6. Wetland Exploitation and Upland Relations of Prehistoric Communities in the Netherlands

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Introduction

In spite of occasional discoveries of isolated prehistoric objects, and even hoards of bronzes such as as that of Voorhout in 1904, the wetlands of the Western Netherlands were, in pre-War times, considered as unsuited for occupation by 'primitive' prehistoric communities, and the finds conceived as having been left by uplanders during occasional wanderings into the marshes. It was not until the end of the 1920s that discoveries were made that pointed to true settlement in the wetlands: Neolithic settlements in Holland (eg Lisse in 1927; Zandwerven in 1928) and the establishment of the early origins of the *terpen* by means of Van Giffen's Ezinge excavations (Van Giffen 1936). From then on discoveries rapidly increased in number and diversity: Bronze Age barrows in Westfrisia (1944) and the first true wetland settlement at Hekelingen (1949) are important in this respect. Post-war times demonstrate a positive feed-back between systematic and detailed soil and geological mapping, the development of organised amateur archaeology and the growth of professional archaeological capacity. Many hundreds of settlement sites now reflect that the coastal wetlands were intensively used, exploited, and settled throughout prehistory (Table 6.1; Fig. 6.4).

Research into wetland archaeological sites, with their organic preservation, sealed intra-site spatial patterning and frequent micro-stratigraphy (to name the most prominent qualities; Fig. 6.2), has become one of the characteristic features of Dutch archaeology. 'Archaeology in the Netherlands usefully can be called delta archaeology' stated Waterbolk (1981) in a review article, but that must be considered as a slight exaggeration in view of all the upland archaeology going on.

So we are confronted now with a long sequence and wide geographical variety of prehistoric communities in and around the delta and northern marshes, of which subsistence, settlement pattern and way of life was intimately related to the various delta ecozones and their prominent qualities. Their existence is generally described as 'adapted' to their environment, with the *a priori* idea of adaptation to an unpleasant — or, at any rate, less pleasant and 'more difficult' — environment, which then automatically raises the need for an explanation as to why one settled in such wet conditions. This is the idea of people being driven into marginal areas (by 'population pressure') and the vision of specific delta-bound backward communities. A consequence and major drawback for archaeology of this typical 'upland' approach is that the detailed wetland observations and knowledge gained on subsistence and way of life in the various wetland zones had to be considered *a priori* as being non-representative in a wider respect.

The main purpose of this paper is a plea for an opposite approach: to conceive wetland settlement as a deliberate choice by prehistoric communities for the exploitation and exploitation strategy of these ecozones; not to consider the wetlands as being unsafe, but as offering attractive ecological conditions and a high natural productivity or agricultural potential. Instead of concentrating on synchronic diversity in exploitation of various ecozones and interpreting that as adaptive behaviour, it is preferred to look to the long-term diachronic changes in the use of the wetlands in their totality, and to view the restricted or wider inter-ecozonal differentiation more as the reflection of social constraints or restrictions on the way of life, of subsistence strategy especially. In this way a 'wetland attitude' of prehistoric communities can be established: their perception of their environment (*cf.* Brandt 1988; Brandt and Van der Leeuw 1987). We will observe communities with a wide range of tolerated behaviour and an open eye for natural qualities and communities with very narrow behavioural margins and, consequently, a very restricted attention and appreciation for the rich natural wetland bio-resources.

Our approach will be a thematical one in the first place with particular attention paid towards long-term changes within each topic and also towards research problems and pitfalls in interpretation. We will end with a characterisation of subsistence strategy and settlement system for the six phases distinguished in this study, based on wetland evidence but considered to be valid in a wider context.

Natural conditions

Wetlands

The original prehistoric natural delta conditions were very different from the present day landscape, which is in full agricultural use or built over, reclaimed, embanked and drained. The

Figure 6.1 Map of the Netherland with locations and regions referred to in the text. Coastal dunes and Pleistocene upland shaded

original landscapes can, however, be reconstructed by combining Quaternary geology, palaeobotany and relics in nature reserves as a frame of reference. This holds good for the physical-sedimentary aspect, slightly less so for vegetation reconstruction and considerably less for the faunal part of the palaeo-ecosystems.

The *Rhine/Meuse* delta measures about 200km along the coast and 100km from the coast inland, which is about six times the extent of the Wash Fenland (compare Figs 6.3 and 5.1). This huge wetland — or rather, complex of wetlands — was a dynamic depositional environment, subject to continuous change as the result of the gradual rise

	upland	wetland margin	wetland
organic	decayed	bad preservation	good preservation
erosion	surface erosion	restricted erosion	locally lateral erosion
intra-site patterns	blurred by cultivation, bioturbation, *etc*	sealed by covering sediments	
inter-site patterns	visibility to land use	visibility related to cover thickness and commercial digging	
recovery	fieldwalking of arable	borings, prospection of trenches, ditches and digging works	

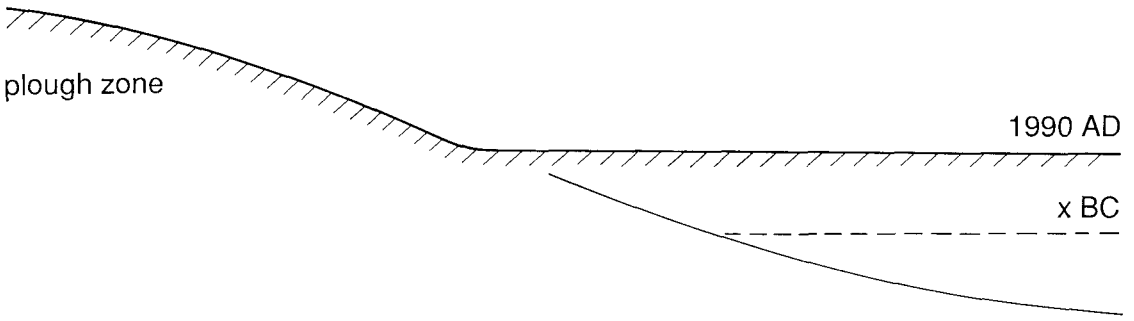


Figure 6.2 Diagram showing differences in the archaeological record between wetland and upland

of sea-level and, especially, of the diminishing rate of it (Van de Plassche 1982). However, through the millennia the ever-changing palaeo-geography can broadly be characterised by two ordering lines. First, an east-west zonation, that finds its origin in the gradual diminishing influence of the sea when moving inland. Factually the lay-out of the delta reflects a subtle equilibrium between the fluviatile and marine forces. Where rivers are powerful the zonation is, going inland:

— coastal barrier, dunes
— river estuaries
— fresh water tidal zone, creek systems
— peat zone, rivers, outcropping dunes (*donken*)
— river sedimentation area
— upland

Superimposed on this zonation is a north-south division in separate sedimentation basins.

Deposition in this basic pattern was governed by the gradual (and gradually diminishing) relative rise in sea-level and — superimposed on its very smooth curve — by cycles of pronounced or restricted marine influences in the delta plain, the so-called transgression-regression cycles (see also Lane and Hayes, Chapter 5). So, if regions within the extensive wetlands were silted up in the end of the transgression phase, they could turn into dry land when the tidal water retreated. They subsequently turned into swampy marshland because of sea-level rise and could, at last, be eroded and replaced by fresh sediments in one of the next transgressive phases. In other words: we should not speak of one wetland but, instead, of a whole complex of ecological zones that offered very divergent conditions for exploitation and occupation in ever-changing patterns and varying extents (Jelgersma *et al.* 1979; Zagwijn 1986; Louwe Kooijmans 1974; 1985).

The major question is not what the delta wetlands as a whole could offer to prehistoric communities, but why *specific ecozones* were attractive at certain times for specific communities. When we want to comprehend the differences in this respect between the Dutch delta, the northern Netherlands and northern Germany and the English Fenland, we should realize how different the natural settings were.

The coastal Holocene of the *northern Netherlands* and *north Germany* are of a different and a more simple and regular lay-out, because no large inflowing rivers, only some brooks, interfere with the marine elements. This means that no wide estuaries and complex fresh-water tidal creek systems developed, nor peat bogs of a similar extent to those that filled the delta plain in the later part of prehistory. Instead, wide zones of tidal flats and saltmarshes dominate the northern palaeo-geography. Incidentally, salt influences reached

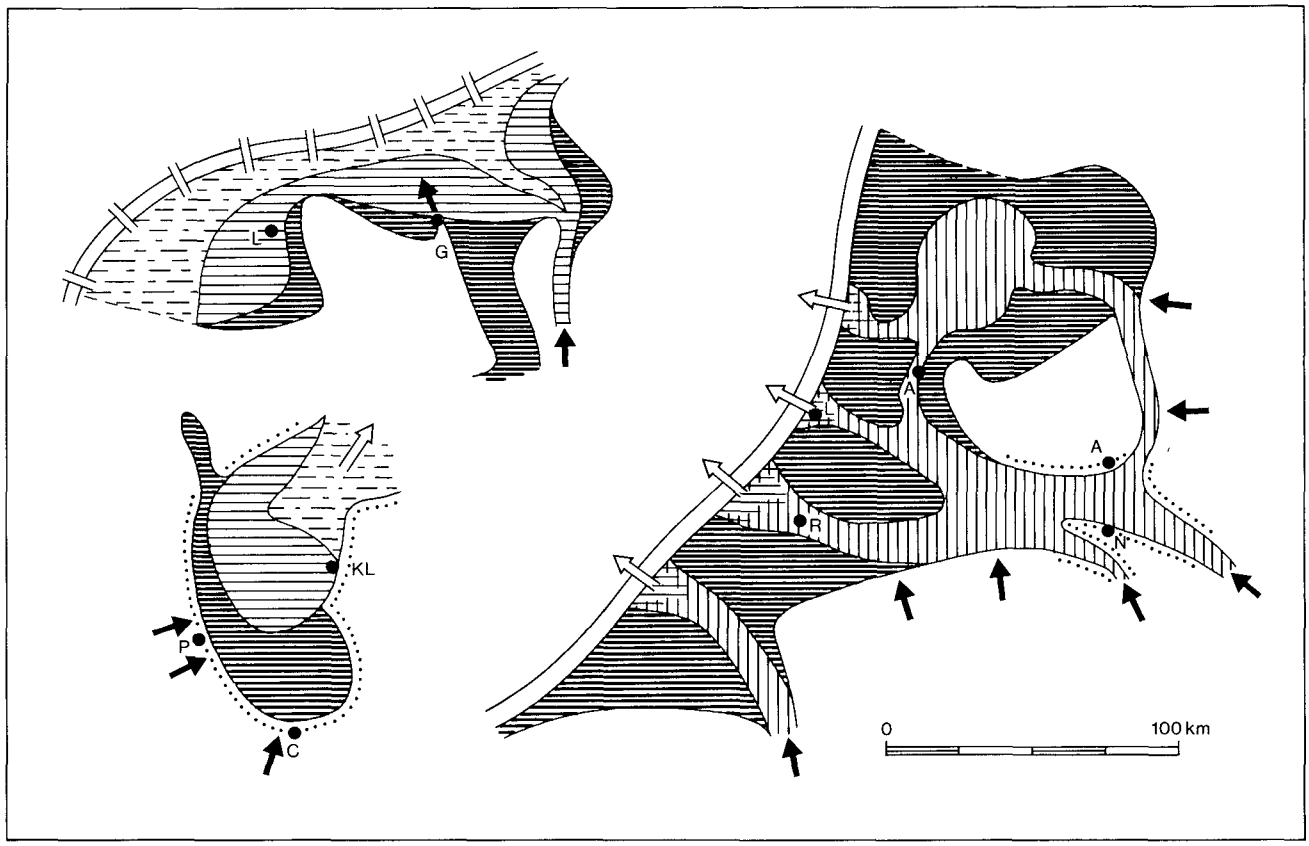


Figure 6.3 Very schematic representation of the Wash Fenlands, coastal marshes of Friesland/ Groningen, and the Rhine/Meuse delta to demonstrate differences in extent and layout

further inland than the tides, leading to brackish lagoons between saltmarsh and the peat beyond. The zonation in this region is as follows:

— coastal barrier islands with dunes
— tidal flats
— saltmarshes
— lagoons
— peat zone
— upland

The Friesland-Groningen zonation is not dissimilar to that of the *Wash Fenland*, but there coastal barriers are missing, even barrier islands, because of the relatively narrow access to the basin and the resulting strong tidal currents in a single large inlet. The major difference of the Wash Fenland with respect to the northern Dutch and German coastal Holocene results from the form of the deposition area: a closed basin in the Fenland as opposed to a more or less open coast at the continent. This means very wide zones in the Fenland, very long horizontal lower courses of the small rivers like the Ouse and Welland with connected drainage problems and very long connection lines from the upland, through the peat, to the silt-deposits around the Wash (Louwe Kooijmans 1988).

Uplands

'Uplands' are to be considered the permanently dry land around the wetland, irrespective of genesis, that could support settlements without the danger of flooding. In the Dutch case this is almost everywhere the very gently sloping — factually almost flat — cover sand landscape. Travelling nowadays through the Netherlands you will hardly discern the borderline between the Pleistocene and Holocene in relief, but perhaps

only in land-use. Nowhere do we find a marked hill slope bordering the wetland, the only exception being the river-eroded ice-pushed ridges along the river clay district. Under natural conditions, however, the boundaries will have been marked by a change in vegetation, but these too will have been gradual and covering wide zones, restricting easy access to the delta wetlands.

The extensive and broad belt of coastal barriers covered by the low Old Dunes (the present day Younger Dunes are of historic age) must be considered as a second upland zone. Although this landscape is part of the Holocene delta formation it does not fit into the wetland definition.

The third upland category are two types of outcrops: some relatively extensive boulder-clay elevations, in Gaasterland and in the cores of the (former) islands of Texel, Wieringen and Urk, and some hundred outcropping tips of Late Glacial river dunes (*donken*). These are situated in the zone of the now deeply buried Late Glacial valley of the Rhine-Meuse east of Rotterdam where they escaped from erosion in the peat growth zone. Most of these donken are too small for crop cultivation of any importance but they are perfect dry bases for the exploitation of the wet surroundings.

There is a marked contrast to the upland and Fen margin conditions in England, where conspicuous slopes and hilly countryside dominate. In both Germany and Fenland are the 'islands' and peninsulae in the peat zone large and conspicuous features, while dune tips like the donken of the Dutch river district are missing.

In summary, the Rhine-Meuse delta on the one hand and the Fenland on the other are different in many respects: dimension, general lay-out, zonation and qualities of the surrounding upland. Distance, especially distance between wetland margin and exploitation zone, will also have been a factor that helps to explain colonisation of some zones in the Rhine/Meuse delta and the rarity of wetland settlements before Roman times in the Fenland. From a geographical and ecological point of view other types of exploitation systems and other types of upland–wetland relations might have been developed in these different settings by societies of comparable organisation. The fen district has more in common with the coastal zone of the northern Netherlands and north Germany.

Palaeo-ecology

Systematic geological and soil surveys not only revealed the main lay-out of the Dutch delta, but many detailed maps also give us the finer patterning of regions within each zone.

Vegetation reconstruction is possible in very much detail in most regions (*cf.*, for example, Van der Woude 1983; 1984; 1985) on the basis of these detailed maps, pollen- and macro-remains studies and using (semi-) natural vegetation and its zonation in nature reserves as a reference. Not always, however, are such references available. The fresh-water tidal creek system, prominent in prehistory, has no good counterparts and so the vegetation of their levees (deciduous forest with oak or not?) can only be postulated on the combined basis of pollen, macro-remains and wood samples (Bakels 1986; 1988). Another case are the landward parts of saltmarshes and desalinated fossil saltmarshes, transformed into natural fresh-water pasture lands. The modern counterparts are all embanked and cultivated and the same holds for the levee and backswamp landscape of the river clay area.

Considerably more problematical is any assessment of the wetland fauna, especially for the part that interests us most: the mammalian macro-fauna. Our basic information consists of bone samples from archaeological contexts, the composition of which is biased by all types of human selection and archaeological formation processes. It is interesting to note that, while we are using modern relics as analogies for palaeo-ecological reconstructions, our palaeo-ecology is reversely used as an 'ecological reference' in the modern planning of large scale nature management known as 'nature development' (Bruin *et al.* 1987; Ministry of Agriculture 1988). It is increasingly being realised that the modern reference is different from prehistory by the absence — in many nature reserves — of large grazing animals, be they game or more-or-less free-wandering domesticates. Most important is the present-day absence of man in nature, first as the main predator, later as maker of clearances and herdsman. In the delta too, man may, by his activities, have influenced or even controlled the 'natural' conditions.

So, carrying capacity calculations are rather tricky in the absence of modern reference data: do we have anywhere in the temperate zone a natural wetland (or better, a comparable complex of ecozones) of sufficient extent, together with a full mega-fauna? We have to rely here on 'educated guesses' with large margins of error, when we want to judge the (relative) richness (*ie.* the biomass production) of wetland and upland and the possibility of seasonal wetland-upland migration of certain species, such as red deer (Louwe Kooijmans 1983a; 1985). So we wonder, for instance, about the wide variety of game hunted in Neolithic times in the wettest parts of the delta, including species like red deer, that, in our modern view, is a typical dry land animal. Aurochs (now extinct), brown bear, elk (disappeared from north-western Europe), beaver (recently reintroduced), pine marten (rare) and otter (very few left) offer us, together with wild boar and roe deer, a rich and varied animal world; but how rich? From the Bronze Age onward wild mammals almost disappear in the archaeological record. What does this mean: lack of game, replacement of game by domestic grazers, a tremendous increase in population, a lack of interest in game for food, or perhaps even ideological restrictions on its use?

These are questions that are rarely asked and not easy to answer. Population certainly increased, space for arable land and cattle grazing will have

diminished space for game, and the attention of later prehistoric farmers seems to be have been directed towards their farmsteads and not to surrounding nature. We can hardly imagine that game such as wild boar and roe deer had disappeared because of over-hunting and competition by farmers at such an early date and in view of historical sources on all types of hunting in the coastal district.

The avifauna might be predicted on the basis of the palaeo-geography and palaeo-ecology with bird sanctuaries as a reference and with the support of bird remains from archaeological sites (Clason and Prummel 1979; Clason *et al.* 1979). Specialities of the delta will have been, like today but in a much larger extent, the breeding of water fowl (various ducks, grey-lag goose, mute swan, cormorant, Dalmatian pelican) and of various types of large stilt birds (various herons, spoonbill, crane) and the wintering of many arctic breeders along the coast as well as on inland waters. The present-day bird sanctuary avifauna should be extended with, typically humans avoiding species such as crane, white-tailed eagle and osprey. The Neolithic finds of bones of the Dalmatian pelican (Vlaardingen, Clason 1967) demonstrate that the breeding geography of at least some birds in prehistory was very different from nowadays.

The waters must have been very rich resources: rivers, lakes, peat drainage creeks, tidal creek systems, none of these polluted as nowadays. From documentation on specialised fisheries in the main rivers during the past centuries it can be predicted that these must have been rich resources for two large anadromous fishes: sturgeon and salmon. Both migrated to their summer spawning grounds, the salmon upstream, the sturgeon into the creeks and basins of the delta itself. The present-day fish population of the stagnant or gently flowing fresh inland waters must be considered as a good reference for prehistory, when modern introductions on behalf of sport fishing are subtracted. The archaeological remains match this reference very well, with as a major surprise, the abundance of catfish in prehistory (Brinkhuizen 1979a; b). So various species of perch, roach and tench must have been abundant and especially eel, which is the single inland fish still fished on a commercial basis. The rich fish resources of the salt tidal waters with their flat fish (flounder, plaice, sole, haddock) and many others must have been within reach in geographical respect as were the shellfish of the inter-tidal zone of the tidal flats.

In addition to fish, various sea mammals, like porpoise and bottle-nosed dolphin, will have swum into the estuaries and up river. Others (seal and grey seal) will have used the beach and sand shoals as resting places, while large whales will have been beached on the shallow shore. In view of the pollution of the sea and the severe disturbance of marine life by fishing and whaling, one should be careful in the extrapolation of the modern situation, but our assumptions are supported by bone refuse from several archaeological (esp. Neolithic) sites.

Prehistoric communities

Culture patterns

In view of the rich natural resources of the extensive coastal wetlands and in contrast to common thinking, we can be pretty sure that the prehistoric delta inhabitants were not 'driven into marginal areas' but, in contrast, were attracted to one or more ecozones of these regions. They were not 'forced to adapt themselves to the harsh conditions', but, in contrast, carefully selected their settlement locations to take profit of conditions that were considered especially favourable for their preferred way of living. People were pulled to the wetlands by the special attractions of these and pushed by unfavourable aspects of the upland, such as soil deterioration and wind blown sands. Wetland margin locations will have been optimal to profit from the qualities of both major landscapes.

Any presumed isolation or separation of wetland communities is refuted by the culture-specific traits of the archaeological material of all phases. Pottery typology does not allow us to isolate wetland-bound groups. Even the supposed material originality that gave rise to the definition of the 'Vlaardingen Culture' appears now to be preservation-governed. As far as material culture is concerned 'Vlaardingen' is one element of a wide culture complex between Trichterbecher (TRB) and Seine-Oise-Marne (SOM) (Louwe Kooijmans 1983b).

