Western Continental Europe

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ABSTRACT: Subject of this contribution are the published seed and fruit remains from the Netherlands, Belgium, Luxemburg and northern France. The material is reviewed in a chronological order, beginning with the Palaeolithic and ending with the Middle Ages and Later Historical Periods. Where possible, the interpretation of the botanical data by the various authors has been summarized. Most of these interpretations are of an economic nature.

1 INTRODUCTION

Western continental Europe comprises the Netherlands, Belgium, Luxemburg and the north and west of France. The southernmost French départements included in this research are Charente-Maritime, Charente, Vienne, Indre-et-Loire, Loir-et-Cher, Loiret, Yonne, Haute-Marne, Haute-Saône and Haut-Rhin. The greater part of the area consists of rolling country dissected by rivers, the only mountains being the Vosges. Two features which play a rather important rôle in the following are the combined delta of the rivers Rhine, Meuse and Scheldt, and the tidal marshes in the north. Both are referred to as the "wetlands".

The research done before the sixties was not very systematic in the sense that the botanists who investigated macroremains did not form part of the archaeological teams responsible for the excavations. Summaries of the early work can be found in van Zeist (1970), De Ceunynck and Verbruggen (1985) and Marinval (1988). Since then systematic sampling, supervised by specialists, has become more and more the rule, especially in the Netherlands. The larger Dutch archaeological institutes have their own botanists. These institutes are the Biologisch-Archaeologisch Instituut at Groningen, the Albert Egges van Giffen Instituut voor Prae- en Protohistorie at Amsterdam, the Instituut voor Prehistorie at Leiden and the Rijksdienst voor het Oudheidkundig Bodemonderzoek at Amersfoort. Unfortunately, the situation is less advanced in Belgium, Luxemburg and France.

The aim of the following will be to give a survey of what is known on the subject of fruits and seeds in the studied area. Unfortunately, for lack of room, other macroremains cannot be dealt with here and even the remains of wild plants can hardly be discussed in the way they deserve. The material will be reviewed in a chronological order. Only fully published reports will be discussed. However, in a few cases the results of an incompletely published or internal report have been included as they fill an otherwise serious gap.

2 THE PALAEOLITHIC, EPIPALAEOLITHIC AND MESOLITHIC (.....-6400 BP)

This paragraph covers the longest period of man-plant relationships, but presents the shortest list of data. No seed and fruit remains whatsoever have yet been ascribed to the Palaeolithic proper. This is not due to inadequate research. At the intensively sampled Middle Palaeolithic site of Maastricht-Belvédère, for instance, even charcoal had crumbled to powder. Remains of seeds, if at all present, must have disintegrated beyond recognition (Roebroeks 1985: 111). Many of the Palaeolithic sites may simply not have favoured the preservation of seeds over such a long stretch of time.

The gathering economy of the Epipalaeolithic and Mesolithic did leave some traces, but well-preserved finds are scarce. Charred fragments

Table 1. Sites with Epipalaeolithic and Mesolithic hazelnut shells.

site	BP	author(s)
Abri de Bellefond		Patte (1971)
Coincy	8190±190	Parent (1973)
Montbani	7280±350	Parent & Planchais (1972)
Chambre des Fées, Coincy		Hinout (1964)
Manlefelsen, Oberlarg	9030	Thevenin & Sainty (1974)
Weelde-Paardsdrank	6990±135	Huyge & Vermeersch (1982)
Neerharen-De Kip	9170±100	Lauwers & Vermeersch (1982)

of Corylus avellana are mentioned most often (Table 1). Other species have been recorded for the Late Mesolithic (Atlantic Period). Newell (1973) mentions Trapa natans, Quercus sp. and Prunus avium as remains of the Dutch Leien-Wartena complex, but the full data have never been published. The Prunus avium stones found in the often-cited Belgian site of Obglabbeek-Ruiterskuil (Vermeersch et al. 1974) may, on second thought, be subrecent. These uncarbonized remains came from a podzol and no clear connection has been established between the remains and the Mesolithic artefacts; they do not look very old either (Vermeersch, pers. comm.; Bakels, unpubl.). The famous French site of Téviec (Morbihan) is reported to have yielded carbonized pears of the species Pyrus cordata (Boone & Renault-Miskovsky 1976), but these may require reexamination.

3 THE EARLY NEOLITHIC (6400-5900 BP)

Food production was introduced from elsewhere. In the largest part of the studied area this way of life was made known by people of the Bandkeramik Culture. As this culture originated in central Europe, to be precise in the Carpathian Basin, agriculture must have reached our region from the east via Germany.

Bandkeramik settlements have been excavated in the southeastern part of the Netherlands, in the loess region of Belgium, and in the northern part of France, including the Paris Basin. Synopses of the carbonized finds found at these sites have been published by Bakels (1979, 1984), Heim (1983) and Bakels and Rousselle (1985). The main crop was Triticum dicoccum, in most cases with an admixture of Triticum monococcum. There is no evidence to suggest that einkorn was cultivated as a crop in its own right. The Triticum aestivum reported to have been found at Oudoumont (Belgium) was incorrectly identified. Other crop plants are Pisum sativum, Lens culinaris and Linum usitatissimum. Hordeum vulgare var. nudum has only been identified at two Belgian sites at the very edge of the loess belt and in the French Aisne valley. Another uncommon crop plant is Papaver somniferum var. setigerum, which has so far only been recovered from Dutch sites. Presumably domesticated in the West Mediterranean Basin, it is the only southwestern European element in a collection of crop plants which came from central Europe and, ultimately, from the Near East (Bakels 1982).

The crop plants are accompanied by a set group of weeds, at least in the Netherlands and Belgium (Table 2). Insufficient French sites have been investigated to allow us to draw up a list of the most common species of France. The list of the Netherlands and Belgium closely resembles that of the German Rhineland. The weeds, first and foremost Lapsana communis, indicate the cultivation of small fields which were shaded part of the day, presumably because they were surrounded by remnants of the primeval forest. It is difficult to conclude whether the Bandkeramik farmers sowed their cereals in autumn or spring, because the weed species identified permit either conclusion

Table 2. Frequency of weeds in seven Dutch and Belgian Bandkeramik sites.

Bromus secalinus	6
Chenopodium album	6
Polygonum (Bilderdykia) convolvulus	5
Lapsana communis	5
Phleum sp.	4
Polygonum persicaria	3
Bromus sterilis + tectorum	3
Galium aparine	3
Vicia hirsuta + tetrasperma	2
Echninochloa crus-galli	2
Rumex sp.	2
Galium cruciata	2

(Bakels & Rousselle 1985). Further data on crop processing will be published by Bakels (in press c). The carbonized cereal remains can be split into two categories. The first consists of not yet dehusked kernels which could represent unsuccessful grain parching. The second is the by-product of dehusking: the chaff. A third category of waste is unripe seeds of Chenopodium album, which are interpreted as the remains of the cleaning of vegetables. Charred fragments of wild nuts and fruits, such as Corylus avellana, Prunus spinosa and Malus sylvestris, show that these were still being gathered, but the relative importance of this activity cannot be assessed.

The above-mentioned finds all come from pit-fills in open-air settlements, the only exception in this region being the cave of La Baume de Gonvillars (Haute-Saône), a site which deserves special attention. Layer XI of the cave sediments revealed three hearths, six vessels, three querns, some tools, etc. and a cubic metre of carbonized cereals. One of the hearths yielded a ^{14}C date of 6250±300 BP. All artifacts had been deposited in an orderly and well-planned manner and the cave is therefore thought to have been suddenly abandoned (Pétrequin 1970). M. Villaret identified the grain and found that just over half of the assemblage consisted of remains of Triticum dicoccum, a quarter was Hordeum vulgare var. nudum and less than a quarter Triticum aestivum. The grain was clean consumption grain, free of weeds and almost free of chaff. Two of the chaff fragments recovered looked as though they may have belonged to Triticum spelta, but it is not certain whether this wheat was indeed known here (Villaret, in Pétrequin 1970). Unfortunately, the report does not state whether the cereals had been stored as a mixture or whether they were found separately. The great botanical importance of the find is the presence of large quantities of naked barley and naked wheat, which are strange to the Bandkeramik world, but did occur in the south of France. The pottery is not of the classical Bandkeramik style either. Gonvillars may represent a point of contact between the central European (Bandkeramik) tradition and the Mediterranean Neolithic.

Whereas the Bandkeramik culture has been fairly extensively studied, very little research has been done on the second Early Neolithic culture in our region, that of western France. This Neolithic culture is known best for its cairns (funeral monuments). Before the cairn of Dissignac near St. Nazaire (Loire-Atlantique) was constructed the site seems to have been occupied by Neolithic settlers who left carbonized remains identified by J. Heim as Triticum aestivum, Hordeum vulgare var. nudum and Corylus avellana (Heim, pers. comm.). Charcoal from the ancient surface yielded dates ranging from 6250±150 BP to 5780±150 BP but a date of 4940±140 BP was also obtained (l'Helgouach 1977, 1981).

