85
Voorschoten	GrN 4908	2030 ± 60	charcoal	—	1967, 125
	GrN 4907	2130 ± 70	charcoal	—	1967, 125
	GrN 5031	2080 ± 40	charcoal	—	1972, 85
	GrN 4906	2140 ± 50	charcoal	—	1967, 125
Leidschendam	GrN 5027	1710 ± 60	charcoal	—	1972, 86
	GrN 5028	1860 ± 60	charcoal	—	1972, 86
	GrN 5029	1710 ± 80	charcoal	—	1972, 86
Haamstede	GrN 1577	2460 ± 60	charcoal	—	1963, 179
		Estuarine area			
Hekelingen	GrN 254	2250 ± 120	charcoal	De Vries *et al.*	1958, 135
	GrN 684	2120 ± 85	bone	De Vries & Waterbolk	1958, 1553
Vlaardingen	GrN 2480	2240 ± 70	charcoal	Vogel & Waterbolk	1963, 178
	GrN 2304	2300 ± 75	wood	—	1963, 178
	GrN 2303	2380 ± 60	charcoal	—	1963, 178
	GrN 2487	2330 ± 100	wood	—	1963, 178
	GrN 2306	2460 ± 100	wood	—	1963, 178
	GrN 4114	2470 ± 120	wood	—	1972, 84
	GrN 4948	2180 ± 40	bone	—	1972, 85
		River clay/wood peat area			
Hazendonk	GrN 5175	2340 ± 40	peat	Vogel & Waterbolk	1972, 85
	GrN 6213	2520 ± 40	peat	unpublished.	

and at least five, very probably seven, settlements have been identified on the *donken* (fig. 6). We must assume that still many more VL settlements lie buried in the subsoil on the levee deposits of former rivers at a depth of about 1.50 m. under the surface.

Characteristic finds of the VL Culture were recently made in the river clay area proper and on the sand hills of Wijchen, S. W. of Nijmegen. First, at the *donk* called Bommelse Loo, west of Zaltbommel a few (early) VL sherds were found during building works. Second, a few sherds found near Geldermalsen in washed position might belong to the VL Culture. At a site named Homberg near Wijchen amateur archaeologists recently discovered a small find group. The finds comprise two big rim-fragments of S-profiled pots, built-up in strips, like the Almkerk pot (fig. 6) and two clay-disc fragments. The original distribution of the VL Culture, limited to the coastal districts, has been extended to the east by the new finds. It is now the more clear that the VL Culture had in the first place its links with the Southern Netherlands [55].

[55] These sites are not indicated on the map (fig. 5). We thank Mr R. S. Hulst, Amersfoort, and Mr W. N. Tuyn, Nijmegen, for the information on these sites. The author is preparing a more detailed report on these finds and on the site Het Vormer, where Hazendonk pottery was discovered.

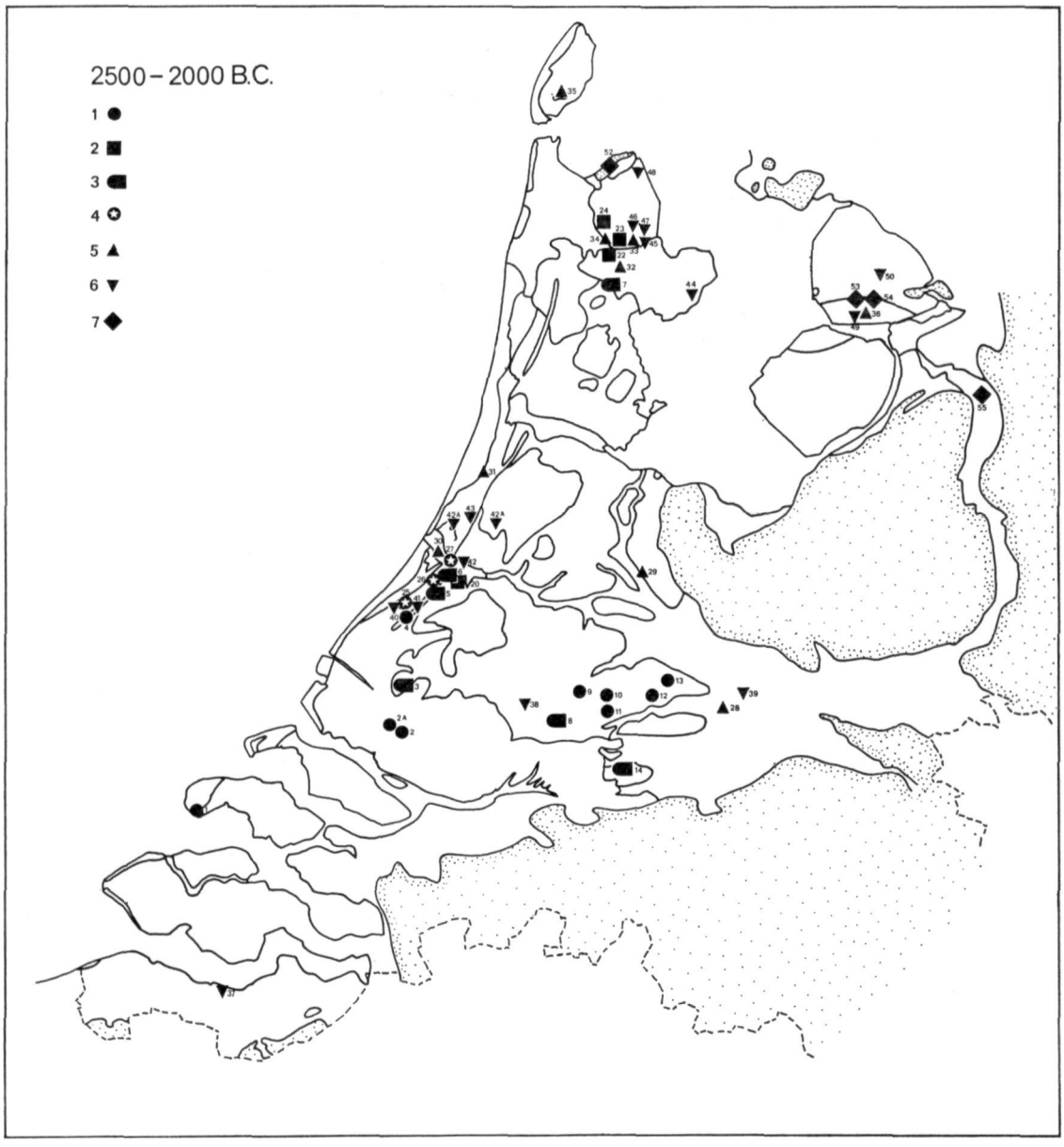

Fig. 5. Prehistoric finds in the Western Netherlands, dated :

— between 2500 and 2000 B.C.
— in the period of the VL Culture
— between the transgression phases Calais IV^{a} and IV^{b}.

The numbers refer to the documentation of the mapped sites in Appendix I, section II.

Legend :

1. VL Culture, settlement or pottery.
2. SVB or Hybrid Beaker, settlement or pottery.
3. 1 and 2 at one site.
4. various artifacts.
5. battle axe.
6. flint axe.
7. TRB Culture, various finds.

Connections with the Southern Netherlands were already evident on cultural grounds: the VL people used flint axes of a southern type and the finds at Stein and Wijchen [56] are closely related to the VL Culture. The pottery of the VL Culture, moreover, shows obvious differences from that of the late TRB Culture of the Northern and Eastern Netherlands (Late Havelte or Angelslo phase), especially in workmanship, shape and the lack of ornament. Judging by the occurrence of decorated clay discs with eccentric perforations and similar undecorated collared flasks in the VL Culture and the Angelslo phase of the TRB Culture it seems that there were also contacts with the north, aside from the dominating southern cultural relations [57]. The routes along which these contacts were maintained may have lain in the IJsselmeer district and/or have been also the same as those used for contact with the south: the active and old river beds in the Holland peat area.

1.4.3.2. *The situation of the settlements*

The three settlements in the estuarine region all lie along the drainage creeks of the end of the C IV^a ("Wieringermeer") transgression. The occupation level lies at about —3 m. NAP at Vlaardingen, between —2.10 and —2.80 m. NAP at Hekelingen I, between —2.70 and —2.90 at Hekelingen II [58].

Five settlements are known on the Older Dunes with a noticeable concentration (of isolated finds also) between the mouth of the Meuse and the mouth of the Rhine. It is very likely that the conditions there were particularly favourable for settlement. The oldest system of coastal barriers, covered with low dunes, was situated there in the form of a broad, high sand ridge behind a very wide shore flat. Its vegetation consisted of a tall-growing forest, undoubtedly full of wild animals; there was a good supply of fresh water and no danger of being flooded. There are, however, so many factors affecting the distribution pattern that we cannot say that the other coastal barriers, existing at that time, were not inhabited. The belt of coastal barriers, which at the time of the VL Culture formed the actual coast or lay in its immediate vicinity, was in any case visited, as appears from a few isolated finds there (a flint axe and whetstone in The Hague [59]), and the find of a sperm-whale tooth and bones of the grey seal in the settlements of Voorschoten and Leidschendam. As this coastal barrier belt was not yet "fossilized" but was still in the process of formation, and was certainly still subject to active dune formation we need not be surprised that all traces of settlement are lacking there. The chance that they would have escaped from erosion is particularly small. On the other hand it can,

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[56] For Stein see Modderman 1964^b, for Wijchen see p. 166, note 70 and p. 21.

[57] We leave another theoretical possibility out of discussion here: the "northern" elements of the VL Culture can be the result of influence from a third culture area, that influenced both areas (the northern, TRB and the western, VL area) more or less independently.

[58] We thank Dr J. A. Bakker, Amsterdam, for his permission to use the height measurements made during the exploration of this site by the IPP, autumn 1970.

[59] *Cf.* Jelgersma *et al.* 1970, 137. The whetstone was found at the base (*i.e.* under the peat) of the 3rd shore flat and almost on the landward slope of the 4th coastal barrier. We must, however, remember that this type of whetstone indeed occurs in graves of the Battle Axe Culture, but that in the Netherlands only two cases are known (both PFB graves). The PFB Culture lasted until about 2000 B. C. (perhaps even one century longer) and this type of whetstones might also have been used in later (*viz.* Bronze Age) times.

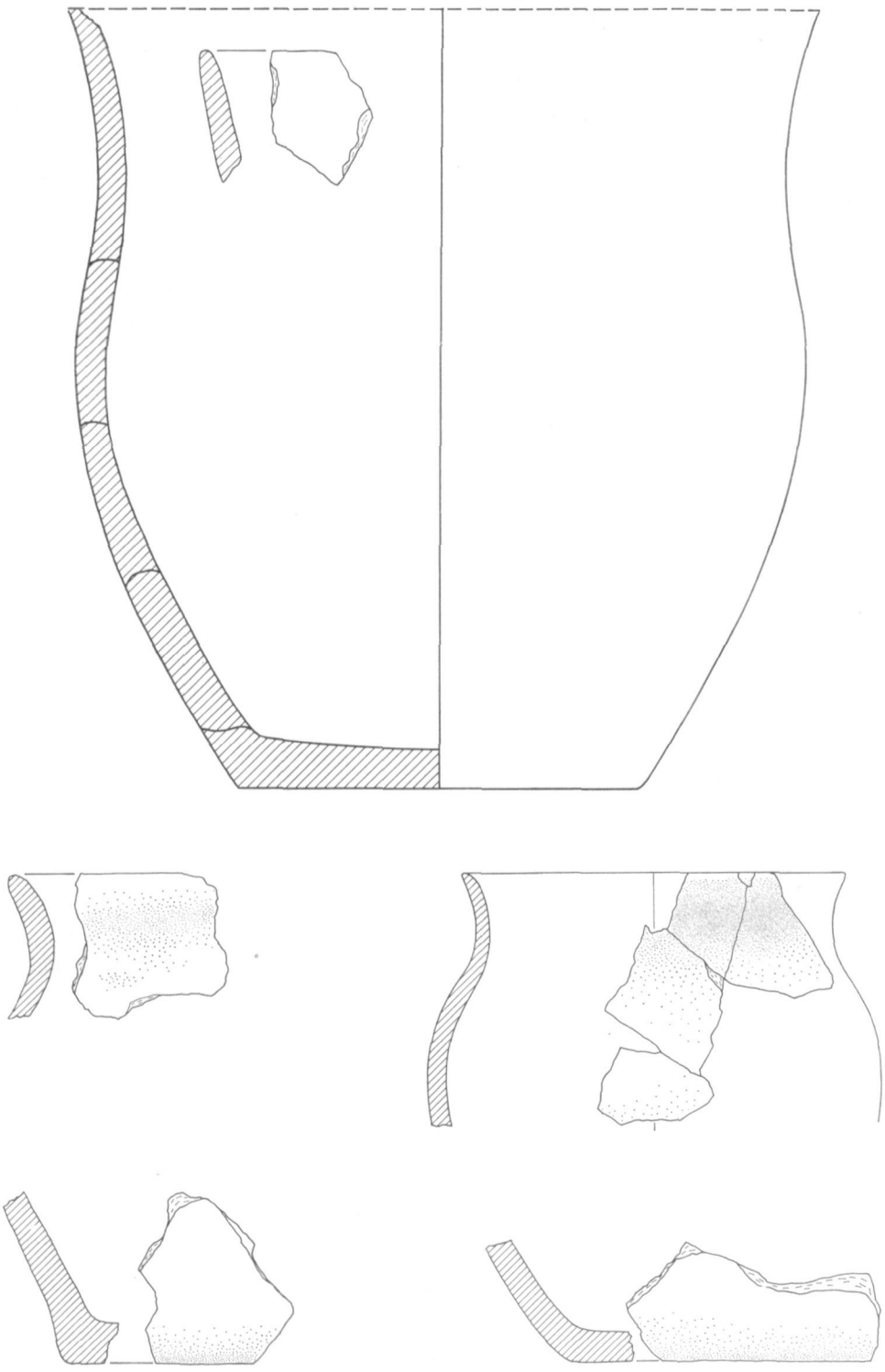

Fig. 6. Vlaardingen Culture pottery from a *donk* near Waardhuizen, mun. Almkerk, North Brabant (fig. 5, no. 14). Scale 1:3.

however, be imagined that the environment of such a coastal strip could not have been very attractive for an agrarian community to establish itself permanently. As the dune formation decreased with a first growth of vegetation, the soil must have still been poor in humus and therefore dry. Fresh water must, however, have been available soon. Although in our view the factor of shelter did also play a role in such a case, people did not wait to occupy these terrains, as is shown for later times (Iron Age, Roman period) by the excavations at Velsen [60].

A number of explanations can also be given for the absence of VL settlements north of the mouth of the Rhine. In this area the seaward shift of the coast-line between C III and C IV was much smaller (see p. 40). The shore flats of this period are much narrower than they are south of the Rhine, or they do not exist at all. In general it may be stated that the coast-line at this time acquired a more concave and less straight outline. It is possible that for this reason coastal conditions, especially the formation of dunes, lasted longer to the north of the Rhine. The same arguments apply to the absence of finds on the coastal barrier Voorhout-Lisse-Haarlem (the second belt), as we mentioned for the contemporaneous coastal barrier south of the Rhine. In this case the find of an axe fragment near Lisse is instructive. This indicates that the VL people at least visited this place, while it is even possible that it is one of the last remains of a settlement of which all traces have disappeared by erosion.

Two entirely different factors appear to us, however, to be all important north of the Rhine. First, the effect of the present use of the land, the bulb cultivation, for which already long ago large terrains were levelled to the most favourable height above the ground water table. Second, its accessibility for the VL people may have played a part. It is possible that the region north of the Rhine estuary was more or less isolated from the southern nucleus of the VL Culture and that the population density was not so high that it was necessary to make use of this apparently less attractive section of the coastal barrier region. In our opinion there is, however, no question that the coastal barrier region as a whole was isolated because of its poor accessibility, as Pons has suggested [61].

Large parts of the former tidal flat area behind the coastal barriers had already become salt marshes during the VL Culture. In the present Wieringermeer Polder the conditions for making finds are relatively favourable: the present day surface was for a long time the sea floor, where often a slight erosion took place. After the reclamation a relatively large number of stone axes, including a number dating from the period under discussion, were washed free or ploughed up. In other polders, where the Old Sea Clay lies at the surface, it was, however, often covered by a deposit of a peat detritus sediment. We should therefore not conclude from the lack of finds that these regions were not made use of. The recent find of a flint axe near Abbenes in the Haarlemmermeer Polder is the first proof of the contrary (fig. 4 b) [62]. It is,

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[60] Jelgersma *et al.* 1970, 140 f.

[61] Pons (see note 54) p. 110 stated: "the coastal barriers were probably more isolated at that time than the Frisian islands are at present. One must postulate water transport, since the barriers would have been inaccessible by land".

[62] This axe was discovered by Mr H. van der Lugt, Utrecht. According to Brandt 1967 (esp. p. 102) the axe is a *Flint Flachbeil* and a transitional form of his variants 1 and 2. Brandt dates these types to the TRB and the Early PFB Cultures, *i.e.* 2700-2300 B.C. The axe was found on the surface of the Older Sea Clay deposits *sensu stricto*, which are dated between the older Hoofddorp and the younger Beinsdorp deposits, the whole sequence being Calais III (Haans 1954). In view of the rather quick rise in sea-level occupation is considered likely only during a few centuries

however, not yet clear whether there were also permanently occupied agrarian settlements on these salt marshes.

1.4.3.3. *The character of the inhabitation*

Thanks to a number of excavations we know that the settlements were small and permanently occupied, with rather small rectangular houses. On the coast, especially where natural pasture land (salt marshes, shore flats) was available, cattle breeding was the most significant means of subsistence, together with arable farming. In the marshy wilderness hunting and fishing were the prevalent sources of food.

1.4.3.4. *Settlement finds of the Battle Axe Culture*

At four or five settlement sites of the VL Culture finds have also been made of the "Protruding Foot Beaker Culture" (PFB, the Dutch *facies* of the Battle Axe Culture, 2400-2000 B.C.). One other, pure PFB settlement was discovered at Aartswoud in West Frisia, a few years ago. The rich finds at this site make future excavations very promising. Outside the Western Netherlands proper, *i.e.* in the northern part of the province Friesland, near Dokkum, two more PFB settlements were discovered in recent years. They are situated on the surface of the Pleistocene subsoil (which is relatively high in this district) at —1.20 m. at Bornwird and at —1.50 to —1.80 m. at Beerdaard [63]. Both are covered with Holocene deposits. The three mentioned sites prove first that the VL Culture and the PFB Culture relate to different groups of people, and second that both these groups were attracted by the low lying regions. The occurrence of PFB Culture remains on VL sites reflect a (seemingly peaceful) intercourse of both groups.

A remarkable change in the influence of man on the natural vegetation of the Older Dunes has been determined at Voorschoten at the moment of the first contacts of the VL people with the newly arrived PFB people. The VL people grazed their cattle on the natural pastures, but after the PFB contacts clearings were made in the forest of the Older Dunes. This also is a characteristic of the PFB Culture in the high sand areas [64].

1.4.3.5. *Settlement finds of "Hybrid Beakers"*

On the PFB settlement at Aartswoud and on some VL settlement sites sherds of the so-called Hybrid Beakers have been found. Both the 1^{II} ("Zigzag Beakers") and 2^{IIb} (All Over Cord Beakers) types are represented [65].

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after the formation of the deposits. Since the geological and archaeological datings agree very well, there is no need to consider the possibility that the axe might come from former covering deposits that were washed away when the Lake Haarlemmermeer came into existence. These were, moreover, mainly peat formations.

It now appears that the RMO, Leiden had received another axe from the Haarlemmermeer Polder as early as 1853, found during the reclamation works in the year before. It is the cutting-edge fragment of an axe with flat sides and convex upper and lower surfaces, made of quartzite or a coarse flint. Inventory no. JvL 43.

63 We thank Mr G. Elzinga, Leeuwarden, for the data of Bornwird and Beerdaard. The last named site is actually situated at Stenendam half-way between Oudkerk and Beerdaard. Dr J. A. Bakker, Amsterdam, kindly informed us about the Aartswoud site.

64 Glasbergen *et al.* 1967.

65 Typology according to Van der Waals & Glasbergen 1954.

They must date from the end phase of the occupation on those sites. It seems that the VL people were able to continue occupation longer on the coastal barriers and the outcropping Early Holocene dunes than in the estuarine area. It is only at the site of the VL settlement at Voorschoten that some Early Bell Beaker sherds have been found. Like the finds on the *donken*, they do not necessarily imply continuity of occupation.

1.4.3.6. *Isolated finds*

As to the isolated finds, we can ascribe most of the flint axes to this period. Twelve pieces are of the southern type (with oval cross section), one belongs to the TRB Culture (with rectangular section, Schokland) and three are difficult to date. The flint axes of southern type may be partly older than the VL Culture like perhaps the pointed-butted axe from the Schoonenburgse Heuvel, Nieuw Lekkerland (fig. 22). Small flint axes on the other hand may have been used until the Early Bronze Age. The majority, however, belongs in all probablility to the VL Culture and form one of the southern elements in this culture.

Seven battle axes or fragments of them belonging to the PFB Culture are indicated on the map at fig. 5. The typologically latest pieces fall, however, in the period dealt with in the map at fig. 7.

We interpret two complete beakers, both from the Wieringermeer Polder, as grave gifts. The circumstances in which one of the beakers was found also point to this interpretation. They are an atypical early "Protruding Foot Beaker" and an equally atypical 2^{IIa} beaker. They indicate that the surface of the Calais IV^a ("Wieringermeer") deposits was inhabitable, at least in places.

The "other artifacts" on the map are a flint dagger blade, a scraper of Grand Pressigny flint and the whetstone from The Hague.