Wetland communities participated in medium- and long-distance exchange networks to the same extent as did upland communities. This is reflected by high quality stone from far inland, like Rijckholt flint found in Hazendonk 2/3 (Louwe Kooijmans 1981) or tephrite querns in Iron Age settlements (Van Heeringen 1985). In these cases participation of wetlanders in the long-distance exchange networks does not seem to have been any problem. In the Bronze Age, bronzes of Dutch typology are found as well as bronzes with origins in regions as far apart as Wales (at Voorhout), southern Germany (Veenenburg) and Scandinavia (Noordwijkerhout) (Van Heeringen 1986a).

We can conclude that the prehistoric Dutch delta communities were fully integrated in cultural terms with those on the upland, in all phases of occupation.

Technological capabilities

The technological capabilities of the prehistoric communities and their ability to take full profit of the delta resources is demonstrated by organic artefacts, preserved in the favourable delta conditions. Sites like Bergschenhoek, Hazendonk, Vlaardingen and Hekelingen demonstrate a workmanship of flint-dependant communities, 6000–5000 years ago, in certain respects comparable to that of the 'old crafts'. Tools and other equipment were executed in an optimal

design and made out of the most appropriate wood species: yew and elm for bows, ash for paddles and axe or hammer shafts, oak for dug-outs, red dog wood for fish traps (Louwe Kooijmans 1985; 1987).

Iron Age woodwork includes wooden spades (Van Heeringen 1983, 107; Van Trierum *et al.* 1988), a yoke and tripartite wheels (Van der Waals 1964; Therkorn *et al.* 1984) and a complete hurdle, not dissimilar to sub-recent ones, discovered a few years ago near Leiden (Van Heeringen 1986b). In spite of our deficient knowledge on many aspects of prehistoric technology, the conclusion seems permissable that the technology of the prehistoric delta communities was not on an essentially lower level then that of the 'old crafts' (*cf.*, for instance, Seymour 1984).

Prehistoric subsistence

Relation between settlement pattern and ecozones (Fig. 6.4)

Land and its resources in simple, decentralised societies, are in the first place used and chosen in consideration of subsistence. Changes in the strategy of food procurement must imply changes in the valuation of the same ecological conditions and so of the attraction of certain ecological zones and preferred site locations. This holds especially for diversified wetland like the Dutch delta. So the changing pattern of presence and absence of settlement sites in the various ecozones will reflect shifts in subsistence strategies, taking into account all deformation of the present-day archaeological record by selective preservation and recovery processes. The delta as a whole, the 'dune upland' included, appears to have been settled continuously from the Early Neolithic. Two ecozones — the fresh-water tidal and peat districts — were, however, deserted in Late Beaker times. The fresh tidal area was not resettled before the Early Iron Age, as documented by several regional surveys: Zeeland (Van Heeringen 1988), Meuse estuary (Bult 1983; Van Trierum 1986), Rhine estuary (Van Heeringen 1988) and the Bergen inlet region (a.o. Brandt and Van der Leeuw 1987). The peat district was reclaimed not earlier than the full Middle Ages.

Two explanations can be brought forward for this shift: one ecological and the other cultural or, thirdly, a combination of both.

The *ecological* explanation sees the increasingly swampy and marshy conditions in both districts making them unattractive for communities for which agriculture was of more than secondary importance. This period is indeed a phase of restricted marine access, of impeded drainage and of wide-spread raised bog formation all over the intra-coastal plain, namely the time between the Calais IVb and Duinkerke I transgressive phases, embracing the modest Duinkerke O transgression. The wide-spread drainage of the raised bogs in

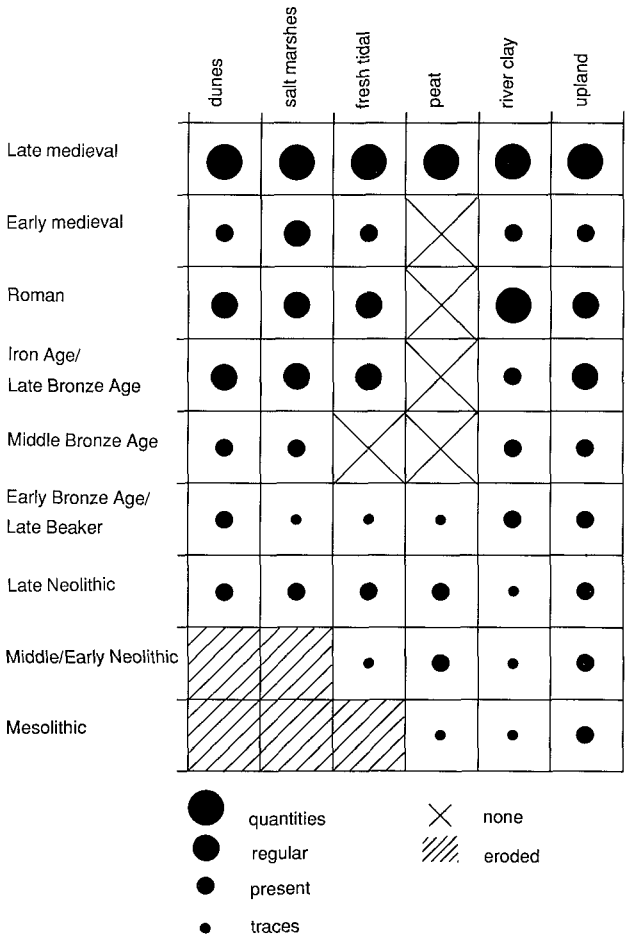


Figure 6.4 Impressionistic representation of the distribution of pre-and protohistoric sites according to chronophase and ecozone in the Rhine/Meuse delta. Note that Molenaarsgraaf, Ottoland, and Zijderveld are attributed to 'river clay'; Iron Age sites around the estuaries to 'fresh tidal'

Subatlantic times is generally connected with the widening of inlets and the extension of creek systems of Duinkerke I phase (Zagwijn 1986, 40). One might doubt whether these arguments might explain the total absence of sites in these zones.

The *cultural* explanation says that the shift in settlement pattern indicates that a semi-agrarian way of life was no longer socially acceptable in this period and that this change in attitude very probably started in the Late Beaker phase.

No such preference for a particular ecozone is visible in the Neolithic. The documentation of Early Neolithic sites in the peat and fresh tidal zones only can be easily explained by preservation and recovery chances.

Zoological evidence (Table 6.2; Fig. 6.5)

Of great value is the 'hard' evidence embodied in a large number of scientifically analysed bone assemblages, spread over all prehistoric periods and ecozones, be it self-evidently somewhat

	dunes	salt marshes	fresh tidal	peat	river clay	upland
Late medieval						
Early medieval						
Roman						
Iron Age / Late Bronze Age	176 359 465 135	5466 3827	124 192 84 84 69		1864 86	15 150 130 230
Middle Bronze Age	589	282 1154 1003 3529			150 762	
Early Bronze Age / Late Beaker	103 50	–			282 294	
Late Neolithic	460 430	48 449 128	2182 495 1233	436 610	455	
Middle / Early Neolithic			3181	115 438		
Mesolithic						

Figure 6.5 Volume of 41 bone assemblages (no of bones) according to phase and ecozone as used in this paper. Total number of remains of large mammals only (game + domestic)

unevenly. Detailed comparisons of the figures are, however, not possible, because of many factors that govern the bone ratios from each site. Deposition factors and recovery methods vary widely; a few assemblages are rather small (less than 50 identifications); there are differences in the calculations and statistics which have been applied by the various archaeo-zoologists and through time. There is no consensus as to which animals should be included in the 'bone sum', that is, the 100% reference. Fish, fowl, fur animals, dog bones, *etc*, all can influence statistics to a high degree and so blur the principle aspect: the major sources of animal protein. In some Neolithic assemblages separation of wild boar and domestic pig is essential, but problematical and executed in different ways. In spite of all these restrictions general trends can be traced and linked with the trends in other data sets.

The husbandry:hunting ratio (Figs 6.6, 6.7)

A *fully hunter* strategy is documented only for the small assemblage from the small Early Neolithic extraction camp of Bergschenhoek (Louwe Kooijmans 1987).

Eight spectra, with large game percentages of 50–90% can be considered as *semi-agrarian*. These are all from Early to Late Neolithic sites in the peat and fresh-water tidal zones. The samples all are from sites for which semi-permanent or seasonal occupation has to be considered as, at least, a serious option. Some (those of the Hazendonk sequence) might lack historical integrity and be composed of several subsequent and different activities. But varied hunting was, at any rate, of great importance at this location.

Late Neolithic settlements in the other zones, less favourable for hunting and fishing and more suited for agriculture, are consistently predominantly agrarian with a varying contribution of large game hunting. The saltmarsh assemblages show a remarkable quasi-absence of large game which, however, was compensated for by fowling, fishing and collecting shell fish. It might be that these sites were summer residences and that large game hunting was a winter activity (*cf.* Van der Waals 1987).

The quantity of wild animal bones rarely rises above 5% in all younger settlements. The semi-agricultural way of life — even on a seasonal basis — appears not to have been socially acceptable from Late Beaker times onward.

	dunes	salt marshes	fresh tidal	peat	river clay	upland
Late medieval						
Early medieval						
Roman						
Iron Age / Late Bronze Age	1,3	0,2	5		0,5	0,4
Middle Bronze Age	0	0,5			0,7	-
Early Bronze Age / Late Beaker	3	-			1,6	-
Late Neolithic	14	0,5/7	60	87	7	-
Middle/Early Neolithic			59	75/83		
Mesolithic						

Figure 6.6 Hunting:husbandry ratio according to phase and ecozone, expressed as No of Remains (large game:all large mammals) x 100. Mean value over all assemblages of the chrono/eco unit plotted. For no of assemblages for each unit see Figure 6.5

Figure 6.7 Hunting:husbandry ratios for three Early/Middle Neolithic and eleven Late Neolithic (Vlaardingen Group and Single Grave/Battle Axe Culture) bone assemblages, arranged according to ecozone. Large mammals = 100%. Data = No of Remains

Animal Husbandry (Figs 6.8, 6.9)

Although the number of assemblages in most of the chronological/ecological units and their volume are both modest in most cases, distinct changes in livestock composition from phase to phase are obvious while, within some phases, an additional differentiation might be visible between the various ecozones.

In the *(Late) Neolithic* livestock is variable in its composition, but this variability — as far as the present data allow conclusions — is not bound to

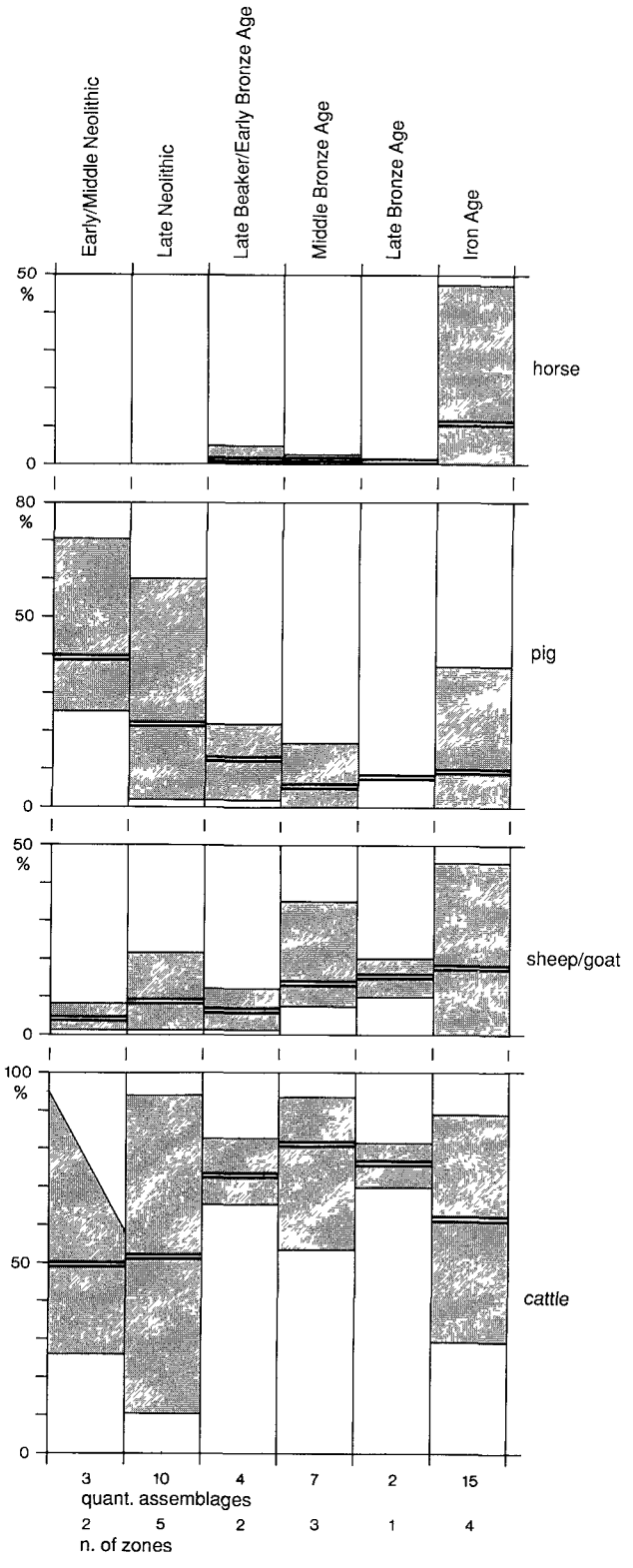


Figure 6.8 Livestock composition as reflected in bone assemblages from prehistoric sites in the Rhine/Meuse delta. Maximum, minimum, and mean values plotted for assemblages from each phase

the agrarian/semi-agrarian division, nor to ecozone. Assemblages from the same ecozone show considerable differences and the overall variability seems to be purely random. Cattle and pig, as measured in numbers of bones have similar scores. A distinct trend is visible of an increase in importance of cattle, a modest decrease of sheep/goat and a very distinct decrease of pig, culminating in the Middle Bronze Age with a fully cattle dominated animal husbandry. After this period of specialisation a new diversity is documented for the Iron Age. The pigs regain some of the lost terrain, the sheep/goat curve continues upward and, most prominent, horses were raised for meat. This *diversification within the agricultural system* seems to start in the Late Bronze Age and will have been one of the factors that opened the possibility of settlement in the fresh-water tidal area.

Hunting

The *semi-agrarian* Neolithic communities practised a very generalised hunting, in the pure Mesolithic 'broad spectrum' tradition. Large ungulates are the main game (75–80% in bones, much more in live weight), with red deer, roe deer, wild boar and beaver in varying proportions. Aurochs, elk and brown bear were rarely shot. The remainder are small predators (otter, marten, polecat, wild cat) in the first place shot for their fur, but the otter, at least, was also eaten (Zeiler 1987). In the estuarine area sea-mammals make up not more than 0–3% of all wild animal bones. Grey seal and porpoise might have been hunted, but one must consider scavenging of beached animals as an option too, especially for the 'great whales'.

The question to what extent the hunted game reflects the natural fauna in quantitative respect and to what extent it demonstrates (also) cultural preferences, is difficult to answer. We might wonder whether elk, bear and aurochs were really that scarce, but the total picture is one of full profit of the mammalian richness.

Zeiler (1987) points out that beaver and otter were hunted very selectively at Swifterbant and in all Hazendonk phases. Hardly any young animals were killed, which means an active hunt and no trapping. Prummel (1987) concludes to the same in respect to red deer, roe deer and wild boar at Hekelingen. The hunting strategy for large mammals during the Neolithic can thus be characterised as *selective cropping*, similar to Late Mesolithic Denmark (Bay Petersen 1978).

There is a marked contrast to the agrarian communities from the same period, the Late Neolithic. Red deer and roe deer were specifically used as an additional source of meat and at the coastal sites some grey seals were shot or scavenged, most probably at the beach, but hardly any attention was paid to beavers and the small game.

In Late Beaker times people started, we might say, to live with their backs to nature or, in more modern terms, an essential change in the perception of the landscape (= environment) had taken place. We can hardly imagine that game of all types had become scarce as early as these times.

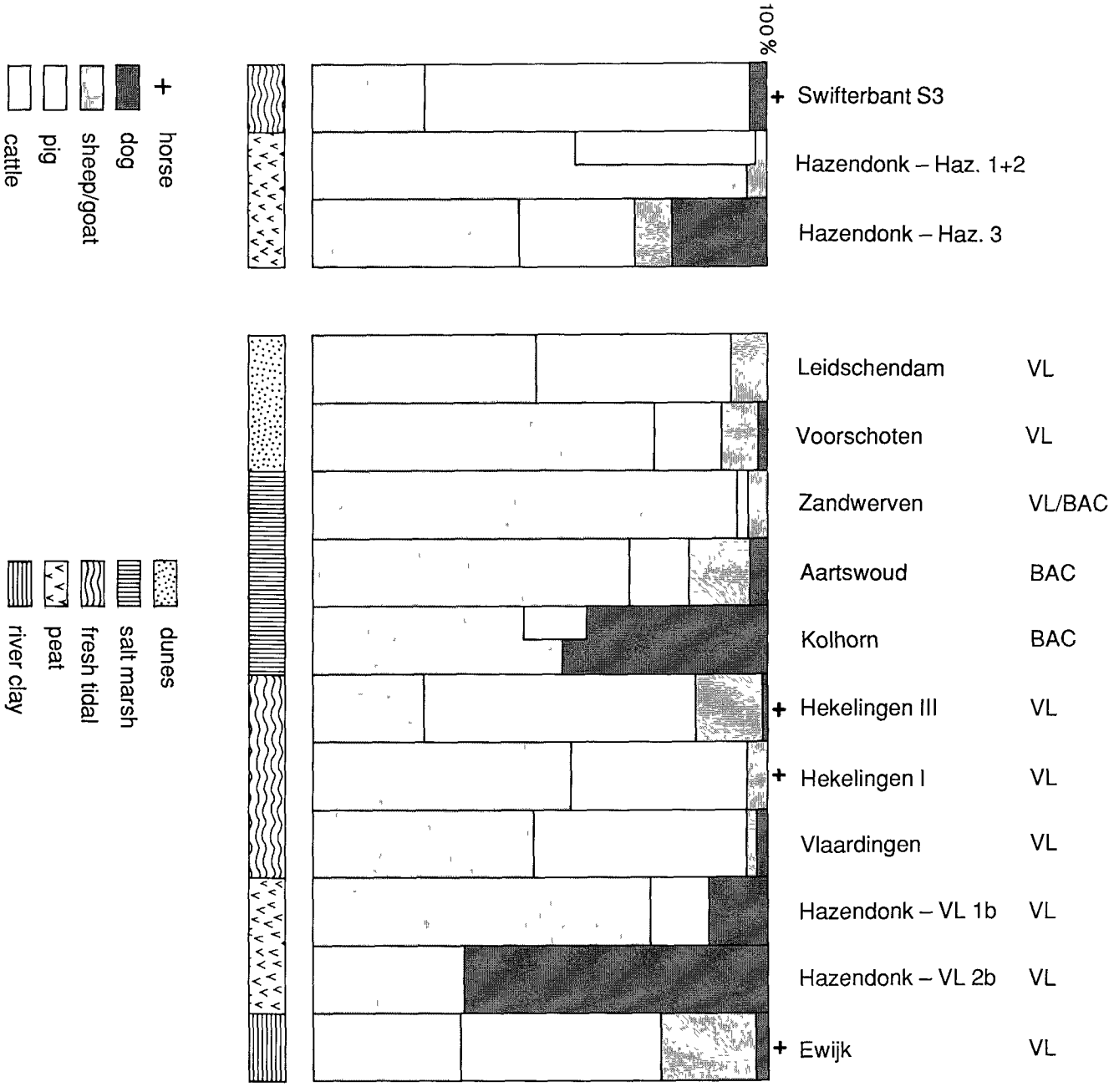


Figure 6.9 Livestock composition as reflected in bone assemblages from three Early/Middle Neolithic and eleven Late Neolithic sites, arranged according to ecozone

These communities concentrated fully on agriculture, which apparently offered a safe livelihood. Hunting must have occurred on a very opportunistic basis, except amongst the Iron Age estuarine communities. No specialisation or concentration on any special game demonstrates any concentrated attention to any of the surrounding richness.

Fowling

Although hunted birds will have been taken to the settlements and consumed there, bird remains are rarely numerous, which might be explained by negligent recovery, by large-scale depositional destruction (trampling, gnawing, burning), or by a restricted fowling itself, as an activity. The proportion of bird bones can be considerably increased by systematic sieving. But even when we take these processes into account we have to realise that, calculated in live weight, birds will always have been a secondary source of animal protein.

A site like Bergschenhoek, interpreted as a winter camp primarily for hunting wintering birds with additional fishing, demonstrates, however, the importance of fowling for the Early Neolithic semi-agrarian communities within their seasonal

broad spectrum exploitation scheme (Louwe Kooijmans 1987). In the semi-agrarian assemblages (Vlaardingen, Hekelingen III) bird bones can amount up to 10% of all wild animal bones. Exceptional is Late Neolithic Kolhorn (completely sieved) where fowling appeared to be a very prominent activity in addition to cattle herding. *Circa* 15% of all bone fragments in a large sample (6500 pieces) are from ducks or geese and in the identified bones the large mammal:waterfowl ratio is as much as 151:945 (Zeiler 1989). This gives the site, like others in the region, a very 'special' character.