4 THE MIDDLE NEOLITHIC, LATE NEOLITHIC AND CHALCOLITHIC (5900-3700 BP)

This time range covers the Rössen, Cerny, Chasséen, Funnel Beaker, Michelsberg, Seine-Oise-Marne and Beaker Cultures, to mention a few well-known names.

The direct heirs of the Bandkeramik Culture are Rössen and Cerny, but it is now clear that at least as far as the Rössen people are concerned, their agricultural tradition was no direct continuation of Bandkeramik practices. Although the field weeds indicate that their fields were laid out according to the same pattern, they grew a greater variety of cereal crops. Triticum aestivum and Hordeum vulgare var. nudum were also cultivated as main crops, alongside the emmer and einkorn wheat of earlier times. The new cereals are thought to represent a fresh influence from, ultimately, southern France (Bakels, in press a,b). In this light it is a pity that so little is known about the French Early Middle Neolithic proper. The only relevant seed assemblages come from the Villeneuve-St. Germain group. Two pit fills from the type site have been published (Bakels 1984) and they did not contain naked wheat or naked barley. So far, no research has been done on the other follower of the Bandkeramik tradition, the Cerny Culture.

The still very scarce data available on western and northern France, Belgium and Luxemburg make it almost impossible to draw a picture of the Neolithic and Chalcolithic in those regions. The available information is presented in Table 3.

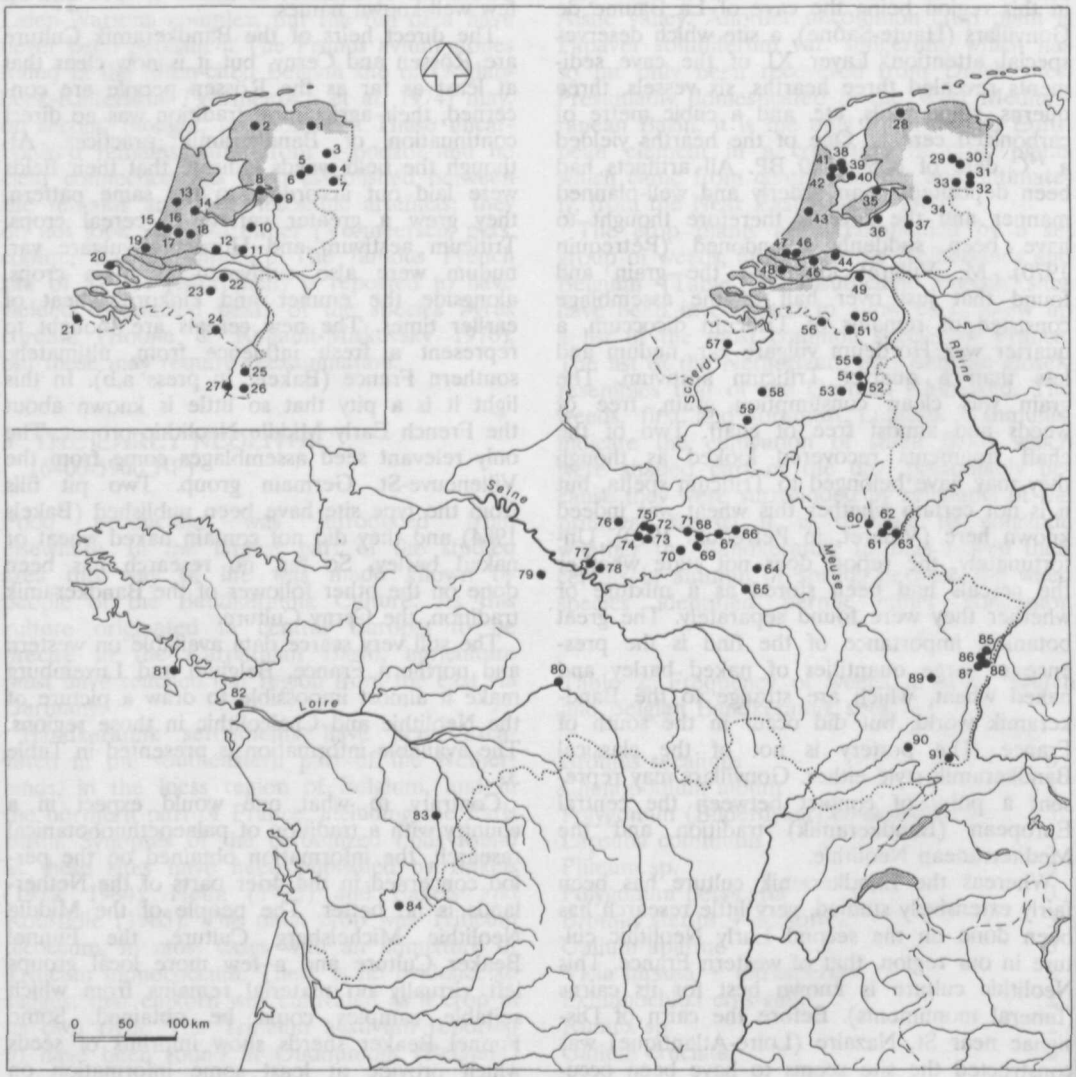
Contrary to what one would expect in a country with a tradition of palaeoethnobotanical research, the information obtained on the period concerned in the drier parts of the Netherlands is no better. The people of the Middle Neolithic Michelsberg Culture, the Funnel Beaker Culture and a few more local groups left virtually no material remains from which suitable samples could be obtained. Some Funnel Beaker sherds show imprints of seeds which provide at least some information on

crop plants. Triticum dicoccum, Triticum monococcum, Hordeum vulgare var. nudum and Linum usitatissimum have been identified (van Zeist 1970; Bakels 1976).

Little more is known about the Late Neolithic. The most detailed information comes from Eeserveld, where van Zeist (1970) found separately stored supplies of emmer, naked barley and acorns. The Bornwird samples came from an old plot of cultivated land which showed ard marks.

The lack of data from the upland sites is to some extent offset by that from the Dutch wetland sites. In these wetter regions traces of human occupation usually are buried beneath thick layers of sediments, but some lie close enough to the surface to be excavated. These are situated either in the higher parts of the landscape or in areas where erosion or human action have removed large parts of the overlying sediments. All kinds of plant remains have been preserved in the wet environment and as a rule the excavation of sites includes intensive sampling programmes.

The oldest traces of Neolithic occupation were discovered at Bergschenhoek near Rotterdam. Around 5400 BP people camped there in an environment of fresh-water marshes and lakes. They used a floating island consisting of



peat, which they repeatedly visited during the late autumn, witness the bones of migrating birds. They left a hearth, some pottery sherds and parts of their hunting and fishing gear, such as fish traps, but no remains of cultivated plants. Plant remains include Corylus avellana shell fragments, Prunus spinosa stones and carbonized apples of Malus sylvestris (van Zeist, pers. comm.).

Another Middle Neolithic seasonal settlement has been excavated at Swifterbant. It is dated to around 5300 BP and is thought to have been occupied in summer. People lived on the levees of a system of fresh-water creeks. The landscape was one of willow and reed marshes. Swifterbant did yield cereal grains, all of which were carbonized. The majority are grains of Hordeum vulgare var. nudum, the rest are grains of Triticum dicoccum and a single grain of what is thought to be Triticum aestivum (Casparie et al. 1977; van Zeist & Palfenier-Vegter 1983). Rachis and glume fragments of naked barley were also found at this site and this is taken as an indication that the crop was grown locally, in spite of the unfavourable edaphic conditions. "For, if the plants had been grown elsewhere, the threshed grains, which are considerably less bulky than the ears, would have been transported" (Casparie et al. 1977: 51). The quality of the crop, as expressed by the size of the grains, is not poor at all, but this tells us nothing about grain yields or frequency of crop failures. According to van Zeist and Palfenier-Vegter, it is unlikely that the locally grown crops constituted the main item of the diet of the inhabitants of Swifterbant. Wild species were collected too, as is clear from the presence of seeds of Corylus avellana, Malus sylvestris, Crataegus monogyna, Rosa sp. and Rubus fruticosus. As for some of the plants found, such as Chenopodiaceae, Polygonum species and Urtica dioica, it is not certain whether they were eaten or whether they simply represent the local vegetation of a disturbed habitat (van Zeist & Palfenier-Vegter 1983).

A rather important series of layers containing Neolithic occupational waste, separated by clean sediments, was excavated on the slopes of a now almost buried river dune near Molenaarsgraaf: the Hazendonk. The dune constitutes a dry spot in an environment of lakes, reed marshes and alder carrs. The sequence begins with the "Hazendonk 1" phase which is

Fig. 1. Location of the sites mentioned in the text. Dotted line: boundary of the area under review. Shaded: ares with wetland sites. For the sake of clarity, Dutch settlements (nos 1-27) belonging to the Roman period and historical times are presented on an inset map.