1.4.4. The Bell Beaker and Barbed Wire Beaker Cultures (fig. 7)

1.4.4.1. *The Maritime Bell Beaker phase*

Inhabitation during the earliest phase of the Bell Beaker Cultures (MBB) has been determined with certainty at only one place, namely at the type site of the VL Culture and almost at the same level (—2.90 m. NAP). After the VL occupation a marked change took place in the activity of the creek. In the first phase the creek shows the characteristics of the early stages of quietly silting up. The second creek has an asymmetrical section with an erosion bank in the outside bend and sedimentation in the inside bend. About 1950 B.C. people who used Maritime Bell Beakers established a very temporary encampment on the inside bend deposits [66]. They remained there at most a few weeks, a simple rectangular hut serving for shelter. This brief stay might just be a characteristic of those who used the Maritime Bell Beakers; yet it might be just as well a consequence of the unfavourable conditions during the transgression phase Calais IV^b.

[66] See note 54, esp. 1962, 28-29 and 232, Groenman-van Waateringe & Jansma 1969.

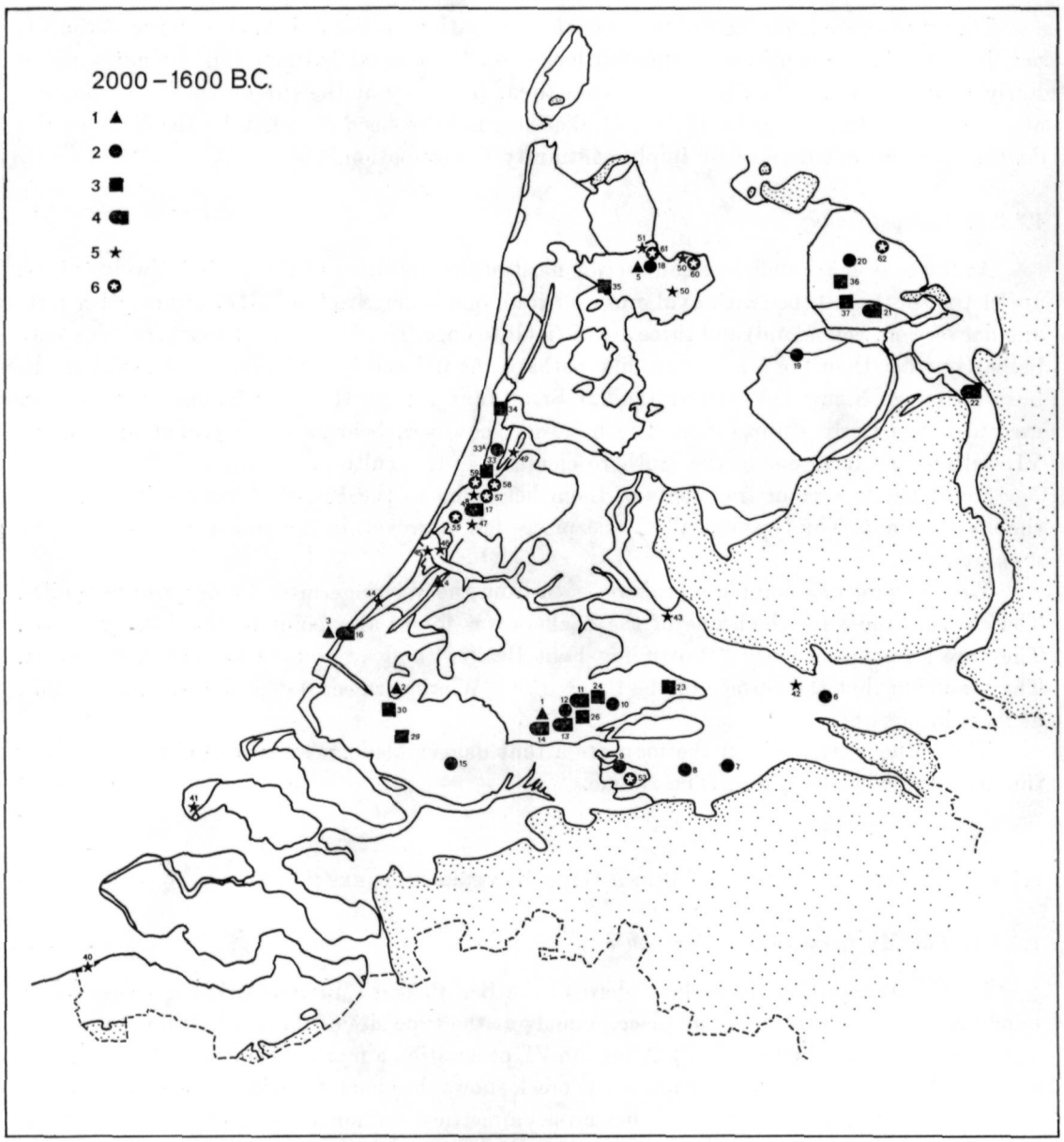

Fig. 7. Prehistoric finds in the Western Netherlands, dated :

— between 2000 and 1600 B.C.
— in the period of the BB and BWB pottery.
— between the transgression phases Calais IV^b and Dunkirk O.

The numbers refer to the documentation of the mapped sites in Appendix I, section III.

Legend :

1. MBB, settlement or pottery.
2. VBB, settlement or pottery.
3. BWB, settlement or pottery.
4. 2 and 3 at one site.
5. flint arrow-head, tanged and barbed or hollow-based.
6. various artifacts.

with the earlier VL inhabitation. The ground water table must have risen considerably in the meantime, for no wood was preserved in any of the post holes attributed to the VL Culture. So the clay layer 3 [70] was deposited between 2200 and 1700 B.C., during the transgression phase Calais IV^b and is as such contemporary with the change in activity in the creek at Vlaardingen, and at the same time with the high water deposits of the Schoonrewoerd stream ridge, which will be fully discussed later.

Verwers [71] has already drawn attention to the clear indications of the existence of communication between the West and East Netherlands through the river area at this time. It must have been a (trade) route running from settlement to settlement, that probably followed the Schoonrewoerd stream ridge [72] through the peat area. On this stream ridge, near Molenaarsgraaf, Ottoland, Goudriaan and Noordeloos at least seven occupation centres, together forming one long settlement are all dated to this period. There were probably other communication routes along (and by) the then active river courses. Widespread isolated finds in the river clay area and the settlement at Dodewaard show more clearly than in the VL Culture that the inhabited area extended from the coast to far into the Betuwe.

1.4.4.3. *The character of the inhabitation*

With the VBB/BWB occupation we are clearly concerned with a settled population in permanent dwellings. On a number of terrains (Oostwoud, Velsen, Molenaarsgraaf, Ottoland-Oosteind and Ottoland-Kromme Elleboog) post-holes have been determined and, at Velsen, cultivation of the soil with the *ard* by the BWB people. At Molenaarsgraaf two large spool-shaped houses were built one after the other. Cattle breeding and fishing were the two most important means of subsistence there, but grain was also cultivated on the narrow stream ridge. Hunting was not of importance. The dead were buried in the settlement terrain. The character of this VBB/BWB settlement is in strong contrast to the observations made of the early BB phase at Vlaardingen. Are these differences primarily cultural or a question of environment?

1.4.4.4. *Isolated finds*

The isolated found implements follow the distribution pattern of the settlements: besides a wirst-guard, a number of flint daggers (partly, especially those in West Frisia, atypical pieces) and thirteen flint arrow-heads. These last, namely the three Sögel arrow-heads, belong partly to the first centuries of the map at fig. 8. The absence of transverse arrow-heads may be attributed to the less easily recognizable shape.

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[70] As indicated by Modderman 1953[a], fig. 2.

[71] Verwers 1968.

[72] See p. 97 f. for the Schoonrewoerd stream ridge.

Elsewhere typological early Bell Beaker sherds occur only in insignificant quantities beside later Bell Beaker pottery. This indicates not so much an early occupation phase, but rather forms an old element of a later domestic assemblage.

1.4.4.2. *The Veluwe Bell Beaker/Barbed Wire Beaker phase*

A large number of sites, many of which were only discovered in recent years, are known from the period of the Veluwe Bell Beakers (VBB; 1900-1700 B.C.) and the Barbed Wire Beakers (BWB; 1700-1500 B.C.) [67].

Settlement finds have been made on the coastal barriers, in West Frisia, the IJsselmeer district, the estuarine creek area in the province South Holland and in the whole river area. Graves are known from West Frisia (Oostwoud), the western river area (Molenaarsgraaf) and, if we consider the beaker from the Veenenburg estate near Hillegom as a grave gift, also on the coastal barriers [68]. As the same factors played a part in determining the choice of terrains the distribution pattern of the VBB/BWB finds is identical to that of the VL/PFB inhabitation. There is, however, no continuity in the settlements. With the exception of some *donken* and Hekelingen we are concerned with new terrains, where the oldest finds are sherds of Maritime Bell Beakers.

The inhabitation of the coastal barriers seems to have taken place mostly on the second belt of coastal barriers which had formed the coast in VL times. The oldest coastal barriers and the Older Dunes on top of them were apparently too marshy. This may explain the absence of inhabitation on the coastal barrier of Voorschoten-Leidschendam. At Voorschoten a depression in the Older Dunes was already rather wet during the VL inhabitation, as may be seen from its peaty filling. Another factor was possibly the inaccessibility of the most easterly coastal barrier, which was separated from the later coastal barriers by the then broad and marshy shore flats, while east of it no creeks occured to serve as contact routes. A few finds (a flint arrow-head at Scheveningen, a flint dagger at Voorhout, finds at De Zilk, Noordwijkerhout) indicate, moreover, that the coastal barriers nearer the contemporary coast were also at least visited.

In the marine and fluviatile sedimentation areas the division between VL and VBB/BWB settlements is well-marked because first deposits of the Calais IV^{a} ("Wieringermeer"), then those of the Calais IV^{b} ("Westfrisian I") transgression phases were inhabited. This is the case at Oostwoud, Hekelingen and also at Molenaarsgraaf in the western river area. One or two small decorated sherds found at Hekelingen [69] show BW impressions, some others fingertop imprints in V-motif. They will belong to the level at —1.90 m. NAP, above the fine sandy clay covering the VL remains. From this level pointed wooden posts had been struck into the ground. The occurrence of BWB occupation is here in our opinion fortuitous and has no direct relationship

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[67] For the definition of BWB: Modderman 1955^{b}. His term "thread-wound stamp decorated beaker pottery" gives the most accurate name for this type of beaker ware. We will use, however, the shorter and more commonly used "Barbed Wire Beakers" and the abbrevation BWB (in contrast to Ber. ROB 15/16, 1965/'66, 7-11) for this type of pottery. See further Bloemers 1968, J. N. Lanting 1969^{a}, this paper part IV p. 288 f.

[68] For Oostwoud see p. 310, for Molenaarsgraaf this paper part IV, esp. p. 242 f, for Hillegom: Bursch 1933, *Taf.* III, 10.

[69] Modderman 1953^{a}, 5.

1.4.5. The Bronze Age after the Barbed Wire Beaker Culture (fig. 8)

1.4.5.1. *Introduction*

Half way through the Early Bronze Age, about 1500 B.C. the occurrence of the first Hilversum Urns (HVS) is established in this country. These evolved fairly quickly into Drakenstein Urns (DKS) and finally into the Laren type (LR) [73]. These urns were used as burial pottery until 1000 B.C. In the Northern Netherlands the Barbed Wire Beaker Culture evolved into the Elp Culture (ELP), which is characterized by the *Kümmerkeramik* pottery, the long houses of Elp type and the "family barrows", surrounded by post circles. In the Late Bronze Age late types of *Kümmerkeramik* still might have been in use side by side with early urnfield forms [74]. In the southern part of the country the Middle Bronze Age domestic assemblages are easily recognizable because of the fabric of the pottery. In the Late Bronze Age the *Grobkeramik* (well-known from the HaB urnfields) must be a common type in the domestic pottery (*cf.* also p. 115). It should be borne in mind, however, that typological datings of the pottery are very inaccurate in the period between about 1500 and 700 B.C., because of the small changes in shape and decoration and our ignorance of well-dated domestic find groups. We must in general rely upon direct ^{14}C dates.

1.4.5.2. *The Early Hilversum Culture* [75]

HVS pottery has been found on a number of terrains on the coastal barriers, in three cases on sites where previously (BWB) inhabitation took place (Monster, Velsen and Veenenburg). A single sherd from Vogelenzang shows, moreover, BW decoration [76]. In the whole of the remaining area, that is, outside the coastal barriers, HVS is, however, unknown. The terrains at Oostwoud, Molenaarsgraaf and Dodewaard were abandoned. Again it seems that the coastal barriers were possibly longer inhabitable than other, more vulnerable areas. Also, the HVS occupation was always apparently situated at some distance from the coast-line. In this connection the Sögel arrow-head of Langeveld is interesting. It is an isolated find and at the same time the most coastward find of this period.

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[73] For HVS and DKS: Glasbergen 1954, 1969.

[74] Waterbolk 1964[a].

[75] It is very confusing that the Hilversum Culture includes not only the Hilversum urns but also the later Drakenstein and Laren types. It would be better to change either the name of the whole group, or the name of the earliest type (phase). Since the urn from Drakenstein appeared to be not a typical representative of the group called "Drakenstein Urns" it would be best to give the subphases new names, for instance those of newly excavated settlement sites (*e.g.* Vogelenzang and Zijderveld), as was done earlier with the TRB Culture (*cf.* Van der Waals 1964). In this caption, however, we follow tradition.

[76] Monster: Stuurman 1965, Glasbergen and Addink-Samplonius 1965. Velsen: Vons 1969, Jelgersma *et al.* 1970, esp. 138-139. In both cases BWB and HVS finds were separated by a thin layer of wind-blown sand. Veenenburg: Oppenheim 1927/'28, 1929, Bursch 1933, *Taf.* V, 7. I thank Miss W. Metz, Amsterdam, who drew my attention to the BW imprints on some of the Vogelenzang sherds.

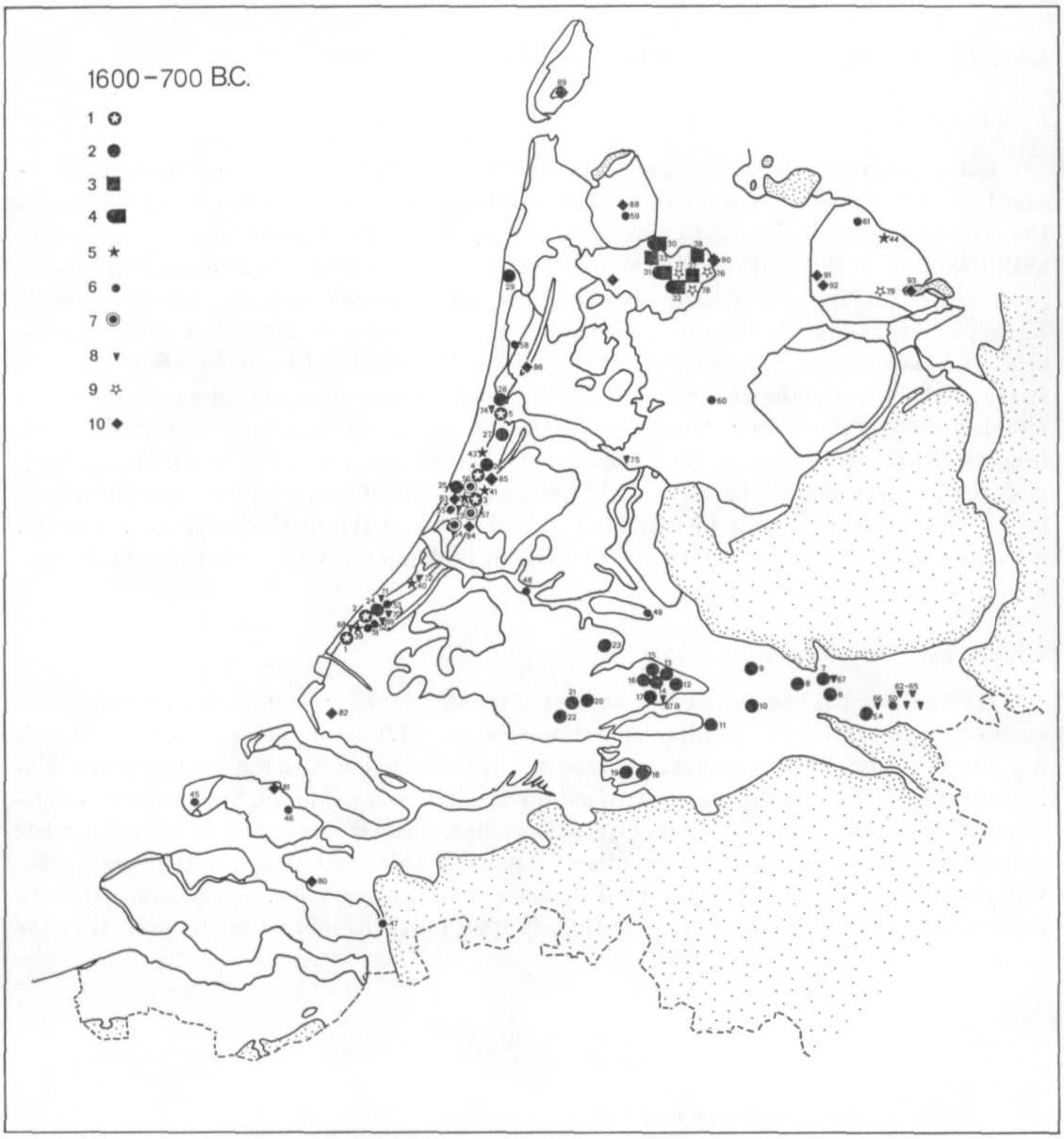

Fig. 8. Prehistoric finds in the Western Netherlands dated :

— between 1600 and 700 B.C.
— in the period of HVS, DKS and ELP pottery and the Late Bronze Age.
— between the transgression phases Dunkirk 0 and I[a].

The numbers refer to the documentation of the mapped sites in Appendix I, section IV.

Legend :

1. HVS, settlement or pottery.
2. DKS or ELP, settlement or pottery.
3. barrow, Middle Bronze Age.
4. 2 and 3 at one site.
5. bronze implement, Early Bronze Age.
6. bronze implement, Middle Bronze Age.
7. Middle Bronze Age hoard.
8. bronze implement, Late Bronze Age.
9. bronze implement, not dated.
10. stone hammer-axe.

1.4.5.3. *The Middle Bronze Age*

There is a great contrast between the distribution of the remains of the HVS and DKS phases. Few settlement sites of the Middle and Late Bronze Age are known on the coastal barriers, particularly in comparison with the relatively long period and with the large number of sites in West Frisia and in the river area. The map of the Middle Bronze Age inhabitation shows therefore a marked difference from that of the VL/PFB and BB/BWB periods.

This picture is probably partly inaccurate, however, since it is influenced by the find circumstances. For if we accept that inhabitation of the coastal barrier area took place chiefly on the seaward part of the coastal barrier complex (although not on the coast-line itself), then the occupation remains of this period will be situated for the greater part beyond our observation, as these coastal barriers are largely under the Younger Dunes (which came into existence after A.D. 1100), or have disappeared through erosion. Only at a few points do they lie at the surface. It is nevertheless clear that a preference developed for the marine and fluviatile sediments which had been deposited shortly before: regions were HVS inhabitation really never took place at all, as it seems.

Renewed inhabitation in the river area took place at a relatively early time, as appears from the ^{14}C dates of some Middle Bronze Age settlements [77]:

Zijderveld	GrN 5376	1420 ± 80 B.C.
	GrN 5220	1315 ± 60 B.C.
Molenaarsgraaf	GrN 5177	1400 ± 35 B.C.
Wijk en Aalburg	GrN 5357	1175 ± 40 B.C.
Benschop	GrN 5356	1010 ± 60 B.C.

In West Frisia the occupation of the deposits of the previous trangression phase (D O/Cardium/Westfrisian II) clearly began later, as appears from the following ^{14}C dates [78]:

Zwaagdijk	GrN 4243	1250 ± 60 B.C.
Oostwoud	GrN 797	1075 ± 80 B.C.
Grotebroek	GrN 160	975 ± 140 B.C.
Wervershoof	GrN 2359	1065 ± 55 B.C.
	GrN 2168	1015 ± 45 B.C.
Hoogkarspel	GrN 5050	1070 ± 40 B.C.

In other sedimentation areas, such as the Meuse estuarine area there are no traces whatsoever of inhabitation in the Middle and Late Bronze Age until now.

These variations in the time of beginning of the (DKS) inhabitation and the occurrence or not of such inhabitation may be connected with the course of the DO (Cardium) transgression. In the river area, far from marine influence, the Cardium transgression has not yet been

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[77] Vogel & Waterbolk 1972, 87-88, 92-94.

[78] Vogel & Waterbolk 1972, 95 (Hoogkarspel); 1967, 134 (Zwaagdijk; *cf.* also Bakker & Brandt 1966, 178 and Bakker & Metz 1967, 214); 1963, 191 (others). See also De Vries & Barendsen 1958, 1141 (Grootebroek) and Waterbolk 1964[a], 114, 121.

identified geologically, not even in the recent and very detailed mapping of the region between Andelst, Zetten and Dodewaard by Havinga [79]. The only marked stream displacements of the otherwise conservative river courses have taken place there between Havinga's deposits 3 and 4 (C IV and older) on the one hand, and 2 and 1 (D I and later) on the other. There is no question of a sedimentation phase in the period between 3 and 2. This was once again strikingly illustrated by the excavations at Dodewaard, where VBB and DKS remains occurred at the same level. In the western river area (the "river clay/wood peat area"), there is hardly any trace of deposits from the D O transgression phase. Verbraeck [80] notes only some thin and local clay deposits, indicating some flooding in quiet circumstances. The same picture is provided by the excavation at Molenaarsgraaf, where at about 1500 B.C. renewed flooding occurred through the already half silted-up break-through channel.