Later bird bones become very rare. There is a very marked contrast with the enormous quantity of bones from the Middle Bronze Age settlements at Bovenkarspel in the same district. Only forty-two bones of ten bird species were found and, of these, many relate very probably not to Bronze Age subsistence, but to post-occupational agencies (IJzereef 1981, 115).

In all phases and regions waterfowl dominate by far: ducks, geese, swans, cormorants. The attention paid to wild fowl as a source of food follows the pattern for game animals.

Fishing (Table 6.3)

Similar comments as we made on fowling are valid for fishing, of which diversity and relative importance — in which we are most interested — are even more difficult to establish by archaeo-zoological means. The frequency of fish remains is largely, if not fully, dependant on preservation conditions and recovery processes. So prehistoric sites with fish remains are essentially sites with waterlogged conditions at the time of occupation, at least in the artefact traps. Sites with quantities of small fishes are those where sieving of soil samples or complete culture layers has been practised. A survey of pre- and protohistoric fish remains in the Netherlands, mostly from the delta region, is given by Brinkhuizen (1979a). The presence or absence of species is interesting for environmental interpretation and seasonality but of no use as far as relative importance for consumption is concerned. Non-zoological information, such as site location and remains of fishing gear (Van Iterson Scholten 1977; Brinkhuizen 1983) is of great help here.

A wide diversity of fishing activities has been attested for the Neolithic, documented above all on the sites in the fresh-water tidal and peat districts. The large species like pike, catfish and especially sturgeon, with its numerous large bone plates, will be over-represented in the archaeological reports, while another large and historically important species, like the salmon, is very scarce, probably because of the easy decomposition of its fatty skeletal parts.

The group of small resident fishes — various types of perch, roach and bream — plus the eel are documented at various sites in the intra-coastal area, together with rare occurrences of some salt-water species (thin-lipped grey mullet and flounder) that might visit fresh-water in summer.

Systematic salt-water fishing has been attested only at one pre-Roman site — Kolhorn — in a saltmarsh situation not far from salt tidal water in an intra-coastal embayment (*cf.* Zeiler 1989).

The fishing implements recovered to date, comprise heavy post settings in small creeks, plaited fish traps, coarse net fragments, wooden leisters and bone fish hooks, demonstrating a wide range of fishing techniques.

Fishing in later prehistory did not receive similar attention by archaeologists, which might, together with poorer preservation, be responsible for a lack of knowledge that would easily lead to the conclusion that — similar to hunting and fowling — fishery was of no importance. This, however, seems to be falsified by Middle Bronze Age Hoogkarspel and, more prominent, Bovenkarspel (IJzereef 1981, 117 f). A keen sieving programme and a thorough study by the zoo-archaeologist revealed that the Bronze Age farmers on the (fossil) saltmarshes made use of this aquatic source of protein and especially the *Cyprinidae* (bream and others), with eel and pike second and third (calculated in live weight). We have the impression (it cannot be more!) that fishing was of considerable importance at this site. It might be that fishing, especially trapping and net-fishing, could be integrated better into the farmers daily routine than hunting and fowling. Remarkable non-zoological evidence (grave-goods, site location, wooden posts in a gully) demonstrates the same combination for Late Beaker Molenaarsgraaf. But on Iron Age sites, even when preservation is optimal and excavation executed with great care like at Maasland-Foppenpolder (A.A. Abbink, pers. comm) fish remains are scarce.

Natural botanic food sources

There is a series of more or less detailed palaeo-botanical studies of prehistoric sites in the Dutch delta, ranging from single samples of macro-remains to impressive studies, in which paly-nology, wood identification and sampling programs for charred and uncharred macro-remains are used for an integrated approach to the palaeo-ecology and palaeo-economy. Early Neolithic Swifterbant (Casparie *et al.* 1977; Van Zeist and Palfrenier 1981); Hazendonk (Bakels 1981; Van der Woude 1983); Hekelingen (Bakels 1986; 1988); Bronze Age Westfrisia (Buurman 1979; 1988); the Iron Age–Roman Assendelver Polder Project (Groenman-van Waateringe and Pals 1983; Pals 1987; 1988; Therkorn *et al.* 1984); and the Iron Age Helinium Project (Brinkkemper in press), are the major examples of this category.

We are, however, frustrated when we seek to establish to what extent prehistoric communities relied on natural plant resources. Of the many possible natural food sources, of which the use is very plausible, only a few are documented in the archaeological record as such, that is by charred remains. These are exclusively the pips, kernels

and shells of nuts and fruits: hazel, acorn, apple, hawthorn, waternut, blackberry, and so forth. It is, however, generally assumed that hunter-gatherer communities in the temperate zone could supply 40–60% of their food (as measured in calories) from botanical sources and the plea of David Clarke (1976) on behalf of the botanical component in the subsistence of temperate hunter/gatherers applies especially to this type of rich environment.

Vegetables like *Chenopodium album*, *Artemisia* and several *Polygonum* species will have been important as well as tubers, like those of *Nymphea alba* and *Nuphar luteum*, that must have been abundant in the fresh waters. Any quantification on the part of the relative importance of these food sources or the relative importance of their components must, however, remain speculative.

In view of the rich natural plant resources it should not be assumed without supporting arguments that communities which had adopted (some) animal husbandry automatically also started to practise crop cultivation, the more since it is most plausible that both relate to the separate domains of men and women respectively.

Crops (Table 6.4)

We are relatively well-informed on crops, especially cereals, from charred macro-remains. Two main topics of interest are the establishment of local crop cultivation and the identification of the cultivated species.

The identification of cultivation is critical for functional site interpretation in zones considered marginal in this respect: the fresh tidal and peat zones.

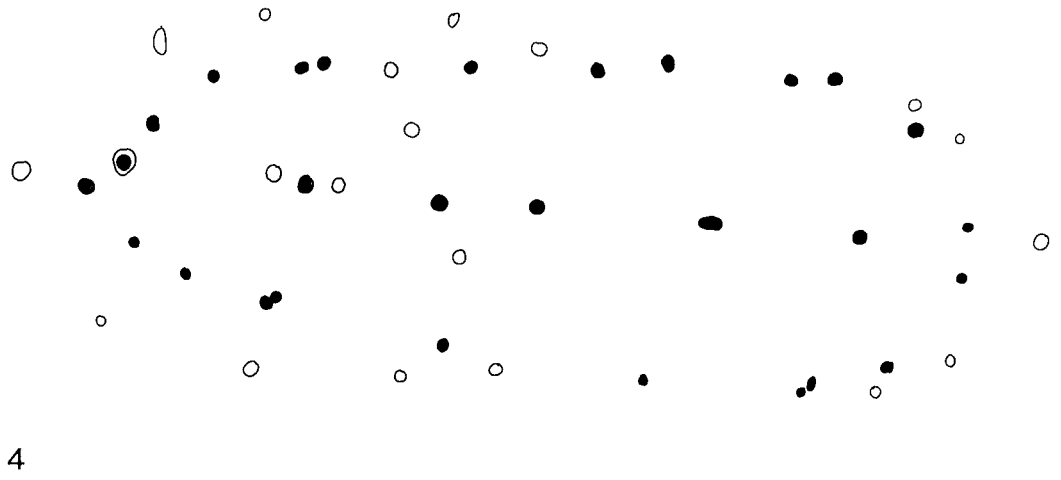
It has gradually been realised that the presence of (charred) cereal grains, even of chaff and internodes and even of cereal pollen in contemporaneous pollen samples are, by themselves, not full proof of local cereal cultivation. These data have to been considered in their environmental, cultural and processual context (Bakels 1986; 1988). Cereal pollen, it has been argued, is no valid argument by itself, since cereals are bad pollen dispersers and the pollen is especially liberated in threshing. Since grain might very well have been exchanged, transported or imported *unthreshed in the hull* neither cereal pollen nor charred grains, chaff and internodes fully correlate to cereal cultivation on the site. When there are severe environmental restrictions, like the narrow and wet condition of the creek levees at Vlaardingen, Hekelingen and Swifterbant, or the very restricted space at Hazendonk, additional arguments are needed. When such arguments fail, one has to assume that the grain was brought to the site, either in seasonal moves or in exchange with communities in other ecozones. Such additional arguments are, for instance, large-scale forest clearances reflected in a pollen diagram and agricultural implements or activities, like microwear proof of sickle gloss and soil marks of ploughing. In this approach crop cultivation at all semi-agrarian sites is unlikely.

In this line of reasoning, cultivation of cereals at all semi-agrarian sites is unlikely, except perhaps at some donken. The shift in occupation at the end of the Neolithic away from the peat and fresh tidal zones can perhaps be related to a growing interest in self-sufficient crop cultivation, resulting in the termination of either exchange of crops or (the other option) of seasonal migration. This 'growing interest' might be either linked with the development of an initial 'true mixed-farming system' or it may have at least provided the necessary basis for it. A true mixed-farming regime is characterised by the linking or inter-dependency of crop cultivation and animal husbandry, of which the arable component was not practicable in the peat and fresh tidal zones, especially not since ploughing of the fields was an integral part of it and fresh tidal clays are unsuited for ploughing with the light ard.

The best archaeological correlate for tillage is plough marks. These marks are documented for all fully agrarian communities from the Late Neolithic onward: the earliest, from Bornwird (Friesland, Late Neolithic, Fokkens 1982), in a covered upland margin location and from Zandwerven (dune ridge, Late Neolithic), but perhaps significantly *not* from Kolhorn, in spite of special attention for these features (Van der Waals 1987; 1988)! They are especially widely documented from the Middle Bronze Age onward. We safely can assume that on all sites with over 90% husbandry, crop cultivation was practised and occupation was permanent. The Iron Age sites in the fresh tidal zone remain, however, problematical. Long straw would be a good argument in absence of plough marks (Pals 1987, id. in Therkorn *et al.* 1984; Brinkkemper in press). Additional arguments can be found in the successful Medieval cropping of cereals in peat reclamations as revealed by tax yields (De Boer 1978; Van der Linde 1955, 68) and 11th–13th century plough marks in the peat at Assendelft (Besteman and Guiran 1987).

An important factor in colonising new environments, especially wet ecozones, will have been the availability of suitable crops and it is especially such a change and a growing diversity of available crops that can be observed around the Bronze Age/Iron Age transition in the Netherlands, in upland as well as wetland locations (Van Zeist 1980). Emmer wheat and naked barley are the dominant cereals from the earliest delta Neolithic up till the Middle Bronze Age. In the Iron Age einkorn wheat disappeared and emmer became unimportant. Naked barley is replaced by the hulled variety. New in Iron Age contexts (upland and wetland taken together) are:

— millet	*Panicum miliaceum*
— spelt	*Triticum spelta*
— oat	*Avena*
— gold-of-pleasure	*Camelina sativa*
— carrot	*Daucus carota*
— rapeseed, turnip	*Brassica campestris*
— Celtic bean	*Vicia faba*



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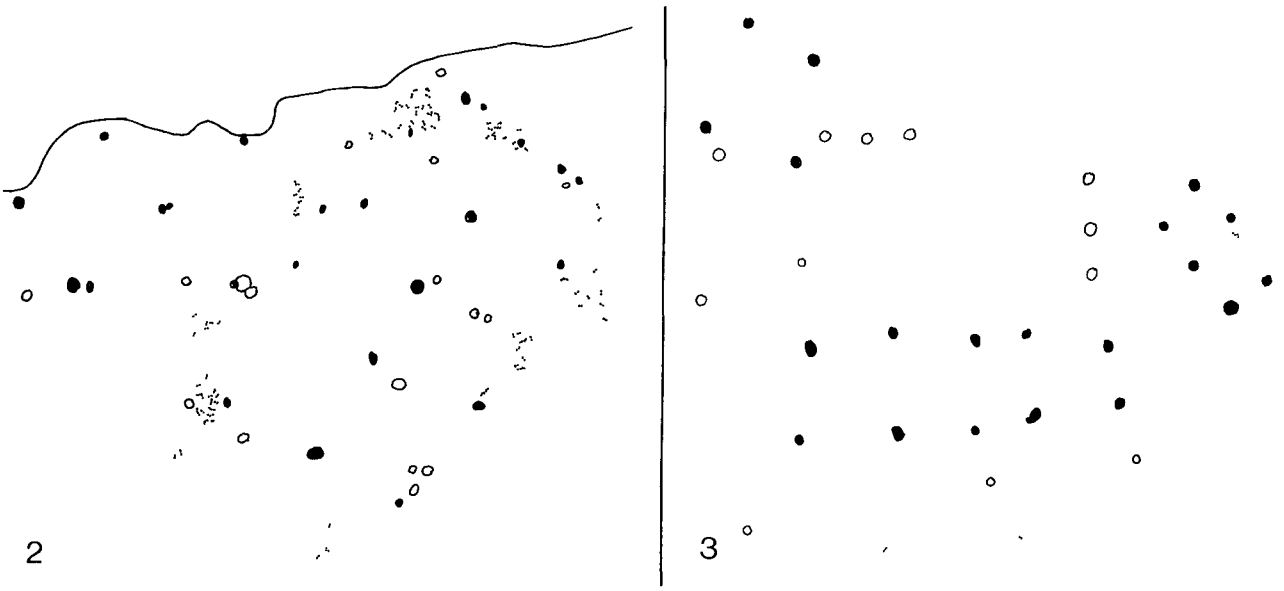

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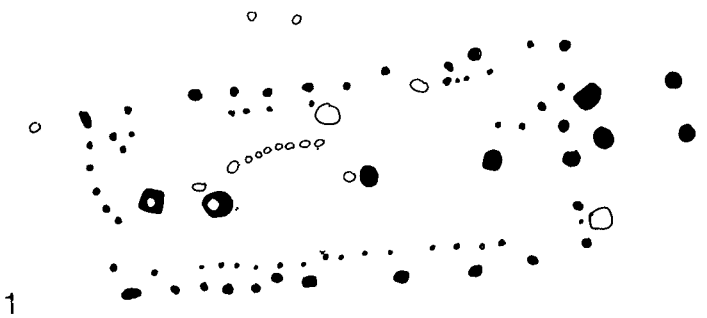

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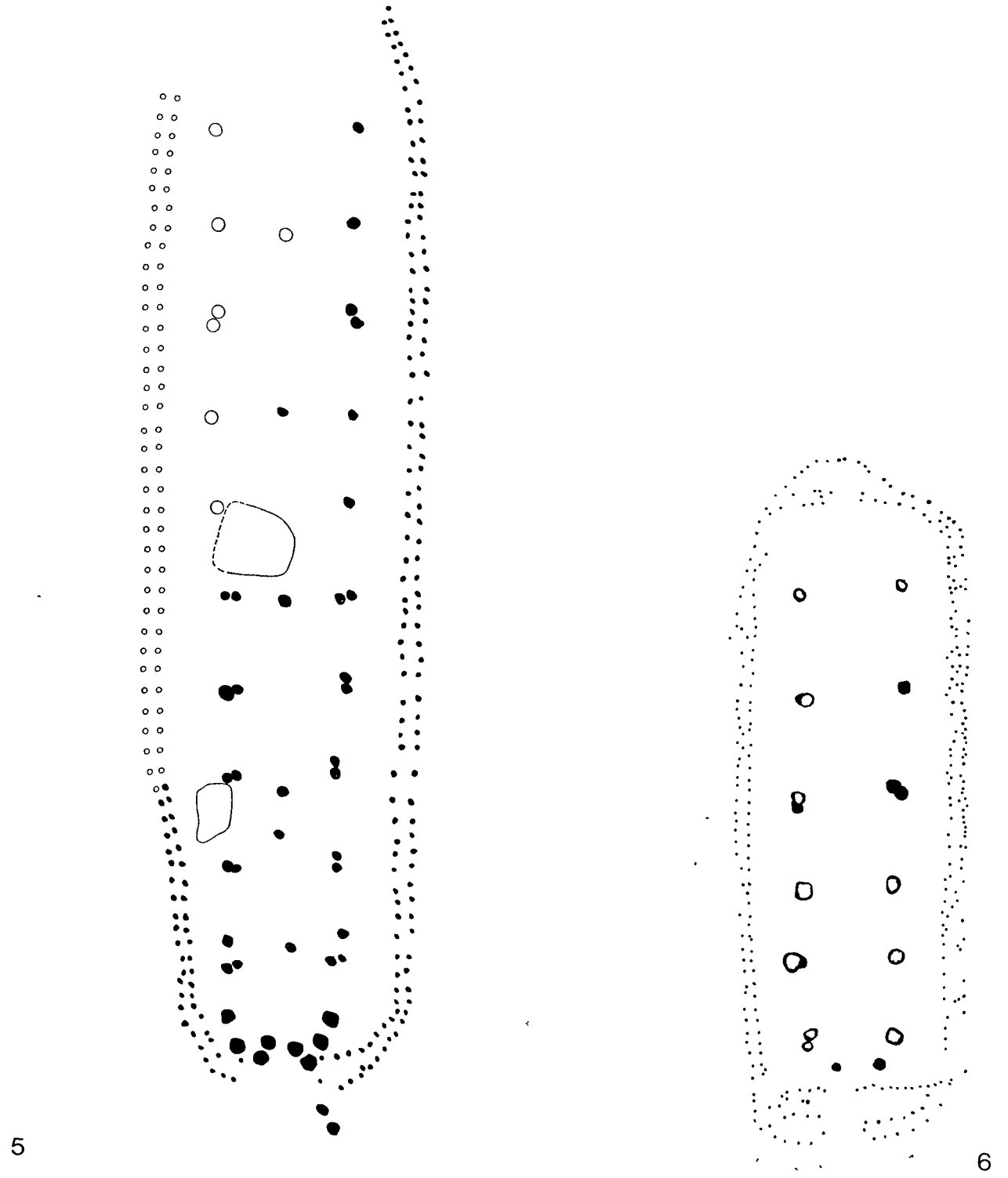
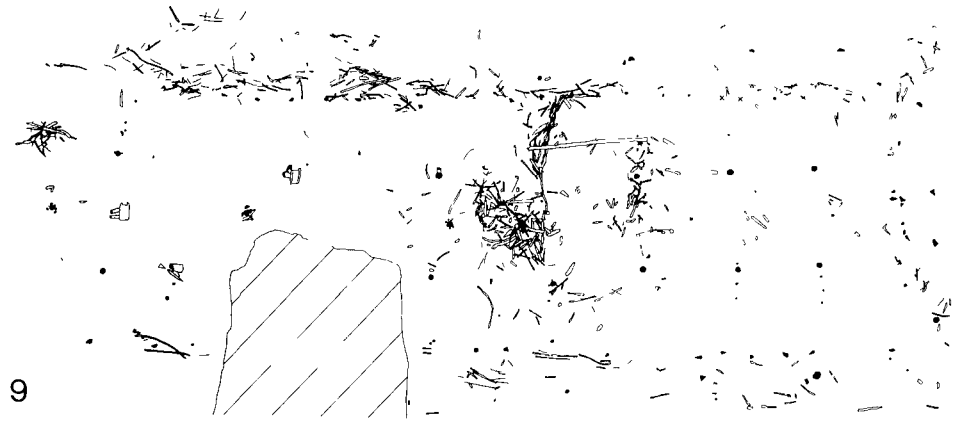
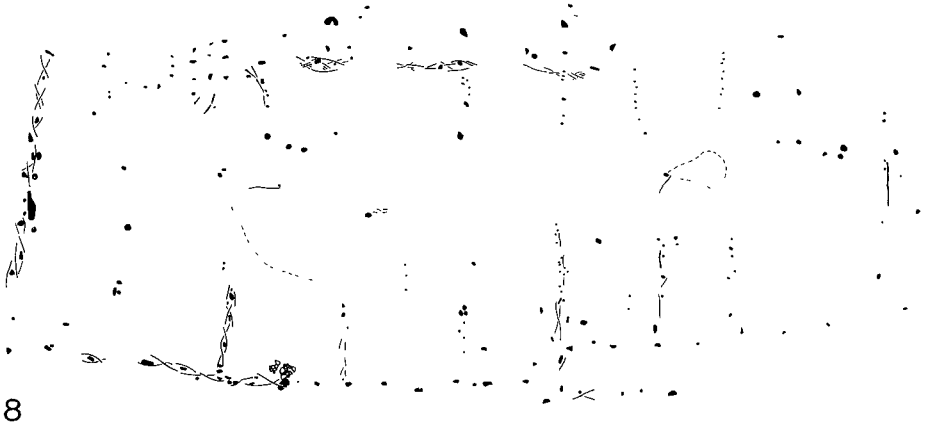


Figure 6.10(b) Middle Bronze Age house plans from the Dutch wetlands. Scale 1:150. 5) Zijderveld, 3-aisled long house, MBA, partly disturbed by modern ditches and there reconstructed (open symbols) (after Hulst 1973); 6) Andijk, MBA. 3-aisled long house with two construction phases, surrounded by drainage ditches. Entrances in both ends. Post ghosts in main post-holes left blank (after Van Regteren

Figure 6.10(a) *Opposite*: Late Beaker house plans from the Dutch wetlands. Scale 1:150. 1) Haamstede, LN Vlaardingen Culture, one of two small rectangular houses with granary? (after Louwe-kooijmans 1985, 50); 2) Ottoland, small 2-aisled house plan. Late Beaker–EBA (after Wassink 1981); 3) Molenaarsgraaf, post-settings in earliest part (Late Beaker–Barbed Wire Beaker) of settlement, probable house relics (after Louwe-Kooijmans 1974, Fig. 68); 4) Molenaarsgraaf, 2-aisled long house? Most probably EBA (after Louwe-Kooijmans 1974, fig. 68)





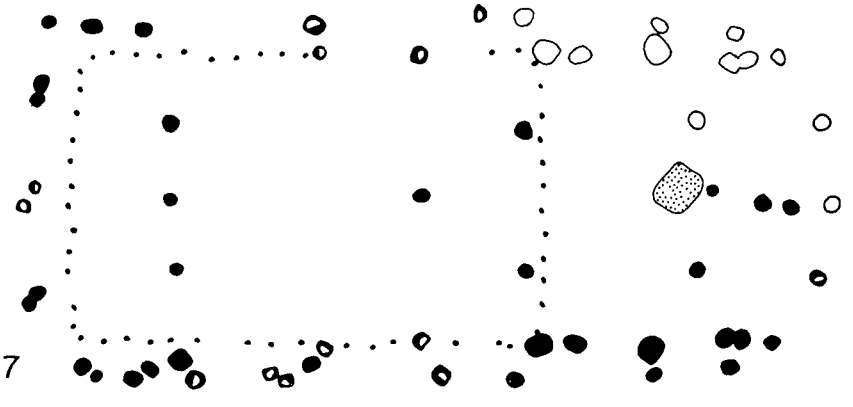


Figure 6.10(c) Iron Age house plans from the Dutch wetlands. Scale 1:150. These show the typical Early Iron Age combination of paired and central main posts. 7) Zijderveld, EIA, partly reconstructed. Soil traces in stream deposits (after Hulst 1973); 8) Vlaardingen, Holierhoek, EIA. Wooden substructure preserved in peat. Byre section with boxes at the left, living section (largely disturbed) at the right (after Louwe Kooijmans 1985, 107); 9) Spijkenisse, site 17–34. EIA. Wooden substructure preserved in peat. Byre with stall boxes at the right, central corridor, living part to the left (after Van Trierum *et al* 1988)

The total spectrum has not been documented at a single site and some crops are restricted to one or two complexes, but all except *Vicia faba* are documented from wetland sites, either in the northern saltmarsh district, or in the fresh tidal areas of Holland. The differences between sites might partly be caused by restricted sampling, but might, on the other hand, reflect true differences in cultivated or imported crops. Vlaardingen-Broekpolder, for instance, produced large quantities of seeds of *Linum usitatissimum* and *Camelina sativa*; Assendelft Q of *Camelina* and *Hordeum*; Spijkenisse site 17–34 of *Triticum dicoccum*; and Geervliet of *Triticum spelta* (Van Zeist 1968; Pals 1987; Brinkkemper in press). This diversity contrasts with the similarity of samples from the preceding phases.