1 Groningen
2 Leeuwarden
3 Gasselte
4 Odoorn
5 Wijster
6 Pesse
7 Noordbarge
8 Kampen
9 Dalfsen
10 Kootwijk
11 Ede-Veldhuizen
12 De Horden
13 Haarlem
14 Amsterdam
15 Valkenburg
16 Leiden
17 Alphen-aan-den-Rijn
18 Woerden
19 Naaldwijk
20 Ouddorp
21 Aardenburg
22 Oss
23 's-Hertogenbosch
24 Dommelen
25 Sittard
26 Voerendaal
27 Maastricht
28 Bornwird
29 Elp
30 Eeserveld
31 Angelsloo + Emmerhout
32 Noordbarge
33 Gees
34 Ommen
35 Swifterbant
36 Ermelo
37 Colmschate
38 Opperdoes
39 Twisk
40 Bovenkarspel
41 Aartswoud
42 Zandwerven
43 Assendelver Polders
44 Zijderveld
45 Hazendonk
46 Bergschenhoek
47 Vlaardingen
48 Hekelingen
49 Oss
50 Son & Breugel
51 Dommelen
52 Maastricht
53 Broekom
54 Neerharen
55 Opglabbeek
56 Weelde
57 Evergem
58 Ittre
59 Givry
60 Titelberg
61 Düdlingen
62 Peppingen
63 Weiler zum Turm
64 Suippes
65 Châlons-sur-Marne
66 Menneville
67 Cuiry-lès-Chaudardes
68 Chassémy
69 Montbani
70 Coincy
71 Villeneuve-St. Martin
72 St. Pierre-en-Chastre
73 Champlieu
74 Béthisy-St. Martin
75 Compiègne
76 Catenoy
77 Baillet-en-France
78 Villiers-le-Sec
79 Le Fort Harrouard
80 Orléans
81 Téviec
82 Dissignac
83 Abri de Bellefond
84 Chazelles
85 Cronenbourg
86 Geispolsheim
87 Rosheim
88 Entzheim
89 Etival-Clairefontaine
90 Gonvillars
91 Manlefelsen

Table 3. Carbonized seeds from the Middle Neolithic, Late Neolithic and Chalcolithic periods. Gr. = Grossgartach, Röss. = Rössen, Epiröss. = Epirössen, VSG = Villeneuve-St. Germain group, Mich. = Michelsberg, Vla. = Vlaardingen, PFB = Protruding Foot Beaker, SOM = Seine-Oise-Marne, c = cf. Dates in years BP.

			Triticum monococcum	Triticum dicoccum	Triticum aestivum/durum	Hordeum vulg. var. nudum	Hordeum vulgare	Pisum sativum	Linum usitatissimum	Papaver somniferum	Quercus sp.	Corylus avellana	Malus sylvestris	Prunus spinosa	Crataegus monogyna	
upland sites:																
Rosheim, Gr.					+											Erroux (1976)
Maastricht, Röss.		5800		+	+	+	+					+		+		Bakels (in press a,b)
Entzheim, Epiröss.		5400		+	+		+		c							Hopf (1975)
Givry, Epiröss.		5300			+	+						+				Heim (1979)
Ittre, Epiröss.-Mich.				+		+	+					+				Heim (1987)
Villeneuve-St. Germain, VSG				+	+							+				Bakels (1984)
Cuiry-lès-Chaudardes, Mich.					+			c			+		+			Bakels (1984)
Geispolsheim, Mich.				+	+	+	+									Hopf (1987)
Cuiry-lès-Chaudardes, SOM												+				Bakels (1984)
Eeserveld, PFB		3955±50			+		+				+					van Zeist (1970)
Bornwird, PFB	before	3930±50			+		+					+				van Zeist (1970)
wetland sites:																
Swifterbant		5300		+	c	+						+	+		+	van Zeist & Palfenier-Vegter (1983)
Hazendonk		5300		+		+						+	+		+	Bakels (1981)
Hazendonk, Mich.		5000-4800		+		+					+	+	+	+	+	Bakels (1981)
Hazendonk, Vla.		4600-4400		+		+					+	+		+	+	Bakels (1981)
Hekelingen, Vla.4		300-4000		+		+			+		+	+	+	+		Bakels (1988)
Vlaardingen, Vla.		4300		+	+		+									van Zeist (1970)
Zandwerven, Vla.				+		+						+				van Zeist (1970)
Aartswoud, PFB		4000-3900	+	+	+	+			+		+	+	+			Pals (1984)
Hazendonk, BB		3600									+	+				Bakels (1981)

contemporary with Swifterbant, i.e. datable to 5300 BP. The next two phases are dated to 5000 and 4800 BP, respectively, and these are ascribable to a local version of the Michelsberg Culture. These were followed by three "Vlaardingen Culture" (a Dutch Late Neolithic Culture) phases, dated to 4600, 4400 and 4100 BP and finally a Bell Beaker/Barbed Wire Beaker occupation phase, dated to 3600 BP. A preliminary report on the seeds shows that Hordeum vulgare var. nudum was known there throughout all of these phases. The other cereal found, Triticum dicoccum, occurred here up to and including the Vlaardingen phase 1 only. The material comprises carbonized kernels and chaff. In spite of the intensive research carried out, no non-carbonized cereal remains were found. The cereals were accompanied by weed seeds, the most important of which was Bromus secalinus (chess). In one of the Hazendonk 1 assemblages the emmer/barley/chess grain ratio is 100/400/150, which suggests that the chess was eaten along with the cultivars (Bakels 1981). As at Swifterbant, the question arises as to whether the crops were in fact cultivated on the small river dune itself. During the occupation of Hazendonk 1, the dry surface area of the dune amounted to approximately 1.2 ha; by

the time of the last Vlaardingen occupation phase it had already shrunk to 0.4 ha, due to continuous sedimentation and peat growth around its base and on its slopes. There was very little space for fields, because it must not be forgotten that there must have been room for huts and for activities such as fish cleaning. In spite of the abundance of chaff, it seems most unlikely that crops were grown locally and, contrary to the views held by the researchers working at Swifterbant, the crops are thought to have been brought to the site in the ear. The Hazendonk excavation also yielded wild plant foods such as Malus sylvestris, Prunus spinosa and Crataegus monogyna, all of which were carbonized. They could have been picked locally, but again, there was only little dry surface area and local harvests cannot have been very plentiful. It is, however, impossible to quantify the amount of plant food gathered.

The same question, of whether crops were raised locally or not, arose in connection with a third wetland site: Hekelingen near Rotterdam. Here the narrow levee of a fresh-water tidal creek revealed traces of intermittent Vlaardingen Culture occupation between 4300 and 4000 BP. The waste included both kernels and chaff of Triticum dicoccum and Hordeum vulgare var. nudum, in addition to remains of Linum usitatissimum. Some of the species collected are Corylus avellana, Prunus spinosa, Malus sylvestris, Quercus sp., Trapa natans and Ranunculus ficaria (tubers). As the levee was only about 20 m wide and was bounded by an active tidal creek on one side and by a backswamp with active alder-carr peat formation on the other, arable land was scarce. Even if the levee was occupied by only a small group of people, a considerable stretch of land must have been cleared for cultivation but there is no evidence of this in the pollen diagrams. Therefore, the grain was most probably imported and perhaps the acorns too, as it is unlikely that oak trees grew nearby (Bakels 1988).

If the grain found at both Hazendonk and Hekelingen was imported, where was it produced? The coastal dunes and the broader levees have been suggested as possible sources. Unfortunately, only few samples have been taken in these areas. One sample, from Vlaardingen, shows, surprisingly, not a main crop of naked barley and emmer, but of Triticum aestivum, with an admixture of Triticum dicoccum. The sample also contained four grains of hulled Hordeum vulgare (van Zeist 1970). As yet, this is an unique find. More in accordance with our expectations are the Vlaardingen Culture samples from Zandwerven, which contained the remains of Triticum dicoccum and Hordeum vulgare var. nudum (van Zeist 1970). At Zandwerven ard marks indicated the existence of local fields. But this, of course, does not prove that such sites produced the grain for the sites on the smaller parcels of dry land, whether these were seasonally occupied or not.

The discussion of Dutch Neolithic wetland sites will be concluded with the mentioning of a Late Neolithic Protruding Foot Beaker/Bell Beaker settlement near Aartswoud. This site is also situated on the levee of a tidal creek, in this case a brackish one. The landscape was open and, as opposed to the sites described so far, the levees were not yet covered with trees. The surroundings were vast salt marshes in some stage of desalination. Linum usitatissimum, Triticum dicoccum and Hordeum vulgare var. nudum were the staple crops. Triticum aestivum was a scarce admixture (Pals 1984). The few hulled barley grains published for this site are now interpreted as carbonized milk-ripe naked barley grains. The presence of robust carbonized Gramineae stems was originally thought to indicate local agriculture, but the possibility that they are the tops of Phragmites rather than cereals cannot be ruled out (Pals, pers. comm.). However, the carbonized weed remains are dominated by Althaea officinalis, Atriplex sp., Scirpus sp. and Chenopodium album, and the first three support a local provenance of the crops because they grow in brackish environments and presumably came from the lower-lying margins of the quite recently desalinated fields. Wild plants were still gathered to a varying extent. Remains of Rubus sp., Malus sylvestris, Quercus sp. and Corylus avellana have frequently been found. It is quite unlikely that the apples, acorns and hazelnuts were gathered near the settlement. As the site is thought to have been occupied the year round, there must have been organized "fruit gathering expeditions in autumn to the higher sandy soils which were at least 15 km away" (Pals 1984).