Nearer to the coast, within the area of the marine sedimentation, deposits from this transgression period occur mainly in Westfrisia and the IJsselmeer district. The eastern parts of Westfrisia were built up relatively high at the end of the D O transgression and protected against further marine influence, so that renewed inhabitation was possible there soon after the Westfrisian II sedimentation had finished. The barrows on these deposits lie at almost the same level as the Bell Beaker settlement at Oostwoud. Later compaction has, however, strongly influenced the original height of the bases of the barrows [81].

Near the wide tidal inlets and in the areas where Dunkirk O sedimentation remained incomplete, such as those behind the inlet at Egmond and the "Oer Y" [82], behind the Rhine mouth and at the Maas estuary, marine influence persisted for a longer period. Generally D O deposits in these regions were covered with peat, the base of which usually gives ^{14}C dates of 1100-1000 B.C. In such, less highly built up regions, this beginning of the growth of peat coincides with the continuation of the DKS inhabitation elsewhere.

From the above account of sedimentation and inhabitation the Dunkirk O transgression seems to be mainly a coastal phenomenon. This contrasts with the C IV^b transgression, which was much more widespread and is also clearly recognized in the river area. This will be discussed in more detail when we come to deal with the Schoonrewoerd stream ridge in Part II. The occurrence of this C IV^b transgression must be attributed to generally operative climatological changes. The DO transgression phase might be caused by a climatic change only in the coastal regions (as indicated in the dune investigations) and not in the catchment areas of Rhine and Meuse.

1.4.5.4. *The Late Bronze Age*

It is difficult to determine when the Middle Bronze Age inhabitation (DKS or ELP) ended, especially since domestic assemblages from the Late Bronze Age are hardly known in this country. In the Northern Netherlands the Elp settlement continued until about 800 B.C., with

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[79] Havinga 1969.

[80] Verbraeck 1970.

[81] See p. 55.

[82] Pons & Wiggers 1960, fig. 27, Zagwijn 1971.

in the last centuries a co-existence of late *Kümmerkeramik* and early urnfield material [83]. South of the river Meuse Late Bronze Age settlements are unknown. In general we notice that the Late Bronze Age in this country is only represented by the bronzes and the early urnfields, while settlements are lacking. But in the last few years new discoveries in the Western Netherlands have thrown some light on this period. Van Regteren Altena published recently three find groups from Velsen [84] (that is: from the coastal barriers), dated to the Late Bronze Age partly on the evidence of the occurrence of biconical pots. In West Frisia the end of the occupation falls in the beginning of the Iron Age. A well recognizable new type of pottery is dated there at Hoogkarspel site I at about 700 B.C. [85]. In our opinion it is, however, quite possible that it was already in use in the Late Bronze Age, and that it forms the direct continuation of the "Middle Bronze Age" finds. In the western river area we can distinguish a certain type of pottery that for various reasons must be dated to the Late Bronze Age. It is known from four sites, which means a sharp decrease of the inhabitation density. In the Alblasserwaard the occupation comes to an end about 800 B.C. [86]. In the Iron Age the prehistoric inhabitants established their settlements farther to the east, in the Vijfheerenlanden. The Alblasserwaard will have been uninhabitable at that time due to the extensive peat formation.

Evidently it is difficult to summarize the Late Bronze Age inhabitation. It seems, however, that the Western Netherlands were not uninhabited, but at least sparsely occupied and in various regions. Moreover we presume (also in the light of the earliest Iron Age occupation) a break at least in the most vulnerable areas, at the end of the Late Bronze Age. This will be discussed further in section 1.5.

1.4.5.5. *The character of the inhabitation*

Although our knowledge of HVS settlements is incomplete, the excavations at Monster, Velsen and Vogelenzang provide sufficient information to conclude to a settled way of life. Plough marks of the *ard*, a few postholes and remains of slaughtered animals support this conclusion.

We have recently become much better informed about the Middle Bronze Age. In West Frisia barrows and flat graves, accumulations of domestic refuse, plough marks and a few house plans point unmistakably to a well settled farming community. The extensive permanent settlements consisted of a few widely separated large farms of the Elp type. The recent excavations at Zijderveld and Dodewaard have also thrown much light on the inhabitation of the river area. The extensive settlement at Zijderveld consisted of a large number of round huts and numerous fences. At Dodewaard Elp houses and round huts occur together. Bones and pollen analyses will give a clear indication of the subsistence economy.

1.4.5.6. *Isolated finds*

Bronze implements are fairly rare in the Western Netherlands and are mostly limited to

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[83] Waterbolk 1964[a].

[84] Van Regteren Altena in Jelgersma *et al.* 1970.

[85] Reliable ^{14}C-dates are: GrN 5051,730 ± 50 B.C., GrN 5048,700 ± 45 B.C. (Vogel & Waterbolk 1972, 95-96).

[86] Based on, first, the pollendiagram Molenaarsgraaf and the ^{14}C date GrN 5264, 760 ± 35 B.C. in that diagram, second, the ^{14}C date GrN 6252, 865 ± 55 B.C. indicating the end of the settlement Ottoland-Oosteind. *Cf.* p. 114 f.

the coastal barriers. All periods are represented proportionally, indicating a continuity of inhabitation in a general sense that was not easy to distinguish from the settlement finds. An explanation of the distribution lies in the difficulties of discovering the finds and recognizing them: bronze implements are unmistakable, even to a layman. Today the Older Dunes on the coastal barriers are intensively employed for building, bulb cultivation and other horticulture, whereas the meadows and orchards in the river area and West Frisia are much less favourable to the discovery of archaeological objects. The three bronzes found in West Frisia were all found in horticultural areas in the eastern part. Notable is also the small concentration of (late) bronzes, mostly socketed axes, found in the eastern part of the Betuwe.

In addition to the bronzes the hammer-axes probably belong as a group in the period 1600-700 B.C. These axes, however, can hardly be dated more accurately, except for the Sijbekarspel type that must be placed in the end of this period.

1.4.6. Unreliable and insufficiently dated Finds

The group of finds with unreliable find circumstances, and finds which cannot be dated well enough for our purpose (which we omitted from our discussion above) do not provide us with any essential complementary information. The first group comprises the finds said to be dredged up from the rivers, especially the Meuse and Waal east of Gorinchem, which found their way to the museums via antique dealers. This group comprises firstly at least 25 stone and flint axes, 24 bronzes, 7 antler implements and 2 "various" implements, in addition to a large group of finds from the Waal near Nijmegen. These finds wrongly tend to stress the importance of the eastern river area on the distribution maps.

Apart from the above-mentioned finds we collected at least 27 antler implements from the whole area studied, not including those found at Spoolde. Some finds dredged up in Zeeland and a few pieces found at Krimpen aan de IJssel are interesting. To some extent they fill the blank parts of the map. Among the more than 25 stone axes not recorded on the maps a small axe from Leimuiden [87] deserves special comment on account of the location. Finally, about ten terrains may be mentioned where only a few pieces of worked flint were found. The distribution of this second group of finds, about 60 in number, as a whole only intensifies the distribution patterns, particularly those given on the maps at figs. 7 and 8, where to a large extent the finds probably belong. Only after a special study of the stone and antler axes in this country may it be possible in the future to insert these finds into one or more of the maps.

1.4.7. Some Conclusions

1.4.7.1. *The choice of the terrains for settlement*

We can summarize that the settlements are restricted to the following deposits:

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[87] RMO inventory no. h 1964/12. 1.

— outcrops of the Late Glacial/Early Holocene subsoil (the *donken*)
— the coastal barriers and the Older Dunes on them
— the highest marine, estuarine and fluviatile deposits, *i.e.*
  a) natural levees of creeks in the marine tidal deposits.
  b) natural levees of estuarine creeks.
  c) inversion levees and sand fillings of former river courses (stream ridges) in the peat area.
  d) natural levees in the river clay area.

It is clear that the prehistoric inhabitants in the Western Netherlands have always chosen their settlement sites very carefully. In each period there were extensive regions which were difficult of access or entirely inaccesible, against regions of limited extent constituting the inhabitable area. Within these last regions lay the terrains which were suitable to establish the settlements.

In this respect two regions must be opposed to each other: the coastal barriers, and the area behind them with marine and fluviatile sedimentation and peat formation. The coastal barriers offered good possibilities for occupation when vegetation fixed the sand. These must have been periods with a relatively high ground water table, which means a somewhat higher annual precipitation. In the sedimentation area the most important condition was a restricted inconvenience by water, which meant good drainage and adequate height. Good drainage is necessary to guarantee a reasonable degree of dryness and practicability, particularly after rainfall or flooding. Sufficient height is necessary to remain free from too frequent flooding. The local Mean High Water (MHW) will have been the lowest level that met this requirement.

In the surroundings of the settlements there were often areas which were less suitable for permanent settlement (salt marshes, shore flats, the lower parts of stream ridges and natural levees *etc.*) but usable for the grazing of cattle when reasonably drained. Their presence certainly played a part in the choice of the settlement site. The extensive tidal flats, the peaty salt marshes and the peat moors will have been used only for hunting and fishing.

If the above-discussed requirements are met the accessiblility or isolation of the otherwise suitable land is a further important point. It is clear that in considering these features we must think in different scales: regional and local. In the first case we are concerned with the accessibility of whole landscapes, such as the coastal barrier area (or sections of it) or the *donken* region. In the second case it is a matter of choice within such a region: whether or not a particular dune ridge or *donk* was chosen for occupation. Then, at the same time, other, previously noted factors played a part: sufficient arable land and pasture in the vicinity, enough fresh water, shelter and naturally also drainage and height.

1.4.7.2. *Distribution patterns*

The distribution of finds (and therefore of occupation) shows a high degree of consistency over the various phases of inhabitation.

The continuous inhabitation of the Older Dunes is strikingly shown. The relatively large number of finds is a consequence of the intensive use made of the ground nowadays. The Zeeland coast and the coastal strip north of Egmond would have shown a similar picture, but nearly all evidence is lost through erosion or is inaccessible by being covered with the Younger Dunes.

Behind the coastal barriers lay in the Atlantic and the Early Subboreal a broad belt of tidal flats and salt marshes, of which it is certain that the salt marshes were used for pasture. Only in exceptionally favourable circumstances they were inhabitable. Along the eastern border of these marshes a great peat bog was situated extending up to the high Pleistocene sands. Periodically this uninhabited bog stretched out over the tidal marshes. In this peat area the active river courses and the levees of former ones served as water and land routes of communication between the coast and the high sandy hinterland. There and on the outcropping tops of the Early Holocene dunes are the places where we find the settlements. This pattern was preserved best between Rotterdam and the Betuwe. Between the present IJssel estuary and the tidal inlet near Egmond no coherent picture exists because of the severe later erosion. Along the river Old Rhine, which was active until historical times, the chance of finding traces of early occupation has been much reduced by erosion and covering by later sediments. It is only an occasional find that suggests there too a communication route, perhaps of less importance. In the Scheldt region there is almost no evidence at all, as a result of the later geological events.

These communication routes were the lines along which both the northern and the southern cultures could reach the coastal regions. On the other hand, these are also the routes along which the overseas cultural contacts of the coastal strip could find their way inland.

1.4.7.3. *The character of the inhabitation*

The character of the inhabitation, where it can be determined (*i.e.* from the VL Culture onward), is that of permanently occupied settlements, generally small and consisting of one or several houses. It is only in the Middle Bronze Age that the settlements are of greater extent; this will only be partly the result of the longer duration of the occupation. It seems there was a real increase in population. The subsistence economy has been established in only a limited number of cases, and seems to have been excellently adapted to the environmental possibilities. In the estuarine area hunting and fishing for migratory fish (certainly sturgeon and perhaps salmon) where most common. Among the fresh-water peat bogs there was sufficient agricultural land for the small number of people living there to concentrate on cattle raising and arable farming. The very small amount of hunting was compensated for by fishing in the well-stocked fresh water. On the coastal barriers and salt marshes there was likewise a preponderance of cattle raising over hunting. Large areas of natural pasture land were available there.

1.4.7.4. *The coastal barriers*

A further theme for discussion is the relationship of the finds in the coastal barrier area to the separate coastal barrier belts, and the extent to which these finds may be used to determine the age of these barriers. Van der Meer and Bennema [88] have studied this problem. From the later works of Van Straaten and Jelgersma, among others [89], it appears that it is not the

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[88] Van der Meer 1952, Bennema 1954 esp. 24-29.

[89] Van Straaten 1965, Jelgersma *et al.* 1970. In the latter publication the best map of the coastal barriers is published. For additional maps we name: Buttler 1963[c], Glasbergen *et al.* 1967, Pannekoek (ed.) 1956, Jelgersma & Van Regteren Altena 1969.

coastal barriers themselves, but the Older Dunes which were blown up on them immediately after their formation, that are of relevance here. These dunes do, however, seem to follow the pattern of the coastal barriers below them.

A dating based on archaeological finds, which is always a *terminus ante quem*, is thus less accurate than was formerly imagined. Only the finds made on the coastal barrier surface itself and under the dunes are reliable for dating purposes. Very few of such finds are, however, known. One such a find is perhaps the stone axe of Heemstede, which has already been commented upon [90]. In our opinion, however, the other archaeological material can be used as well for dating, if we are aware of the above-mentioned limitations.

Almost the entire coastal barrier complex, in so far as it has remained intact, has been dated as belonging to the phases Calais III and IV [91], as is shown by the detailed investigations of the dunes carried out in recent years. Immediately after and even during the formation of a coastal barrier the Older Dunes were formed upon it. There are repeatedly aeolic deposits in dry periods with a low ground water table, separated by humic or peaty vegetation layers from periods with a high ground water table. This, however, can only temporarily have hindered inhabitation, or made it difficult. Especially when the growth of peat once occurred in the shore flats west of the coastal barrier concerned (this means that the next coastal barrier was formed at that moment), the supply of sand was largely cut off and caused the formation of dunes to be of only local significance.

It is noteworthy that a general westward shift of finds in the course of time can be determined from the pictures provided by the archaeological maps. The explanation of this can be that the more westward the coastal barriers occur the more recent they are and the later did the first formation of the dunes end. Another factor is of course the relatively low position of the older coastal barriers. It is equally remarkable that the oldest settlements on the various coastal barrier belts (*i.e.* series of Older Dunes) are generally contemporary with the beginning of the growth of peat in the shore flats west of them.

Although it is difficult to get a direct absolute date, it seems, however, possible to get an impression of the relative age of the various coastal barrier belts by means of the archaeological finds.

Other evidence, such as the height of the shore flats and the beginning of peat formation there have also been used for datings. As the subsoil of the shore flats consists also of dune sand, as Jelgersma *et al.* show, we cannot use the level of the surface of the sand in such flats directly for dating purposes, by comparing it with the curve of the relative rise of sea-level. Yet there certainly occurs a gradual rise in level of this sand surface in a seaward direction and, consequently, a later beginning of the peat formation. There is a possible link between the height of the aeolic sand deposit in these shore flats and the original water levels, which has led to

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[90] Louwe Kooijmans 1969; this paper, note 53.

[91] Jelgersma *et al.* 1970. As long as no convincing proof is given for these datings, we prefer to defend the older conception (*viz.* that of Van der Meer and Bennema), which is supported by enough data and theoretical considerations. But there are two ^{14}C dates that give a direct dating to the coastal barriers (shells in life situation from the top of the coastal barrier sand). Both come from the Velsen area and point to a slightly older date than is proposed here. One is published: Jelgersma *et al.* 1970, 109 (note): GrN 5853, 3845 $\pm$ 45 B.P. (1895 B.C.). The other dates the outermost coastal barrier at IJmuiden to Dunkirk O (pers. comm. Mr J. F. van Regteren Altena).

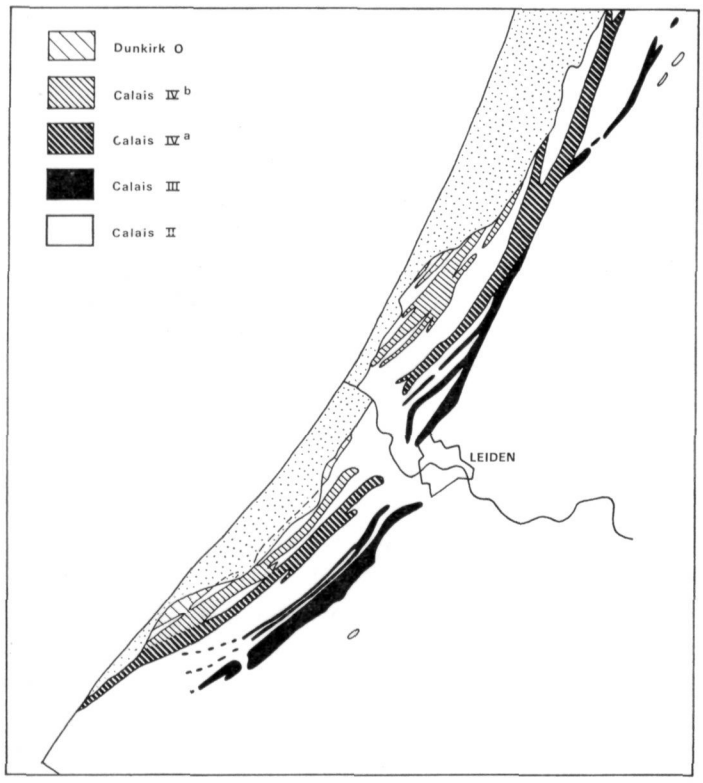

Fig. 9. The coastal barriers between Hook of Holland and Haarlem, differentiated as proposed in the text and as documented in table 3.
Scale 1:500,000.

TABLE 3

Coastal barriers
north and south of the Rhine
Correlation with transgression phases

Sequence	Situation	Arch. finds*	Peat in the strand flat**		Supposed correlation with transgr. phase
			^{14}C date	Depth	
		North of the river Rhine			
5	under the Younger Dunes				D I
4	Langeveld	(EBA) *DKS*			D O
3	Noordwijkerhout / De Zilk	(EBA)	1050	—0.80	C IV^b
2	Voorhout / Lisse / Haarlem	(VL) *BB*	1500	—2.00/1.65	C IV^a
1	Spaarnwoude / Oegstgeest	(pre VL) (VL)	2300	—2.60	C III
0	near the IJ				C II?
		South of the river Rhine			
5	under the Younger Dunes				D I
4	Scheveningen		450	—0.50	D O
3	Wassenaar / Kijkduin	*DKS*	1250	—0.50	C IV^b
2	Den Deil / Monster	(VL) *BB*	1950	—1.65	C IV^a
1	Voorschoten / Voorburg	*VL*	2200/2000	—3.00/2.75	C III
0	Nootdorp				C II?

* Settlements in italics. Isolated finds in brackets.

** The base of the peat in the strand flat to the west of the coastal barrier belt concerned.

the above-mentioned effect. In any case, we are here concerned with a clear chronometer, which provides us at the same time with at least a *terminus ante quem.*

The level of the tops of the coastal barriers themselves also tells us something about their age. For in our view there must be a fixed relationship to a certain sea-level lying considerably above MHW and perhaps corresponding approximately with Mean High Water Springs. Jelgersma *et al.* show in fact that the coastal barriers below the Older Dunes become successively higher seaward. Four coastal barriers, with their highest parts at —1 m. NAP in the east and +1 m. NAP in the west, would all have been formed during Calais IV. It seems to me to be more in accordance with the data given above to attribute the more westerly coastal barriers to the phases D O and D I (a and b). It is even questionable whether the second coastal barrier belt must be dated as C III and not as C IV[a]; for there are no proofs, that the coast-line lay further westward during the Vlaardingen Culture, except for the grinding stone from The Hague, and even that find, in our view, cannot be closely dated.

In a scheme (table 3) we have assembled the available information which is important for dating the coastal barriers south and north of the Rhine, and indicated what we consider to be the most probable ages for the individual coastal barrier belts. This picture corresponds at the same time closely with Bennema's conclusions [92]. He presumed that the formation of the individual coastal barrier belts occurred primarily during transgression phases, and that the shore flats generally originated from regression phases. Hageman [93] gave an explanation for the formation of the coastal barrier complex as a whole. He says there were two operative factors: a diminishing rate of rise in sea-level and an increasing resistance offered by the sand accumulating along the coast.

The turning point, when a landward withdrawal of the coast-line changes to a seaward advance, occurs between 3000 and 2700 B.C., at the end of Calais III, and perhaps even earlier when the formation of the coastal barriers, remains of which were found near Nootdorp and near the IJ, are taken into account. This moment therefore occurs well before the bend in our curve for the rise of sea-level (at least 9 centuries earlier, *cf.* fig. 14) [94]. This turning point must therefore have been caused mainly by balancing around an equilibrium, or a change in the pattern of currents. It cannot be attributed to a sudden change in the rate of rise of sea-level. Yet it is clear that the much smaller rise after 1800 B.C. was in favour of a westward shift of the coastline.

When we consider the period with a generally seaward advancing coast-line it must have been precisely during transgression phases that the separate coastal barriers (or -belts) were

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[92] Bennema 1954, 28-29. The opinion of Van der Meer that the coastal barriers got their form in the "consolidation period at the beginning of a regression", also comes to the same thing. For the genesis of the coastal barrier complex as a whole see Hageman 1969 and this paper p. 7.

[93] Hageman 1969, 385 f.