We can conclude to a rather sudden widening of the variety of available crops, the introduction of wetland-tolerant species and the plausibility of the development of exchange relations for other, less tolerant, crops.

We also observe two parallel trends in crop cultivation and animal husbandry: a growing diversity at the expense of one (cattle) or some (wheat/naked barley) food production activities, and a widening of the food spectrum *within* the agricultural sphere. Altogether wetland location became a serious option, under these conditions.

In the author's opinion, one should not think in terms of 'population pressure' in the traditionally settled zones (especially the dunes) and the chasing of some groups to unfavourable zones. Would exchange relations fit to such an option? It seems more in line with the general Iron Age developments to consider the fresh-water tidal zones as attractive for communities with the more variable system, that opened this zone for occupation.

Houses (Table 6.5; Figs 6.10, 6.11)

Prehistoric houseplans can inform us on various basic aspects of former societies. The presence or absence of a byre or stable part is a clue to basic agricultural strategy — from the byre length the number of cattle per household can be established, from variation in byre length can be concluded a differentiation in wealth and, consequently, in prestige. In other cases simple light constructions may provide an additional argument for non-permanency, *etc.*

During the last decades several hundreds of prehistoric houseplans have been documented from the delta and the surrounding upland. Reports are spread over a wide range of publications, but there are synthetic studies for the northern Netherlands (Waterbolk 1980; 1982) and in preparation for the southern part (Van der Sanden 1987, Van der Sanden and Van den Broeke 1987). From most houses, located on well-drained soil, only soil traces remain, but under high ground water conditions the lower ends of the uprights can be preserved and in really wet conditions — such as the Iron Age and Roman sites in the fresh-water tidal zone — complete wooden foundations and the lower parts of wattle-work walls may be preserved.

A general survey shows that the houseplans in the delta in the various phases and ecozones are not essentially different from those on the upland, as far as is known.

From the Late Neolithic a few small rectangular houseplans of varying cogency are published, all from fully agricultural sites. Dimensions range from 4 x 9m (Haamstede) to 5 x 14m (Vlaardingen). At other sites (Early Neolithic Swifterbant, Late Neolithic Kolhorn and Hekelingen) large or small clusters of stake-holes with diameters below 12cm are suggestive of light, non-rectangular, constructions and the house at Vlaardingen was similarly located amidst a 'cloud' of hundreds of small posts. These are all sites where hunting, fowling, fishing and/or shell collecting was of considerable importance.

There is a marked contrast with the Middle Bronze Age. Houses in this phase are exclusively long, three-aisled and with entrances in one or both rounded ends. In some well-preserved examples stable boxes are documented (Waterbolk 1975) and so are assumed to have been present in all other cases as well. Most detailed and superfluous information has been obtained in Westfrisia.

In the course of the occupation, the period 3200–2800 BP, distinct shifts in the agricultural system can be identified there. Farms gradually became smaller, from *c.* 25 to *c.* 15m. There are even early farms of 30m, good for stalling *c.* forty cattle, like those of Hoogkarspel (Brandt 1976; Bakker *et al.* 1968). There are strong arguments for a shift from predominantly meat cattle to more use of milk, providing the same calory yield from less cattle. In terms of crops, there is shift from emmer wheat and hulled barley to exclusively barley (Buurman 1979; 1988; IJzereef 1981, 180). These shifts can be connected directly with environmental changes, namely the gradual rise of ground water table, the concommitant gradual diminishing of the pasture land, and the deterioration of the arable land on the sandy creek fills, that will have become too wet for wheat.

The stalling of livestock indicates a considerable rise in labour investment in agriculture. It requires the provision of winter fodder which, in the pre-scythe age, must have been very laborious. It implies also the provision of stable straw and mucking-out of the stable, at least in spring, and this is hardly imaginable without a cart. The use of dung can be considered as an intensification of the supposed grazing of animals on fallow land and stubble fields in the Neolithic. Houses with byres are, in the author's opinion, a firm correlate for a mixed-farming strategy. The development of this system must be considered the major innovation after the 'secondary products revolution' during the Neolithic. In view of the transport involved, the wheel must be seen as an essential prerequisite, which means its development after the All Over Ornamented (AOO) Beaker phase.

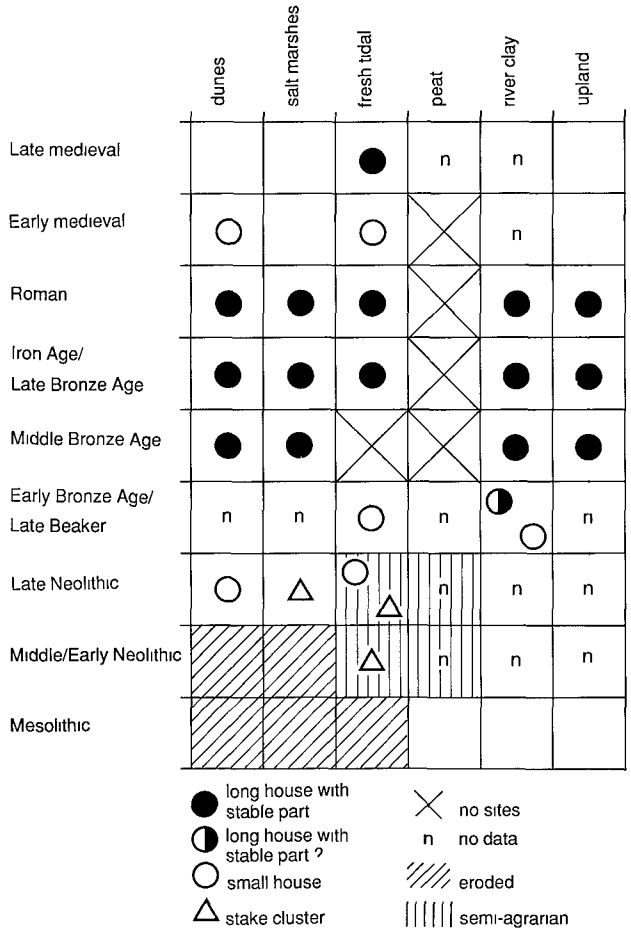


Figure 6.11 House types according to phase and ecozone

The crucial system change indeed must have taken place sometime in the Late Beaker phase, but supporting evidence from the phase itself is scarce and factually restricted to Molenaarsgraaf and the other (partly) excavated sites in the same cluster. Upland evidence is totally lacking for the Netherlands and wide surroundings (Louwe Kooijmans 1974, 196f). Information on houseplans is not very consistent. At Ottoland a small two-aisled house, 5 x 8m (Wassink 1981, fig. 56) and a four-post structure have been documented in a site characterised by a thin spread of Late Bell Beaker and Barbed Wire Beaker pottery and — apart of these small structures — a remarkable lack of post-holes. A small, possibly three-aisled structure and additional post-settings in Molenaarsgraaf (Louwe Kooijmans 1974, fig. 68) deserves more attention than given in the publication. Finds distribution patterns are the only means for more specific dating and the argument for a Late Bell Beaker or (less probable) a Barbed Wire Beaker date. These observations resemble those of the Late Neolithic in general and especially those of Haamstede.

Reconsidering the long-house plans of Molenaarsgraaf, these might be considered as dating from the later, or even latest, phase of occupation, characterised by domination of plain pottery, that is the evolved Early Bronze Age. These plans have raised some dispute because of the rather irregular outline of House I and the unusual curved walls of both, but the soil traces were certainly post-holes, fully comparable to those of houseplans from other periods in similar soil conditions. Together with the argument of some regular, curved and straight post-lines, relatively large post-built structures seem altogether well- attested, be it that these might be slightly later than suggested. This very restricted evidence on housing in Late Beaker/Early Bronze Age times suggests that the Late Neolithic small-house tradition continued and that long-houses, implying cattle stalling, came into use not earlier than the end of this phase.

The Iron Age farms in the delta are similar in all respects to those on the sands. Entrances are now in the long walls and a transverse 'working space' or corridor separates the more or less square living part from a byre of varying length. It is not clear whether this change in lay-out has to be connected with changes or other accents in the farming practices. For what special purpose was the 'working space' meant? One can think of an indoor threshing floor, parking for a waggon or cart, and/or a stricter separation of people and animals. Lengths are 12–25m, mostly in the range 15–20 m, with stall boxes for 16–24 (still rather small) cattle. The shorter length, at any rate by comparison with Westfrisia, implies a strong accent on milking and/or a shift in the crop cultivation:husbandry ratio in favour of crops.

Most surprising is the fact that the Iron Age farms in the newly colonised fresh-water tidal zones, built on naturally drained peat, do not differ from those in other regions: cattle boxes are clearly documented thanks to wood preservation. From these farms, built in an extremely wet environment, 'normal' husbandry was practised. Botanical macro-remains point to open conditions and good grazing in the immediate surroundings (Brinkkemper in press). People must have lived there, for certain, in winter too — which means permanently.

Prehistoric settlement sites (Fig. 6.12)

Zoological and botanical remains are very important sources of information on subsistence activities at a prehistoric settlement site and it has been demonstrated that site structures, especially houses, can be equally informative for the specification of the agrarian strategy. But settlement sites should not be conceived of as separate, independent entities. They are the relics of the use of a location by a group of people over a certain time period and these people were members of wider, regional communities, inter-connected by flows of information, goods and people, either individual or groups. Thus basic

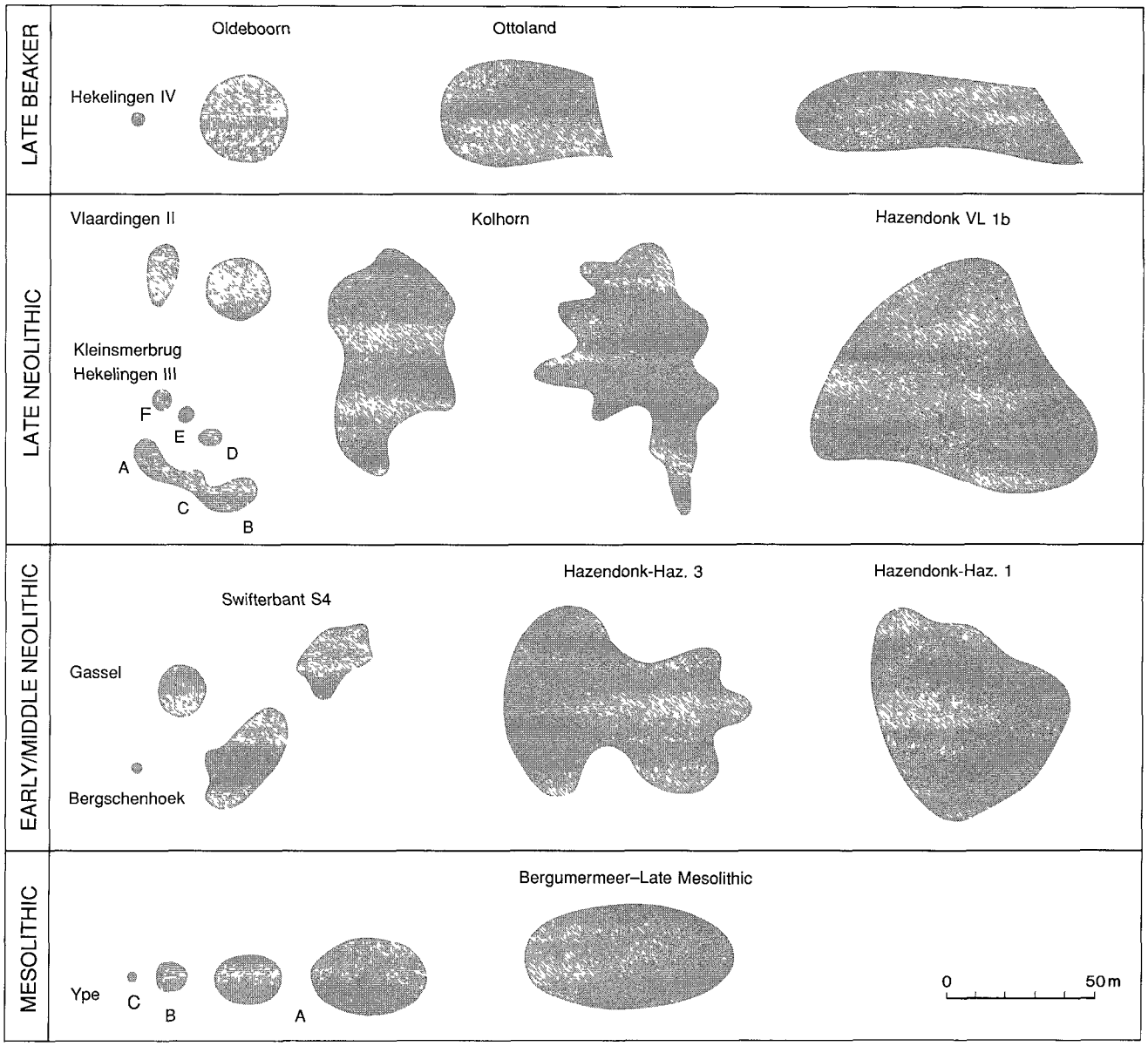


Figure 6.12 Extent of a selection of Early Neolithic–Bell Beaker wetland settlements compared with upland Mesolithic site dimensions (according to Newell 1973). The site Zeewijk has similar dimensions to Kolhorn, both being paired sites. Only Aartswoud, 40–80 m wide and 300 m long, is considerably larger. Compare these with dimensions, for instance, with Linear Bandkeramic Elsloo (c. 10 ha, 300 x 600 m) or MBA Bovenkarspel (at least 4 ha in its early phase, 100 x 400 m). Scale 1:2000

needs and desires, social as well as economical and biological, were met. The organisation of these communities, especially the strategy in which the landscape was exploited, might have differed widely, especially with respect to mobility and degree of self-sufficiency. The various functions of settlements will have been reflected in the archaeological record of the sites and these sites have to be interpreted as members of settlement systems. This, in turn, reflects to a certain degree the organisation of the societies involved and especially their subsistence strategies. Before these systems can be specified, various site-use parameters should be considered, with their possible archaeological correlates. The specifications of these site-use parameters are essential for the specification of the settlement systems, themselves essential for understanding wetland use and wetland-upland relations.

As to *site function*, domestic sites, occupied by complete households and fulfilling all basic domestic tasks, are to be distinguished from special activity sites, used by special task forces for a restricted range of activities and generally on a

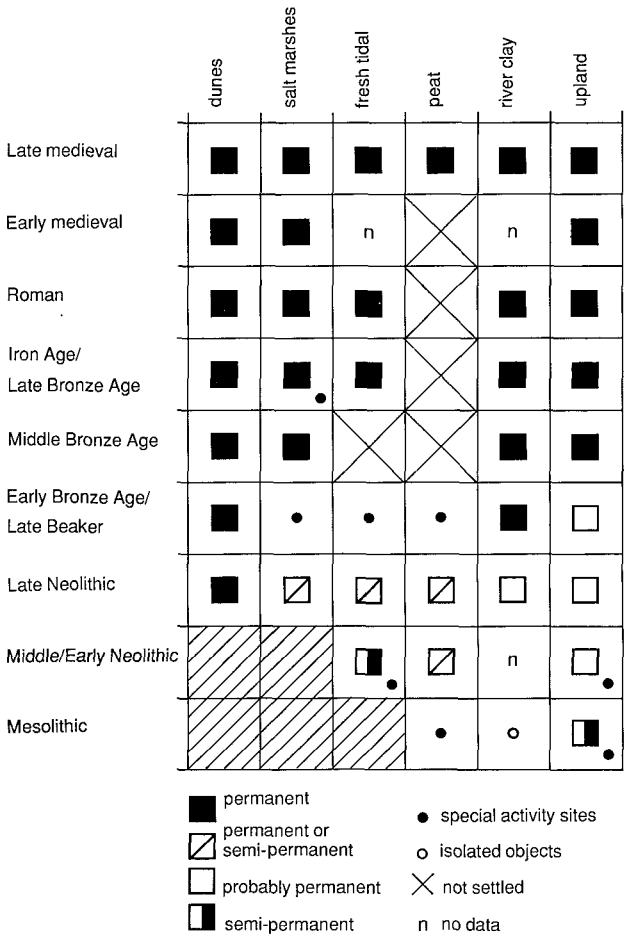


Figure 6.13 Site function according to phase and ecozone

non-permanent basis. The occurrence of small, special activity sites can be considered as a correlate to *logistic mobility* of the communities.

As to *permanency of occupation*, permanent sites, used the whole year round, should be separated from non-permanent settlements, mostly seasonally used. Non-permanency of domestic occupation directly relates to *residential mobility*.

The *duration of occupation* at a certain location, as measured in years and irrespective of the permanency-factor, can be seen as reflecting the *continuity* and especially the *stability* of the community.

Settlement discard essentially does *not* reflect local *production* but, rather, *consumption*. Via inter-site exchange relations or off-site special activities imported food has been added to local production, while export might have reduced it. Exchange relations are seen as compensating local specialisation and as reflecting *inter-dependency*.

Site function, seasonality and mobility are favoured topics in the study of Late Palaeolithic and Mesolithic hunter-gatherer societies. These topics appear to be especially relevant for the earlier, semi-agrarian delta communities that, in many respects, demonstrate firm roots in the preceding Mesolithic.

The criteria of site dimension, flint density and composition, and intra-site pattern are not all directly applicable in the delta because of the widely different preservation and the different socio-cultural context. As compared to the uplands, wetlands have three positive qualities and one severe restriction (Fig. 6.2):

1. preserved organics give detailed information on subsistence and site function
2. intra-site patterns are preserved better by later sediment covers
3. (micro)stratigraphy and ample radiocarbon samples give much better estimation of age and duration
4. on the negative side is our dependence on chance discoveries, restricting regional studies of inter-site patterns.

Models of settlement systems have to be based on a relatively small number of high quality sites, as opposed to the often large numbers of sites of relatively low quality in upland situations.

Duration

For many sites in the delta a continuous or discontinuous use over several or many centuries is documented by stratigraphies of varying detail.

The Hazendonk was used for more than twenty centuries, between 5300 and 3700 BP (4100–2000 cal. BC), but intermittently or with widely varying intensity. Phases of one or two centuries of intensive activity alternated with forest recovery and the (quasi) absence of Neolithic men. Sites like Hekelingen (Late Neolithic), Velserbroek (Bronze Age, Therkorn 1987b), Spanjaardsberg (Iron Age, Modderman 1961–62) were used over several centuries synchronous with aquatic or wind-blown sedimentation that separated levels of discard from sub-phases. In Swifterbant S3 accumulation is estimated at *circa* one century; Hazendonk–3 and Vlaardingen 1b phases at the Hazendonk are estimated at one or two centuries. Even the small Early Neolithic extraction camp of Bergschenhoek demonstrates a repeated use over some ten years. In other settlements, like the Westfrisian Bronze Age sites, long-term continuity is documented by radiocarbon dates and settlement evolution.