To conclude, the research carried out in the wetlands has provided us with a question which is never raised by the contemporaneous upland sites, namely are the sites at which edible plant remains and especially crop remains are found always producer sites? The answer is plainly no. However, wetland sites may form a special case. A non-agrarian economy, such as fishing and fowling, might have been more rewarding in these areas than a food-producing system.

5 THE BRONZE AGE (3700-2600 BP)

Unfortunately, most of our knowledge of the Bronze Age concerns burials and hoards and very little is known about Bronze Age settlements. However, recent excavations are beginning to alter this unbalanced situation and this is of benefit to palaeoethnobotany.

To begin with western and northern France, the richest collection of seeds published so far is that from Le Fort Harrouard near Dreux (Eure-et-Loir). This hillfort is situated on a promontory between a steep-banked dry valley and the river Eure and must have controlled a large area. It certainly occupied a central position. Part of the site was excavated at the beginning of this century by Abbé J. Philippe, who not only recorded the architectural remains and rich mobilia, but also took a large number of seed samples (Bakels 1982-'83, 1984). Predominant in the Early and Middle Bronze Age assemblages is Panicum miliaceum, found as lumps of fused grains still covered by the palea and lemma. These lumps contain no remains of other species, not even of weeds. Other species encountered in the samples are Triticum dicoccum, Hordeum vulgare, Vicia faba var. minor and Quercus sp. The richest finds are from the Late Bronze Age. The ubiquitous presence of lumps of carbonized grain suggests that the hillfort, or some quarters of it, must have burned down at least twice, once during the Late Bronze Age I and again during the Late Bronze Age III. The charred food supplies comprise Triticum dicoccum, Hordeum vulgare, Panicum miliaceum, Vicia faba var. minor, Pisum sativum and Quercus sp. Less common are Triticum aestivum, Malus sylvestris, Rosa sp., Prunus spinosa and Corylus avellana. The stores were very clean, only a few remains of Avena sp. and Bromus sp. were found. Some years ago the investigation was started again and the first botanical samples taken were identical to those described above.

Recent research at another hillfort, Catenoy (Oise), revealed the same species as those of Le Fort Harrouard: Triticum dicoccum, Hordeum vulgare, Panicum miliaceum, Vicia faba var. minor and Pisum sativum (Bakels, unpubl.).

A 19th century excavation of a third hillfort, St. Pierre-en-Chastre near Vieux-Moulin (Oise), yielded a small decorated Late Bronze Age vessel full of beautifully preserved Hordeum vulgare with an admixture of some Triticum dicoccum, Panicum miliaceum and a few weeds. The grain must have been carbonized in the pot, because the apical hairs and rachillae were undamaged. The function of the vessel is still not clear. It is far too small to have been used for storage purposes, even for the grain of one meal or for the sowing of one field. It may have been an offering (Bakels 1984). The remains found at other French Bronze Age sites are presented in Table 4.

No Bronze Age finds from Belgium are as yet available, but two Late Bronze Age (Urnenfelderkultur) sites have been discovered in Luxemburg: Düdlingen-Budersberg and Peppingen-Keitzenberg, which yielded rich assemblages of carbonized seeds. The crop plants identified in these assemblages are Triticum dicoccum, Triticum spelta, Hordeum vulgare, Panicum miliaceum and Lens culinaris. Prunus spinosa, Quercus sp., Sambucus ebulus and Rosa sp. must have been collected as wild plants and fruits. The assemblages are also rich in wild herb species (Bakels, unpubl.).

The rather scarce Dutch Bronze Age finds recovered from the higher grounds are presented in Table 4. The seeds from one site, Oss-IJsselstraat, were found in a well which has been dated to 3200±30 BP. This Middle Bronze Age well provided remains of a rather unexpected species, which is not mentioned in the table, namely an uncarbonized stone of Prunus insititia (Bakels 1980a).

Bronze Age wetland occupation is discussed by Buurman (1979 and especially 1988a), who investigated material from the province of North Holland. In this region the occupants settled on gully ridges, the remnants of a previously tidal flat landscape. The silted-up tidal gullies became sandy ridges during the inversion of relief through differential shrinkage. At the time when they were occupied they were the highest and driest parts of the landscape. Here finds have been recovered datable to the Middle Bronze Age, from 3200 to 2850 BP, and the Late Bronze Age, from 2800 to 2650 BP.

The arable fields were situated on top of the ridges where the light, well-drained soil was the easiest to till. The lower-lying clay basins were used as pasture-land. There may have been fresh-water lakes in the lowest parts of these basins (Buurman 1988a). The fields themselves were recognizable by the ditches marking their boundaries. Other, circular, ditches and circles composed of pits, both with diameters of about 4 metres, are interpreted as the remains of drainage ditches around corn stacks. This interpretation is based on the discovery of carbonized cereal stems, heavy and fine chaff and kernels in two of them (at Bovenkarspel). Seeds of low- and tall-growing weeds were also

Table 4. Carbonized seeds from the Bronze Age.
EB = Early Bronze Age, MB = Middle Bronze Age, LB = Late Bronze Age. Dates in years BP.

		Triticum dicoccum	Triticum aestivum	Triticum spelta	Hordeum vulg. var. nudum	Hordeum vulgare	Panicum miliaceum	Vicia faba var. minor	Pisum sativum	Lens culinaris	Linum usitatissimum	Quercus sp.	Corylus avellana	Malus sylvestris	Prunus spinosa	
upland sites:																
Fort Harrouard, EB		+	.	.	.	+	+	.	.	.	.	.	.	.	.	Bakels (1984)
Compiègne, EB		.	.	.	.	.	+	.	.	.	.	.	.	.	.	Bakels (1984)
Fort Harrouard, MB		+	.	.	.	.	+	+	.	.	.	.	+	.	.	Bakels (1984)
Chazelles, MB		.	.	.	+	+	+	.	.	.	.	.	.	+	.	Marinval (1983)
Son, MB		+	.	.	.	+	+	.	.	.	.	+	.	.	.	Bakels & van der Ham (1980)
Oss-IJsselstraat, MB	3200±30	.	.	.	.	+	.	.	.	.	.	.	.	.	.	Bakels (1980a)
Zijderveld, MB/LB	3370±80	+	.	.	.	+	.	.	.	.	.	.	.	.	.	van Zeist (1970)
Emmerhout, MB/LB	3320±60	+	.	.	+	.	.	.	.	.	.	.	+	.	.	van Zeist (1970)
Elp, MB/LB	3200-2750	+	.	.	+	+	+	.	.	.	.	+	.	.	.	van Zeist (1970)
Fort Harrouard, LB		+	+	.	.	+	+	+	+	.	.	+	+	+	+	Bakels (1984)
Catenoy, LB		+	.	.	.	+	+	+	+	.	.	.	.	.	.	Bakels (unpubl.)
Vieux-Moulin, LB		+	.	.	.	+	+	.	.	.	.	.	.	.	.	Bakels (1984)
Chazelles, LB		.	.	.	.	.	.	.	.	.	.	+	.	.	.	Marinval (1983)
Compiègne, LB		+	.	.	.	+	.	.	.	.	.	.	.	.	.	Bakels (1984)
Düdlingen, LB		+	.	+	.	+	+	+	.	.	.	.	+	.	.	Bakels (unpubl.)
Cronenbourg		.	.	.	.	.	.	.	.	.	.	.	.	+	.	Hatt & Zumstein (1960)
Peppingen, LB		.	.	+	.	+	+	.	.	+	.	.	.	.	+	Bakels (unpubl.)
wetland sites:																
Twisk, MB	3350±35	+	.	.	+	.	.	.	.	.	.	.	.	.	.	Buurman (1988a)
Bovenkarspel, MB		+	.	.	+	+	.	.	.	.	.	.	.	.	.	Buurman (1988a)
Opperdoes, MB		+	.	.	+	+	.	.	.	.	.	.	.	.	.	Buurman (1988a)
Bovenkarspel, LB		.	.	.	.	+	.	.	.	.	+	.	.	.	.	Buurman (1988a)
Opperdoes, LB		.	.	.	.	+	.	.	.	.	+	.	.	.	.	Buurman (1988a)

found in these circular ditches and it is thought that whole sheaves were destroyed by an accidental fire. Further processing of the crop took place near or in the houses, as is apparent from the distribution of fine chaff and weed seeds.