[94] Also according to the mentioned equilibrium of Hageman, the coastal barriers would have been formed in transgression phases. The equilibrium was shifted then in favour of the landward coast-line displacement. This signifies a phase with a stationary or even a slightly withdrawing coast. In a regression phase with a stationary or slightly rising sea-level, coastal accretion is possible much more easy. When, however, the general tendency shows an eastward shift, as in the Atlantic, it will have been just the regression phases that were characterized by a more stationary coast. So the oldest barrier remains (Nootdorp (Schans & Van der Knaap, 1956) and near the IJ-polders (Pons & Wiggers 1959/'60, figs. 17, 27)) must be dated C II/III rather than C II.

formed, according to the above-mentioned equilibrium suggested by Hageman. For it was then that the relatively rapid rise in sea-level (or at least the greater destructive capacity of the sea) will have caused a retardation or even a stop of the seaward coast-line displacement. On the other hand, it was during a regression phase, during a stationary or slightly rising sea-level, that coastal sedimentation grew and a broad coastal plain was formed.

Apart from the question of the absolute dating, the comparison of the data given in table 3 reveals a correlation of the coastal barriers on both sides of the Rhine estuary. This picture (fig. 9) agrees well with the correlations by Van der Meer and Bennema. The shift at the Rhine estuary has already been recognized and explained by Van Straaten [95].

1.5. AN OUTLINE OF INHABITATION IN THE IRON AGE AND LATER

Although our main interest lies in the Bronze Age and Neolithic, it is useful to give an outline of our knowledge on the later occupation sequence and its relation to the geological events [96]. The wider perspective contributes to a better understanding of the older data and events, since no fundamental changes in the relation men-natural environment occurred before *c.* A.D. 1000, the start of the embankments.

1.5.1. The transition Bronze Age/Iron Age

Inhabitation from the beginning of the Iron Age appears to occur on widely dispersed points in the Western Netherlands, but it remains obscure whether this is a continuation of the previous Bronze Age inhabitation, or whether both were separated by an inhabitation gap.

Continuity may be assumed for sites like Langeveld near Noordwijkerhout (coastal barriers) [97], Hoogkarspel (West Frisia) [98] and Noordeloos (western river area) [99]. It is not surprising that the inhabitation on the coastal barriers was continuous; this has already been suggested by the isolated bronzes. The interruption of inhabitation in both low-lying areas seems to be due to too frequent flooding and/or peat growth, while in the meantime no deposits high enough to establish the settlements were formed [100].

On the other hand sites are known where new settlements were established, as at Holy Polder in the estuarine area, Culemborg in the western river area, and at nearby Zijderveld, where the Iron Age settlement was separated from the previous Middle Bronze Age occupation by a hiatus [101].

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[95] Van Straaten 1965, 44.

[96] Here only a sketchy outline is given, based on comprehensive literature, especially: Edelman 1953, Van Giffen 1954[a], Bennema 1954, Modderman 1955[d], Pons 1957, J. P. Bakker 1954, 1958, Van Hoorn 1967, Van Regteren Altena in: Jelgersma *et al.* 1970. See also notes 9 and 16 for further literature.

[97] De Raaf 1959, 1966.

[98] Bakker 1959, 1966[a], 1966[b], — & Brandt 1966, — & Metz 1967, — *et al.* 1968. *Cf.* also note 85.

[99] Unpublished, see App. I, no. IV-20; App. III, no. 16.

[100] See p. 35 and p. 116.

[101] Holy Polder: Havelaar 1970 and pers. comm. of Mr J. F. van Regteren Altena; Zijderveld: J. de Jong 1970/'71,

In the Northern Netherlands the beginning of the inhabitation of the salt marshes took place in the same period (about 600 B.C.) during the Zijen Culture characterized by the Ruinen-Wommels I pottery [102].

Generalizing the above data, there appear to be enough arguments to accept an interruption of the occupation in the regions outside the coastal barriers between 900 and 600 B.C. coinciding with a transgression phase (sedimentation phase) that cannot be another than the phase Dunkirk I^a. Only in West Frisia and in the Alblasserwaard there seem to have been at least locally possibilities for a continuous occupation. Much study of the period 1000-500 B.C. has to be done, however, before a more accurate statement can be made.

1.5.2. The Iron Age [103]

Our knowledge of Iron Age inhabitation allows only a rough or incomplete outline. A more detailed account must wait until more data, especially from the period 500-200 B.C. are available.

During the Iron Age the Dunkirk I transgression phase occurred. It is dated between 600 and 200 B.C., though it might have started earlier. Pons and Wiggers [104] distinguished two subphases: the pre-Roman transgressions I and II, named here Dunkirk I^a and I^b.

Recent investigations of the Older Dunes revealed that three vegetation levels (peat layers or soil profiles) were formed there during the transgression phase Dunkirk I [105]. The oldest level (Bl, 750-600 B.C.) represents Dunkirk I^a. The second level (B2) is dated 500-300 B.C., the third and highest level (B3, 300-150) can be linked with Dunkirk I^b. The existence of three vegetation levels is a first indication that the Dunkirk I transgression might show a tripartition, and that either the phase I^a or I^b might be divided in two subphases in the future.

From the Early Iron Age date some sites with Ruinen-Wommels I pottery, all in North Holland and three of them on the coastal barriers (Zandvoort, Velsen, Limmen, Den Burg-Texel) [106]. The Spanjaardsbergje near Santpoort was occupied from RW II times onward [107]. Behind the coastline the surface of the peat and the levees of creeks were settled in the Zaanstreek near Assendelft and in the Westland near Vlaardingen (Holy Polder) in Ha C/D times [108]. Other settlements as Bosch en Gasthuispolder near Leiden (on small creek levees) and Escamp Polder near Loosduinen (on remains of coastal barriers) are slightly later. The

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R. S. Hulst 1966 and pers. comm.; Culemborg: excavation by the author (Louwe Kooijmans 1966[b]) ;[14]C dates: Vogel & Waterbolk 1972, this paper Appendix IV.

[102] Waterbolk 1962, 1970, Boersma (ed.) 1970.

[103] Much of my insight into this period has been formed during the various times I exchanged views with Mr J. F. van Regteren Altena, Amersfoort, for which I am greatly indebted to him.

[104] Pons & Wiggers 1960, 34-38. *Cf.* also Pons in: Stichting voor Bodemkartering (ed.) 1965, and Bennema 1954, 72, fig. 17.

[105] Jelgersma *et al.* 1970, esp. fig. 6 and 32; Jelgersma & Van Regteren Altena 1969.

[106] Van Regteren Altena in: Jelgersma *et al.* 1970; Van Regteren Altena 1969.

[107] Modderman 1960/'61.

[108] Holy Polder: Havelaar 1970 and pers. comm. Mr J. F. van Regteren Altena; Assendelft: Hallewas 1971, Helderman 1971.

Iron Age settlement at Vlaardingen Broekpolder has a ^{14}C-date: GrN 1951 370 $\pm$ 70 B.C. [109] In the western part of the river clay area we have mapped a widespread Iron Age occupation (*Cf.* fig. 31). One of the sites at Culemborg is ^{14}C-dated from *c.* 750 to *c.* 200 B.C. and might have been occupied without interruptions. Another site (Zijderveld) is contemporaneous and also most of the other (not excavated) sites might date from the same period [110]. In the river clay area proper, farther to the east, evidence of the Early Iron Age has not yet come to light, but among the finds of the old excavation at Ressen a group of Early La Tène "Marne" pottery has been recognized recently [111].

A sparsely but widely distributed Early Iron Age inhabitation seems to be the best conclusion. It follows after the early phase of the Dunkirk I transgression phase, when some of the inhabited creek levees will have been formed.

A second well defined period with widespread inhabitation started in the last century before Christ, at the end of the Dunkirk I^{b} phase. In this period two types of pottery were in use. One is a richly decorated ware, often called "Celtic", showing southern relations with the Belgian Late La Panne pottery. The other, the *streepband* pottery, is of Frisian origin and might reflect an expansion of the Frisians to the West. *Streepband* pottery is found as far south as the Hague, the "Celtic" pottery as far north as the Zaanstreek [112].

The "native" ware of the *woerden* [113] in the river clay area shows a relationship to the "Celtic" pottery and might belong partly to a pre-Roman occupation. This supposition is supported by the relatively large number of La Tène glass arm ring fragments, all of the later types from the last century B.C. found on these sites [114]. Perhaps we have here an archaeological proof of the well-known story that the *Batavi* occupied the *Insula Batavorum* shortly before the arrival of the Romans, coming down the river Rhine [115]. A very instructive sequence has been found at Haren (prov. North Brabant) where a back swamp clay deposit was intercalated between two archaeological refuse layers, the lower with Marne pottery, the upper with some late La Tène glass arm ring fragments. The clay layer is thus dated between 400 and 100 B.C. or Dunkirk I^{b} [116].

In the *terpen* district the inhabitants were troubled by renewed flooding soon after the first settlements (the *Flachsiedlungen*) were established. It was there that for the first time the people did not retreat because of deteriorating conditions, but defended themselves by the raising of artificial hills. These first *terpen* or *wierden* were thrown up about 500 B.C. [117]. More favourable conditions seem to have returned about 200 B.C. and seem to have lasted

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[109] Modderman 1952, Bennema 1954, 45 f. (Leiden, Loosduinen). Mr J. F. van Regteren Altena informed me that he identified RW II and III sherds among the material of these sites; Vogel & Waterbolk 1963, 193 (Vlaardingen).

[110] The ^{14}C dates of Zijderveld range from 715 to 200 B. C. (Vogel & Waterbolk 1972, 92-93). The ^{14}C dates of Culemborg are listed in Appendix IV.

[111] Braat 1949, pers. comm. of Mr J. H. F. Bloemers and Mr R. S. Hulst, Amersfoort, who study these finds anew.

[112] Van Regteren Altena in Jelgersma *et al.* 1970, Sarfatij 1971, 38 f., Helderman 1971.

[113] *Woerden* are Roman settlement soils, up to 1 m. thick, generally forming an extensive and marked low hill in the flat river clay area.

[114] Peddemors 1971. The arm ring fragments are dated expecially to the second half of this century.

[115] Byvanck 1943, 49, citing Tacitus, *Germania* 29, *Historiae* IV 12 and 15.

[116] Pers. comm. Dr G. J. Verwers, Leiden.

[117] *Cf.* note 102.

until the end of Roman times. So the western and the northern sequences appear to correspond in broad outline, differing mainly in the slightly earlier start of D I^b in the north. We must, however, be aware that our model of the course of events might be too rough and might obscure finer details, as for instance possibly a finer subdivision of Dunkirk I.

1.5.3. The Roman Period

Remarkably favourable conditions for inhabitation were available during Roman times, as is seen by the widespread settlement, which was only ended by the collapse of Roman power in this country half way through the third century. It was at the same time a period when inhabitation conditions deteriorated as a result of renewed transgressional activity. Although in our opinion there is no need to doubt the existence of this transgression phase, recently, because of a more critical attitude towards the datings and because of a number of new finds, some uncertainty has arisen as to whether this D II transgression was in fact so widespread as was at first assumed. It is sure that a number of phenomena dated as D II must be assigned to a later period [118].

1.5.4. The Merovingian Period

In Merovingian times (5th - 7th century) only a few occupation centres are known on the coastal barriers, namely in Zeeland near Domburg and at Rijnsburg situated on the estuary of the Rhine. The fifth and sixth centuries form a marked interruption of the inhabitation, even of the coastal barriers [119]. In the river clay area (the Betuwe) only a relatively small number of settlements of this period have been mapped. Most of the sites are moreover only based on a few ill-defined sherds among the much greater quantity of Roman and mediaeval sherds. Some doubtless Frankish finds are, however, known, indicating at least a scanty population. The western river area, the estuarine area and self-evidently the peat areas too have yielded no finds whatsoever. Especially for this period we must, however, realize that dates are based on imported material only and that real occupation can escape our observation by the lack of imports in a certain period. In the *terpen* district the centuries after A.D. 200 are marked by increased flooding, the further extension of the salt marshes and the abandon ment and subsequent covering with clay of a series of settlements.

In general everywhere in the Holocene sedimentation area there is a marked occupation hiatus in Merovingian times, exactly corresponding with the transgression phase D II. The beginning of this interruption may have a political cause, the evidence may be seriously influenced by the lack of imports; this can only modifie our statement in degree, not in essence.

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[118] Sarfatij 1971, 171 f.; Jelgersma *et al.* 1970, 144.

[119] Sarfatij 1971; Jelgersma *et al.* 1970, 144.

1.5.5. The Carolingian Period

In Carolingian times a new colonization of the low-lying regions appears, namely in the Betuwe, in Zeeland, on the coastal barriers and in West Frisia. In the *terpen* district new settlements were established on the fresh salt marshes: the third generation in the *terpen* sequence [120]. It is only in this district that the short lived D III^a ("post-Carolingian" or "Ottonian") transgression is recognizable in the inhabitation history: it is the fourth period of salt marsh formation, the last before the construction of the sea dikes. The occupation extended to these new salt marshes already about A.D. 1000, when the *Pingsdorf* pottery came into use.

1.5.6. From the later Middle Ages until Recent Times

The period of the 11th and 12th centuries shows a further increase and extension of inhabitation. Everywhere the settlements became more widespread, even over the peat areas, which in the so-called *Cope* reclamations were within a few centuries entirely parcelled out [121].

At the same time it is the period when dikes were first constructed on a large scale as a more active defence against floods. The transgression phases express themselves from now on as periods of frequent and catastrophic dike-breaching. Such a period occurs in the 14th to the 16th centuries, and a second possibly in our own time [122]. To what extent the frequency of dike breaches is a measure of aggression by the sea is, however, a matter for debate, The quality of the maintenance of the dikes also plays a part. Dike building even leads to more and more serious flooding, because the water storage capacity of the region is reduced [123]. In historic times we see how the inhabitants of the low areas, after the reclamation in a quiet period, persisted in the occupation of their land below sea-level, in spite of the strains and dangers involved.

1.6. INHABITATION AND THE TRANSGRESSION PHASES

A diagrammatic general view of the evidence discussed above appears in fig. 10. Here the facts about inhabitation in each district or area have been brought together, alongside the

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[120] See esp. Haarnagel 1969 and Van Hoorn 1967, further the lit. in note 102.

[121] *Cf.* Van der Linden 1956, Van Regteren Altena in Jelgersma *et al.* 1970, 144 f.

[122] After completion of our manuscript Mrs Dr Gottschalk published the first part (until A.D. 1400) of a very detailed and critical study on storm floods and river floods in the Western Netherlands (Gottschalk 1971). In summary we may learn the following from her book.

Although before A.D. 1000 only one storm flood can be defined with certainty (on 26th Dec. 838) there must have been more in this period. The 11th and the first half of the 12th century seem to have been a quiet period. The fact that no storm floods are known from this period cannot be ascribed to a lack of written sources. During the period 1150-1300 three storm floods are identified with certainty for every half century. After that time there is a marked increase to 12 or 14 storm floods in the 13th century. The quiet period of the 11th and 12th centuries is a period of extensive reclamation and a spread of inhabitation all over the Western Netherlands. Are the following storm floods the result of the dike building all over the country or do they reflect a new transgression phase (D III^a) ?

[123] *Cf.* Zonneveld 1960, part A, 16 f.; Pons in Van Regteren Altena *et al.* 1962/'63, 104.

currently used division of the geologically determined transgression and regression phases. The scheme forms a supplement to similar diagrams made earlier by Bennema and Pons [124] to show the periodicity of the transgression cycles in the Western Netherlands.

The diagram provides a three-dimensional picture (distribution and time) of the information about inhabitation in the Western Netherlands. The maps (figs. 2, 5, 7, 8) may be viewed as sections of a limited duration, showing distribution in more detail.

Information about the period before the VL Culture is incidental only. The peat region between the marine tidal areas and the high sand area seems, however, to have been regularly inhabited. Knowledge rests almost entirely upon finds on the (partly covered) tops of dunes. The chances of discovering settlements on stream ridges are very small since they are covered by an appreciable amount of younger deposits. The limited number of find places and finds does not permit of any comment on the periodicity of inhabitation. The regular division over the time-scale is more noticeable than concentrations in particular periods. If it is possible to speak of any relationship, it is that of inhabitation to the regression phases between C I and C II, C II and C III, C III and C IV^{a}. This would link up with the picture of the later inhabitation. Future evidence will show whether this relationship is apparent or real.

The turning point in the geological development of the coast, as new coastal barriers were formed seawards of the earlier ones and the barriers became more and more closed, is at the same time a turning point in our knowledge of its inhabitation. The preserved coastal barriers as a whole were continuously inhabited ever since the VL Culture. In the estuarine area behind, an inhabitation periodicity has been determined which was dominated by the transgression and regression phases: C IV^{a}, VL inhabitation, C IV^{b}, VBB/BWB inhabitation, DO, DKS inhabitation.

Something of this periodicity can also be traced in the inhabitation of the coastal barriers. In the VL settlements occupation is also broken off, if somewhat later than in the estuarine region. The VBB/BWB settlements have always been found there upon other terrains, on later coastal barriers situated more westward. Settlements of this phase of inhabitation in their turn are similarly abandoned in the low areas (the western river area and West Frisia) while on the coastal barriers occupation is known to have continued at various places during the HVS and DKS phases. Outside the coastal barriers there is no evidence at all of the presence of HVS remains.

The picture of the DKS inhabitation presents a strong contrast to that of the HVS phase. Large parts of previously uninhabited regions were resettled, especially in the river area. Deposits which had been formed shortly before, such as those in West Frisia, were extensively colonized. There appears to be a clear association between the course of the D O ("Cardium") transgression in the various regions and the course of occupation.

For the later times, beginning with the Late Bronze Age, the sequence is: D I^{a}, Early Iron Age occupation, D I^{b}, *streepband*, "Celtic" and Roman occupation, D II (?), Mediaeval colonization and reclamation, as pointed out earlier. This is the model that fits best the available data. We are, however, sure that there are possibilities to refine this model by means of future research on archaeological sites.

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[124] Bennema 1954, 72, fig. 17; Pons 1957, 36 and 38, figs. 26 and 27.

We are aware that a phasing of inhabitation as described above might to a certain degree be the result of cultural discontinuities or the "like" or "dislike", which a culture can show for a marshy environment. We will, however, not discuss these questions here, but only state, that the possibilities for occupation presented by the region itself, must have been the chief cause in the phasing of the inhabitation. To a certain extent the relationship between regression phases and occupation phases, as shown in fig. 10, is already a proof in itself.

Fig. 10. Schematic representation of the inhabitation of the Western Netherlands, between 4000 B.C. and A.D. 1500.
Composed with the data, mentioned in the text and in the cited literature.
Transgression phases after Hageman 1969, division in subphases (a, b) by the present author.

Legend :

occupation, well-established.

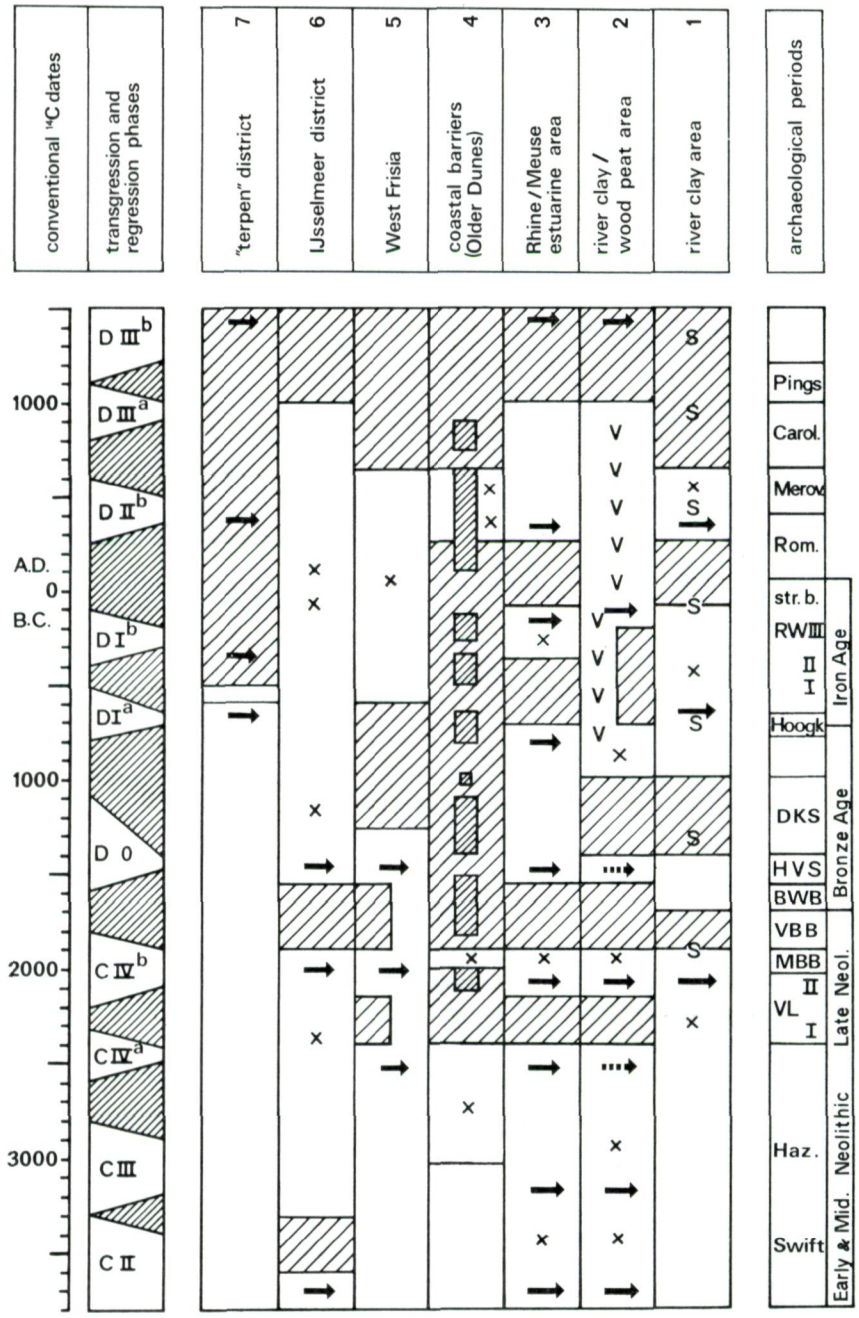
X occupation, scarce evidence.

formation of a peaty layer or soil profile in the Older Dunes, according to Jelgersma *et al.* 1970.

sediment of transgression phase established (in the river clay area after Havinga 1969).