It is obvious that stable settlement systems with long-term continuity prevailed. Remarkable exceptions are some single phase farm sites from the Iron Age in the fresh tidal zone (Van Trierum *et al.* 1988).

Permanency (Fig. 6.13)

Permanent occupation should not be considered as self-evident for all 'fully agrarian' sites, especially not for those in the Neolithic period. For the 'semi-agrarian' sites we should be even more critical in view of alternative options, based on a certain degree of residential mobility.

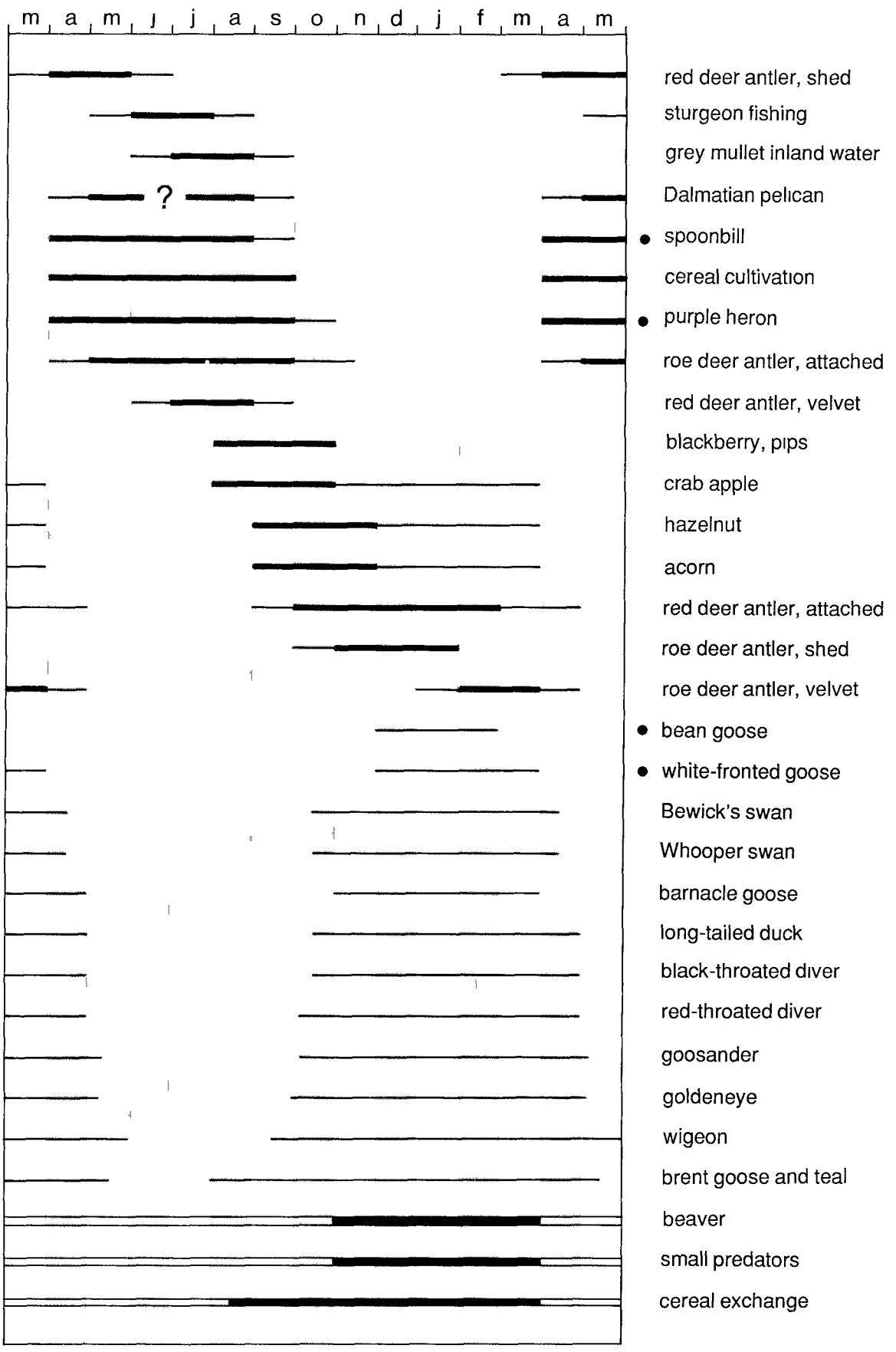


Figure 6.14 Seasonal bio-correlates, based on modern animal behaviour and plant growth, as used (or possibly to be used) in Dutch wetland prehistory. Thick lines = main period of availability. For wintering birds no such distinction has been made; Black dots indicate birds not attested in prehistoric assemblages as yet. For beaver, small predators, and cereal exchange an 'all year' and a 'winter' option are indicated

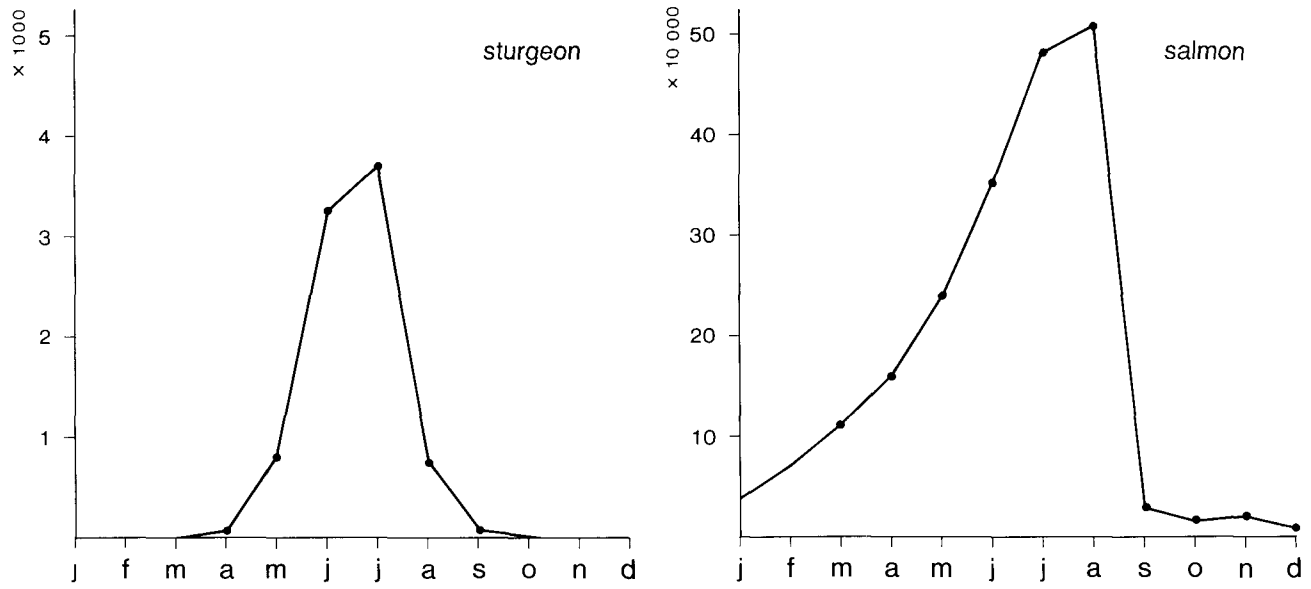


Figure 6.15 Monthly catches of sturgeon in the Biesbosch (1824–1852) and of salmon, as sold at the market of Kralingense Veer (1870–1974), both showing distinct seasonality. Note the symmetrical curve of the sturgeon, caught at the spawning locations and the asymmetrical curve of the migratory salmon (after Boddekke 1971)

Considered as firm archaeological correlates for permanency are:

1. Farms with stable part, which implies winter presence of households at the site. The presence of small rectangular, round or oval huts is considered as no convincing evidence, since such permanent structures can very well have been used on a seasonal basis.
2. Firm evidence for crop cultivation at the site. As such are considered;
   a. plough marks and/or field systems
   b. local pollen evidence for large-scale clearings and field weeds.

According to criteria 1 and 2a all Bronze and Iron Age sites can be considered as permanent, as well as Late Neolithic Bornwird and Zandwerven on the basis of the reported plough marks.

Late Neolithic Voorschoten and Leidschendam (Glasbergen *et al.* 1967) and Bell Beaker Molenaarsgraaf and Ottoland (Louwe Kooijmans 1974) can be added on the basis of pollen evidence (criterium 2b).

Some other agrarian sites do not meet these criteria: Late Neolithic Ewijk, Late Single Grave Culture Aartswoud and Kolhorn and Iron Age Middelstum. For these and for all semi-agrarian sites more complex options should be taken into account and environmental data and site characteristics used as arguments.

Not considered as firm correlates are:

1. Animal husbandry without one of these crop cultivation correlates, in view of nomadic or transhumant husbandry as an alternative strategy.
2. A formal cemetery (as opposed to incidental burials). This should, in the author's opinion be considered correlate more to fixed territories than to permanent settlements.
3. A combination of summer and winter correlates in the biological remains, in view of alternative interpretation: multi-seasonal use or a shift in site function.

Seasonality (Figs 6.14–6.18)

The distinction between permanent occupation and various types of seasonality is essential for the specification of the Neolithic settlement systems in the Dutch delta and their upland relations. So the seasonal aspects of several semi-agrarian Neolithic sites have received much attention: Vlaardingen by Clason (in Van Regteren Altena *et al.* 1962–63; 1967), Swifterbant by Zeiler (1986; 1988) and Van Zeist and Palfrenier (1981), Hekelingen by Prummel (1987) and Van Gijn (1990), Aartswoud by Pals (1983).

As compared to the restricted and rather debatable seasonal arguments for upland sites (*cf.* for instance Mellars 1976, 392–4), the delta wetlands offer a wide range of possible biological seasonal correlates, but still there are great interpretational problems. Most of the biological season correlates, as used in the Dutch wetland sites, can be brought together in a scheme with their modern time range (Figs 6.14, 6.15). The major problems, as can be seen in the figure, are the long duration of these ranges and their overlaps, while some short summer and winter correlates are not attested in the archaeological record. Hunting of beaver and otter, moreover,

A uni-seasonal, domestic
B uni-seasonal, special purpose
C multi-seasonal, domestic
D multi-seasonal, special purpose
E bi-seasonal
F multi-seaonal, domestic, intermittent
G bi-seaonal, intermittent
H multi-seasonal, special activity, intermittent
I permanent, intermittent
J permanent
K seasonal, domestic ——→ permanent
L permanent ——→ seasonal, special activity
M seasonal, domestic ——→ seasonal, special activity

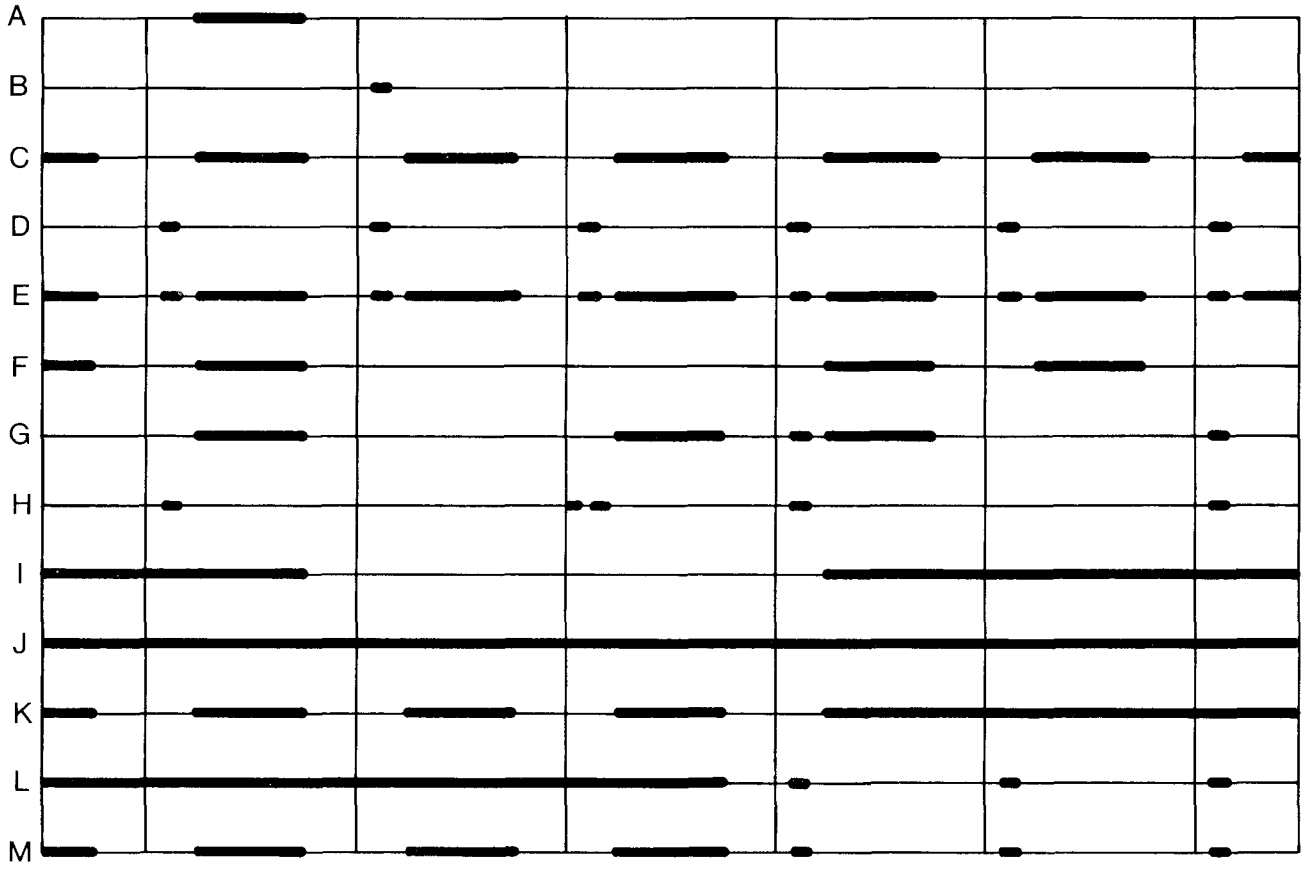


Figure 6.16 Some examples of non-permanent settlement use and of functional changes, to be used as alternative options for a conclusion of permanency, based on compound and possible palimpset assemblages

appeared to have practised, at least at Hazendonk and Swifterbant, all year round (Zeiler 1988).

Another complication in seasonal site interpretation is that the domestic discard at the sites, factually, is a palimpsest of discard of a wide range of separate activities over a long time period. Alternatives to permanent occupation in most cases are multi-seasonal use or a functional shift through time (Fig. 6.16), especially when other site characteristics — such as a very specific site location (Swifterbant, Hekelingen), very specialised hunting activities (Hazendonk, Kolhorn) or small, distinct discard scatters at hut sites (Hekelingen, Vlaardingen) — are more indicative of non- permanent occupation (*cf.* Van Gijn 1990: 128–32 for Hekelingen). The quasi-absence of

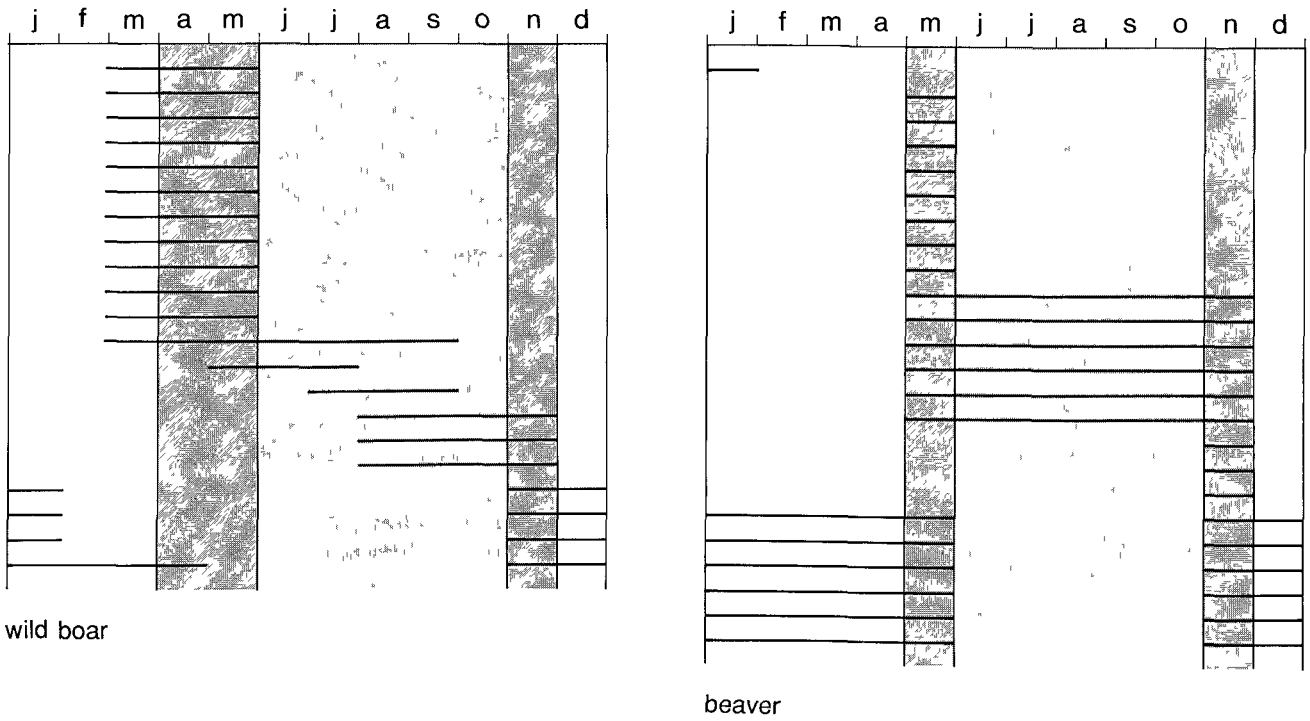


Figure 6.17 Seasonal bio-correlates for Swifterbant (after Zeiller 1988), and three interpretational options: bi-seasonal short term use (dark shading), long term uni-seasonal use (dark and light shading) and permanent settlement

expected winter correlates (especially bones of wintering birds) at Swifterbant is in conflict with a year-round occupation option, as is the very localized occurrence (in sub-site M1 only) of such bird remains at Hekelingen.

Other arguments for considering sites like Swifterbant, Kolhorn and Hekelingen to be non-permanent (and more specifically as summer sites) are the absence of definite houses and the presence of smaller or larger clusters of stake- or post-holes, most probably the relics of frequently repaired or rebuilt light huts or sheds (Van der Waals 1977; Kielman 1986; Louwe Kooijmans 1987; Van Beek 1990). The dimensions of these sites (Fig. 6.12) are, moreover, well within the range of the Late Mesolithic upland sites (Newell 1973), while the spatial co-occurrence of hut traces and refuse points more towards temporarily- than permanently-used sites. Their fully 'domestic' character is, however, not in doubt. The 'domestic' use-wear spectrum on flint at Hekelingen III (Van Gijn 1990, 128) and the presence of erupted milk teeth of children at Swifterbant are just some of the arguments. It appears that the seasonality problem can not be solved by bio-correlates, especially because of quantitative restrictions (Figs 6.17, 6.18), and that other aspects of the archaeological record are decisive, at least in relation to the permanent/non-permanent question.

We might wonder whether the question of permanent versus seasonal occupation of these sites will ever be satisfactorily resolved but, in this paper, the domestic long-term seasonal option (especially in summer) is favoured, in agreement with Van der Waals (1987) and Van Gijn (1990) and opposite to Prummel (1987), Zeiler (1988, 260) and Van Beek (1990, 243, 250)

Special activity sites

Very small sites, with dimensions up to 30m^2, with a low find density and a restricted set of tools reflecting a similarly restricted set of activities, are interpreted for the Mesolithic as extraction camps. I have the impression that, on the whole, the role of the extraction camp in post-Mesolithic prehistory is very underestimated so that, as a result, our vision of settlement systems is biased towards the main domestic sites. It will be special activity sites that are responsible for a major part of isolated broken axes, small flint assemblages and the total of the diffuse 'off-site' material on the upland. In wetland conditions preservation is much better than under dry conditions, but the chances of recovery are much more restricted.

A very distinct and rather showy example is the Early Neolithic fowling and fishing site of Bergschenhoek (Louwe Kooijmans 1987). In view of its altitudinal position (at –8 m O.D.) it is likely that many more similar sites will be hidden within the delta deposits. The site of Schiedam (Louwe Kooijmans 1974, 164) might be another example. Vlaardingen Culture examples are 'Hekelingen 4' (unpublished) and some flint scatters on donken (IJsselmonde, Van Trierum *et al.* 1988, 19). Very small Late Beaker sites are relatively frequent: several small scatters in the upper levels of Hekelingen III, two locations at Vlaardingen (Van Beek 1990, fig. 95) and several observations in Westfriesland (Woltering 1985, 217).