The first crop plants to have been sown are Triticum dicoccum, Hordeum vulgare var. nudum and Hordeum vulgare. Barley and emmer were also common. Naked barley, however, occurred only in the colonization phase. It was rather soon replaced by hulled barley, which is the only cereal to have been cultivated in the Late Bronze Age, because emmer vanished too. This change is ascribed to the increasing wetness of the area; only the highest gully ridges remained inhabitable. Nevertheless, at least one other crop plant became common in the Late Bronze Age: Linum usitatissimum, which shows that crop cultivation did not end with a monoculture of hulled barley.

The most striking aspect of the rather heterogeneous collection of Bronze Age plant remains discussed in this paragraph is the appearance of new crop plants. Hulled barley had either already taken the place of naked barley by the beginning of the Bronze Age or gradually did so in the course of this period (in the wetlands of North Holland). Millet was (suddenly?) present everywhere and the stored supplies of the inhabitants of the hillforts of northern France included horsebean. Of the various wheat species, emmer was most common, whereas naked wheat has only been identified at Le Ford Harrouard. Einkorn has not been

found at all in Bronze Age contexts, but this may be due to the small number of sites sampled. Opium poppy seed has not yet been recovered either. The presence of remains of spelt wheat and lentil in the assemblages of the Urnfield Culture of Luxemburg deserves some attention.

6 THE IRON AGE (2600-2000 BP)

Most records of Iron Age fruits and seeds concern the Late Iron Age. Early Iron Age finds are relatively scarce. As usual, most material comes from settlement sites, but there is one exception: a La Tène I burial near Châlons-sur-Marne (Marne) is reported to have yielded a few carbonized grains of Triticum dicoccum and Hordeum sp. (Hopf 1969). It is not clear, however, whether these are connected with the burial ceremony or ended up in the grave by mere chance.

Four of the settlement sites mentioned in the literature are oppida: defended central places. These are Béthisy-St. Martin (Oise), Villeneuve-St. Germain (Aisne), Etival-Clairefontaine (Ardennes) and Titelberg (Luxemburg). Very little information has been published on them; the available data are presented in Table 5, with the exception of those relating to Etival. Part of a floor of a La Tène III house at Etival was covered with two separate heaps of charred grain. These consisted of "wheat, barley and rye varieties still cultivated today" and Triticum turgidum (Billoret 1968). This large quantity of grain may need re-examining.

As for the remaining non-wetland settlement sites mentioned in the literature, all of which are rural sites, the finds listed were recovered from silos in at least seven cases (Table 5). These usually cylindrical, conical or beehive-shaped pits with flat bottoms were used from the times of the Neolithic Bandkeramik Culture onwards, but they were most spectacular in the Iron Age, when large aggregations of pits were dug, for example at Suippes (Marne) and Son & Breugel (the Netherlands). One of the most pressing problems concerning the charred grains found in these silos is whether they formed part of the original contents of the pit or whether they represent dumped waste. In most cases, the lack of concentration of carbonized seeds near the bottom of the pit or adhering to the pit wall suggests that we are dealing with waste material. This is further confirmed by the fact that the silos were clearly used as dumping places for other kinds of domestic waste too. The general composition of the seed assemblages by no means suggests that we are dealing with the remains of a stored product. At Suippes the cultivated plants: wild herbs ratio ranges between 1:1.5 and 1:42 (Bakels 1984). The silos of Son contained a mixture of all kinds of cultivated and wild plants from different habitats (Bakels & van der Ham 1980).

One pit discovered at Menneville (Aisne), two pits found at Neerharen-Rekem (Belgium) and a number of pits sampled at Colmschate (the Netherlands) could possibly be identified as silos containing stores carbonized in situ. One of the Compiègne (Oise) pits and a pit discovered at Evergem-Ralingen (Belgium) may possibly also be added to this list. The floors of these pits were covered with a thick layer of carbonized seeds. Surprisingly, none of these layers consisted of the remains of one single species (Table 5) but with the exception of the contents of a pit excavated at Colmschate, the assemblages were poor in weed seeds.

Some authors are of the opinion that layers of pure grain are indeed to be interpreted as stores in situ and hence indicative of the primary function of the pit. They ascribe the carbonized state of the grain to the burning out of the silos to sterilize them for continued use. But it is difficult to obtain conclusive evidence of this. According to the experiments carried out by Reynolds (1974) such assemblages should at least include some germinated grain, but no germinated kernels are reported to have been found at the sites in question. The only record of germinated grain found in a storage pit concerns the site at Weiler zum Turm (Luxemburg) and this was clearly not burned on the spot (Hopf 1980). Another indication are red-fired pit-floors and walls. These were observed in one of the Neerharen pits, in one of the Colmschate structures and at Weiler zum Turm. They form a very small minority in the vast number of silos excavated in this region. Although these red walls indicate that something was burned in the pits, they are not necessarily proof of cleaning by fire. In spite of the large number of silo contents analysed, we still do not know whether the layers of carbonized grain indicate the cleaning of the silo by fire and whether they are in fact to be seen as an indication of the primary function of the pit.

In the wetlands the first terpen appeared. Terpen are artificial mounds built by man to serve as dry habitation places. They consisted of layers of clay, plant matter and dung, and were enlarged whenever necessary. Older buildings were incorporated in the mounds and the re-

Table 5. Carbonized seeds from the Iron Age, upland sites. EIA = Early Iron Age, MIA = Middle Iron Age, LIA = Late Iron Age, c = cf. Dates in years BP.

		Triticum monococcum	Triticum dicoccum	Triticum aestivum	Triticum spelta	Hordeum vulg. var. nudum	Hordeum vulgare	Panicum miliaceum	Secale cereale	Avena sp. + A. sativa	Vicia faba var. minor	Pisum sativum	Linum usitatissimum	Camelina sativa	Quercus sp.	Corylus avellana	Malus sylvestris	
oppida:																		
Titelberg, Tène II	2256±55	+	+	+	.	.	+	.	.	+	.	.	.	.	.	.	.	Rowlett et al. (1982)
Titelberg, Tène III		.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	Rowlett et al. (1982)
Béthisy, Tène III		.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	Jouve (1973)
Villeneuve-St. Germain, Tène III		.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	Bakels (1984)
silos:																		
Weiler zum Turm, Hallstatt D		+	+	+	.	.	+	.	.	.	.	+	.	.	.	.	.	Hopf (1980)
Colmschate, EIA		.	+	.	+	+	+	+	.	+	.	c	+	+	+	.	.	Buurman (1986)
Menneville, Tène I		.	+	.	+	.	.	.	.	+	.	.	.	.	.	.	.	Bakels (1984)
Suippes, Tène I		+	+	.	+	.	+	+	.	+	.	.	.	+	.	+	.	Bakels (1984)
Neerharen, Tène I	2530±50																	
	2435±35	.	+	.	.	.	+	.	.	+	.	+	.	+	.	.	.	Roymans (1985a)
Evergem, Tène I	2490±60	.	+	.	.	.	+	+	.	+	+	.	.	.	+	.	.	Ceunynck et al. (1984)
Son, MIA	2460-2250	.	+	.	+	.	+	+	.	.	.	+	+	+	+	+	.	Bakels & van der Ham (1980)
others:																		
Angelsloo, EIA	2570±55	.	+	.	.	+	+	+	.	+	.	.	.	.	.	.	+	van Zeist (1970)
Ommen EIA		.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	van Zeist (1970)
Ermelo, EIA/MIA	2140±60	.	+	.	.	.	+	+	.	+	.	.	.	+	.	.	.	van Zeist (1970)
Compiègne, Tène I		.	+	.	+	.	+	+	.	+	.	.	.	.	.	.	.	Bakels (1984)
Chassémy, Tène Ia		.	+	+	.	+	.	.	.	.	.	c	.	.	+	+	.	Hopf (1969)
Dommelen, MIA		.	+	.	.	.	+	+	.	.	.	.	+	.	.	.	.	Roymans (1985b)
Oss-Ussen, MIA		.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	Bakels (1987)
Gees, MIA	2420±35	.	+	.	.	.	+	.	.	+	.	.	.	.	.	.	.	van Zeist (1970)
Oss-Ussen, LIA		.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	Bakels (1987)
Noordbarge, LIA		.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	van Zeist (1976)
Broekom, Tène III		.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	Vanvinckenroye (1988)

sulting structures could be seen as wetland tells. Terpen occur in the coastal areas of the Netherlands and especially in the northern provinces. Terp bodies are excellent preservers of plant material and it were terp bodies that formed the object of the first systematic palaeoethnobotanical research to be carried out in the Netherlands (Beijerinck 1929-1931). Most of the results obtained in these investigations were recapitulated by van Zeist (1974).