S sedimentation periods in the river clay area, after Pons 1957.

V inhabitation prevented by general peat formation.


conventional ¹⁴C dates
transgression and regression phases
"terpen" district 7
IJsselmeer district 6
West Frisia 5
coastal barriers (Older Dunes) 4
Rhine/Meuse estuarine area 3
river clay / wood peat area 2
river clay area 1
archaeological periods
A.D.
B.C.
1000
0
1000
2000
3000
D III b
D III a
D II b
D I b
D I a
D 0
C IV b
C IV a
C III
C II
Pings
Carol.
Merov.
Rom.
str. b.
RW III
II
I
Hoogk.
DKS
HVS
BWB
VBB
MBB
VL II
I
Haz.
Swift
Early & Mid. Neolithic
Late Neol.
Bronze Age
Iron Age

1.7. SEA-LEVEL CHANGES

In a slowly subsiding region such as the Western Netherlands inhabitation is a good natural gauge for measuring former water levels. Archaeological data still have special value because of the sharp, often multiple datings which cannot yet be surpassed by a separate ^{14}C date, certainly not if archaeological and ^{14}C dates can be directly combined. Moreover at archaeological excavations good approximations of water levels existing during the period of inhabitation can often be determined.

1.7.1. Earlier Investigations

The relative rise of the sea-level or the relative subsidence of the land has been the subject of study for long times in the Netherlands. This is very easy to understand, when we realize the consequences of these movements on daily life and the desirability to know the rate and the nature of these movements. In the first instance one was interested in the rate of relative subsidence per century or the mean secular subsidence, especially during the most recent (historical) times [125].

One of the first publications by Van Giffen deals with this subject. He summarizes the findings of a large number of authors who had earlier dealt with the problem of changes in sea-level. He introduces a modern method of reasoning, which has subsequently changed little, by using well-established levels and archaeological dates. From the height of the base levels of the *terpen* it appeared clearly that the relative rise in sea-level since Roman times can have been at most 10 cm. per century and that this very probably was 6 to 7 cm., and that there is no evidence of any drop in sea-level in the Subboreal. Judging by his later publications the problem continued to occupy him [126].

In the first half of this century the knowledge of both the geological structure of the Rhine/Meuse delta and of the forces involved in the relative movements of land and sea became known in detail. A review of the state of research on sea-level changes was given by Escher in 1939 [127]. In the following years the first attempts were made to give a representation in a graph, realizing that the rise of the sea-level is a variable phenomenon. The first curves of Umbgrove and

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[125] This gave rise to two different approaches of the sea-level problem. The one approach is the attempt to measure the present changes by means of the long term registrations of tide gauges and by comparison of precision-levellings. Some serious difficulties are met in the interpretation of the old measurements, because of the displacements and "corrections" of the gauges, and the subsidence of level-marks caused by compaction. But it seems now to be well-established that the sea-level has risen since about 1830 A.D. with a rate of about 12-14 cm. per century, while between 1700 and 1830 the relative sea-level was more or less stable. The mean relative rise of sea-level over the whole period is about 5-6 cm. per century. *Cf.* Van Veen 1945, 1954, Kuenen 1941, 1954, T. Edelman 1954.

The second approach is the one, followed in this paper: the evaluation of the data that are fixed by nature in the level, facies, sequence and human occupation of the Holocene deposits.

[126] Van Giffen 1910, 1916, 1930[b], 1954[a]. By his excavations, especially in West Frisia, Van Giffen made available many new data: Van Giffen 1930[a], 160 and *Taf.* 117; 1944, 1953, 1961.

[127] Escher 1939.

Zwart [128] are both still dominated by the presumed Subboreal fall of the sea-level and handicapped by the lack of good datings. A mile-stone was reached in 1954 when Van Straaten made use of some ^{14}C dates from Velsen and Bennema at the same time assembled the available geological and archaeological evidence [129]. Both resulting curves (for MSL) differed only in detail. Although others [130] had not forgotten the archaeological data, Bennema made use of them in a very intensive and systematic way. It was chiefly for the most recent times (Roman and later) that they could be used. For the older times Bennema had available the observations Van Giffen had made in West Frisia and the results of the investigation at Hekelingen.

Mention should also be made of Jelgersma's important study of sea-level changes in the Netherlands coastal area [131]. Her curve is exclusively based on ^{14}C dates of compaction-free peat samples and as such might be seen as the worked-out version of Van Straaten's curve. She explains that her curve is related not to the MSL but to the MHW level. Both Bennema and Jelgersma give a review of the work of earlier authors. Their curves differ in so far that Bennema's curve provides reliable information concerning the most recent times, after about 500 B.C., and Jelgersma's curve does the same precisely for the period before that. As such both studies are complementary.

It is noteworthy that the importance of exact observations of the level of archaeological finds has been realized for a long time. As early as 1880 a stone axe was reported from Giessen as having been found under a 2.2 m. thick layer of clay and sand, at —4.50 m. NAP. In 1903 a flint axe was found in Terneuzen in a peat layer, at —2.50 m. NAP [132]. It is only now that enough material seems to be available to venture to give a systematic representation in a graph.

1.7.2. The Time-depth Graph of the Archaeological Sites

1.7.2.1. *The depositional level in relation to sea-level*

It may be stated in general that inhabitation under natural (*i.e.* not artificially affected) conditions always took place above local MHW [133]. This level can and does generally differ to some extent from the average MHW in open water near the coast, for settlements were made on relatively sheltered places and not directly near the open sea. For this reason it is possible to find occupation on a level lying just below the coastal MHW level. In the Western Netherlands occupation can also be found appreciably above MHW, namely on outcrops, coastal barriers and salt marsh ridges.

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[128] Umbgrove 1947, Zwart 1951.

[129] Van Straaten 1954, Bennema 1954, 1954[a]; Bennema was seriously handicapped by the absence of an exact dating method. At that time the Cardium transgression was dated too early (or too old deposits were named "Cardium"). The *Pingsdorf* pottery was dated a few centuries too old (Carolingian instead of 11-12th century).

[130] As for instance Tesch 1947, J. P. Bakker 1958.

[131] Jelgersma 1961; data corrected to Suess-effect: Jelgersma 1966 and Hageman 1969.

[132] Giessen, in the "Land van Heusden en Altena", S. E. of Gorinchem. RMO, inventory no: Ggn. Terneuzen: Van der Feen 1952, docum. RMO, Leiden.

[133] For a general description of the landscape in the Western Netherlands before the embankment see Pons in Van Regteren Altena *et al.* 1962/'63, 1963, 97-111.

Inhabitation on the tops of the *donken* means in any case a MHW below the height of the top. If the level corresponding with the inhabitation can be indicated in the peat covering the slopes of the *donk*, then the (compaction free!) "juncture point" of peat and sand gives the original level, corresponding approximately to the local MHW of that time [134].

Another opportunity for establishing settlements well above MHW was provided by the coastal barriers and the Older Dunes covering them. The coastal barriers themselves were probably formed to a height well above MHW, perhaps up to High Water Springs [135]. The low Older Dunes could add a few meters to this. Further the ground-water table in the coastal barrier region was to some extent convex; first as a result of the well-known floating of the fresh water on the salt water just as at present in the Younger Dunes [136], and second as a result of the width of this relatively high strip, hampering the water from flowing off laterally. The relatively high level on which peat formation took place at Voorschoten during the VL Culture in a depression of the dunes on the oldest coastal barrier shows that this was indeed the case. The formation of the various peat layers and vegetation levels in the dunes is explained in the same way [137].

The natural levees along creeks influenced by ebb and flood in open, not embanked tidal regions rise to a maximum of 60 cm., and in general to 25-40 cm. above MHW, dependent upon the absolute level of this high water. The Westfrisian deposits are formed in a region of more marked differences between high and low tide, and the highest creek ridges there lie higher therefore in relation to MHW than normal, In the Northern Netherlands salt marsh area, broad and relatively sandy barriers were repeatedly formed on the seaside. They can reach a height of 120 cm. above MHW [138].

In the river area we must take account of an annual periodicity in the high water levels instead of one occurring twice a day. Moreover, it should be borne in mind that the discharge of the rivers was more regular than now. In the first place the water drained off more regularly, because the natural vegetation in the catchment area was only moderately destroyed or affected by man. In such a dense vegetation the surface run-off of the rainwater was much less than in the present open landscape, which implied more modest extremes in the discharge of the main streams than today. Second, there were no dikes in the sedimentation area, and during high waters the water could be stored in a much larger basin than at present. As a result high water levels (discharges being equal) must have been considerably lower. It seems reasonable to accept the MHW level as the maximum height to which natural river levees in such an unembanked landscape could be formed. "MHW" means, however, something quite different there than in the regions where sedimentation was controlled by the tides.

An intermediate position is taken by the estuarine area with creeks where tidal differences are small and the effect of changes in river levels almost unnoticeable.

Exact data about the relation between deposition and the water levels in the unique freshwater tidal area, the Biesbosch, are available from I.S. Zonneveld's study. The tidal amplitude

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[134] *Cf.* Jelgersma 1961, 31-33.

[135] None of the authors on sea-level changes did, however, express himself in this sense.

[136] Edelman 1960, 90; Van der Meer 1952, 3-4; Pannekoek (ed.) 1956, fig. 58. The occurrence of fresh water of good quality may have been one of the factors, that made the coastal barriers attractive.

[137] Jelgersma *et al.* 1970.

[138] Van Giffen 1921, Bennema 1954, 39-42, 46; Pons in Van Regteren Altena *et al.* 1962/'63, 1963, 107.

is, however, quite considerable there, and in any case greater than it formerly must have been in unembanked estuarine creek systems. In the Biesbosch sandy shoal deposits in the form of ebb and flood scours do not reach to more than about +60 cm. NAP, at a MHW of +130 cm. NAP. In general a change in the sedimentation process appears when the sandy deposits have reached approximately the NAP mark, because they then become covered with a dense vegetation, by which clay sedimentation is very much favoured. In general the levee deposits of the creeks are the highest sandy deposits. They are a few decimetres higher than the sandy shoal deposits. The maximum level of sedimentation seems to lie at about MHW, that is at about +130 cm NAP. As the current velocity in such areas is low at high water (unlike the strong currents at high water in the river and tidal areas) the highest parts of the deposits are never sandy [139].

Since both inhabitation and sedimentation are well defined and directly related to MHW and not to MSL, only former MHW levels can be directly derived from the observations on inhabitation and sedimentation. So in the following pages we will refer only to former MHW levels.

A complication is that at present MHW differs quite considerably at various places along the coast. In Zeeland MHW decreases from +1.60 to +1.25 m. NAP at the mouth of the Meuse, sinks to +0.88 and +0.40 m. NAP between the Hook of Holland and Den Helder, and increases again to +0.61 at Harlingen, +0.98 at Zoutkamp and +1.15 m. at Delfzijl [140]. These differences will have existed also in earlier times and were certainly not less than they are today. Their distribution along the coast might, however, have varied from period to period, on account of changes in the form of the coast-line and sea-bottom morphology. In the region from which nearly all our information is derived the present-day variation is fairly small: +0.60 to +1.00m. NAP. For the time being we have not taken this factor into consideration and in doing so only a small margin of error remains. We shall return to this point later, bringing it into account when considering the Westfrisian deposits.

1.7.2.2. *Compaction* [141]

The base of the settlements is always formed by more or less sandy deposits slightly or not susceptible to compaction. The deposit is usually well-"founded", by which is meant that no compressible deposits such as peat or unripened (not settled or shrunken) clay occur in the subsoil. The elimination or the calculation of the factor "compaction" is always a source of error. This has already been pointed out and taken into account by Van Giffen.

Compaction is the result of shrinkage by (artificial) drainage, the evaporation of plants, the pressing out of water caused by the weight of the sediment itself or by the pressure of overlying layers. This latter cause can influence particularly the height of levels under artificial mounds.

Unfortunately a number of compaction-free deposits, namely the coastal barriers, and

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[139] Zonneveld 1960, Part B, 35, 43, 48 and 132; Part A, figs. 48, 78°; Part C, App. 5, esp. J and K.

[140] *Cf.* Van Hoorn 1967, Van Giffen 1921, Faber 1947/'60, I, 185.

[141] For the mechanism of compaction in general see Bennema 1954, 11; Bennema *et al.* 1954. A more theoretical approach was made by Huizinga 1940. The values given in this paper might, however, be rather out of date.

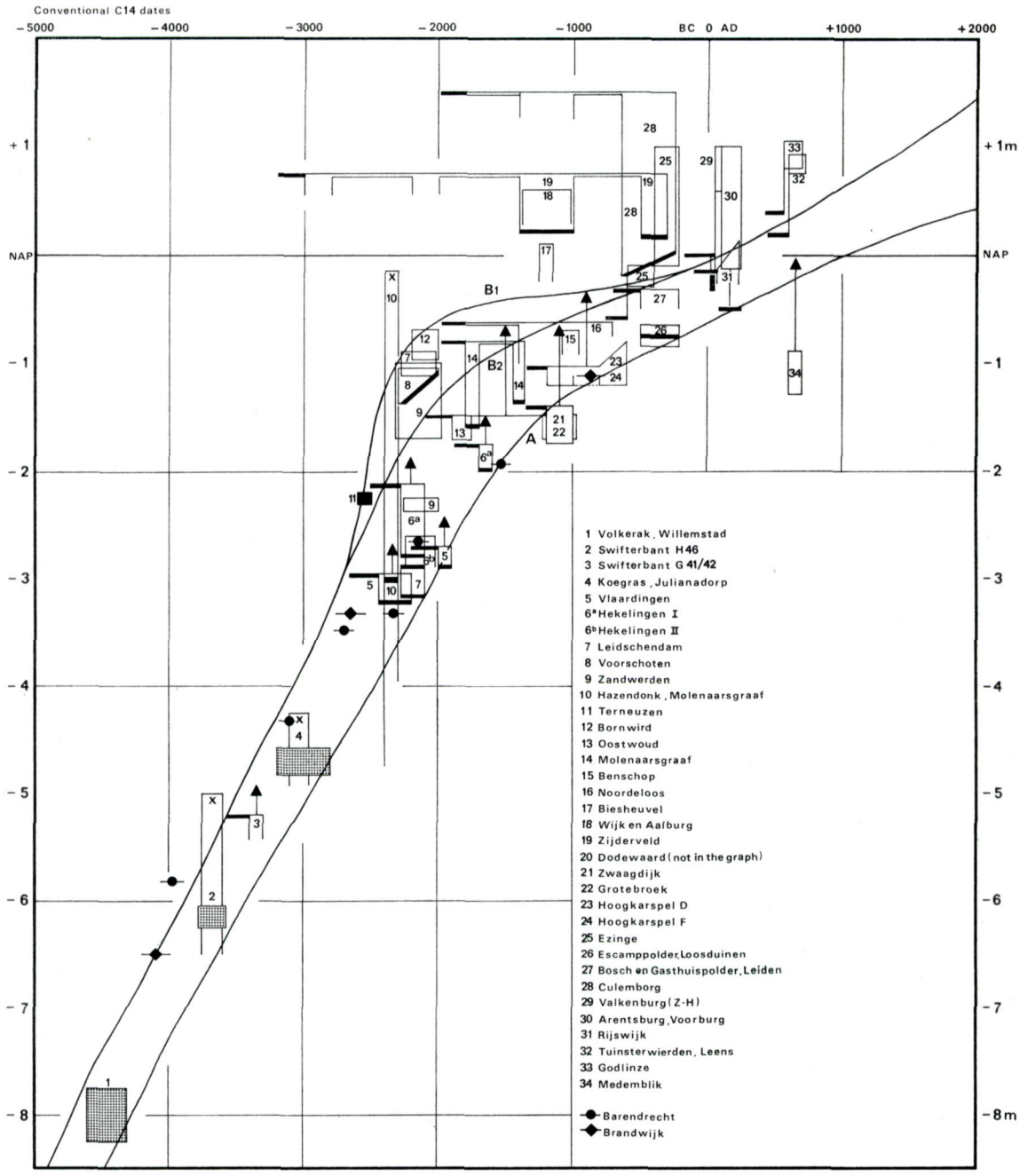

Fig. 11. Time-depth diagram with the most important well-founded archaeological finds and sites in the Western Netherlands. Added are some traditionally used sites that are not compaction-free and the ^{14}C dates of peat from the sites Brandwijk and Barendrecht (Jelgersma 1961 and 1966).

For the documentation of the data used, see App. II.
For the explanation of the symbols used, see fig. 12.

curve A — lower limit of the dated MHW levels.
curve B1 — upper limit of the dated MHW levels.
curve B2 — as B1, but some extreme or less representative sites excluded.

the Older Dunes, are not the most suitable for the determination of former water levels. Most settlement terrains, having some clay in their profile, will have suffered a slight compaction. Bennema assumes that the compaction in such terrains was not more than 20-30 cm., which we can accept as an error. Such a compaction would apply, for example, to Vlaardingen, and to the estuarine creeks inhabited during the Iron Age, *e.g.* Bosch en Gasthuispolder. Ideal places for observations are the *donken* and the well-founded bodies of sandy stream ridges, such as the Schoonrewoerd stream ridge.

The observations in West Frisia require a more detailed commentary. The study of Ente and the data provided by H.H. van Regteren Altena show that these are of less value for the present purpose than Van Giffen and Bennema assumed [142]. The artificial drainage which began at least after 1200 A.D., caused compaction of soft, unsettled clay and peat layers, which are widespread, particularly under most barrows: these are not situated on the sandy filling of the creek itself but somewhat on the side of it. The highest points of these creek levees are now at —0.75 m. NAP [143]. The base of the barrows will have been situated originally on about the same level or somewhat (max. 25 cm.) higher, but have subsided to a present level of —1.90 to —1.30 m. NAP. In our diagram we have corrected the average level of the barrow bases (—1.60 m.) for the average subsidence due to compaction (80 cm.).

The remarkably high level of the Westfrisian deposits can be explained by the landscape at the time of the deposition. It was a region where an extensive sea arm came into existence and where the mean flood height probably differed considerably from that at the open shore.

It is noteworthy that these deposits were silted up approximately to the same height as the most westerly still well-founded part of the Schoonrewoerd stream ridge and that subsequently the course of inhabitation on both deposits is identical. Inhabitation started in both areas with VBB settlements and ended almost simultaneously in the beginning of the Iron Age. In the Alblasserwaard this may be attributed to the continuous growth of peat. In West Frisia too the surface at this time had probably become too marshy.

1.7.2.3. *The graph*

The observations on the levels of the archaeological terrains are assembled in a graph (fig. 11). This time-depth diagram is necessary to give a complete picture of all four parameters (and their mutual relationships) of the inhabitation problem of the Western Netherlands. The chronological column of fig. 10 did show already the relationship between time and distribution, while the distribution in different periods of limited duration is represented in detail in the maps (figs. 2, 5, 7, 8). In the schematic cross-section of the Western Netherlands and the river area (fig. 23) the connection between time and depth is determined, but now in relation to

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[142] Ente 1963, 169-179; H. H. van Regteren Altena & Bakker 1968; older publications dealing with the position of the barrows in relation to the geology: Wensink 1959, Ente 1960, Kwaad 1961. See also Van Giffen 1954[a], Bennema 1954, 40. It is still under discussion whether West Frisia was ever covered with peat. See on this problem: Ente 1963, 16, 40 f. and esp. 146-155, on the "woud" soils: Edelman 1960, 130-131, on the field pattern: de Cock 1969, on the occurrance of peat: H. H. van Regteren Altena & Bakker 1968 and the literature cited there.

[143] The top of the big Westfrisian II ridge lies between —0.10 m. in the west (near Zwaagdijk) and —0.70 m. in the east (Grotebroek). *Cf.* Pons & Wiggers 1960, figs. 27 & 29.

the distance from the open sea. This cross-section, however, does not incorporate any really new factual information.

We were primarily interested in the period prior to the Iron Age, for which period all reliable data known to us have been plotted. To complete the diagram data from some important younger archaeological sites have been included. References for all data provided are given in Appendix II. The majority of the terrains plotted are situated in the Rhine/Meuse estuarine area. The most easterly and those on the coastal barriers are, however, not well suited for our purpose. A second group is formed by the data from the IJsselmeer district, and a third by a few observations made in the Northern Netherlands from the salt marshes around the Lauwerszee.

Plotted is the present depth at which occupation has been established, against the age of the occupation (*cf.* fig. 12). Most ^{14}C dates are based on samples from the site itself. Otherwise the current ^{14}C dates for the relevant culture or period or historical datings have been used. The position of occupation levels relative to NAP is based on the measurements in the field, that are not corrected for possible compaction.

As only terrains with well-founded, sandy deposits, were included, the error due to compaction is estimated to be 20 cm. at most. It seemed preferable to omit corrections rather than to apply them in view of the always somewhat speculative character of the estimations of compaction in the cases under consideration. Only in a few cases has any exception been made: for Vlaardingen, Hekelingen and for the Westfrisian barrows.

The range of level at a site is between the highest point of the former surface and the lowest point of the settlement terrain. The determination of the latter level is not without problems.