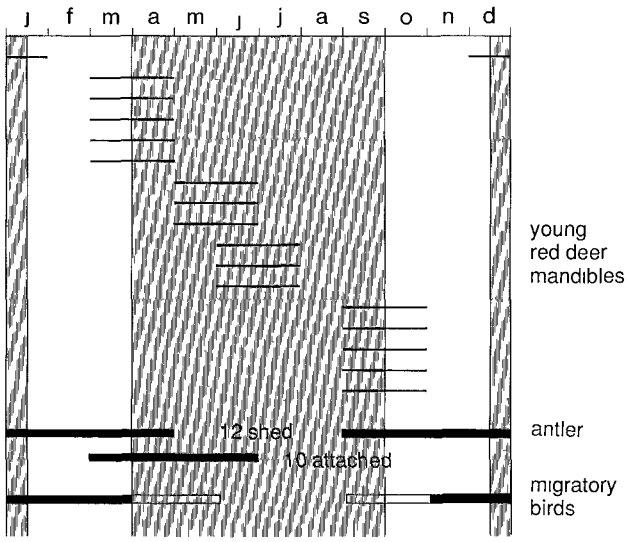


Figure 6.18 Seasonal bio-correlates for Vlaardingen (after Clason 1963), and two interpretational options: bi-seasonal use (grey shading) or permanent settlement. *Note*: the bi-seasonal option has two main variants: E and M of Fig. 6.16

A long term, multi-seasonal use or a different special function than those of the Mesolithic — point of support of transhumant animal husbandry for instance — might result in larger extraction camp sites than in the Mesolithic. Good examples are the smaller Single Grave sites of Westfriesland, such as Zijpe-Keinsmerbrug (Woltering 1987, 295–7); Bell Beaker–Bronze Age Oldeboorn, measuring 30m in diameter (Fokkens and Van Gijn in prep); and Middle Neolithic Gassel, located on the upland margin (Verhart and Louwe Kooijmans 1989). Site location, intra-site patterning or site dimensions are used as arguments for short- term, special functions for these sites.

The small Late Beaker find scatters in Westfrisia contrast markedly with the rather large earlier Beaker sites (Aartswoud, Kolhorn, Zeedijk), on the one hand, and with the permanent agrarian settlements from the Middle Bronze Age, on the other. They reflect a system of exploitation which is different from both other phases. For the first stage, a summer-seasonal use from fixed sites is considered most plausible, in the second stage a more logistically mobile exploitation, which would be in agreement with a gradual decrease in *residential* mobility in this period.

A similar case in environmental aspects, but very different in social context, is the colonisation of the northern saltmarshes in the Early Iron Age. The Early Iron Age site of Middelstum has a very special lay-out in its early phases, providing one of the arguments in favour of an initial phase of transhumant cattle herding, in which people became acquainted with the special qualities and constraints of the salt-marshes. Middelstum would have had the special function as a fixed basis for these herdsmen (Van Gijn and Waterbolk 1984; Waterbolk 1988).

Site location, micro-regional setting

Up till now, only the wider ecozonal context of settlement sites and the primary archaeological sources of information on subsistence have been taken into account. Only incidentally has reference been made to natural limitations to specific subsistence activities like cereal cultivation and to the consequences of presumed harsh winter conditions. But site location and site catchment have *not* been used as argument, or additional argument, for the specification of subsistence strategy. When other independent data are lacking one might resort to locational or site catchment analysis but must at the same time be aware of the ecological deterministic basis of these analyses and of the premise of a rational and optimal economic land-use. The very different ways of subsistence of the Late Neolithic and Iron Age communities in the fresh water tidal zone of the delta and the differences between Late Neolithic and Middle Bronze Age exploitation of the (Westfrisian) salt-marshes are a warning that two other factors play an important, or even dominant, role: available strategies and social constraints or the perception of the environment. But given the rich information from primary sources (bio-remains, structures, features) in the Dutch wetlands, site location and micro-regional setting can *illustrate* the measure of economic rationality of these communities in their choice of settlement location and so be a test for the application of methods such as site location and site catchment analysis.

Not surprisingly it will appear that locations generally were perfectly suited for the inferred subsistence strategies, but that is not the same as saying that specific natural conditions would determine the way of life of people, with certain technical capabilities, on a certain location!

In a strategic site location three major conditions should be fulfilled:

— no or very restricted flooding, simply in order to keep dry feet. Pile dwellings or other raised living constructions would have been solutions but these were, however, not opted for.
— availability of fresh water
— enough land of various qualities to meet the requirements of the desired system of subsistence, be it hunting, fishing, animal husbandry and/or crop cultivation.

These conditions were fulfilled in and around the delta from the Early Neolithic onward, for the northern Netherlands from the Early Iron Age, for northern Germany and the Fenland apparently from Roman times (see Lane and Hayes, this volume). A major choice to be made must have

been whether to exploit the potential of the deltalands from the margins or from the interior and this will have been mainly a matter of logistics: accessibility and distance of the attractive wetland.

But we should take care to see things in the right proportions and not over-emphasise the apparent opposition between 'upland' and 'wetland' or 'Pleistocene' and 'Holocene'. Prehistoric people were not geologists! 'Sand' and 'dry' will have been more their criteria. There is, in fact, a gradual sequence from true fen-edge, via outcrop margin (eg, Peacock's Farm in the Wash Fenland, Isle of Texel in the Netherlands) to small outcrops like Hazendonk. How far was a low dune ridge (like Velserbroekpolder, Bosman and Soonius 1990) perceived as being different to a sandy saltmarsh inversion creek ridge?

The three site catchment conditions could be fulfilled in various ways and sometimes this involved, for logistical reasons, what we perceive as 'true wetland' settlement as opposed to 'upland margin', but did they too?

Typical *Early Neolithic* locations are the outcropping tips of Late Glacial dunes, present in the lower course areas of Rhine and Meuse and the IJssel river, especially in the Alblasserwaard and in the Flevolandpolder near Swifterbant. These, mostly very small, dry, islands in the extensive swamps can be considered as excellent bases for the exploitation of the wide surroundings, a year-round strategy not excluded. At Swifterbant, fresh-water creek levees came within archaeological reach as a result of artificial drainage of the new polders. Sites cluster around a point where creeks are inter-connected, a perfect location for fishing and exploitation of the surroundings in various directions. Other sites are along main creek branches. Such sites might have suffered from regular flooding, especially in autumn and winter. The coastal barriers and the dunes situated on them were narrow and continuously reworked in that period. Saltmarshes along the upland side of the wide intra-coastal tidal flats will have been narrow and frequently flooded. Use of these zones will have been restricted to special expeditions. Any possible remains are, however, today reworked or covered.

Similar site locations are documented for the *Late Neolithic*. Moreover, sites are located at the fringes of fossil low dune ridges at some distance behind the coastline, beyond the major coastal constraints of salt and wind, on low creek ridges of desalinated saltmarshes, and, in one case, at a sub-fossil river levee in the eastern river clay area. Thus sites are located in a wide variety of ecozones and, in each case, in a relatively elevated location. These are all more or less sandy, well-drained deposits, with the exception of the creek levees in the tidal zone.

Middle and Late Bronze Age settlements demonstrate an exclusive preference for moist sandy or silty units bordered by drained high water clay deposits: dune fringes, saltmarsh creek ridges (Westfrisia), levee splays and levees (central river clay, Havinga and Op 't Hoff 1983), or upland margins (Oss, Den Burg, Van den Dries 1990; Woltering 1984). The clayey levees of the fossil stream-ridge on which Zijderveld and other sites are located must be considered as marginal, especially in view of the presence of arable; the ground water table was, however, slightly lower than nowadays. These stereotype settlement locations perfectly agree with the suggested moderate variability of the agricultural strategy of this period.

We find the same conditions fulfilled in the Molenaarsgraaf/Ottoland cluster of Late Beaker sites on western extensions of river deposits far into the peat area. This locational argument supports the idea of a beginning to the Middle Bronze Age agricultural system as early as this phase.

The *Iron Age* in this region is essentially a continuation of the Bronze Age settlement pattern as far as possible. There is continuity on the upland margins in Oss and Den Burg, as well as, in general, on the dune margins. Saltmarsh occupation of Westfrisia continued until the last and highest inversion ridge at Opperdoes and verylast and highest inversion ridge at Opperdoes and its immediate surroundings became too damp, in the Early Iron Age (Woltering 1985, 225–7). Shortly after, new colonisation of freshly formed distant salt-marshes started in the northern Netherlands where creek levees and marsh ridges were chosen for settlement location. Stream ridge and levee settlement in the river clay district is continued from Bronze to Iron Age. The river splays apparently became too wet and no new splays were formed. New are the settlements on clayey creek levees, on the drained margins of raised bogs or on small patches of such bogs. These provide the best locations for the exploitation of these wetlands.

Inter-dependencies/settlement systems

The settlement sites of the subsequent phases reflect different strategies of food procurement and environmental exploitation, different wetland-upland connections, and different settlement systems. Using settlement permanency and degree of self-sufficiency, three main categories of settlement systems can be made out and correlated with food procurement strategies (Fig. 6.19):

strategy	local subsistence	settlement
1 residential mobility	independent	non-permanent
2 strategical site location optional satellite sites	independent	permanent
3 exchange	inter-dependent	permanent

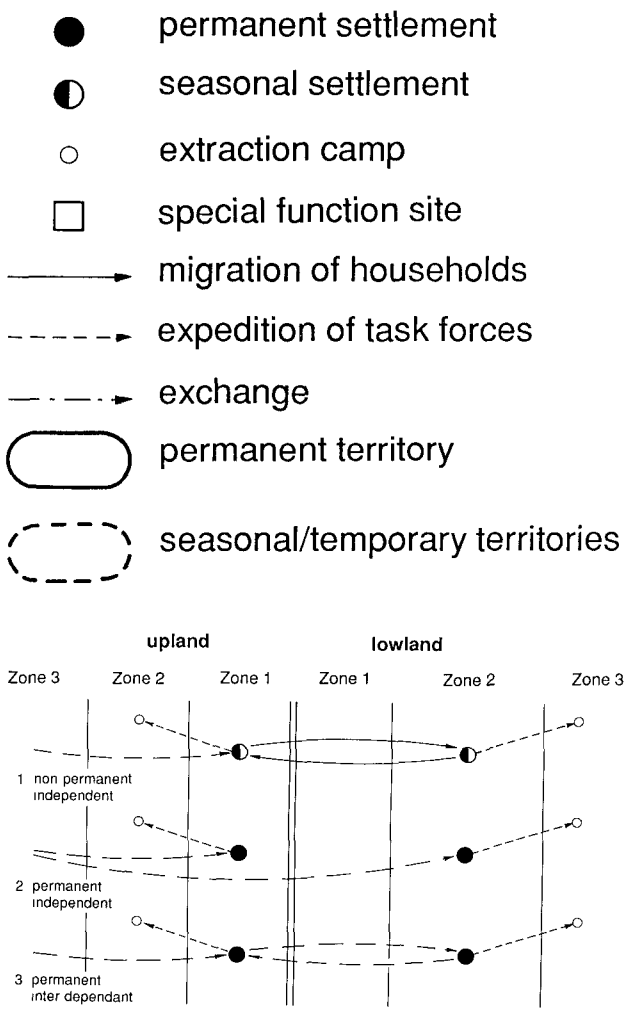


Figure 6.19 The three main categories of settlement systems, based on permanency of settlement and inter- or independency of subsistence at the sites

On this basis various models for settlement systems in the Dutch delta are suggested. As the exploitation of various ecozones, upland as well as wetland, is considered as a main factor structuring the systems, an upland and a lowland/wetland, both comprising several ecozones, are opposed in the models. The distinction between residential and logistical mobility (Binford 1982) is applied here to (semi-) agrarian societies.

A. Fully residential mobile systems

These are represented as a sequence of camps of middle-range duration (some weeks, some months) located in various ecological zones in order to take profit of the seasonal attractions of specific zones, with optional extraction camps.

In the upland–wetland opposition view three variants can be distinguished:

— purely upland strategy
— combined wetland–upland strategy
— purely wetland strategy

Such systems are not positively identified in the data. They are less plausible options for some early stray finds and extraction sites.

B. Systems of restricted residential mobility

Here exploitation is based on long-term seasonal (*ie*, summer- and winter-) settlements in different ecozones, with optional extraction camps. The same three variations as under A can be distinguished.

Shifts of domestic sites are interpreted in these models as representing shifts to other ecozones — a plausible option if these shifts are motivated by environmental changes and differences in conditions and resources. Extraction camps are presented as exploitation points in neighbouring ecozones, which might include other subzones of the same ecozone. The model can be extended by many more variants and in detail. Here only five essentially different systems from the upland-wetland point of view are given.

Logistical mobile systems are all systems based on permanent all-year settlements, either located on the upland (margin) or in the wetlands themselves. A main division has been made in independent (C) and inter-dependant (D) settlements.

C. Independent logistical mobile systems

1. Permanent wetland exploitation from permanent settlement in the wetlands. Site generally separated from upland by other ecozones or subzones. Territory generally covering various landscape units of one ecozone. Optional extraction camps and expeditions for the exploitation of other ecozones including upland. Exchange relations with upland site only for specific raw materials and valuables.
2. Direct wetland exploitation from upland sites on a daily basis, without wetland satellite sites. Site location on upland margin. Territory covering both upland and wetland. Two variants shown.
3. As 2, but with subordinate upland margin sites.
4. Indirect wetland exploitation based on subordinate seasonal base camps.
5. Indirect wetland exploitation from upland sites, based on wetland satellite camps. Travel camps optional.
6. As 5, but permanent lay-out and structures in large satellite site.

D. Inter-dependant logistical mobile systems

Settlements are connected by exchange of staple crops and/or domestic animals that are essential for subsistence. Two variants can be considered:

1. with site to site exchange
2. with centralised exchange

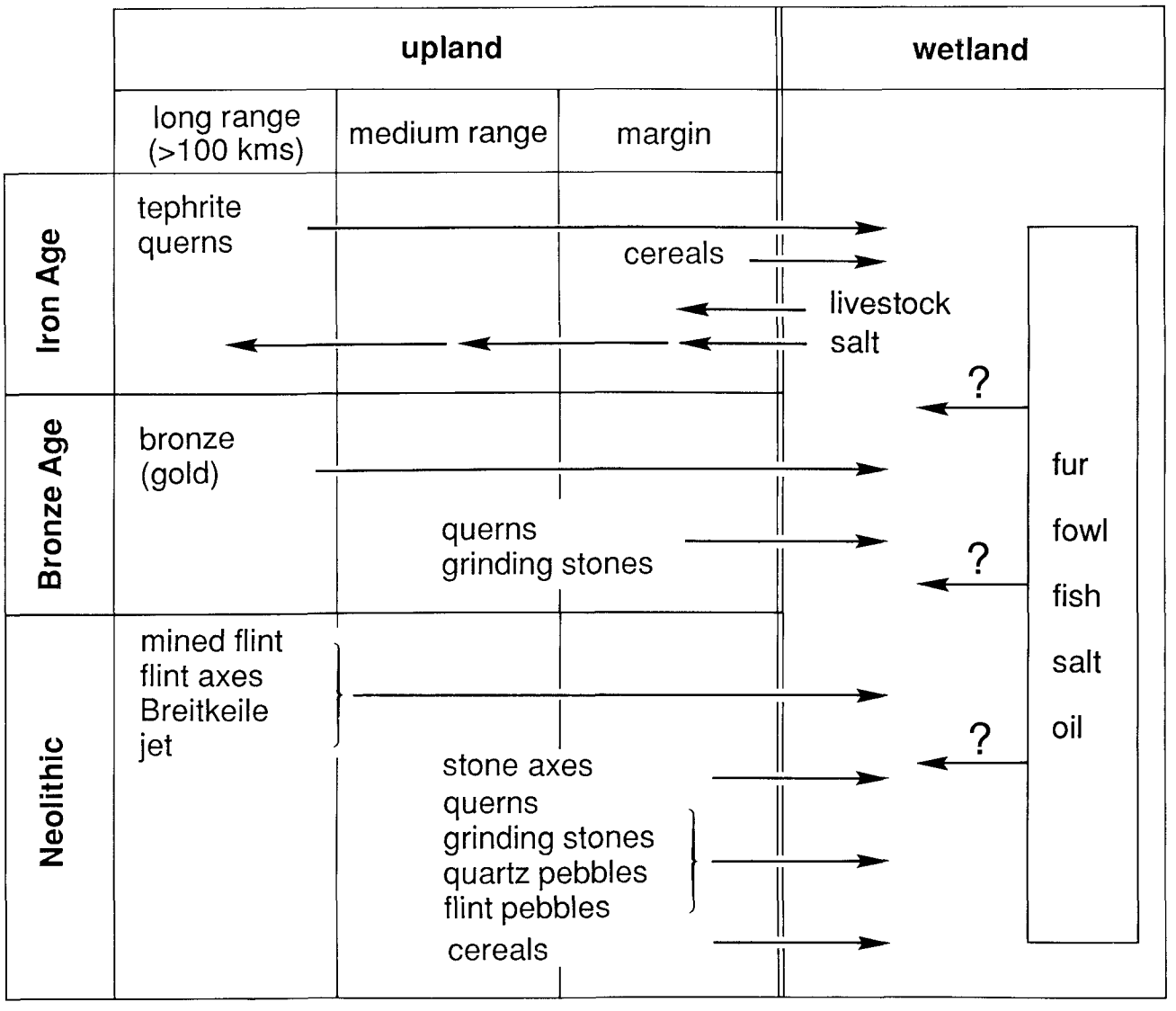


Figure 6.20 Schematic representation of the flows of raw materials and agricultural products between upland and wetland in the Netherlands during prehistory. Mineral materials and Iron Age salt are well-documented, other flows presumed. Neolithic mechanism predominantly transport by migration and expedition, Metal Age mechanism mainly or exclusively exchange

The settlement systems are visible only in a very fragmentary state by selective and distorted preservation and recovery processes, but we have to assume a certain degree of consistency in their evolution which we can use as a guideline, as in the case of houses (Waterbolk 1980; 1982).

The exploitation of wetland from upland sites is, moreover, hardly reflected in the archaeological record. One of the few examples is the Iron Age 'coastal pottery', interpreted as salt containers, in upland sites (Van den Broeke 1982; 1986). A special settlement lay-out, special settlement structures or settlement concentration along the upland margin might be other arguments. The Iron Age-Roman site concentration in the Maaskant around Oss (Van den Dries 1990) is a good example of upland margin settlement, as are the remarkable occurrence of several Middle Neolithic sites at the 'apex' of the Meuse delta deposits near Grave (Louwe Kooijmans and Verhart in press) and, in more general terms, the rich prehistoric archaeology of the Land van Maas en Waal (Peddemors 1978).

For special settlements, only one case is under discussion: the Late Iron Age 'walled enclosures', like Zeijen, in the Northern Netherlands (Waterbolk 1977). These are multi-phased enclosures not far from the upland margin, for which a role as foci in the exchange of agricultural products between saltmarsh and upland is a first functional option. Upland connections of wetland sites are mainly documented by discarded non-local material, mainly stone and flint (Fig. 6.20).

It is important to realise that the connections of upland and wetland sites are basically different in residential mobile and permanent settlement systems: permanent sites are linked by exchange systems of various kinds, seasonal sites by migration of their inhabitants; two very different systems designed to profit from various ecozones.

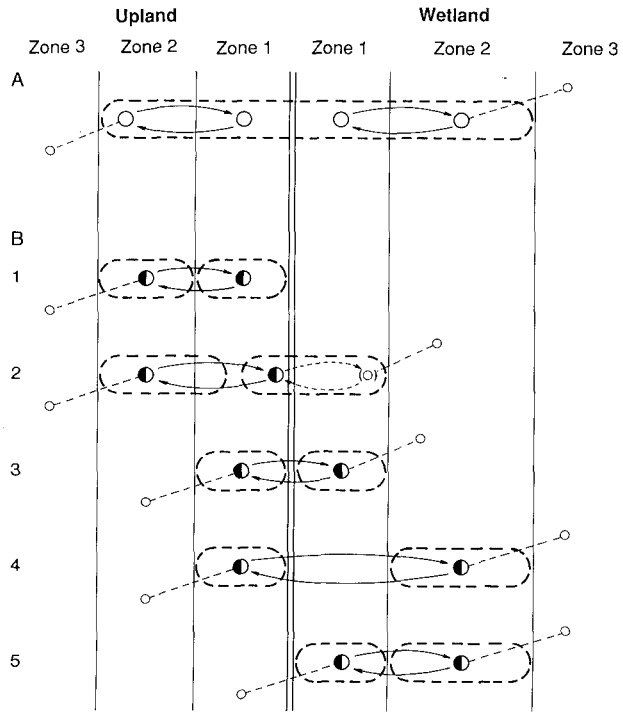


Figure 6.21 Schematic representation of possible settlement systems in the Dutch wetlands and the upland margins, for residential mobile and intermediate mobile communities. Mesolithic and Neolithic systems, as far as these are not based on permanent settlements, are all considered to be of B2, B3 or B4 type (upland-wetland combinations)

B2	Mesolithic	Europoort, Ridderkerk/ IJseelmonde (Leerdam)
	Neolithic	Hazendonk? (some phases) Hekelingen IV (or C5)
B3	Neolithic	Aartswoud, Kolhorn
B4	Neolithic	Swifterbant, Hekelingen III (or C4), Vlaardingen (or C4), Hazendonk? (or C4)

A–systems (Fig. 6.21): The fully residential mobile system is considered an option for the Mesolithic only, but no short-term base camps are known from the wetlands, nor from the upland margins. Both, if existent, are beyond reach. Microlithic assemblages, like those at Aardenburg (Zeeland Flanders: Trimpe Burger 1960–61), now close to the upland margin, were originally located tens of kilometres inland. The Swifterbant river dunes were, at the time of the Boreal Mesolithic occupation (Price 1981), not yet surrounded by delta wetlands, but the region might have been attractive because of the lower courses of the IJssel-Vecht river system. All we have from the delta proper are some isolated microliths from donken, such as those from Leerdam and Ridderkerk, the last case associated with a small fire place (Van Trierum *et al.* 1988, 17; Louwe Kooijmans 1985, 15). These reflect short visits or true extraction camps, belonging either to A– or B–systems.