The crop plants of these sites are Hordeum vulgare, Linum usitatissimum and Camelina sativa, and also some Triticum dicoccum and Vicia faba var. minor. Most of the terpen lie in salt marsh areas. The presence of the remains of crop plants does not necessarily imply that these plants were grown in the immediate surroundings, but the presence of threshing remains of barley, gold of pleasure and flax show that at least these products were not imported. Experiments conducted by van Zeist et al. (1976) and Bottema et al. (1980) have shown that it is in fact possible to raise crops in the unprotected salt marshes, provided that the area is not flooded by sea water too often, especially during the seedling stage. Avena sativa, Hordeum vulgare, Linum usitatissimum, Camelina sativa and Vicia faba var. minor gave reasonably reliable yields. Triticum species and Panicum miliaceum were less suitable or even unfit for cultivation in these areas. The risk of flooding meant that the sowing had to be done in the spring. The field weeds found in the samples taken from the terpen indeed point to

summer crops. Nevertheless, some products were certainly imported and this does not only apply to the Triticum dicoccum found; remains of Corylus avellana and Prunus spinosa also have been found, and these shrubs cannot have thrived in the neighbourhood.

The salt marshes were not the only wet environments where farming communities lived. The fresh-water tidal areas and peats were also inhabited. Intensive research is at present being carried out on Iron Age farming in these regions. Some reports have already been published on one of these projects, namely the Assendelver Polders Project (Therkorn et al. 1984; Pals, in Brandt et al. 1987).

The Assendelver Polders lie at the edge of a vast peat area east of the Older Dunes in the province of North Holland. One of the excavations carried out as part of the project yielded a beautifully preserved Early Iron Age farmstead (site "Q"). Building materials were ^{14}C dated at 2465±30 BP and 2520±30 BP. The inhabitants' subsistence economy was based on stock raising, but the presence of threshing remains of Camelina sativa suggests that this crop at least was indeed grown on the local peat. This was possible because in this area the peat was drained by gullies; in fact it was this drainage that had made the land suitable for habitation in the first place. The samples also indicated the presence of cereals, predominantly Hordeum vulgare and some Triticum dicoccum, Panicum miliaceum and Avena sativa, but these are not considered to have been local products. The same applies to Linum usitatissimum. It is not possible to determine whether the inhabitants of this farmstead had their own cereal fields at some distance from the site, in a non-peaty area, or whether the cereals were traded.

The most remarkable aspect of the data obtained so far for the Iron Age is the appearance of Camelina sativa, at both upland and wetland sites, and the common occurrence of Triticum spelta at upland sites. Vicia faba var. minor, which has only been encountered at French hillforts in Bronze Age contexts, is found at rural settlements in Iron Age contexts. However, its former absence at such settlements it presumably due to the scanty set of available Bronze Age data. One Iron Age site yielded remains of Secale cereale. But as only a few grains were found, it is not quite certain whether rye was already being cultivated as a crop plant at this time, though the possibility remains (van Zeist 1976).

Because from the Iron Age onwards crops were contaminated by many weeds, not only of the taller species but of low-growing ones as well, it is often assumed that some aspect of the farming practices, for example harvesting methods, must have changed fundamentally (Knörzer 1971; but see also Willerding 1988). In Western continental Europe, insufficient data have so far been obtained to help the discussions on this subject any further. Weed seeds are certainly much more abundant in Iron Age samples, in absolute numbers as well as in number of species, than in Neolithic ones, but at present the Bronze Age and the Iron Age cannot be adequately compared because the sources of data are too diverse. However, if we are to pinpoint this change in farming practices it is better to date it around the transition from the Middle to the Late Bronze Age than around the transition from the Late Bronze Age to the Early Iron Age. Samples taken at the Late Bronze Age sites of Düdlingen and Peppingen already contained numerous weed seeds.

7 THE ROMAN PERIOD (2000-1500 BP)

This period derives its name from the fact that in these times Rome controlled the greater part of the studied area. What was at that time the largest branch of the Rhine marked the northern border of the Roman Empire: the limes. The branch passed Arnhem, Utrecht and Leiden. The area south of the limes came under the influence of the Roman market system. North of it, life went on more or less as before, although some Roman influence is observable in these regions too. Within the Empire different classes of settlements started to arise. There was greater differentiation than there had been in the preceding Late Iron Age. Besides rural settlements, there were also military camps and proper towns. The inhabitants of the latter two were not food-producers themselves and this led to the emergence of food-producing centres: commercial farms which are called villae rusticae.

In contrast to the large amount of information on this period yielded by other sources, the data obtained from palaeoethnobotanical research are still scanty. The only villa rustica on which some details have been published is the villa at Voerendaal (the Netherlands). Here a granary (a horreum), and a threshing floor indeed produced the expected remains, i.e. cereal grains and chaff, respectively. The villa specialized in the production of Triticum spelta, but Triticum dicoccum, Triticum aestivum and Hordeum sp. were also harvested (Willems &

Kooistra 1987).

The cargo of a second century Roman ship which sank in the Rhine at Woerden (the Netherlands) was at first assumed to have consisted also of spelt wheat (Haalebos 1986), but the final investigation showed that it was emmer (Pals & Hakbijl, in press).

Very little has been published on the consumer side of the agrarian economy too, but several large-scale investigations are now being carried out. As far as towns and other civil settlements are concerned, only Champlieu (Oise), Maastricht (the Netherlands), Aardenburg (the Netherlands) and Ouddorp (the Netherlands) can be mentioned. The Gallo-Roman grain from Champlieu is a very clean mixture of Triticum aestivum, Hordeum sp., Secale cereale, Avena sp., Pisum sativum and Lens culinaris. What this assemblage was intended for is not clear (Bakels 1984). A large charred grain deposit at Maastricht consisted mainly of Triticum aestivum with an admixture of Triticum spelta, Secale cereale and one grain of Hordeum sp. With the exception of some Bromus mollis/secalinus and Agrostemma githago seeds, this grain was free from weeds too (van Zeist 1970). The waste product of such grain was discarded on the banks of the river Meuse in Maastricht. The dump, dated to the end of the second/beginning of the third century AD, contained a large amount of uncarbonized Triticum spelta chaff, Linum usitatissimum capsules, and smaller amounts of Panicum miliaceum, Papaver somniferum, Malus sp., Corylus avellana, Prunus sp., Ficus carica and the kitchen herbs Coriandrum sativum, Anethum graveolens, Satureja hortensis and Apium graveolens. Remains of field weeds were also encountered (Kuijper 1984a). At Aardenburg a small carbonized weed-free sample of Triticum aestivum was found. It dates from between AD 170 and 270 (van Zeist 1970). The same wheat species dominated a find from Ouddorp, whilst a second assemblage found at Ouddorp, with a ^{14}C date of 2030±35 BP, was dominated by Hordeum vulgare. Both were only slightly contaminated by seeds of other species, among which one Vicia faba var. minor seed (van Zeist 1970).

Information on the military section of society is provided by the samples from the castella at Valkenburg and Alphen-aan-den-Rijn, both in the Netherlands. Military granaries in the civilian settlement (vicus) next to the Valkenburg castellum, which was burned down in the first century AD, possibly during the revolt of the local inhabitants in AD 69, contained separately stored cleaned Triticum aestivum and Hordeum vulgare. The grain was in good condition and showed no signs of infestation by insects (Pals et al. 1989).

The remains of a grain supply within the castellum itself, which was also burned down during the same revolt, consisted, on the contrary, of undehusked Triticum dicoccum and Triticum spelta which had begun to germinate - an indication that the storage room was very damp. Two more deposits were found in this destroyed castellum, one consisting mainly of Triticum aestivum and the other of Hordeum vulgare, stored in the chaff (van Zeist 1970). All these Valkenburg samples contained only few weed seeds.

Virtually pure chaff was found too. The floor of a well close to the two granaries is the vicus, but dated to the second century, was covered with a 20-cm-thick layer of Triticum spelta chaff. This chaff was mixed with large weed seeds only, which showed that it was the remains of the dehusking of a stock similar to those described above.

There was, of course, more to eat than the cereals mentioned. Charred plant matter and waterlogged material revealed the consumption of Secale cereale, Avena sativa, Vicia faba var. minor, Vicia sativa spp. obovata, Linum usitatissimum, Papaver somniferum, Beta vulgaris, Corylus avellana, Juglans regia, Coriandrum sativum, Ruta graveolens and Satureja vulgaris, to mention only a few species.

The final stage of the consumption process has been found too. In both the Valkenburg and Alphen-aan-den-Rijn castella an officers' latrine was excavated. The one found at Valkenburg yielded remains of Papaver somniferum, Prunus cf. avium and Fragaria vesca (van Ledden-Hulsebosch 1955). The recently analysed contents of the Alphen structure included fragments of cereal bran, among which bran of Triticum spelta, some chaff remains of Triticum spelta and Triticum dicoccum, seeds of Vicia faba var. minor, Papaver somniferum, Coriandrum sativum, Anethum graveolens, Apium graveolens, Olea europaea, Ficus carica, Vitis vinifera, Prunus persica, Malus sp. and Crataegus laevigata, and pollen of Pimpinella anisum, Foeniculum vulgare, Carum carvi and Anthriscus cerefolium (Kuijper & Turner, in press).