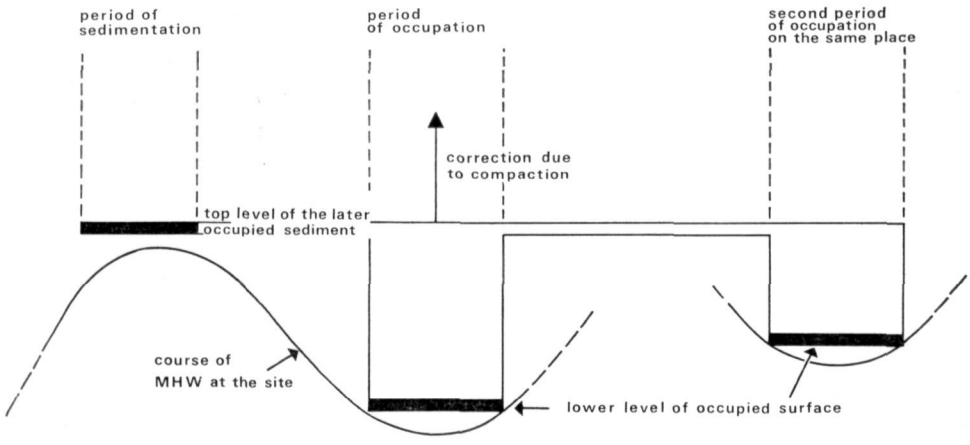

Fig. 12. Diagram illustrating the relation between the MHW level during the sedimentation and the MHW level during the subsequent occupation. This type of representation is used as symbol in fig. 11 and in the construction of the curves C1-C9 in fig. 13.
A dated MHW level is always indicated with a heavy black line.

We took as criteria the continuation of an "occupation layer" into a contemporary natural deposit (peat layer, infilling of a gully and such like), the point beneath which wood has been preserved (this will no longer be the case above MHW, but certainly beneath the then MSL), and the occurrence of soil traces. This lower limit has been determined with the greatest possible care.

Finally, the moment at which the inhabited deposit was formed has been indicated as accurately as possible and is represented by a horizontal line, connected to the right with the highest point of the small squares (*cf.* fig. 12). In this way the line gives the time which elapsed between sedimentation and inhabitation.

1.7.3. The Curve for the Relative Rise of the Coastal Mean High Water Level

1.7.3.1. *A first approximation*

Two dissimilar sets of information have therefore been embodied in the diagram at fig. 11:

1. Inhabitation data, nearly always belonging to a regression phase and originating from sites which, at the time of inhabitation, were generally well above MHW level.
2. Data of the inhabited deposits, generally a sediment from a transgression phase and a relatively high point of this deposit.

The curve A (fig. 11) which forms the lower boundary of the plotted data, indicates the general rise in the MHW in periods when inhabitation was possible: the regression phases. The curve A forms at the same time a lower limit above which the rise of the MHW at the open coast-line must have occurred.

The curve B 1 (fig. 11) links the highest points of the various inhabited sediments at the moments of sedimentation and so forms an upper limit below which the true rise of the MHW occurred. At the same time this curve gives the maxima for the MHW during the culminations of the various sedimentation (transgression) phases. In some cases, however, it indicates points (namely West Frisia (C IV^b and D 0) and the Alblasserwaard (C IV^b)) where the local MHW was considerably above the usual MHW. If we eliminate these areas we can draw curve B2 instead of B1, a curve which in our view is a good approximation of the general rise in the MHW during transgression phases. The differences between B1 and B2 are primarily of significance between about 2500 and 1000 B.C. The distance between the curves A and B2 varies between 100 and 50 cm. The ideal curve giving the true mean rise of MHW lies between A and B2, with values during transgression phases nearer to B2 and during regression phases nearer to A [144].

1.7.3.2. *The fluctuations of local Mean High Water at the archaeological sites*

Changes in the MHW can be determined in detail for a few points or limited areas where a number of factors causing regional differences are more or less constant. These factors are:

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[144] In an ideal curve all regionally and locally operating factors are excluded. There is no site where the MHW rise really follows this curve. This will have been the case only in the coastal open sea.

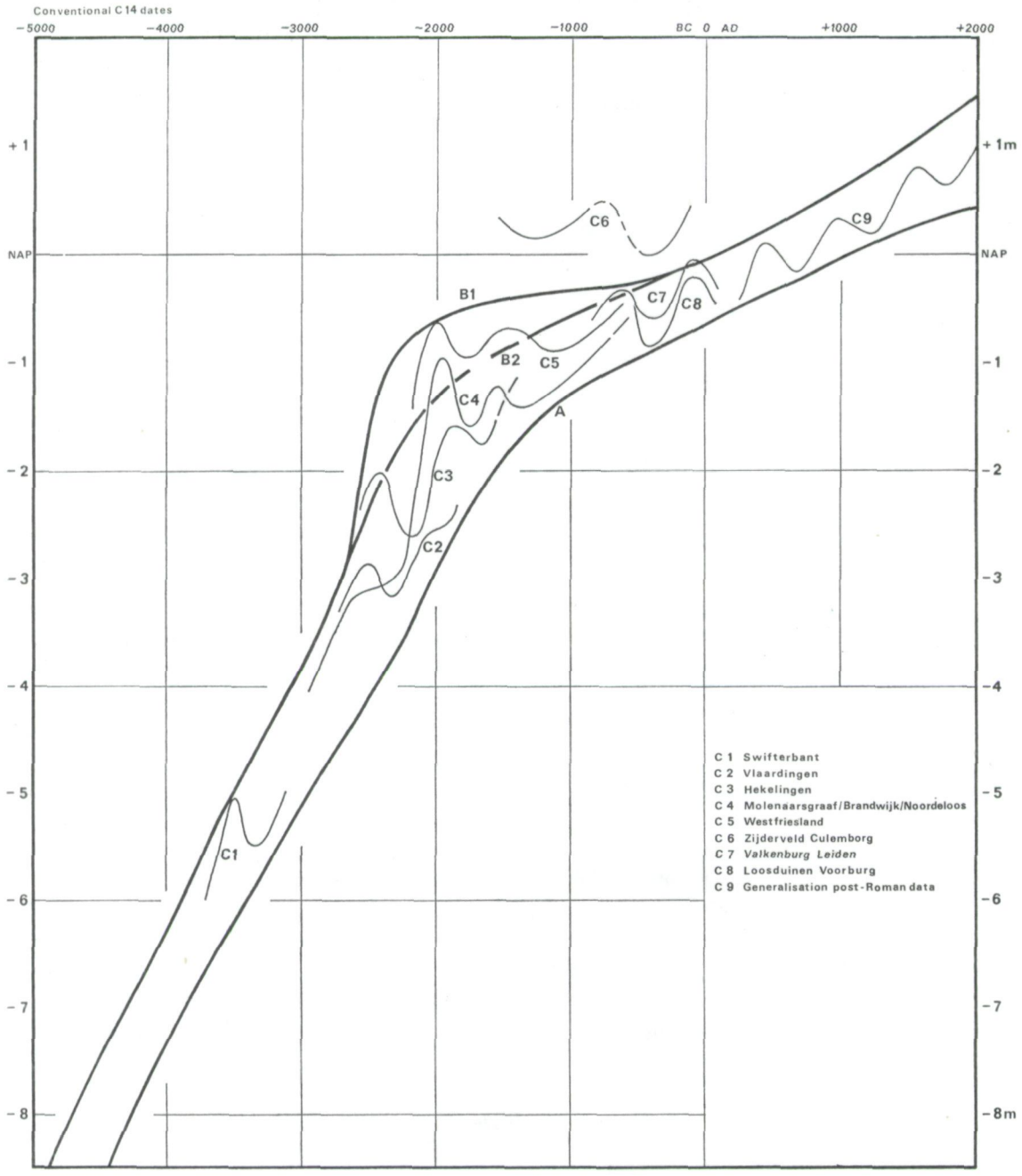

Fig. 13. Time-depth diagram with fluctuations in the MHW level for some selected archaeological sites or areas of restricted dimensions.

Construction of the curves C1-C9 according to fig. 12 and based on the data of fig. 11.

— the distance to the open sea,
— the height of MHW in relation to mean sea-level,
— the influence of the gradient in the river area,
— any small amount of compaction.

In fig. 13 the curves C1-C6 give the changes of MHW for Swifterbant, Vlaardingen, Hekelingen, Molenaarsgraaf and surroundings, West Frisia and Zijderveld. The curves are therefore valid for a number of selected sites or areas having a relatively high sedimentation level and subsequently a relatively low MHW level, coinciding with a transgression phase followed by a regression phase [145]. In general a clear lowering of the local MHW level between deposition and inhabitation applies to these terrains. This, however, does not necessarily imply any real lowering of the MHW at the open coast. Usually it was the result of a decreasing hydraulic contact with the open water and the development of areas with "flood depression".

Such a "flood depression" (decrease of tidal amplitude) occurs in an estuarine area if the possibility exists of collateral flowing off of the inland flowing flood or dammed-up river water. This is the case in the majority of the furcating estuarine creek systems, which mostly have the form of a relatively narrow mouth with a wider drainage basin behind. The absence of discharging rivers, along the gradient of which the flood can run up, is favourable to flood depression. Zonneveld [146] made a detailed survey of this phenomenon, demonstrating the occurrence of flood depression in a present fresh-water tidal area, de Biesbosch, by means of measurements taken in the years 1930-1939. His diagrams are of great importance to us. First, the MHW level in the main creeks of the Biesbosch rises from 30 cm. in the west to 50 cm. in the east above MHW level at the coast. In the smaller creeks this effect is largely compensated for by a flood depression of 10-40 cm. dependent upon the position and dimensions of the creek.

In our opinion the flood depression can certainly reach these proportions in a natural landscape when a number of factors coincide. We refer particularly to situations often occurring on points where prehistoric inhabitation took place. First, a deposit in or near a large water course from the end of a transgression phase. Next the closing of the coast-line and/or the narrowing of the creeks. The first process limits the entrance of the tide, and the second is likely to result in a continually more distant contact with the open water, which, depending upon the distance to it, means a more or less appreciable flood depression. In this way a lowering of the local MHW can occur at an inland point, even when the sea-level at the coast is stationary or slowly rising, so that an opportunity for inhabitation is created.

In the curves C2-C6 the transgression phases CIV^a, CIV^b and D O are clearly shown as periods of high MHW levels, separated by periods of a much lower MHW. The systematic differences between the sites may be explained by the above-named regionally variable factors.

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[145] Theoretically a transgression phase is a period with a landward shifting coast-line, while during a regression phase there is a seaward shift. So factually the transgression phase is only the period of erosion, while the period of sedimentation belongs to the regression phase. It is, however, common practice to include the period of deposition of mineral sediments in the transgression phase and to restrict the regression phase to the period of peat development. However that may be, in the definition nothing is said about the causes of the phases, and a relative high or low MHW is *not* part of the definition. In the foregoing pages, esp. fig. 10, we demonstrated that inhabitation concentrated in the regression phases, so we can say here that the data from settlement sites relate to regression phases.

[146] Zonneveld 1960, Part A, 16-17, fig. 18-20. See also Jelgersma 1961, 21.

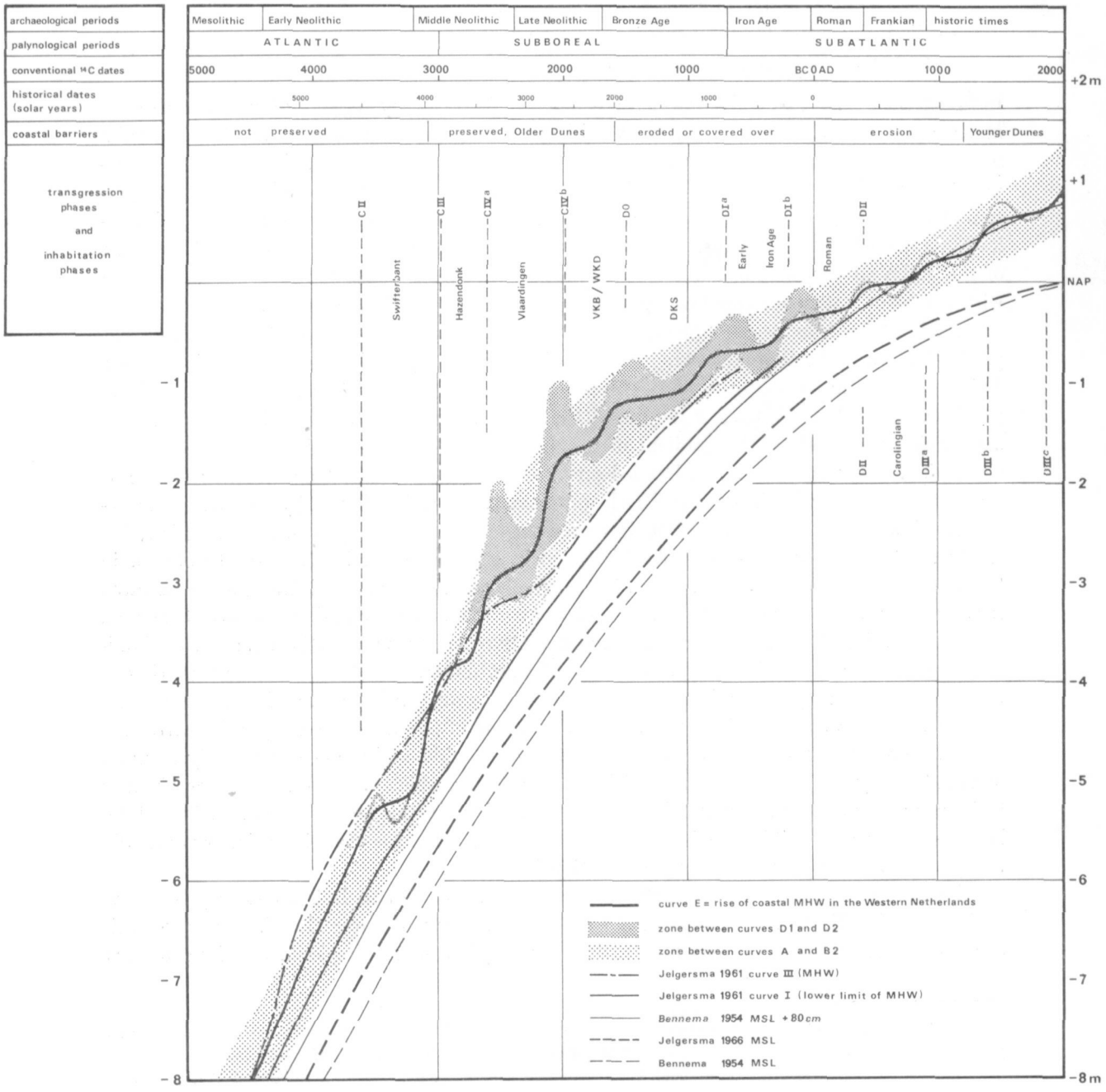

Fig. 14. Time-depth diagram with our curves for changes in MHW level in the Western Netherlands and various curves of Bennema and Jelgersma for comparison.

In Vlaardingen a high MHW at the time of deposition and some compaction, in Molenaarsgraaf no compaction, no high MHW but certainly a small "river gradient effect" [147], which dominates the whole picture somewhat further upstream (Zijderveld). In West Frisia a source of error occurs through the application of a uniform correction of 80 cm. for compaction in the subsoil. The difference between Hekelingen and Vlaardingen, finally, shows strikingly that local circumstances and comparatively small variations in milieu may be of great influence.

The curves C7-C9 give the course of MHW on archaeological sites for the period after the Bronze Age. C7 and C8 depend in the first place upon the given data. C9 is an extrapolation to this, orginating from the equalization of periods of frequent dike-breaches with transgression phases, whereby a relatively high local MHW is attributed to these transgression phases. For these periods of small rises in sea-level the influence of small errors in measurement and local variations is considerable. Human intervention in nature has, moreover, increased local differences. As long as no comprehensive corpus of reliable material from this period has been assembled this approximation seems to lead to a reasonable presentation of the reality. For the construction of curve C9 use was made again mostly of data given by Van Giffen, Bakker, Bennema and Van Hoorn and the other sources for these later times mentioned earlier [148].

1.7.3.3. *The construction of the curve*

Starting from the curves C1-C9 we can make a second approximation of the real relative rise of MHW. The curves D1 and D2 in fig. 14 give the lower and upper limits respectively of the zone within which the fluctuations of C1-C8 take place. Inside this zone lies the curve of the real rise of the coastal MHW level. Because of a lack of data the oldest part of this zone can only be represented as a simple line. For the most recent part we have taken the curve C9. In reality, however, in both these sections also, as in the construction of the curves A and B, the data are spread in a zone and not on a line.

Before we can arrive at a curve giving the real rise and fluctuations of coastal MHW two effects must be evaluated: a local effect, expressed in the sharp fluctuations of the curves C1-C9, and a regional effect that is apparent from the differences in level between these curves.

As far as the first is concerned we start from the fact that in regression phases there is no question of any general fall in Mean Sea Level of any importance. Geologically at least no indications of this exist [149]. The extent of the deviations from the general average, which we can assume for our selected sites, also allows a similar flattening of the sharp local changes: these can be explained entirely by the diminishing or extinction of the tidal amplitude (flood depression) on these points, during the occupation there [150].

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147 By "river gradient effect" is meant the raising of the MHW level (and all other water levels) going up-stream within the reach of the river courses; by other words the effect of the river gradient on the water levels (*cf.* p. 95 and fig. 23).

148 Van Giffen 1954[a], J. P. Bakker 1958, Bennema 1954, Van Hoorn 1967, this paper note 96.

149 Bennema 1954, 30-32 accepts at most short-lived lowering with a maximum of 50 cm. Reference is made in this case to MSL and not to MHW. We are aware that MHW fluctuation may be caused by fluctuations in the mean tidal amplitude and in that case will not be reflected in a MSL curve. This question will be discussed below.

150 *Cf.* p. 59. Rather high values for both the "piling up" of the flood in the sedimentation phases and the flood depression in the occupation phases are needed to explain the fluctuations entirely by these effects. The Biesbosch

As far as the second is concerned we put the case that the most representative point in the Western Netherlands lies in the western river area and so far to the west that the river gradient effect is negligeable but the ebb and flood were already clearly noticeable. The *donk* of Barendrecht, where, moreover, compaction plays no part, appears to approximate best to this ideal point, but the Hazendonk also may be regarded as very representative. Jelgersma is also of opinion that the *donken* are eminently suitable for making observations. In addition to her data on Brandwijk, which may be advantageously combined with those on Molenaarsgraaf, we have therefore set out her data on Barendrecht in the diagram [151].

Taking all known consideration into account, our curve E (fig. 14) is in our view representative for the rise of coastal MHW in the Rhine/Meuse estuarine area. The curve lies within both zones determined for this (A-B2, D1-D2), has no declining sections, but only those which are flatter or steeper, corresponding with regression and transgression phases respectively. The transgression "maxima" lie near B2, the regression "minima" near A.

In constructing the curve, we thought that this curve had to do justice in some extent to the fluctuations shown by the zone D1/D2 and by C9. We tried, moreover, to give the curve a uniform appearance all over its length. But we stress here that we consider the curve E as an idealized one: the lines A, B 1,2, C1-9 and D 1,2 are all based on measured data, but the curve E is an interpretation. Now one can ask whether it is right or not to show the transgression/regression cyclicity in the curve. It is indeed possible to draw a more of less smooth line as an approximation of the real rise of sea-level in open coastal water in between the curves A and B_2, D_1 and D_2. Such a line will certainly raise less discussion. It merely gives the general tendency of the rise of MHW.

Our stepped curve E is in accordance with the theory that the curve of the relative rise of sea-level must show the result of two phenomena:

— the gradual rise of sea-level according to a more or less smooth curve; the result of eustatic, epirogenetic and isostatic movements *cf.* p. 64 f.
— an oscillation, that reflects the transgression cyclicity.

The resulting curve will show steps, which become more and more pronounced, going from older to more recent times [152].

We must ask ourselves now the question whether or not the transgression phases really coincide with a rise of the MHW, and the regression phases with a lowering of it. That is to say whether the transgression/regression cyclicity is (partly) caused by and reflected in a MHW oscillation or not. If this is the case, then the amplitude of this oscillation is unknown. When

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data demonstrate that 50 and 30 cm. respectively for both effects must be regarded as maxima, while 30 cm. for both seem to be more reasonable values for estuarine regions under natural conditions.

[151] Jelgersma 1961, 21, 31-33, 45. In this publication Jelgersma used a uniform correction to eliminate the Suess-effect of 300 years for all ^{14}C dates. According to Vogel and Waterbolk 1963, 164 the corrections vary considerably: 240 $\pm$ 10 for Barendrecht and 0 $\pm$ 20 for Brandwijk. The irregularities, shown by her curve (fig. 22) are less distinct in reality. The corrected graph is published in Pons *et al.* 1963, Jelgersma 1966 and Hageman 1969.

[152] *Cf.* Mörner 1969, 406, fig. 140. Mörner demonstrated that the curve of relative rise of sea-level in uplifted areas must show sharp fluctuations, while the curve in subsiding areas will show only steps. Van Straaten (1954) already used the idea that the sea-level curve must be the result of a continuous rise and an oscillation.

we assume that the transgression/regression cyclicity is mainly or exclusively the result of meteorological (climatic) changes, and that a transgression phase is characterized by a higher precipitation and more frequent and heavier westerly winds (higher gale frequency) [153], then the MHW can rise in these phases. This might be caused by: a more frequent occurrence of extreme high waters, a general stowing of the sea-water towards the Dutch coast (not valid for other coasts around the North Sea !), a more frequent damming-up of the river water, or (hypothetical) a general increase of the tidal amplitude. When the sum of these effects results in an amplitude of the oscillation in the order of 10 cm. or more, then this oscillation will be visible in the sea-level curve. An amplitude of 10 cm. gives an average for the rise or fall of sea-level of 4 cm. per century when we assume an average of 500 years for the transgression/regression cycle. When the amplitude is less, it will be reflected only in the more recent, less steeply sloping part of the curve.