B–systems (Fig. 6.21): Semi-permanent settlement can, very hypothetically, be presumed locally as early as the Early Mesolithic, linked-up with fishing equipment recovered from Europoort (Verhart 1988). The Rhine/Meuse delta at that time, factually, was not more than a gradually drowning Late Glacial valley floor, the low 'terrace edge' of which, now below 15–20m of Holocene deposits, must have been a very attractive settlement location. We presume long-term seasonal base camps on this edge, connected with the documented large-scale fishing (model B2). Since seasonal domestic occupation is considered the first option for all semi-agrarian settlements and for the Late Neolithic saltmarsh sites of Westfrisia, these are all considered as components of settlement systems of the B class.

The first group, separated by a zone of peat from the upland is attributed to B4 (with C4 as an alternative), the second group to B3 since hardly any peat separates the Westfrisian salt-marshes from the northern upland in the palaeo-geography. The interpretation of Bergschenhoek, situated at 45km from both the central and the southern uplands — a trip of nine hours by dug-out and far beyond the 10km territorial limit of hunter/gatherers — poses a special problem. Must we assume very long upland connection lines (with optional travel camps = C5) or winter base camps within the wetlands, for instance on one of the larger dune outcrops (B5)? The functional interpretation of the Hazendonk with its 'very special' location and zoological ratio's through the ages, is even more problematical.

C–systems (Fig. 6.22): Permanent settlements in an environment suitable for both crop cultivation and animal husbandry are attributed to model C1. The earliest might be Late Neolithic Ewijk in the river clay district, but the documentation makes the attribution not fully reliable. This, however, is fully documented from Late Beaker times onwards in all zones.

Direct exploitation from permanent settlements on the dunes and on upland margins, as a component of the subsistence strategy (model C2) is assumed for a row of sites from the Late Neolithic onward. The C3 variant is assumed for some Middle Neolithic sites on the upland margin of the river clay area and Late Beaker/Bronze Age Oldeboorn.

In the following scheme a selection of sites, attributable to C1, C2 or C3 systems is listed according to phase and zone, those with an alternative in brackets (D1 for Iron Age sites, C4 for Ewijk).

Special activity sites as components of permanent settlement systems are known especially from the Late Beaker phase and from various zones. These small sites imply a connection with more permanent settlements in other ecozones and give the Beaker settlement system a special position from a logistic point of view. Of special interest is the fact that, at both at Hekelingen and Vlaardingen, the location of the

	C1		C2/3	
	Dunes	river clay	dunes	Pleistocene
Iron Age	(Opperdoes)	(Culemborg) (Zijderveld)	Spanjaardsberg	Oss
Bronze Age	Bovenkarspel Hoogkarspel Andijk	Zijderveld Dodewaard De Horden	Velserbroek Den Burg	Oss
Late Beaker	Oostwoud	Molenaarsgraaf Ottoland	Monster Velsen-North Sea Channel	Land van Maas Waal
Late Neolithic		(Ewijk)	Leidschendam Voorschoten Zandwerven	Northeast-polder P14
Middle Neolithic				Gassel Het Vormer Kraaienberg

Vlaardingen settlement was re-used, but in a more casual way, that is: with a change in site function. This might partly be explained by environmental changes (silting of the creek), but also must reflect a shift in settlement system and organisation. Other, fully domestic, Late Beaker sites show subsequent permanent Bronze Age use, as at Molenaarsgraaf, Ottoland-Oosteind and Dodewaard.

The C6 system has been added for the special Middelstum evidence in the initial phase of colonisation of the northern saltmarshes. No comparable systems are known from the delta proper.

D–systems (Fig. 6.22): The D–class of settlement systems comprises those settlements for which interdependency in food procurement by means of exchange systems is assumed: the settlements of the Iron Age in the fresh-water tidal areas, those from the Meuse estuary, those from the Assendelft area and, extrapolating this evidence, those from the Scheldt and Rhine estuaries.

This is the first option too for the Iron Age *terpen* settlements of Groningen and Friesland, especially for the period when conditions for crop farming deteriorated in the Duinkerke IB transgressive phase.

The D2 system is separated-off to include the Late Iron Age system of Groningen, with the 'walled enclosures' as possible centralised (re)distribution sites on the upland margins.

Synthesis (Fig. 6.23)

In a system model of society all aspects are interconnected and part of one organic whole. Changes in one aspect are interrelated with positive and negative feedbacks to other aspects. So, in effect, the changes in various elements of settlement systems and subsistence, treated apart, should at last be brought together in one diachronic vision of the developments Dutch wetland communities went through. This is the more important in view of our argument that these developments are representative for a wider sphere, including the surrounding upland.

The communities involved were fully linked-up with communities of the surrounding and more distant upland in material respect, they participated in the same exchange systems and demonstrated advanced technological capabilities. The diachronic changes of various elements (livestock, crops, houses, site functions) are far more prominent than the variability in relation to ecozone. Change and variation are not to be seen as adaptation but as the reflection of deliberate choices within the socially determined margins of freedom of behaviour. These margins can be very wide, resulting in a wide variety in subsistence strategy and settlement variables, or very narrow, resulting in a strict and sharply circumscribed way of life and restricted settlement variability.

In the wide ecological diversity of the Dutch delta and its restricted possibilities for subsistence, the 'wide' or 'narrow' systems are visible archaeologically as distinct changes in the 'wetland attitude': the subsequent communities looked with very different eyes upon wetlands: they either took full profit of natural resources or lived 'with the back to nature', perhaps unaware of these qualities and fully relying on their own production system. This is the basic contrast between the Neolithic and the Metal Ages. We may even wonder how far the basic distinction between 'wetland' and 'upland' was experienced by Bronze Age and most of the Iron Age societies, who seem to have made the distinction between 'moist sand' as suitable for their system and 'too dry' or 'too wet' as less or un-suitable.

Social evolution gave rise to changing needs and desires, technological innovation to changing

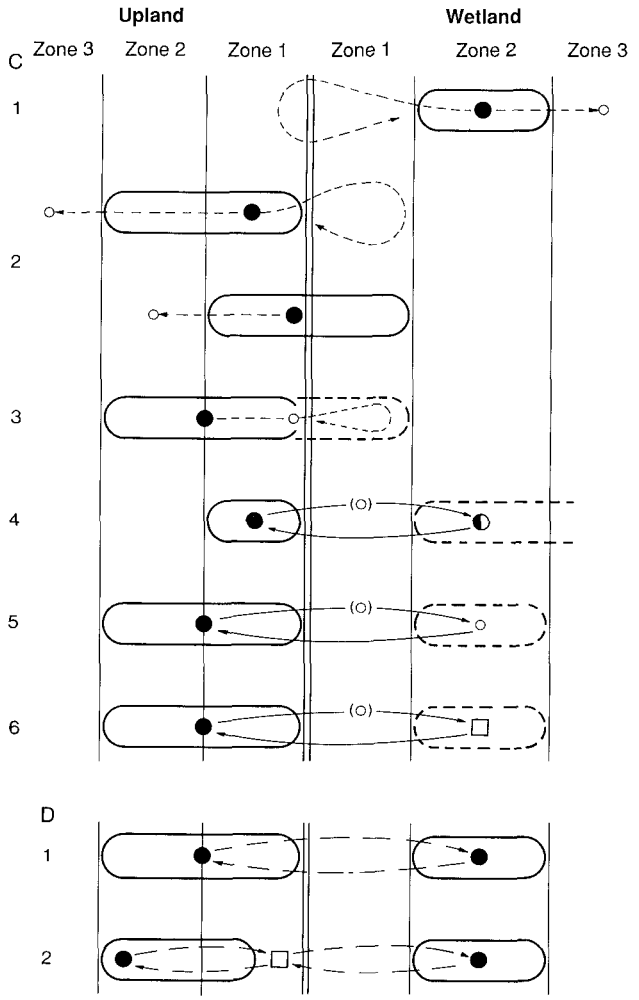


Figure 6.22 Schematic representation of settlement systems in the Dutch wetlands and upland margins, for permanently settled communities. Extraction camps optional for pre-Bronze Age only

C1	Late Neolithic Beaker	Ewijk (or C4)
		Molenaarsgraaf, Ottoland, Oostwoud
	Middle Bronze Age	Zijderveld, Dodewaard,West-frisian sites
	Iron Age	Culemborg, Zijderveld, Opperdoes (or D1)
C2	Late Neolithic Beaker	Voorschoten, Leidschendam
		Monster, Velsen–North Sea Channel
	Bronze Age/ Iron Age	Velserbroek, Oss, Den Burg (Texel)
C3	Neolithic Beaker	Gassel a o
		Oldeboorn
C4	Neolithic	Hekelingen III (or B4), Vlaardingen, Hazendonk?
C5	Neolithic Beaker	Hekelingen IV (or B2)
		Hekelingen III, Westfrisian sites
C6	Iron Age	Middelstum
D1	Iron Age	Assendelver Polders, Delfland sites
D2	Iron Age	terpen, Zeijen

possibilities, and both together to changing reactions with regard to the various attractions offered by the delta. We can *describe* the path societies followed but are rather reserved as far as *explanation* is concerned. Some culture flow, some inter- and intra-group competition, the tension between available and needed technology, and some population pressure will have been sufficient driving forces, but 'adaptation to deteriorating conditions' was always restricted by the social margins of each phase.

We can observe a continuous and very gradual evolution in subsistence and — more generally — in the way of life, during the period under discussion. The sequence starts with a long period of very gradual acceptance of food production by societies with a very flexible attitude to this mode of life. This process covers the whole of the Neolithic period. Variation is expressed in the ratio between food production and the exploitation of natural resources. Not earlier than the end of this phase are mobility and — most remarkably — appreciation for the natural bio-resources, lost. A fundamental change in the perception, the appreciation, of the landscape had occurred. People settled exclusively in those locations which they perceived as being optimal for the husbandry-type of their time, without attention for natural bio-resources. This point of view differs from that of Prummel (1979) in her comparison of eleven prehistoric and medieval bone spectra from the Dutch delta, in which she considers ecology and ecological adaptation as dominant over chronology.

Subsequently an intensification of the food production system takes place, which goes together with a narrowing of behaviourial margins, culminating in the rigid Middle Bronze Age farming system. From that time on, a widening of the subsistence mode, but now within the mixed agricultural system, takes place which, together with some organisational sophistication, allows the renewed exploitation of extremely wet ecozones, but in a strategy widely different from the Late Neolithic, two millennia before.

The process of change can be described in more detail in seven phases.

Phase 1 Mesolithic

Broad spectrum hunter-gatherers
10.000–6400 BP
before 6400 cal. BC

There is not much direct evidence for delta exploitation in the Early and Late Mesolithic. The general North European subsistence strategy is assumed: a broad spectrum economy, based on hunting, fowling, fishing and foraging, with a distinct seasonal strategy in resource exploitation and settlement system. The wetlands will have been attractive from the beginning and exploitation from the upland margins, including outcropping dunes close to these margins, with special activity

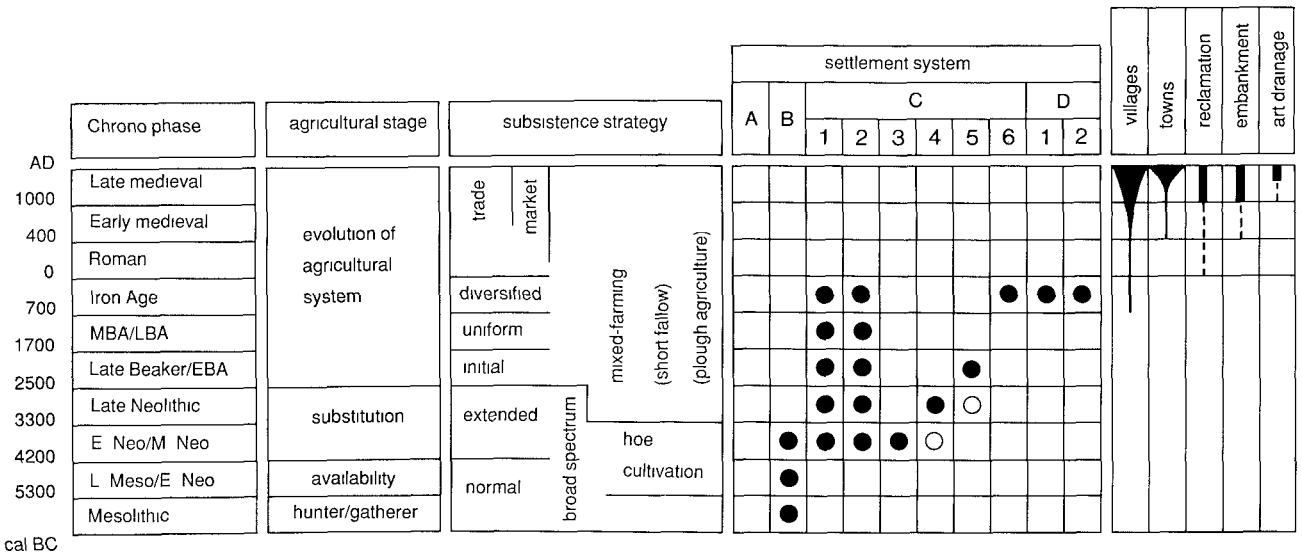


Figure 6.23 Evolution of subsistence strategy and settlement systems of pre-and protohistorical communities in the Netherlands, as based on the wetland data

camps in the relatively narrow wetlands (systems A2/B2), seems most likely. Long term multi-seasonal sites on strategic locations are to be expected in favourable ecozones, such as the upland margins.

The phase is documented in camp-site flint scatters on donken along the lower courses of the IJssel-Vecht system at Swifterbant, a possible extraction site at Rotterdam-IJsselmonde, isolated microliths on a donk at Leerdam, and fishing/hunting equipment from the buried Rhine Valley floor.

Phase 2 Late Mesolithic/Early Neolithic

The 'availability phase'
6400–5400 BP
5300–4200 cal. BC

It is very intriguing what happened in the period between the first Linear Bandkeramik (LBK) settlements on the South Limburg loess, around 6400 BP, and the earliest known traces of food production in the delta, one millennium later. A thin spread of LBK arrowheads and adzes and even of 'Limburg pottery' all over the Limburg Maas Valley as far north as the river clay area (Brounen and De Jong 1988) demonstrate (Late) LBK contacts as far as the delta. This means that we can conceive of, at least, the southern Netherlands and assumably the delta as well, as being part of the 'availability zone', according to Zvelebil (1986). Modest LBK assemblages in the Roerstreek, rather close to the loess, probably relate to active LBK involvement with the sand region, probably for cattle herding activities.

This situation is intensified but not essentially different in the subsequent Rössen phase. Stray Rössen axes of Breitkeil type, found all over the country, are the main documents for this stage (Van der Waals 1972). At some moment, most probably at the end of this stage, communities similar to those described for the next phase must have originated. Evidence for an earlier start, as suggested by presumed very early pottery (6400 BP!) at Swifterbant site S11 (Whallon and Price 1976; Price 1981; De Roever 1986) is still a point of debate.

Phase 3 Early/Middle Neolithic

The first extended broad spectrum economies
Beginning of 'substitution'
5400–4700 BP
4200–3300 cal. BC

The first firm evidence for food production north of the loess zone is the start of the 'substitution phase' according to the 'Neolithisation' model of Zvelebil (1986). This is the case at a restricted number of sites (Swifterbant cluster and Hazendonk) located in the peat and fresh water tidal zones of the delta district, dated around 5300 BP. An intersite prospection of all donken in the river district in the coming years (Verbruggen in prep) might reveal whether these sites document the very beginning of this stage or are preceded by earlier similar communities.

These settlements, and so the communities involved, demonstrate a very specific mix of 'Mesolithic' and 'Neolithic' traits. Together, these allow the interpretation of a native Mesolithic origin and a cultural transformation resulting from direct or indirect contacts with formally Neolithic (= fully agrarian) communities on the upland to the south or east. The settlement types (domestic

base camps and extraction camps), their non-agrarian locations, their dimensions, finds scattering, and internal structure are all not essentially different from what is know from the preceding Mesolithic. A flint industry of specific Mesolithic (small blade) character is combined with the fabrication of pottery and the use of (imported?) perforated axes. The subsistence is semi-agrarian and can most conveniently be labelled as an *extended broad spectrum economy*, since all classical Mesolithic subsistence activities (hunting, fowling, fishing, foraging) were extended with the raising of livestock and (at least) the consumption of cereals, whilst none of either groups of resources (wild, domestic) dominated. We must conceive this wide spectrum of activities as having been scheduled into a seasonal system and with a task division according to age and sex, as in the preceding Mesolithic (Price 1978). Only the specific wetland part of the settlement system is visible and this is most probably of intermediate mobile type (B4, less probably C4), with long-term multi-seasonal domestic sites and extraction camps, represented by a summer facies at Swifterbant, a winter facies at Bergschenhoek and probably a mix of activities at Hazendonk. Seasonal migrations and long distance expeditions far into the wide intra-coastal plain are presumed.

A major problem is the invisibility of the upland facies. For the Maas Valley, south of the delta, more agrarian and permanently settled communities cannot be excluded as early as this phase, but are very hard to establish with any certainty. We have to await the conclusions of the statistical and geographical analysis of the flint assemblages in the Maas Valley Project (Wansleeben and Verhart 1990).

Phase 4 Late Neolithic

The end of natural bio-resource exploitation
Final substitution and initial consolidation
4700–4100 BP
3300–2600 cal. BC

The Late Neolithic gives us a sharper picture of settlement systems and subsistence than the preceding phases. Settlement sites from this period are recovered in all five main ecological zones of the delta. These offer us a picture of a wide diversity and landscape-bound subsistence at the individual sites, that vary from 10% to 90% agrarian, as measured by animal bones. In the fresh water tidal and peat zones the semi-agrarian strategy in summer-seasonal domestic sites seems to continue. The sites are conceived as being members of *restricted residential mobile systems*.

The very different origin of the flint used at the sites is the main argument for linking those of the Maas estuary with (as yet unknown!) settlements to the south in the basin of the River Scheldt; those around the Westfrisian embayment with the north and north-east; and of viewing those on the donken as being part of settlement systems that extended to the east. The *extended broad spectrum economy* is continued at these sites.

In other zones — the coastal dunes and the river clay district — animal husbandry is dominant and combined with crop cultivation. The agrarian aspect demonstrates a considerable variability, not clearly linked to environmental conditions. There is no evidence for cattle stalling and the evidence for ploughing is very restricted. The high proportions of domestic pig point to the importance of swine herding as a separate activity. Although a wide range of food producing activities were practised, these seem to have been rather independent of each other. The only link between crops and livestock might have been the occasional grazing of livestock on the stubble fields and fallow land. One might call the strategy a *quasi mixed farming*, judging from the wide range of agricultural activities. The dominant arable mode will have been long fallow cultivation (*cf.* Fokkens 1986), characterised by hoe and digging stick and occasional ploughing. It depends on our choice between self-sufficiency or exchange relations as to how the diversity of food remains on the individual sites should be interpreted. A high degree of self-sufficiency, at least for staple food, seems the first option in view of the relatively high mobility and, therefore, a settlement system C2 for the fully agrarian sites.

The wide diversity in subsistence demonstrates that hardly any social restrictions existed in this respect and that people (still) had a great appreciation for a wide variety of natural resources. This changes rigorously in the next phases.

Phase 5 Late Beaker/Early Bronze Age

Short fallow agriculture
Initial mixed farming
4100–3400 BP
2600–1700 cal. BC

The Late Beaker phase can, as far as the restricted information allows, be considered as transitional between the (better documented) preceding Late Neolithic and the subsequent Middle Bronze Age. The last semi-agrarian communities seem to have disappeared; basic subsistence was agrarian. We observe for the first time bone spectra in which wild animals are nearly absent (as in the following phases), but pig is still relatively important. Both wheels and ploughmarks demonstrate the use of draught animals (oxen) and, although the plough was known and used earlier, more general use seems to start in this period. Fokkens (1986) emphasises the importance of this transition from long fallow to short fallow arable farming and the consequences for many other aspects of society. The 'beaker phenomenon' might very well be understood as the ultimate consequence of the social and organisational change brought about by this 'agricultural revolution'. It is, however, not yet possible to make more detailed statements on the

agrarian strategy of this phase since evidence on housing is scarce and contradictory.