Besides the meals of the living the meals for the dead have also been studied. At both Valkenburg and Naaldwijk remains of funeral pyres revealed charred food remains. Most of the remains found at Valkenburg were of Lens culinaris, whilst remains of Triticum sp., Hordeum sp., Vicia faba var. minor and Olea euro-

paea were also encountered (Pals et al. 1989). A grave at Naaldwijk contained five seeds of Vicia faba var. minor (Bult et al. 1988).

The finds mentioned so far represent the rather clean crop products belonging to the market economy. They were transported and stored in large amounts. The sources of production have been traced with the aid of large weed seeds such as the seeds of Orlaya grandiflora and Caucalis platycarpos. Seeds of these plants were found mixed with the spelt chaff recovered from Valkenburg, formed part of the Woerden cargo and were also found in the latrine at Alphen, but the plants themselves cannot have thrived in the surroundings of the places were they were found. They belong to the more southern weed flora of Belgium and France. The villa at Voerendaal lies just within the area of this flora district and Orlaya was indeed found there. The weeds show that at least part of the grain supply for the Roman army stationed along the frontier was imported from regions further south. More information on this can be found in Pals et al. (1989) and Groenman-van Waateringe (1989).

How the native rural society responded to the producer-consumer system is not yet clear, at least not from botanical evidence. Again, the published information concerns Dutch sites only, but research on this subject is now being carried out in the French Aisne valley.

The most complete study of plant remains found at a site within the Empire is that carried out at a native settlement close to the limes: De Horden near Wijk bij Duurstede, which was inhabited from 50 BC to AD 225. Some 300 soil samples were processed and their contents were handled with the aid of Correspondence Analysis. The main trend along the time axis is an increase in grassland species and a decline in the numbers of cereal remains. The increase in the grassland component is interpreted as an indication of a switch in the economy from subsistence farming in the pre-Roman period to the commercial production of meat and hides in the Roman period (Lange 1988). Hordeum vulgare and Triticum dicoccum, and to a lesser extent Panicum miliaceum, Pisum sativum, Vicia faba var. minor and Linum usitatissimum, were invariably the local crops, but some influence of the Roman world is reflected in the very small quantities of Triticum aestivum, Triticum spelta, Lens culinaris, Anethum graveolens and Apium graveolens.

An even longer continuous range, from the Early Bronze Age to the first half of the third century AD, has been analysed at Oss-Ussen, but this vast set of data has not been fully published yet. The large excavation revealed three contemporaneous settlements dating from the Roman period. Only one of them shows some signs of Romanization and it is at this same settlement that Coriandrum sativum and Beta vulgaris were found. The preliminary reports do not mention the distribution of the other food plants mentioned: Triticum spelta, Triticum dicoccum, Hordeum vulgare, Secale cereale, Panicum miliaceum, Vicia faba var. minor, Linum usitatissimum, Papaver somniferum and Juglans regia (van der Sanden 1987a, b). It is therefore not yet clear which of these crops were cultivated locally. A contemporaneous settlement nearby, Oss-IJsselstraat, yielded the remains of Triticum dicoccum, Hordeum vulgare and Panicum miliaceum only, which could imply that the spelt of Oss-Ussen is attributable to Roman influence, as it is at De Horden (Bakels 1980a).

Similar series of data have been published for the area north of the limes. One, relating to the Assendelver Polders, shows Hordeum vulgare as the principal crop and Panicum miliaceum, Camelina sativa and Linum usitatissimum as additional ones. Remains of Triticum dicoccum and Avena sativa are scarce and they are interpreted as admixtures (Pals, in Brandt et al. 1987). The occurrence of Triticum pollen, however, suggests that emmer production was known, and Groenman-van Waateringe (1989) thinks that the absence of emmer from the local record is due to the fact that it was traded to the Roman garrisons.

Other data were obtained from the terpen in the northern coastal area. The inhabitants of the terpen apparently continued their former way of life of growing Hordeum etc. (van Zeist 1974), although some material imports show that these people were in contact with the Roman Empire. A rather unusual find of this kind, which was, however, not recovered from a terp, but came from a "normal" settlement, is a small Roman bronze flask filled with Raphanus sativus seeds and some Apium graveolens, Origanum vulgare and Malus sylvestris. The contents are interpreted as some kind of medicine (Buurman 1988b).

Only incidental finds are known from the higher soils north of the limes. They consist of Hordeum vulgare (site at Wijster), Hordeum vulgare with some Triticum dicoccum (Dalfsen), Secale cereale with some Hordeum sp., Avena (sativa) and Panicum miliaceum (Noordbarge), and Secale cereale with a minor admixture of Panicum miliaceum, Hordeum vulgare and Hordeum vulgare var. nudum (Ede-Veldhuizen)

(van Zeist 1970, 1976). A well at Wijster yielded stem fragments of braked Linum usitatissimum.

From the foregoing it is clear that the naked wheat and spelt found in the Roman military and civil settlements were not produced near or north of the limes. They must have been brought in from other areas. It is a historically known fact that large quantities of these wheats were grown on the fertile soils in the south of the Dutch province of Limburg (and the adjacent German Rhineland), in Belgium and in northern France, but, as already stated above, the botanical evidence is still restricted to only one villa rustica.

8 THE MIDDLE AGES AND LATER HISTORICAL PERIODS (1500 BP-.....)

No palaeoethnobotanical data are yet available on the period immediately after the collapse of the Roman Empire. The record starts with the sixth century AD. Quite a number of publications have recently appeared on medieval sites from this time onwards. For France the report on the farms (villae) at Villiers-le-Sec (Seine-et-Oise) and Baillet-en-France (Seine-et-Oise) should be mentioned (Ruas 1988). The Villiers-le-Sec series covers the second half of the sixth up to and including the 11th century. Secale cereale was the dominant cereal, closely followed by Triticum aestivum. Avena sativa and Hordeum vulgare came next, whilst remains of Panicum miliaceum were found only once, in an early (Merovingian) feature. Vicia faba var. minor was as common as oats and barley, at least in the later (Carolingian) periods. Less common was another legume: Pisum sativum. The list also mentions Linum usitatissimum, Cannabis sativa, Vitis vinifera, Malus sp., Pyrus communis, Prunus insititia, Juglans regia, Corylus avellana, Prunus persica and Humulus lupulus. The finds do not appear to change with time.

Another series of data has been obtained in the Netherlands. Van Zeist and co-authors (1986) compared three rural sites on the sandy soils of the province of Drenthe: Pesse, Odoorn and Gasselte. They concluded that Secale cereale, Hordeum vulgare, Avena sativa and Avena strigosa were the cereals cultivated in this area. The scarce finds of Panicum miliaceum cannot be considered evidence of the intentional cultivation of millet. The data suggest that the dominance of rye shifted in the course of time towards a more balanced cultivation with more Avena. In addition to cereals, Linum usitatissimum, Vicia faba var. minor and Pisum sativum were cultivated. It is questionable whether Camelina sativa was still being grown, because its few representatives were found in association with Linum, which suggests that it may have been a weed in flax fields. Remains of kitchen herbs were also found: Anethum graveolens, Satureja hortensis, Apium graveolens and Foeniculum vulgare. The large amount of field weeds indicates that the harvest was threshed and cleaned in the settlement. The weeds show that some of the crops were sown in autumn, but that spring-sowing was also practised.

In this period the coastal sites, in particular the terpen, were still, continuously, inhabited. In his 1988 paper, van Zeist analyses the possibility that the coastal sites imported crop products from the settlements on the higher, sandy soils. He obtained a positive result for the coastal settlement of Leeuwarden, but the evidence obtained for the majority of settlements in the coastal marsh was less convincing. Leeuwarden was a kind of regional market place and its botanical record may have been affected by the town's trading activities. The imported product was unthreshed rye (and mosses). For further information on coastal sites the reader is referred to van Zeist's 1974 paper. The economy of the inhabitants of the area under review there seems to have remained unchanged for a long stretch of time. Until the first dikes were built, around AD 1000, the farming conditions remained more or less the same.

It is not possible to list all the early medieval sites in this paragraph, but two other sites should be mentioned: Dommelen (AD 700-1250) and Kootwijk (AD 750-1000), both rural sites on sandy soils. The Dommelen series has not yet been published in full, but preliminary reports show that Secale cereale dominated during both the Merovingian and Carolingian periods. Hordeum vulgare and Avena sativa were of minor importance. Linum usitatissimum has also been found, as seeds and, in wells, as stem fragments (van Vilsteren 1985). The most remarkable find, however, is a fruit of Fagopyrum esculentum, which was dated to the middle of the twelfth century on the basis of the pottery found in association with it but to 920±100 BP on the basis of charred grain found in the same context. It is the earliest find so far recovered in this area, excluding pollen. The assemblages gave rise to thoughts on the method of harvesting. During the later phases of occupation this must have be done using a

Table 6. Some species found in cesspits, after Vermeeren in press (1), Kuijper 1984b (2), Marinval in Petit 1983 (3), Bakels 1980b (4), van den Brink 1988 (5), Pals 1983 (6), van Zeist 1987 (7), Paap 1983 (8).