But the transgression phases need not necessarily to be reflected in the sea-level curve, that is to say the amplitude of the oscillation might be very small or even zero. The transgression phases might be periods when only the extreme situations (*i.e.* the storm floods) were relatively worse. It is just during such extreme situations that the major part of the morphological changes in the coastal regions occur, and a transgression phase is defined by such changes: the destruction of land and the extension of drainage creek systems. A few extra high storm floods a year will not influence the MHW level very much. Taking this into account one can for instance explain the sequence of the formation of coastal barriers and strand flats without the assumption of marked fluctuations in the MHW curve.

But in drawing our curve E, we have chosen for an amplitude of about 10 cm. and for a stepped curve, as we said mainly to do justice to the oscillations of the curves C1-9 and D1-2. Future research may reveal whether the steps must be accentuated or smoothenated or that they even must disappear.

1.7.3.4. *The curves of Bennema (1954) and Jelgersma (1961, 1966)*

A comparison of the present curve(s) with those of Bennema and Jelgersma [154] shows as the most important difference a less smooth line in the present curves, with a clear bend in the centuries around 2000 B.C. A period of a rapidly rising sea-level then changes to a much slower rise, with more obvious fluctuations [155]. The transition period (about 2500-1500 B.C.) seems to have been a period when a relatively high MHW level occurred locally. This was the

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[153] Jelgersma *et al.* 1970, 140

[154] Bennema 1954, 56, fig. 13, lower curve; Jelgersma 1961, fig. 22.

We think the curve of Zwart (1951) needs no further discussion after the comments given by Bennema and Jelgersma. We know now that some of Zwart's datings were seriously wrong. Moreover he neglected the margin of error in his calculations (as for instance in the rate of the epirogenetic/isostatic subsidence, which he estimated at 9 cm. per century).

[155] Dr M. A. Geyh, Hannover, pointed out to me, that a too small number of data can easily show false fluctuations that are eliminated when the number of data grows. Since we must reckon also with the transgression periodicity and the inhabitation phases and use this knowledge when constructing the curves, this possibility can be excluded in the present case. We thank Dr Geyh for this comments on this part of the work and for sending us a manuscript of his 1971 paper before its publication.

case behind the wide tidal inlets through the still narrow belt of coastal barriers, where the height of the tide was increased by the damming up of the flood wave.

There is no obvious explanation in our curve for the formation of the coastal barriers themselves, especially not for the change about 3000 B.C. from a retreating to an advancing coast-line. The above-mentioned flattening of the curve appears at least 1000 years too late to be of any relevance here.

Our curve A, being the lowest limit of all MHW data, can be closely compared with curve I of Jelgersma. Our curve lies at most 75 cm. higher, namely in the period 2000-1000 B.C. The correspondence between both curves is otherwise so marked that we see in this fact a confirmation of the supposition that inhabitation always took place above MHW level. At the same time it appears that Jelgersma's curve I must have reference to data of regression phases. The growth of peat on an earlier formed sediment does indeed always characterize a regression phase.

The zone limited by A and B2 (fig. 11), in more detail the zone between D1 and D2 (fig. 14) and as the best approximation curve E, give the true rise of coastal MHW. Jelgersma considered her curve II for the *donken* area as the most reliable for this.

Bennema's curve refers to MSL and must therefore be raised by about 80 cm. to be comparable. The explanation of the difference between our curve and Bennema's in the period 3000-500 B.C. must in the first place be sought in the data used by Bennema. It concerns the bases of the barrows in West Frisia and Hekelingen, with a dating of about 1700 B.C. (about 500 years too late according to the later ^{14}C dates) and the deposits at Hoofddorp, which with an age of about 2300 B.C. have also been placed far too late, by about 1000 years [156].

Both Jelgersma's curve II and the present curve, are based on compaction-free sites, and on ^{14}C ages. Thus differences between the two curves are mainly due to the nature and the interpretation of the material used: ours was indeed very detailed but comparatively lacking in uniformity. Jelgersma's data are more uniform but have a rather wide margin of error. The fluctuations in our curve have further such a small range, that they could not possibly have been established on account of Jelgersma's data. The difference between her curve II and our curve E shows a maximum of 75 cm. about 1800 B.C., while there is no difference at all from our curve A at this point. We do not think that these variations indicate any contradiction, but that Jelgersma's data allow our curve E to be regarded as a refinement of her curve II.

1.7.3.5. *Eustatic, tectonic and isostatic components*

Although we are now going somewhat beyond the boundaries of our subject, we cannot omit a few remarks to the possible role that may be attributed to the various causes of the relative rise in sea-level.

The most important components of the relative rise in sea-level in this country and for the period in question are:

— an actual rise of the water as a result of the waning of continental ice caps: the glacio-eustatic rise in sea-level.

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[156] Bennema 1954, 55; in more detail: 26, 39 and 40 f.

— a long-term subsidence of the Western Netherlands: the epirogenetic subsidence.
— the isostatic movements resulting from the unloading of once glaciated areas and the increased loading of the sea floor:
  a) Glacio-isostatic upheaval of the regions formerly covered with ice caps and (partly) compensating subsidence in the marginal areas.
  b) Hydro-isostatic subsidence of the flooded regions due to the weight of the water, and, especially in the Western Netherlands, the sediment.
— Compaction of the pre-Holocene deposits. We think this factor to be very small and will leave it out of consideration in the following discussion.

The most recent and most detailed curve for the eustatic rise in sea-level available at the moment is that of Mörner [157], resulting from a detailed and exhaustively documented study in the Kattegat area, This eustatic curve (for MSL) shows a rise with small but sharp fluctuations from about —6.5 m. at about 4400 B.C. to the present MSL at about 1800 B.C., after which the rise comes to a fairly abrupt end and only a few fluctuations occur around the level attained. By substracting the value of this eustatic curve from that of the present curve E for the relative rise of MHW we obtain a curve for the isostatic-epirogenetic subsidence (fig. 15). This appears to have been fairly constant at a rate of about 4 cm. per century since 4000 B.C. The bend in our curve E at about 1800 B.C. may be attributed entirely to the termination of the eustatic rise in sea-level. It had already been noted that this bend was contemporaneous with this termination.

We must, however, not omit reference to some problems and sources of error. First, the reliability of Mörner's curve is difficult to assess, as it shows only a result and not the margin of error of the observations. It is particularly difficult to determine whether the fluctuations are in fact as considerable as they are indicated in his diagram, which we venture to doubt on account of the current conceptions in this country and the margin of error of the data used. The dates of the periods of rapid rise and subsequent fall correspond closely, however, with the transgression and regression phases respectively in the Netherlands [158]. We do not think, however, that the occurrence of such strong fluctuations in this country is very likely.

Second, it is assumed without question that the plotted values give the MSL. In the light of our discussion about the relation between the height of the deposits to the various reference levels we think that this may be open to doubt. The tidal amplitude in the Kattegat area is, however, small, so that it is difficult to make this distinction there, while, moreover, it would mean an essential difference only for the period which we have discussed.

The third problem is directly related to this: the absence of facts about the period after Christ. In our view, the course of the eustatic curve does not in the least exclude the possibility of a eustatic rise of about 0.5 m. since Christ; in fact, this is likely to have happened, if the

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[157] Mörner 1969[a], esp. figs. 145 and 160; 1969[b], 1971.

[158] Mörner 1969[a]. 393-401. See also below p. 69 and Geyh 1969, 1971. Of course, the agreement of Mörners curve with our data does not prove this curve to be right. On the other hand, this agreement shows that, at least for the part after 4000 B.C., Mörners curve cannot be very seriously wrong, and this is the more likely, since the curve approximates to a mean of the best curves published earlier.

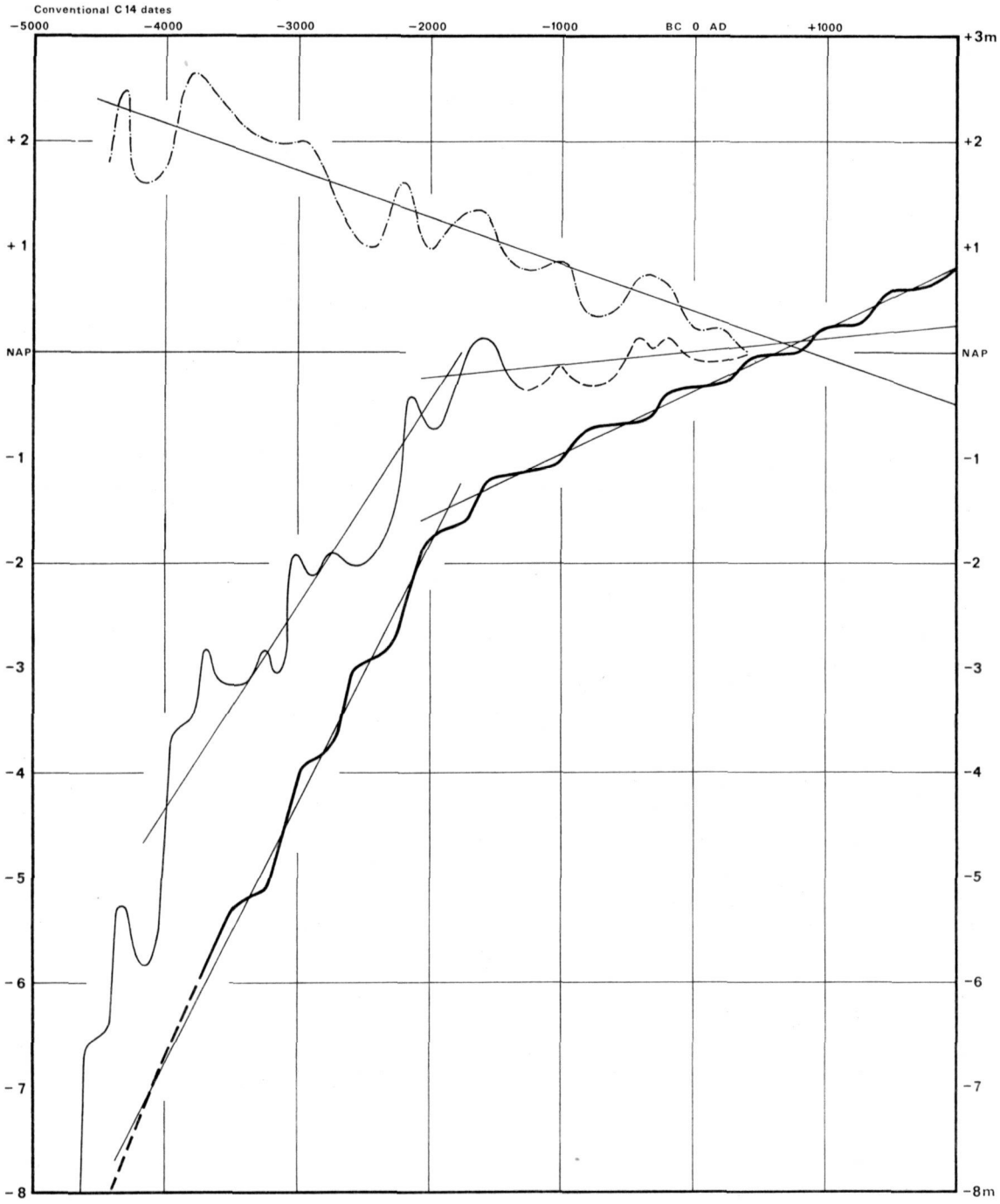

Fig. 15. Comparison of our curve for the rise of coastal MHW in the Western Netherlands (our curve E, heavy line) with the curve for the eustatic rise of sea-level after Mörner 1969 (thin line). The difference between both curves, the isostatic-epirogenetic subsidence of the Western Netherlands (— . — . — .) has been mirrored with respect to the NAP line for the sake of clearness.

given values concern MHW and not MSL. The agreement to the data about the Western Netherlands appears to point clearly in this direction [159].

An isostatic-epirogenetic subsidence of about 4 cm. per century since 4000 B.C. in the Rhine/Meuse estuarine area is a very reasonable amount. By various investigations it has been established now with a great measure of certainty that the subsidence there since the Eemien has been 1½-3½ cm. per century. It is unlikely that considerable or sharp fluctuations occur, so that we may allow that these values are also valid for the last part of the period [160]. This means that either the highest value of this calculation is the correct one in the Holocene, while there is no question of any isostatic effect, or that only a limited isostatic subsidence, something like 2 cm. per century from 4000 B.C. to our times, has occurred. We consider that in the latter case a hydro-isostatic subsidence caused by the weight of the water and especially of the sediment is the most likely.

Mörner himself compares his eustatic curve with that of Jelgersma [161]. It appears that a few serious problems occur in the period before 4000 B.C. but these fall outside the scope of this enquiry and are not discussed here.

1.7.3.6. *The curve after correction of ^{14}C years into solar years*

A final comment on the influence which will be exerted by the correction of ^{14}C years into solar years according to the dendrochronological calibration data of Suess [162]. The extension of the time-scale in the last four millennia B.C. (in ^{14}C years) by more than 1000 years results in the first place in the oldest part of the curve acquiring a less steep course, so that the bend at about 1800 B.C. becomes less pronounced, but does not disappear by this correction.

We did use (fig. 16) an approximation to a smooth line of the data and the detailed curve given by Suess. So we neglected all oscillations of his calibration curve. Doing so, we show only the general deformation of the sea-level curve. In view of the margins of error in the establishment of both the transgression phases and the oscillations of the calibration curve the use of the detailed curve seems not very sensible to us. This would merely led to some minor and disputable shifts of the transgression and regression phases. At the same time we avoid the question whether the oscillations are true or not [163].

The application of this time correction has a considerable influence on all opinions about a possible periodicity in the geological phenomena, for ^{14}C dates were of no use for comparison with chronologies based on enumeration of stratified annual layers. After application of the correction, the distance between the transgression maxima varies between 1000 and 550 years. If we take, however, into account some other recent studies dealing with transgression

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[159] Jelgersma 1966. In fig. 6 she gives a curve for the rise of MSL traced to present times.

[160] Jelgersma 1961, 14-15 and 51-52; Bennema 1954, 13; Ahorner 1962, esp. 101.

[161] Mörner 1969[a], 433, fig. 153.

[162] Suess 1970.

[163] Vogel published a calibration curve with only one fluctuation (Bakker, Vogel & Wíslanskí 1969, 19-27). Proof of the existence of another fluctuation was obtained from the material of the Neolithic bog settlement at Niederwiel (pers. comm. of Prof Dr H. T. Waterbolk). It will be very difficult to prove the existence of all fluctuations in view of the required detail of the necessary chronologies.

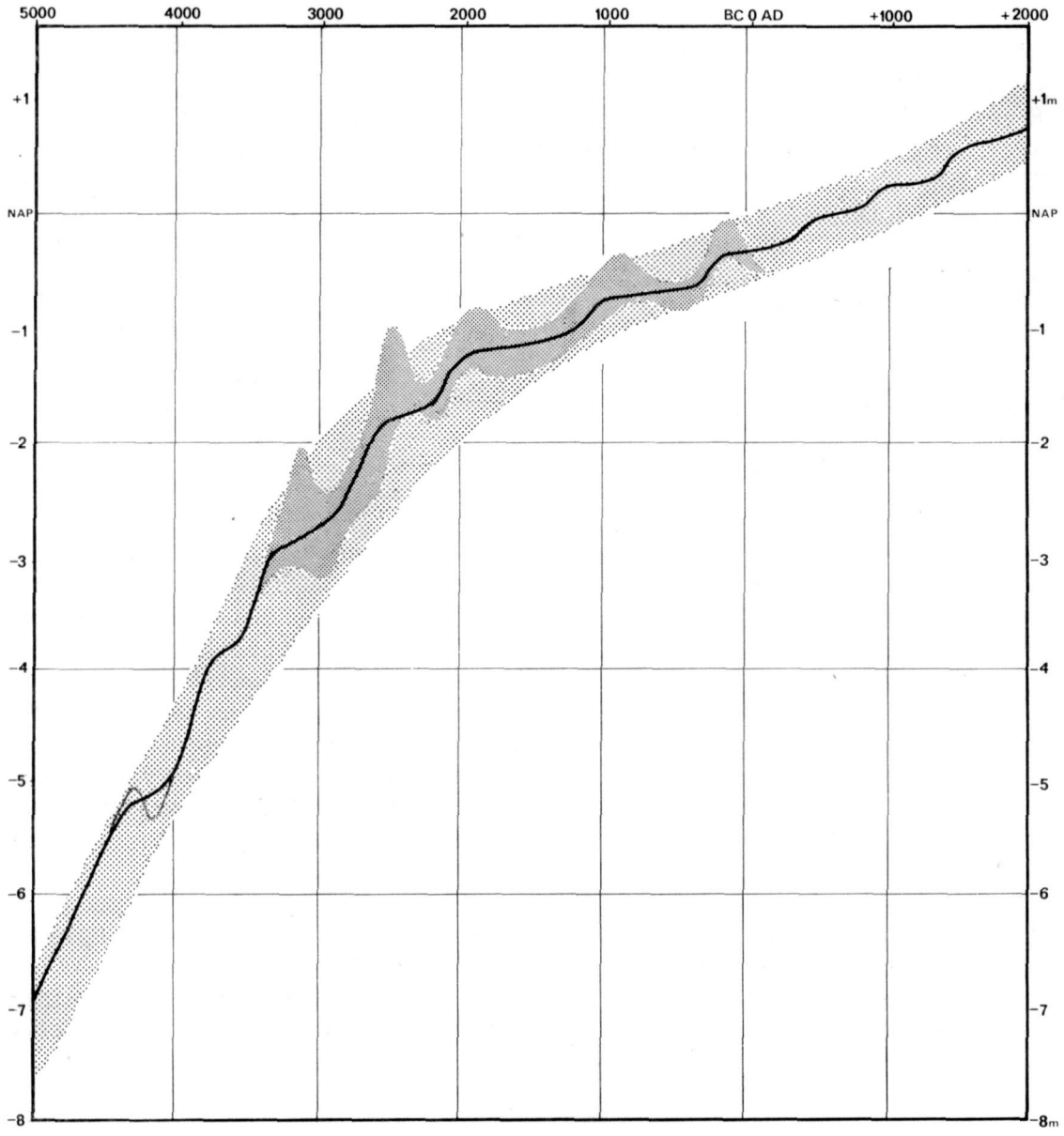

Fig. 16. The curves, constructed with a scale of solar years on the X-axis.

sequences around the North Sea, such as those of Jelgersma *et al.* and Geyh [164], it is clear that most of the transgression phases distinguished at present in the Western Netherlands can be divided up in more phases than shown by us. At any rate this will certainly be possible after future research. So it may be possible to divide C IV into three sub-stages (instead of two), D O into two sub-stages and D I into three (instead of two). These subdivisions will have considerable influence on the establishment of periodicity and the mean duration of one "transgression-regression-cycle". According to Geyh [165] 11 cycles existed since 2900 B.C. (in ^{14}C years) or 3700 B.C. (in solar years), while one cycle has a duration of 250-450 ^{14}C years, or on an average about 500 solar years. Apparently our data do not reflect all these fluctuations.

1.8. NORTHERN GERMANY AND EAST ENGLAND

The above-discussed area between Zeeland Flanders and Texel occupies, as the estuarine region of the Meuse and Rhine, the Scheldt and the Overijssel Vecht with their various tributaries, a special place within the series of Holocene coastal deposits of the southern North Sea. The discharging rivers have exerted a strong influence on the geological history of this area and on its present-day features. Of no less importance is the morphology of the Late Glacial subsoil with the wide river valleys as central elements. A comparison with the other coastal plains around the southern North Sea will therefore only be possible to a limited extent.

1.8.1. Northern Germany

The salt marsh area of Friesland and Groningen forms, together with the coastal region of Niedersachsen (Ostfriesland, Weser/Jade region) and the west coast of Schleswig-Holstein (Dithmarschen, North Friesland) a whole with distinct differences from the Western Netherlands. Nearly all older deposits including possible former coastal barriers were largely destroyed there during the most recent transgression phases (Dunkirk I and later) and replaced by new deposits or in other places covered over. The deposits on which the most ancient traces of inhabitation have been found in the Western Netherlands (tops of Early Holocene dunes, coastal barriers, creek systems of earlier transgression phases, former river courses) are almost entirely lacking here. Recent geological data show, however, that in the whole region a similar cyclicity of transgression and regression phases took place [166]. On suitable sites inhabitation was probably possible also in these regions during the Neolithic and the Bronze Age. A much smaller strip of land was, however, involved, with fewer possibilities for inhabitation than in the Western Netherlands, but a number of finds provide us with some indications of this early presence of men [167]. The distribution of these finds is, in our view, in the first place dependent

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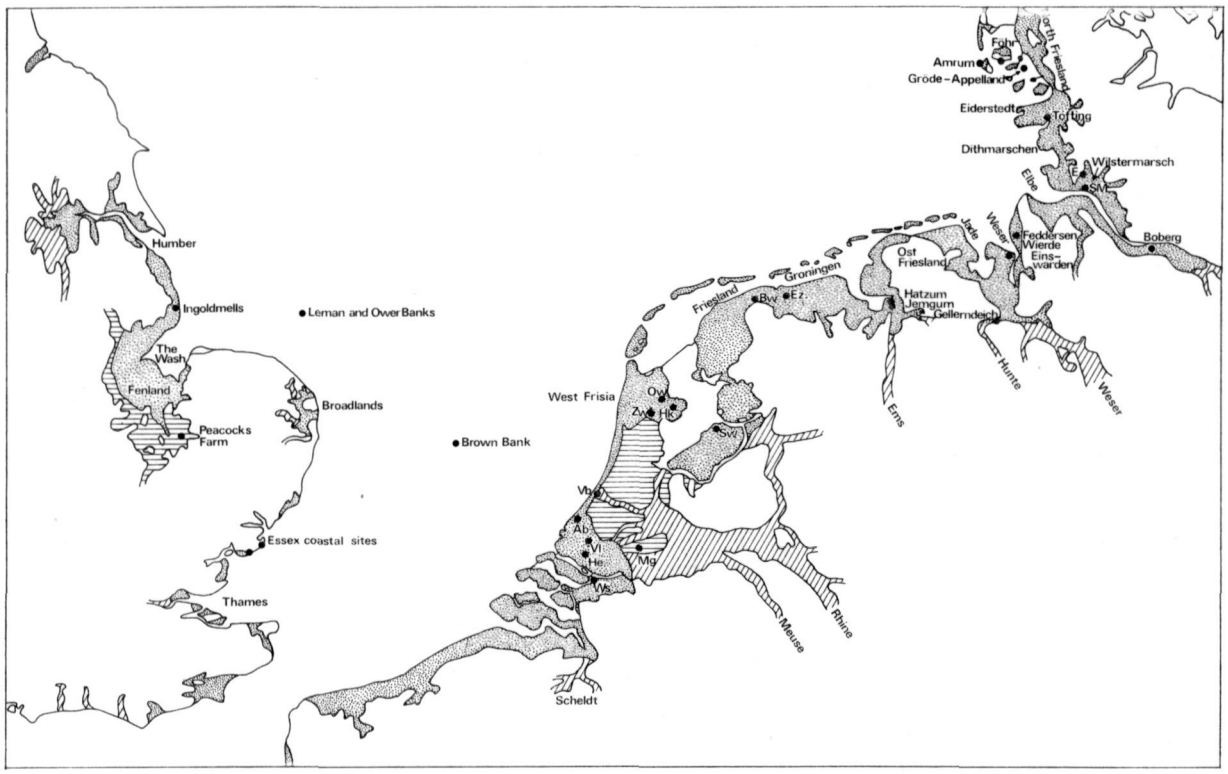
[164] Jelgersma *et al.* 1970, Geyh 1969, 1971, also Müller 1962, D. Hoffmann 1969.