We are, however, inclined to look to this phase for the origin of the fully developed mixed-farming of the Middle Bronze Age and so to assume an *initial mixed-farming system* for this phase: a system with plough and carts as technical means, but not yet fully dominated by cattle and with an option for the development of a farm with byre. The settlement systems are all focused on permanent settlements on upland locations as before but now, for the first time, also at selected wetland locations as in later phases. As in the preceding Neolithic, small extraction sites seem to have been in use for activities in distant ecozones. The wide margins of subsistence had considerably narrowed in this phase.

Phase 6 Middle/Late Bronze Age

A rigid, self-sufficient mixed-farming economy
3400–2600 BP
1700–700 cal. BC

The Middle Bronze Age appears to be the period with the most narrow limits in subsistence strategy, with the most restricted variability in agriculture. A *true mixed farming system* had developed in which animal husbandry and arable farming were inter-linked and fully integrated; a rigid but apparently highly successful system, dominated by cattle as far as livestock is concerned and plough cultivation of cereals. Winter cattle stalling meant the provision of winter fodder, the use of straw in the stable, and the mucking out of stables to manure the fields. Draught oxen were used for traction of carts and ards. Regular fields were surrounded by fences or ditches. The restricted number of domestic pigs were more probably kept close to the farms to live on refuse than separately herded, while sheep and/or goat might have grazed on stubbles or fallow land. Hunting and fowling was not practised, but fishing remained of some importance.

The Middle Bronze Age marks a phase of intensification of, and full concentration on, the food production system, disregarding the natural resources so much favoured up till the Late Neolithic. The slight variability, as far as can be observed, gives rise to the assumption of a high degree — or even of full — self-sufficiency or autarky of the individual households and a low mobility level. These societies remind one of those of the LBK Culture. The agricultural systems of both are essentially different, but both had apparently proved their merits and both societies stuck to their respective systems within very narrow limits. This reflects a similar perception of nature within both societies, in which natural bio-resources played a very restricted role and all confidence was placed in traditional agricultural production.

This is reflected in site location. For the Middle Bronze Age settlements are all located so that communities could profit from moist sandy soils for arable farming and from natural lowland pastures on backswamps or other clayey deposits for cattle herding: the dune margins, creek ridges in saltmarsh deposits, levee splays in the river clay or inversion ridges of river deposits in parts of peat district.

But some diversity can be observed as well. There is a distinct adjustment of farming practise in Westfrisia when the conditions become wetter to more diary farming and the exclusive cropping of barley. Settlement lay-out all over the country demonstrates, moreover, considerable variation in dimensions and number of farms. The colonisation of new regions, like Westfrisia, must have been initiated by some type of transhumance from the dunes. This, however, does not supersede the impression of narrow subsistence limits, discussed above.

Sometime in the Late Bronze Age, and most probably close to the transition into the Iron Age, the rigid Bronze Age strategy comes to an end.

Phase 7 Iron Age

Diversified mixed-farming and inter-dependency
2600–1950 BP
700–0 cal. BC

In the Iron Age a development of the mixed-farming system can be observed towards a wider range of activities, a growing diversity, and toward the loss of self-sufficiency and the growth of inter-dependencies. Cattle are less prominent, as in the Bronze Age and horse breeding has become of importance. Arable farming is extended with several new crops (*Camelina sativa, Vicia faba, Daucus carota, Brassica rapa*). The internal restructuring of the long-house, now generally with doors in the long walls and a working space separating byre and living part, might in some way be connected with this.

Most remarkable is the renewed interest in wet environments, especially the resettling — after a long interval — of the fresh water tidal zone and the adjacent peat margins, where apparently fully agrarian communities permanently settled on drained peat, creek ridges, and former saltmarsh deposits. It is generally assumed that environmental changes, *viz.* improved drainage during a transgressive phase, opened the opportunity for settlement and especially that deterioration of upland conditions played a great part. More likely, however, a wider complex of factors is involved: the change to a more flexible mixed-farming system and less rigid locational preferences, the availability of new crops that made some arable farming possible on the peat and, presumably, the acceptance of a certain degree of inter-dependency, even for staple foods, by exchange with communities in neighbouring ecozones. Such exchanges are, however, extremely difficult to support archaeologically, since the archaeological record primarily reflects

consumption, and production correlates for crop cultivation and animal breeding can hardly be found.

Clearer than before also are systems of lowland exploitation, especially of fresh mineral deposits, from upland margins and it is especially in one of these systems — that of the Groningen part of the northern marshes — that more coordinated organisation, exchange and inter-dependency seems to be reflected. This is apparent firstly in the initial transhumance system and the presumed central role of (sites like) Middelstum and, later, in the walled enclosures. The centralisation reflected in these sites might be connected with the densely clustered form of settlement on the *terpen* — as opposed to the open hamlet structure which existed upto this time everywhere else — and some social hierarchy that might have developed in these situations. For the western Netherlands no such rigorous organisation should be assumed, rather, less centralised relations. The supply of salt by coastal communities to those on the southern upland, partly compensated by a return-flow of tephrite querns is, however, archaeologically visible. Specific agricultural products might very well have gone the same way.

The Dutch wetlands have a very high potential of information on the way of life and organisation of prehistoric communities. The ways of use and non-use of the various ecozones, with their critical conditions for exploitation, give us the opportunity to establish the social margins of the subsequent subsistence strategies and, as such, the appreciation of natural resources and some idea of the prehistoric perception of the environment or 'landscape'. The upland–wetland opposition appears to be very much a matter of our own perception. The range of prehistoric wetland exploitation — differences in archaeological formation processes taken into account! — can be considered as fairly representative of prehistoric society as a whole.

The western Netherlands are just as close to East Anglia as Brittany is to Devon and Cornwall. This does not necessarily imply cultural connections of similar importance or similar lines of prehistoric development, but it might be worthwhile for East English prehistorians to be informed about what has been going on in prehistory and in prehistoric research at the other side of the southern North Sea. Language and restricted availability of publications will, however, be serious draw-backs. Although this paper lacks many details and certainly comprises a series of personal views, it is hoped that it might provide a useful survey of Dutch wetland occupation and its upland relations, at the same time making the primary sources more accessible.

Acknowledgements

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Table 6.1 Principal references for major prehistoric sites located on Figure 6.1

ecozone	site name	reference
Mesolithic		
	Swifterbant	Whallon/Price 1976; Price 1981; De Roever 1986
	Europoort	Verhart 1988
	IJsselmonde	Van Trierum *et al.* 1988
	Leerdam	Louwe Kooijmans 1985
Early/Middle Neolithic		
fresh tidal	Swifterbant	Van der Waals 1977; Casparie *et al.* 1977; Clason/Brinkhuizen 1978; De Roever 1986; Zeiler 1986; 1987; 1988
	Bergschenhoek	Louwe Kooijmans 1987
	Schiedam	Louwe Kooijmans 1984
peat	Hazendonk	Louwe Kooijmans 1974; 1987; Van der Woude 1983; 1984; 1985
upland margins	P14	unpublished
	Grave	Verhart 1989
	Gassel	Verhart/Louwe Kooijmans 1989; Brounen/De Jong 1988
	Het Vormer	Louwe Kooijmans 1980
	Kraaienberg	Louwe Kooijmans/Verhart in press
Late Neolithic		
dunes	Voorschoten	Glasbergen *et al.* 1967
	Voorschoten-Steyn	Van Veen 1989
	Leidschendam	Glasbergen *et al.* 1967
	Haamstede	Trimpe-Burger 1960–1
salt marsh	Zandwerven	Van Regteren Altena *et al.* 1962–3
	Kleinsmerburg	Woltering 1987
	Zeewijk	Gerrets *et al.* 1988
	Kolhorn	Van der Waals 1987; 1988; Kielman 1986
	Aartswoud	Van Iterson Scholten/De Vries-Metz 1981
fresh tidal	Vlaardingen	Van Regteren Altena *et al.* 1962–3; Beek 1990
	Hekelingen I	Modderman 1953
	Hekelingen III	Louwe Kooijmans 1983a; 1987; Van Gijn 1990
peat	Hazendonk	Louwe Kooijmans 1974; 1987
river clay	Ewijk	Asmussen/Moree 1987
upland margin	Bornwird	Fokkens 1982
	Kraaienberg	Louwe Kooijmans/Verhart in press
Late Beaker/Early Bronze Age		
dunes	Velsen–North Sea Channel	unpublished
	Vogelenzang	Ten Anscher 1990
	Langeveld	Clason 1967
	Monster	Glasbergen/Addink-Samplonius 1965
salt marsh	Oostwoud	Van Giffen 1961
fresh tidal	Hekelingen I	Modderman 1953
	Hekelingen III	Louwe Kooijmans 1987
	Vlaardingen	Van Regteren Altena *et al.* 1962–3; Beek 1990
peat	Hazendonk	Louwe Kooijmans 1974; 1987
river clay	Molenaarsgraaf	Louwe Kooijmans 1974
	Ottoland	Wassink 1981
	Dodewaard	unpublished
upland margin	Oldeboorn	Fokkens/Van Gijn in prep.
Middle/Late Bronze Age		
dunes	Velserbroekpolder	Therkorn 1987b; Bosman/Soonius 1990
salt marsh	Andijk	Van Regteren Altena 1977
	Bovenkarspel	IJzereef 1981
	Hoogkarspel	Bakker *et al.* 1968
	Zwaagdijk	Modderman 1964
river clay	Zijderveld	Hulst 1973
	De Horden	Van Es *et al.* 1988
	Dodewaard	unpublished
upland margin	Oldeboorn	Fokkens/Van Gijn in prep.
	Den Burg (Texel)	Woltering 1975; 1984
	Oss	Fokkens 1990

Table 6.1 (continued)

Iron Age		
dunes	Spanjaardsberg	Modderman 1960–1
	Amsterdam WLD	Jelgersma *et al.* 1970
	Wassenaar	Van Heeringen 1982
salt marsh	Middlestum	Boersma 1988
	Ezinge	Van Giffen 1936
	Opperdoes	Woltering 1985
fresh tidal	Assendelft	Therkorn *et al.* 1984
	Leiden	Van Heeringen 1982; 1986b; 1988
	Maasland–Foppenpolder	Abbink 1989
	Vlaardingen–Holiërhoek	Louwe Kooijmans 1985
	Spijkenisse	Van Trierum *et al.* 1988
	Geervliet	Van Trierum *et al.* 1988
river clay	Zijderveld	Hulst 1973
	Culemborg	unpublished
	De Horden	Van Es *et al.* 1988
	Driel	Clason 1977
upland margin	Zeijen	Waterbolk 1977
	Den Burg (Texel)	Woltering 1975; 1984
	Oss	Van der Sanden 1987; Van der Sanden/den Broeke 1987
	Hekelingen I	Classon 1963; 1980
	Hekelingen III	Prummel 1987
peat	Hazendonk VL 1b	Zeiler in press
	Hazendonk VL 2b	Zeiler in press
river clay	Ewijk	Clason in press
Late Beaker/Early Bronze Age		
dunes	Vogelenzang	Clason 1967
	Langeveld	Clason 1967
river clay	Molenaarsgraaf	Clason in Louwe Kooijmans 1974
	Ottoland	Clason in Wassink 1981
Middle Bronze Age		
dunes	Velserbroekpolder	Cavallo 1988
salt marsh	Zwaagdijk	Clason 1967
	Andijk	Van Mensch/ IJzereef 1975
	Hoogkarspel	IJzereef 1981
	Bovenkarspel	IJzereef 1981
river clay	Zijderveld	Clason 1977; 1980
	Dodewaard	Clason 1977; 1980
Late Bronze Age		
salt marsh	Hoogkarspel	Clason 1980
	Bovenkarspel	IJzereef 1981
Iron Age		
dunes	Velsen PEN	Clason 1977
	Spanjaardsberg	Clason 1967
	Amsterdam Waterdunes	Clason 1967
	Wassenaar	Van Heeringen 1982
	Velsen–Hoogovens	Van Wijngaarden- Bakker 1988
fresh tidal	Vlaardingen–Broekpolder	Clason 1967
	Vlaardingen–Old people's house	Clason 1967
	Leiden–Stevenshof	Van Heeringen 1982
	Leiden–Bosch & Gasthuis	Van Heeringen 1982
	Assendelft Q	Van Wijngaarden- Bakker 1988
	Weesp	Van Wijngaarden- Bakker 1988
river clay	Culemborg	Clason 1977
	Driel	Clason 1977
upland	Oss–Ussen, EIA	IJzereef pers. comm.
	Oss–Ussen, MIA	IJzereef pers. comm.
	Oss–Ussen, LIA	IJzereef pers. comm.
	Den Burg (Texel)	Krauwer 1982

Table 6.2 List of sites in the coastal wetlands of the Netherlands, with identified bone assemblages, used in this study. Only main references listed

ecozone	site name	reference
Early/Middle Neolithic		
fresh tidal	Swifterbant	Zeiler in press
peat	Hazendonk Haz. 1–2	Zeiler in press
	Hazendonk Haz. 3	Zeiler in press
Late Neolithic		
dunes	Leidschendam	Groenman-van Waateringe *et al.* 1968
	Voorschoten	Groenman-van Waateringe *et al.* 1968
salt marsh	Zandwerven	Clason 1963; 1967
	Aartswoud	Van Wijngaarden-Bakker 1981
	Kolhorn	Zeiler 1989
fresh tidal	Vlaardingen	Clason 1963; 1980

Table 6.3 Prehistoric sites in the coastal wetlands of the Netherlands with house plans or other structural remains; some upland margin sites included

ecozone	site name	reference
Early/Middle Neolithic		
fresh tidal	Swifterbant S3	Van der Waals 1977
	Bergschenhoek	Louwe Kooijmans 1987
Late Neolithic		
dunes	Haamstede	Louwe Kooijmans 1985
	Leidschendam	Glasbergen *et al.* 1967
salt marsh	Kolhorn	Kielman 1986
fresh tidal	Vlaardingen	Van Beek 1990
	Hekelingen	Louwe Kooijmans 1987
Late Beaker/ Early Bronze Age		
fresh tidal	Vlaardingen	Van Beek 1990
river clay	Molenaarsgraaf	Louwe Kooijmans 1974
	Ottoland	Wassink 1981
Middle/Late Bronze Age		
dunes	Velserbroekpolder	Therkorn 1987b
salt marsh	Hoogkarspel	Bakker *et al.* 1968
	Andijk	Van Regteren Altena 1977
	Bovenkarspel	IJzereef 1981
river clay	Zijderveld	Hulst 1973
	Dodewaard	unpublished
	De Horden	Van Es *et al.* 1988
upland	Oss	Fokkens 1990
	Den Burg (texel)	Woltering 1975
Iron Age		
dunes	Spanjaardsberg	Modderman 1961–2
salt marsh	Opperdoes	Woltering 1985
	Ezinge	Van Giffen 1936
	Middelstum	Boersma 1988; Van Gijn/ Waterbolk 1984
fresh tidal	Vlaardingen–Broekpolder	Van Heeringen 1987; 1988
	Vlaardingen Holiërhoekse polder	Van Heeringen 1988
	Spijkenisse	Van Trierum *et al.* 1988
	Assendelft Q	Therkorn *et al.* 1984
	Assendelver Polders	Therkorn 1987a
river clay	Zijderveld	Hulst 1973
	Culemborg	unpublished
	De Horden	Van Es *et al.* 1988
upland	Oss	Van der Sanden 1987; Van der Sanden/Van den Broeke 1987
	Den Burg (Texel)	Woltering 1975

Table 6.4 (opposite) Fish remains from prehistoric sites in the Dutch coastal wetlands, after Brinkhuizen 1979, with additions. Note the absence of Iron Age data and the relation between numbers of species and sieving of samples. Freshwater species not in taxonomic order but in order of frequency of occurrence in sieved samples

Table 6.4

1 = Brinkhuizen 1979a; 2 = IJzereef 1981; 3 = Prummel 1987

* = partly sieved sample

Bergschenhoek*[1]	Swifterbant*[1]	Hazendonk*[1]	*Early Neolithic*	Hekelingen III*[3]	Vlaardingen[1]	Kolhorn[1]	*Late Neolithic*	Bovenkarspel*[2]	Hoogkarspel[1]	*Middle/Late Bronze Age*	
											salt water fish:
-	+	-		+	+	+		-	-		Thin-lipped grey mullet (*Mugil capito*)
-	-	-		-	-	+		-	-		Cod (*Gadus morhua*)
-	+	-		-	-	-		-	-		Flounder (*Platichthys flesus*)
-	–	-		-	-	+		-	-		Flat fish (Pleuronectidae)
											anadromous fish:
-	+	+		+	+	+		-	-		Sturgeon (*Acipenser sturio*)
-	+	+		-	-	-		-	-		Salmon/sea trout (*Salmo solar/trutta*)
-	-	+		-	-	-		-	-		Alice shad (*Alosa alosa*)
											fresh water fish:
+	+	+		+	+	-		+	+		Pike (*Esox lucius*)
+	+	+		+	-	-		+	+		Catfish (*Siluris glanis*)
+	+	+		+	-	-		+	+		Common eel (*Anguilla anguilla*)
+	+	+		+	-	-		+	+		Perch (*Perca fluviatilis*)
-	+	?		+	-	-		-	-		Tench (*Tinca tinca*)
-	+	+		+	-	-		-	-		Rudd (*Sardinius erythrophalnus*)
-	+	+		+	-	-		+	-		Roach (*Rutilus rutilus*)
-	+	-		-	-	-		-	-		Ruffe (*Acerina cernua*)
-	+	-		-	-	-		+	-		Bream (*Abramis brama*)
-	-	+		-	-	-		+	-		Ide (*Leuciscus ide*)
-	-	+		-	-	-		-	-		Burbot (*Lota lota*)
-	-	?		-	-	-		-	-		Barbel (*Barbus barbus*)
-	-	-		+	-	-		+	-		White bream (*Blicca bjoerkna*)
-	-	-		-	-	-		+	-		Bleak (*Alburnus alburnus*)
+	-	-		+	-	-		+	-		Carp (Cyprinidae)
-	-	-		-	-	-		+	-		Sticklebacks (*Gasterosteus aculeatus/Pungitis pungitis*)

Table 6.5 Macro-botanical remains from prehistoric sites in the Dutch coastal wetlands, after various sources. Only presence noted, which might be a single specimen. The very unequal methods and intensity of recovery will have influenced the scores

	Einkorn (*Triticum monococcum*)	Emmer (*T. dicoccum*)	Bread wheat (*T. aestivum*)	Spelt (*T. spelta*)	Naked barley (*Hordeum vulgare (nudum)*)	Hulled barley (*H. vulgare*)	Millet (*Panicum miliaceum*)	Oats (*Avena sativa*)	Flax/linseed (*Linum usitatissimum*)	Gold-of-pleasure (*Camelina sativa*)	Turnip (*Brassica campestris*)	Carrot (*Daucus carrota*)	Bean (*Vicia* sp.)
Iron Age													
Assendelft K[1]	-	+	-	-	-	+	-	+	-	+	-	-	-
Assendelft Q[2]	-	+	-	-	-	+	+	+	+	+	+	-	-
Spijkenisse site 17–34[3]	-	+	-	-	-	+	-	-	+	-	-	-	-
Geervliet[3]	-	-	-	+	-	+	-	-	-	+	-	-	-
Vlaardingen-Broekpolder[4]	-	-	-	-	-	+	+	-	+	+	+	-	-
Opperdoes[5]	-	-	-	-	-	+	-	-	+	+	-	-	+
Middle / Late Bronze Age													
Bovenskarpel[6,7,5]	+	+	-	-	+	+	-	-	+	-	-	-	+
Twisk[5]	-	+	-	-	+	-	-	-	-	-	-	-	-
Zijderveld[8]	-	+	-	-	-	+	-	-	-	-	-	-	-
Late Neolithic													
Aartswoud[9]	+	+	+	-	+	+	-	-	+	-	-	-	-
Zandwerven[8]	-	+	-	-	+	-	-	-	-	-	-	-	-
Hekelingen III[10,11]	-	+	-	-	+	-	-	-	+	-	-	+	-
Vlaardingen[8]	-	+	+	-	-	+	-	-	-	-	-	-	-
Hazendonk VL 2b[12]	-	-	-	-	+	-	-	-	-	-	-	-	-
Hazendonk VL 1b[12]	-	+	-	-	+	-	-	-	-	-	-	-	-
Early / Middle Neolithic													
Hazendonk Haz. 3[12]	-	+	-	-	+	-	-	-	-	-	-	-	-
Hazendonk Haz. 2[12]	-	+	-	-	-	-	-	-	-	-	-	-	-
Hazendonk Haz. 1[12]	-	+	-	-	+	-	-	-	-	-	-	-	-
Swifterbant S3[13]	-	+	-	-	+	-	-	-	-	-	-	-	-

1 = Pals 1987; 2 = Pals in Therkorn et al. 1984; 3 = Brinkkemper in press; 4 = Van Zeist 1974; 5 = Buurman 1988; 6 = Buurman 1979; 7 = Burrman and Pals 1974; 8 = Van Zeist 1968; 9 = Pals 1983; 10 = Bakels 1986; 11 = Bakels 1988; 12 = Bakels 1981; 13 = Van Zeist and Palfrenier 1981

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