	Kampen, AD 1375-1425 (1)	Leiden, AD 1450 (2)	Orléans, 15th cent. (3)	Sittard, AD 1500 (4)	's-Hertogenbosch, 16th cent. (5)	Haarlem, 16th cent. (6)	Leiden, 17th cent. (2)	Groningen, 17th cent. (7)	Amsterdam, 18th cent. (8)	Groningen, AD 1750-1775 (7)
"Grain":										
Cerealia bran	+	+	.	+	+	.	+	.	.	.
Avena sativa	.	+	+	.	+	+	+	+	.	.
Hordeum sp.	+	.	+	.	+	+	.	+	.	.
Oryza sativa	.	+	.	.	+	+	.	+	+	.
Panicum miliaceum	+	+	.	.	+	+	+	+	+	.
Secale cereale	+	+	+	.	+	+	+	+	+	+
Triticum aestivum	+	.	.	.	.	.	.	.	.	.
Fagopyrum esculentum	+	+	.	.	+	+	.	+	+	+
Pulses:										
Lens culinaris	.	.	.	.	.	.	.	.	+	.
Pisum sativum	.	.	+	.	.	+	.	.	.	.
Vicia faba	+	.	.	.	.	+	+	.	.	.
Fruits and nuts:										
Castanea sativa	.	.	.	.	.	.	.	.	+	.
Cucumis sativus	.	.	.	.	.	.	+	+	+	.
Cucumis melo	.	.	.	.	.	.	.	.	+	.
Cucurbita pepo	.	.	.	.	.	.	.	.	+	.
Cocos nucifera	.	.	.	.	.	.	.	.	+	.
Corylus avellana	+	+	+	.	+	+	+	+	+	+
Ficus carica	+	+	.	+	+	+	+	+	+	+
Fragaria vesca	+	+	.	+	.	.	.	+	.	+
Fragaria sp.	.	.	.	.	+	.	.	.	+	.
Juglans regia	+	+	+	.	+	+	.	+	+	+
Malus domestica	+	+	.	+	+	+	+	+	+	+
Mespilus germanica	+	+	.	.	+	+	+	+	+	+
Morus nigra	+	+	.	+	+	+	.	.	+	.
Olea europaea	.	.	.	.	.	.	.	.	+	.
Phoenix dactylifera	.	.	.	.	+	.	.	.	+	.
Physalis alkekengi	+	+	.	.	.	.	.	.	.	.
Prunus avium	.	+	+	+	+	+	+	+	+	+
Prunus cerasus	+	+	.	.	+	+	+	+	+	+
Prunus domestica	+	+	.	.	.	.	+	.	+	.
Prunus dulcis	.	.	.	.	.	.	.	.	+	.
Prunus insititia	.	.	+	.	+	+	.	+	+	+
Punica granatum	.	+	.	.	.	.	.	.	+	.
Pyrus communis	+	+	+	.	+	+	.	+	+	+
Ribes sp.	+	+	.	.	.	+	+	+	+	+
Rubus caesius	.	+	.	.	+	.	+	.	+	.
Rubus fruticosus	+	+	.	+	+	+	+	+	+	+
Rubus idaeus	+	+	.	.	+	.	+	.	+	+
Sambucus nigra	+	.	.	+	.	.	+	.	+	.
Vaccinium sp.	+	+	.	+	+	+	.	+	+	+
Vitis vinifera	+	+	+	+	+	+	+	+	+	+
Greens, herbs etc.:										
Apium graveolens	+	.	.	+	.	.	.	.	+	.
Anethum graveolens	+	.	.	.	.	.	.	.	+	.
Anthriscus cerefolium	+	.	.	+	.	.	.	.	.	.
Beta vulgaris	+	+	.	.	.	.	.	.	.	.
Brassica sp.	+	+	.	+	+	+	+	+	+	+
Capsicum annuum	.	+	.	.	.	.	.	.	.	.
Carum carvi	.	.	.	.	+	.	.	.	+	+
Cichorium intybus	.	+	.	.	.	.	.	.	.	.
Coriandrum sativum	+	+	.	+	+	+	.	+	+	+
Foeniculum vulgare	+	+	.	+	+	.	+	.	+	.
Lepidium sativum	.	.	.	.	.	.	.	.	+	.
Petroselinum crispum	.	.	.	+	.	+	.	.	.	.
Portulaca oleracea	.	.	.	.	+	.	.	.	.	.
Sinapis alba	+	+	.	.	.	.	.	.	.	.
Others:										
Cannabis sativa	+	+	.	.	+	+	.	+	+	.
Carthamus tinctorius	.	.	.	.	.	.	.	.	+	.
Humulus lupulus	+	+	.	+	+	.	.	.	.	.
Linum usitatissimum	+	+	.	+	+	+	.	.	+	.
Papaver somniferum	+	+	.	+	+	.	+	.	+	.
Reseda luteola	.	+	.	+	.	.	.	.	.	.

scythe, as 50% of the weeds are known to be low-growing species. The size of the weed seeds found together with the remains of crop plants suggests the use of grain sieves with a mesh width of about 2.5 mm (van Vilsteren 1984).

Kootwijk is a clear case of an abandoned village. The inhabitants left the site when drier climatic conditions had caused the pool which provided their drinking water to dry out completely. Again the samples indicated Secale cereale as the most common cereal. Hordeum vulgare and Avena sativa came next whilst Vicia faba var. minor, Linum usitatissimum and Camelina sativa were less frequent in the samples. The list of crop plants also mentions Reseda luteola. Malus sp., Corylus avellana, Rosa sp., Fragaria vesca, Rubus idaeus and Rubus sect. Rubus were gathered. The material was too scanty to permit conclusions as to a shift in the relative importance of any crop in the course of time. The presence of enclosed fields around the village suggests that the crops were raised in an infield - outfield system (Pals 1987).

The investigation in the town of Leeuwarden mentioned above is an example of the work

done on towns and non-rural sites such as monasteries and castles. More and more samples are being taken for seed analysis during the archaeological investigations carried out in connection with the restoration of old buildings and the renovation of old town quarters. The published results are too numerous to be discussed in full here. The lists of crop plants, cultivated and gathered fruits, kitchen herbs, industrial crops and the like are usually rather long because the remains are often found well preserved in waterlogged and even mineralized condition. Table 6 gives an idea of the contents of cess-pits, a rich source of material from the late Middle Ages to quite recent times.

An example of the research done on cess-pits is provided by the complexes from the 13th up to and including the 19th century investigated in Amsterdam. One of the results of this research is that the town has always imported food, ever since its beginning as a small village. Assemblages dating from AD 1500-1550 contained Neslia paniculata, which is in accordance with the historically testified large-scale import of grain from Prussia and Poland at the time. Oryza sativa was quite common in a 17th-18th century Jewish quarter and the presence of Scirpus mucronatus suggests that this rice came from the Mediterranean, perhaps Italy (Paap 1983). This same Jewish quarter can be divided into a richer and a poorer part. A thorough analysis of the differences between the two social classes has not yet been published, but one of the preliminary reports mentions that the main difference found is that the rich people ate other kinds of plums than their poorer neighbours (Paap 1984). The published data reveal no other striking differences in the occupants' diets.

Here the survey of the palaeoethnobotany of historical times must end. However, there is an abundance of literature available on this subject. This deserves a synopsis of its own.

9 CONCLUSION

The article by van Zeist mentioned in the introduction stated that 25 years of collecting seeds in the course of systematic excavations provided the opportunity to fill up at least some of the gaps in our knowledge of crop plants in the Netherlands (van Zeist 1970: 43). This knowledge was mostly limited to which plants occurred in which periods. The same is true of the information contained in two other summaries of the results obtained in previous research.

Twenty years later it appears that we have still been busy fillings up gaps in the species-time record and are continuing to do so. In this respect no progress has been made in our way of working and thinking. Fortunately, progress has been made in other respects. It is observable in the work of those authors who had the opportunity to devote themselves to one site, to one small and geographically restricted area, or to one archaeological culture. The questions raised are mostly of an economical nature. One of these is whether people grew their own food or not. Others concern the location of the fields, the time of sowing, the harvesting methods and the processing of harvested crops. Conspicuously, much of the more advanced work concerns wetland sites. The reason is undoubtedly that more time and effort are spent in investigating these sites because they are rich in plant remains. It is striking that even the carbonized remains obtained from such sites can provide answers to some of the main questions. In one case, one of the problems to be solved led to experimental work, i.e. the growing of crops in a salt marsh unprotected by dikes.

As stated above, true progress is dependant on the amount of time available for research. Where researchers are scarce, or have to work with samples taken by non-specialists, or have to hurry from one excavation to another, progress is limited to the filling in of gaps in our time-table knowledge of plants.

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