[165] Geyh 1971, fig. 1-4.

[166] Brand *et al.* 1966, Geyh 1969, 1971.

[167] On these finds see especially: Bantelmann 1949, 1967, 18-20; Schindler 1953/'55, Haarnagel 1950, Prange 1963, 62-64; 1967, 53-56.



Ab = Arentsburg; Bw = Bornwird; E = Ecklak; Ez = Ezinge; He = Hekelingen; Hk = Hoogkarspel; Mg = Molenaarsgraaf; Ow = Oostwoud; SM = St. Margarethen; Sw = Swifterbant; Vb = Valkenburg; Vl = Vlaardingen; Ws = Willemstad; Zw = Zandwerven.

Fig. 17. The southern part of the North Sea with the most important reference sites mentioned in the text.

upon the chance of discovery and particularly upon their chance of preservation during later transgressions.

Finds from the Early Neolithic are known from the estuarine region of the Elbe: a remarkably complete *Spitzbodengefäss* from Ecklak in the Wilstermarsch and domestic refuse on the tops of largely covered Early Holocene river dunes near Hamburg-Boberg [168]. Even earlier inhabitation seems to have occurred, judging by the Early Mesolithic barbed point found on the island of Föhr, at a depth of about 4.5 m. in a peat layer under the *Marsch* deposits, north of the hamlet Wyk [169].

From the Middle Neolithic date perhaps a few stone and flint axes from the Holocene deposits along the west coast of Schleswig-Holstein [170]. Further data about the depth of these

[168] Ecklak: Bantelmann 1949, 77, *Taf.* III: 2; Boberg: Schindler 1953/'55, 1961, 1960, 83-85. On the dune tops about 30 sites were discovered, five of them of primary importance because of their extent and finds. The finds comprise: some Ahrensburg Culture artifacts, microliths (at 5 sites), tranchet axes of the Oldesloe Culture, pottery from the Early Neolithic onward ending with the BB Culture.

[169] Bantelmann 1949, 77, *Taf.* III: 1. Another barbed point was found nearby at Amrum (*cf.* Clark 1936, 237).

[170] Bantelmann 1949. 77.

finds are lacking, while the datings of such axes are not without problems. Pätzold [171] describes an interesting find of a TRB settlement below NN near Gellerndeich at the end of the valley of the Hunte river. The finds (at any rate the Drouwen phase and as it seems also the Late Havelte phase are represented) were lying at a depth of between —1.0 and —1.4 m. NN [172], compaction-free on a sandy underground, and they were covered with peat. This depth corresponds with that of the approximately equally old finds of Bornwird [173] and forms an upper limit for the former MHW level.

Not better represented is the *Stein/Kupferzeit*, corresponding to the Bell Beaker Culture and the Early Bronze Age in the Netherlands. It is only at Hamburg-Boberg [174] that there is question of settlement remains. Additionally there are only isolated finds of flint daggers and sickles. These latter, however, do not necessarily all belong to this period. Of importance is the hoard of three flint daggers at Kuhlen near St. Margarethen in the Wilstermarsch (near the estuary of the Elbe) [175]. The daggers lay at a depth of 90 cm. and on the former surface. It is possible that a small concentration of flint flakes and a scraper from Gröde-Apelland [176] originate from the same time. The finds lay on the north-east slope of a "fossil sandbank", of which the top reached to —1.08 m. NN. The sand layer, with a maximum thickness of 1.20 m., lay on a clay deposit, so that it is clear that we are not concerned here with an earlier outcrop. It appears that the inhabitable region to the north of Eiderstedt extended far more westward than was the case more towards the south [177].

In the whole northern clay area the transgression phase Dunkirk I^a is of prime significance. Salt march deposits of this period were inhabited in the Early Iron Age in Friesland, Groningen and Niedersachsen. The reaction of the inhabitants during the next transgression phase (Dunkirk I^b) was not everywhere the same: in the Netherlands the first *terpen* were thrown up (among others the initial *terp* of Ezinge) on which the inhabitants could maintain themselves, while in Northern Germany the settlements were abandoned and the people withdrew to the south on the high, sandy *Geest* soils.

In the first century B.C. the people returned again to the salt marshes; in Dithmarschen the low land was inhabited later: from the first century A.D. During the Merovingian transgression period (Dunkirk II) the tale is repeated: the *terpen* of the Northern Netherlands continued to be inhabited, while the salt marshes of Ostfriesland were abandoned. Finally, from about A.D. 800, the whole salt marsh area from the river Ems to North Friesland was settled once again and for good [178].

Haarnagel gives the following data about levels in Jemgum. At a level of —0.5 m. NN the occupation took place in the 7th century B.C., at +0.2 m. in the 1st-4th centuries A.D. and

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171 Pätzold 1955.

172 We are informed by the Dutch Ordnance Survey, Delft that the *Normal Nul* level (NN) is equal to —0.02 m. NAP.

173 See App. II no. 12. We thank Prof Dr J. D. van der Waals for the information he kindly provided.

174 *Cf.* note 168.

175 Bantelmann 1949, 77; 1967, 19.

176 Bantelmann 1938, 1967, 20-24; Haarnagel 1950, 39-49 and *Abb.* 12.

177 Bantelmann 1967, 13.

178 See Haarnagel 1969, esp. 21-27; Bantelmann 1967, esp. 20-24.

at +0.5 m. today. At Hatzum the level of Early Iron Age occupation lay at —0.4/0.6 m. NN, and the Roman level on a 20/30 cm. thick covering layer of clay. The bank of a creek lay at —1.00/—1.20 m., of which the floor lay at —2.50 m. These data correspond closely with observations made in the Northern Netherlands. The differences with the data from the Rhine/Meuse mouth region are also very small. If isostatic movements played a part, there was no difference between both regions since the Early Iron Age [179].

Just as this more recent sequence of inhabitation reflects the transgression and regression phases, so the limited number of older finds seem to belong to periods of regression. They do not, however, as yet permit of a clear allocation to periods. The Ertebølle/Ellerbek finds were to be expected in the peat area; we were familiar with the BB-*Dolchzeit* inhabitation in the Netherlands also. These finds might also indicate a period of favourable possibilities of inhabitation here. The estuary of the Elbe seems comparable to some extent with the Rhine/Meuse estuarine area: there also the tops of dunes offered good opportunities for inhabitation in corresponding periods. Any inhabitation corresponding with the VL Culture, however, is not yet known. This region was, moreover, the best protected against erosion during later transgressions.

1.8.2. East England

Inhabitation is also known in the regions along the east coast of England which are influenced by the rise in sea-level. Here the Fenland is central. Even more than the estuary of the Elbe, it is comparable with the Western Netherlands, both in its vertical succession and lateral variation as well as in the data about inhabitation [180]. A number of small rivers here flow into a basin sloping very slightly in a north-east direction. Under the influence of the rising sea-level the peat formation begins here in the Atlantic; in the deepest parts (the small river valleys) this had already occurred earlier (Boreal). In the whole region there is one important transgression phase, represented everywhere, to be distinguished in the form of the Fen Clay deposit. Local deposits from earlier transgressions appear to occur along the coast. These, however, are only shown incidentally and are limited to the part nearest to the coast, where the Pleistocene subsoil lies deepest. The oldest of these deposits possibly still belong to the Atlantic period. The Fen Clay itself is dated after 2700 B.C. at the coast, reached its maximum extent at about 2500 B.C. and was covered with peat about 1950 B.C. In the river valleys (for example

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[179] Haarnagel (1963, *Plan* II; see also 1940: *Abb.* 6) gave a schematic representation of the changes in level of the surface of the *Marschen* of Lower Saxony, going form east to west. The Bronze Age level lies between —0.5 and —2 m., the Roman level between 0 and +0,5, the Early Mediaeval level at about +1.00.

The data are constistent with those from the Western and Northern Netherlands. But the level increases considerably when we come east resp. north of the Elbe. *Cf.* for instance Einswarden: +50-70 cm. NN (Schmidt 1957), and Tofting: +145 cm. NN (Bantelmann 1955), dated 1st century B.C. and 1st century A.D. resp. This difference might be partly the result of a large tidal amplitude, partly the influence of the isostatic upheaval of Scandinavia.

[180] The author studied the Holocene of East England during his study of Physical Geography in1965; typescript no. D 1616 in the Geographical Institute, State University, Utrecht.

near Shippea Hill) the transgression was noticeable somewhat earlier, about 3000 B.C. [181]. From these dates it appears that the Fen Clay corresponds with the Dutch Calais IV deposits [182].

The archaeological data correspond closely with these datings.

The investigation by Clark and Godwin at Peacock's Farm and Plantation Farm [183] are of special interest to us, since they have much in common with our discoveries on the Hazendonk and offered comparable results. On small, sandy outcrops with very steep slopes (in our view very probably dunes), lying near the "roddon" of the river Little Ouse [184], the remains of settlements from the Late Mesolithic, the British Early Neolithic and the Early Bronze Age were found. Finds were also made on the covered slope of the outcrops and embedded in the adjacent clay and peat layers covering the slopes. The Mesolithic level is a black, sandy layer, "stinking" and dated by pollen analysis at the end of the Boreal. The Early Neolithic level (Windmill Hill, Neolithic A) is slightly sandy and hardly recognizable in the sections. Both levels lie under the Fen Clay. The Early Bronze Age level lies just above this clay and is dated Early Subboreal [185].

On both sites fairly coarse Early Bronze Age pottery with heavy rims, cordons and decoration of cord impressions was found. One sherd at Plantation Farm even shows BW decoration[186]. Sherds of Late Beaker pottery (Long Necked Beaker, A Beaker) were also found there. In neither case was characteristic pottery found in the peat. The appropriate level could, however, be reliably determined by a number of finds of pig and ox bones.

A series of ^{14}C dates [187] with fairly large margins of error shows a good mutual agreement, except for two charcoal datings of the Early Neolithic level (both agreeing well with each other) which in relation to the peat datings turn out to be 500-300 years too young. It is not possible to find a satifactory explanation for this [188]. In the Mesolithic level two ^{14}C dates lying directly above each other differ by nearly 1000 years (5650 $\pm$ 150 and 4733 $\pm$ 150 B.C.) This is due either to a stationary phase in the growth of peat or to wastage of the peat caused by inhabitation. The whole peat layer under the clay wedge is 140 cm. thick and was formed between about 6600 and 2840 B.C.

The data about the height of the various levels have been summarized in table 4. In comparison with the data of the Western Netherlands both the youngest levels are significantly higher. The difference with the two oldest data is, however, remarkably large. The variations might be explained by assuming that an actual rise took place in the Fenland before 3000

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181 On the geology of the Fenland see: Willis 1961, Godwin & Clifford 1939, esp. 401 and the diagram there; Godwin 1939/'41, Godwin & Edmunds 1933, Jelgersma 1961, 52-53.

182 Bennema 1954, 32-33 says that the Fen Clay corresponds with the Cardium deposits, but at that time Cardium was dated too old (*cf.* note 129).

183 Plantation Farm: Clark 1933; Peacock's Farm: Clark *et al.* 1935, Clark 1955, Clark & Godwin 1962.

184 See esp. the aerial photograph in Clark 1955. For "roddons" see p. 75.

185 Godwin 1939/'41, fig. 22; Clark *et al.* 1935, fig. 18.

186 Clark 1933, PL. XLV, 13.

187 Clark & Godwin 1962.

188 Either the dates of the peat samples are too young by some centuries, due to enrichment with recent humus, or the error is in the charcoal sample. The dates are not Suess-corrected. The differences in the corrections are perhaps the cause of the anomalies.

B.C., compensating almost entirely, but not altogether, for the rise in sea-level. Another interpretation, which appears more probable to us, takes into account the "gradient effect" [189]. In the time of the first peat growth the coast was far distant and the peat formation started mainly because of stagnant ground water. According to this hypothesis the water level near Peacock's Farm first came under the direct influence of sea-level movements about 3000 B.C., while it had previously been but little influenced in this way. The systematic difference in height of the later levels at the Hazendonk and Peacock's Farm can be ascribed to the "gradient effect".

TABLE 4

Peacock's Farm, Fenland. Depths in cms and dates of levels with culture remains

Archaeol. date	^{14}C date (B.C.)		Depth above (+) or below (—) the Fen Clay	Depth below OD of the not "founded" level	Depth of "juncture" (= MHW)	Compaction
EBA	after 1940	peat	+ 5/ 15	— 110/130	— 30	80/100
Neol. A.	2910/2990 ± 120	charc.	— 50/ 70	— 380/400	— 310	70/ 90
Mesolithic	5650 ± 150	peat	— 90/110	— 440/460	— 340/360	100
Mesolithic	6660 ± 160	peat	— 130	— 480	—	—

Data of Clark 1935 (esp. fig. 2) and Clark & Godwin 1962 (esp. figs. 3 and 4 and note 1).

The sequence of occupation and sedimentation at Peacock's Farm and the Hazendonk shows a striking conformity, which is of great importance for the correlation of the Holocene transgression sequences around the southern part of the North Sea.

A number of Neolithic axes, found under the Fen Clay at various places in the Fenland, show that one can envisage general inhabitation in the Early and/or Middle Neolithic. Bronze Age finds, namely a number of spear heads, are always found on the Fen Clay; an Early Bronze Age skeleton was also found at that depth [190]. Bridget Trump [191] refers to no less than 65 Middle Bronze Age swords, found in the Fen District. With few exceptions the find places lie along the edges of the peat areas or in the direct vicinity of the "islands" of outcropping boulder clay. We should not interpret these swords as a proof of intensive inhabitation. It is much more likely that they were used for a kind of ritual offering, buried in the peat by people who had come from different directions, and possibly with this purpose in mind, to the Fen District.

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[189] In Clark *et al.* 1935 the surface of the Fen Clay is drawn 0.8 m. too low ! *Cf.* note 1 in Clark and Godwin 1962.

[190] As to the finds see: Godwin 1939/'41, esp. the scheme at p. 281. As to the skeleton: Clark 1933, esp. 278-279. The skeleton was found in the peat at 10 cm. above the Fen Clay.

[191] Trump 1968.

Nor has inhabitation been clearly proved during the Late Bronze Age. The depot of a large number of socketed axes near Stutney, Isle of Ely, shows that the corresponding level must lie some way in the "Upper Peat" [192].

A second, important transgression phase reached less far inland than the Fen Clay. The "Upper Silt" was deposited around the Wash and in and along the river beds in the peat-region. After a "native" inhabitation, an intensive Roman occupation with good water control occurred. The abandonment of the Roman settlements, completed about 425 A.D., coincides with the beginning of a new transgression phase, ending in the 7th/8th century A.D. Subsequent inhabitation was limited chiefly to the deposits of this post-Roman transgression and was concentrated around the Wash. After an inhabitation peak in the 9th-11th centuries a gradual decline occurred, particularly after the 13th century [193]. With the beginning of dike construction, the artificial drainage and the making of polders, especially after about 1630, a new period of inhabitation began. Because of considerable compaction the old creek fillings gradually became visible as ridges ("roddons") after that time [194].

The entire history of sedimentation and inhabitation in the Fenland corresponds in its overall picture with that of the Western Netherlands. Not only the transgression phases Calais IV and Dunkirk I, but also Dunkirk II and III are clearly recognized. The absence of Dunkirk O may be explained by the wide distribution of the Fen Clay (Calais IV) sediments and the resistance offered by these. Moreover, it is possible that a part of what is called Fen Clay is of later age and in fact can be dated as Dunkirk 0.

Data about places outside the Fenland are more sparse. To the north of it, near Ingoldmells and at the estuary of the Humber, only the younger (Dunkirk I, Dunkirk II) transgression phases have been identified. Further north we come to the region of land-upheaval and coastal terraces [195].

South of the Fen District data are available about the Norfolk Broadlands [196]. Two transgression phases are known there, represented by a Lower Clay (between —11.5 and —9.5 m. OD) [197] and an Upper Clay (between —5.5 and —1.5 m. OD). The first, lying on 1 m. peat, is Early Atlantic, the second is Late Subboreal and/or Subatlantic. The oldest clay seems to begin certainly earlier than the Fen Clay, in view of its depth, but the end of both occurred at about the same time. The Upper Clay corresponds with the Upper Silt of the Fen District. The considerable differences in height are certainly attributable partly to compaction, and partly perhaps to a deeper real subsidence in the Broadlands. No archaeological data about Neolithic or Bronze Age inhabitation exist.

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[192] Clark 1940.

[193] See Hallam 1961, also Green 1961. After completition of the manuscript a detailed monograph on the Roman occupation of the Fenland came out (Phillips (ed.) 1971). Miss Hallam gives therein a full account of her observations (p. 22-126).

[194] Fowler 1931/'32, 1932, 1933/'34, 1934; Godwin 1938. As to compaction: Fowler 1933. The roddon at Peacock's Farm has a height of 2 m ! The "shrinkage" of the peat there amounts to 45 cm. between 1935 and 1962. Since 1660 the peat surface has been lowered locally 5 m., of which at least 3 m. in the last century.

[195] Swinnerton 1931, A.G. Smith 1958[a], 1958[b].

[196] Lambert *et al.* 1960, I. S. Zonneveld 1960[b].

[197] By OD we mean Newlynn ODN. The Durch Ordnance Survey, Delft, informed us that this level is situated at —0.23 cm. NAP.

The transgression over the well-known Lyonesse surface along the east coast of Essex has been dated closely after the BWB pottery from the beginning of the Bronze Age [198]. Remains of inhabitation on the surface fall into three groups: an inhabitation phase in the beginning of the Neolithic with (early) Windmill Hill pottery, a phase with Peterborough ware and finally inhabitation by people using beaker pottery. The beaker sherds were found as far as low tide level. They were covered by a thin layer of peat and by about 3 m. of *Scrobicularia* clay, of which the upper surface lay about 1 m. beneath the present MHW level. All this implies in our view an occurrence of Beaker pottery to at least —1 m. OD. Inhabitation did not take place along the open seaboard, but on the banks of the creeks behind. The coast-line itself was possibly formed by a sand spit or a coastal barrier. The finds include wooden objects: a canoe, paddles and even the remains of wooden structures (huts). These can only have been preserved by a very short interval of time between inhabitation and submergence. The submergence seems therefore to have happened during the transgression phase Dunkirk O, which we were not able to identify in the Fenland.

The inhabitation remains show a close correspondence in their dating with the Fenland on the one hand and with this country on the other hand. In East England also a sequence of trangression and inhabitation phases, such as we were able to determine in the Netherlands seems to be applicable, especially during the most recent times, but perhaps also during the Bronze Age and the Neolithic.

1.8.3. Conclusion

The data which we collected on the inhabitation history of the Holocene regions around the southern parts of the North Sea, namely the area indicated by Willis [199] as a subsiding region, seem to show a large measure of mutual agreement. This is probably to an important degree the result of the considerable similarity in the history of the development of the various regions. The succession of transgression and inhabitation phases determined for the Western Netherlands, appears to apply not only to Northern Germany but also to the East England coastal regions, as far as the later times are concerned. But for pre-Roman times in England, and the Neolithic and Bronze Age in Germany the information is still too vague to allow any detailed comparison with the Netherlands.

The Western Netherlands stand out as a unique region having complex origins. Further, the inhabitation of this relatively large region shows a remarkably varied picture because of the different possibilities it presented. For coastal barriers and former river courses were entirely lacking elsewhere. Because geological and archaeological investigations in the Rhine/Meuse delta are relatively far advanced for various reasons, it was possible to make in this region a detailed picture of the inhabitation history in relation to the development of the landscape.

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[198] I. F. Smith 1955; see also Zeuner 1958, 97-99; Warren *et al.* 1936, Warren and Smith 1954.

[199] Willis 1961.

2. GEOLOGY AND INHABITATION OF THE RIVER CLAY/WOOD PEAT AREA

The discussed area forms a vast geological "window", where old morphological units are preserved. Explorations since 1963 by a group of amateur archaeologists revealed an extensive prehistoric occupation in this formerly blank area. The inhabitation history is described, from the Early Neolithic throughout prehistory up to historic times. The sequence and patterns of human occupation appear to be closely linked with the geological events and the changes in environment. These are, therefore, also discussed.