Veget Hist Archaeobot (2008) 17:65–73
DOI 10.1007/s00334-007-0106-x

ORIGINAL ARTICLE

Collected seeds and fruits from herbs as prehistoric food

Karl-Ernst Behre

Received: 11 May 2006 / Accepted: 15 November 2006 / Published online: 19 June 2007

Abstract New investigations of two archaeobotanical finds are presented: a large assemblage of pure fruits of *Polygonum lapathifolium* from Bremen-Strom, Germany and the gut contents of a bog body from Kayhausen near Oldenburg, Germany. The general question is to find out for sure which herb species were intentionally gathered for human consumption. To accept species as such, they have to fulfil mainly two criteria: they must occur in large and pure assemblages, separated from other species, and they should occur regularly in the stomach or gut of dead bodies. To ensure this, the data from all bog bodies whose intestines have been examined were compiled and in addition to this, fossil assemblages of the species in question were put together. It turned out that apart from gathering in the wild, the collection of seeds and fruits from weeds in the process of crop cleaning was a major source of their edible diaspores. Obviously some common weeds, obtained in this way, were welcome as an addition to human diet and received the status of secondary cultivated plants. The following six species are regarded as having surely been deliberately collected and used in human diet: *Polygonum lapathifolium*, *Chenopodium album*, *Spergula arvensis*, *Fallopia convolvulus*, *Bromus secalinus* and *Glyceria fluitans*. Another two, *Setaria* sp. and *Rumex acetosella* probably complete this list.

Keywords Archaeobotany · Prehistoric food · Seed gathering · Bog bodies · NW Europe

K.-E. Behre (✉)
Niedersächsisches Institut für historische Küstenforschung, Postfach 2062, 26360 Wilhelmshaven, Germany
e-mail: behre@nihk.de

Introduction

Gathering parts of plants was, besides hunting and fishing, the basis of human nutrition during Palaeolithic and Mesolithic times. It was also continued in later periods after the introduction of farming, but concentrated mainly on wild fruit, berries and nuts. Archaeobotanical remains of these plants undoubtedly indicate their collection, in particular because these plants were domesticated rather late. Other parts, mainly leaves, bulbs, roots and rhizomes of wild plants were also used for food, but because of poor preservability they can be only identified under extremely favourable circumstances. They have, however, always to be kept in mind when prehistoric diet is considered. None of these remains are treated in this contribution.

Other macro-remains, such as seeds and fruits from wild plants, are often found in large quantities in archaeobotanical samples. There are numerous records of many species which were regarded as having been eaten. On the basis of sometimes even single fruits and seeds which they identified, some authors have published lists of plants which might have been or were explicitly claimed as having been eaten or used as medicine, etc. This culminates, when for instance recovered fruitlets of *Daucus carota* are taken to prove that their roots—carrots—were consumed. Looking at the large body of data that are provided by the flourishing archaeobotanical discipline, we always have to be very critical in their interpretation.

This article focuses on prehistoric seeds and fruits from herbs which can be regarded as having been intentionally collected. With the establishment of fields in the Neolithic period, the possibility of gathering seeds and fruits from herbs increased considerably. These plants expanded from their original biotopes mainly along rivers into the new open areas, in particular on fallow fields, and as weeds several of them became well established in the fields themselves, as well as later in the harvest. In places they were favoured by the anthropogenic accumulation of nitrogen, and they occupied ruderal biotopes in the settlements.

The now larger number of suitable plants, some of them with very high seed production, made it easy to collect their seeds by hand, but the cleaning of the crops from weeds also offered possibilities to collect large amounts of them easily. Nevertheless, there has to be strong evidence that the remains that are found in the archaeobotanical samples were in fact intentionally collected. This is provided mainly in two ways: by finds of pure and preferably large assemblages of the respective taxa or by the repeated records in intestines from dead bodies, the latter is in fact a key aspect.

The motives of this article are new investigations of finds from both sources. A bog body of a young boy from Kayhausen in northwest Germany, which stayed well preserved in a museum for more than 80 years, gave the rare opportunity to examine the gut contents of another such corpse. These results were compared with those from the other European bog bodies, and in particular the gathered plants in human diet. The second finding is a large and pure assemblage of fruits of *Polygonum lapathifolium* recovered under waterlogged conditions in a dwelling mound near Bremen, which can only be explained by having been purposefully collected.

Materials and methods

In 1922 the body of a boy was discovered in the raised bog at Kayhausen, 10 km northwest of the city of Oldenburg in Germany. Fortunately it was preserved wet until the body was autopsied 1952 in the Oldenburg museum. The gut, however, was not examined then, but kept wet until it was investigated by the author in 1998 (see preliminary publication by Behre 1999). Skin and hair as well as the intestines of the bog body were in excellent preservation and even the bones survived the deposition in the acid environment. It was a boy of about 7 years old, who had been stabbed to death, tied and lowered into the raised bog (Hayen 1964; Pieper et al. 1999).

For the investigation of plant macro-remains, the author received five samples that contained different parts of the gut with its contents. These contents were sieved with meshes of 3, 0.75 and 0.25 mm width.

The second object is a large pure assemblage of *Polygonum lapathifolium* (Fig. 1). This was recovered in 1988 in the course of a rescue excavation by the Landesarchäologie Bremen within a settlement horizon in a small *wurt* (dwelling mound) at Bremen-Strom (see Fig. 2). The

Fig. 1 Fruits of *Polygonum lapathifolium* from the medieval site of Bremen-Strom, scale bar = 2 mm

layer of *P. lapathifolium* fruits there was up to 15 cm thick. The *wurt* has the name Hover-Warf and is located west of the river Weser, on the topographical sheet 2918 Bremen at R 34 80 82 and H 58 84 40 (archaeological site no.: 17 Strom, Befund 9). According to Nitz and Riemer (1987) the Hover-Warf belongs to the settlements founded during the Dutch colonization of this area in the early 12th century A.D. A small excavation at this site, carried out by Grohne (1934) gave no other evidence. The village was abandoned around 1520. The rescue excavation in 1988 did not provide any datable archaeological material. Therefore fruitlets of *P. lapathifolium* from the investigated layer were used for radiocarbon dating. Prof. Dr M. Frechen provided two conventional ^{14}C dates, 1,130 ± 45 B.P. or cal A.D. 790–980 (Hv 25413) and 990 ± 75 B.P. or cal A.D. 980–1155 (Hv 25414). These dates leave it open whether the *wurt* was erected in the early 12th century as expected, or some time earlier.

Results

Pollen analyses to date the bog body from Kayhausen were carried out by Hayen (1964). He presented pollen spectra from inside the body, from the hair and textiles, and by comparing them with a survey diagram of this bog, he estimated the age to be between 0 and A.D. 200. Several new pollen diagrams from the region with higher resolution (O'Connell 1986; Mohr 1990; Behre and Kučan 1994) now allow a better age estimation of the analyses of Hayen, mainly using the curves of *Fagus* and *Carpinus*. According to these diagrams, the old spectra have to be placed in the pre-Roman Iron Age between 500 and 100 B.C. This is supported by a radiocarbon date of 2,160 ± 50 B.P. or 348–113 cal B.C. (GrA-1324) presented by Van der Sanden (1996).

Almost all plant remains from the intestines of the bog body had been eaten and partly digested. Most of them had been bitten into small pieces, however complete seeds occurred too. No remains had traces of burning or carbonization. There was only very little contamination by raised bog species like *Calluna vulgaris* and *Erica tetralix* (see Table 1) as well as some *Sphagnum* and brown moss leaves which probably found their way into the body after it had burst.

As is shown in Table 1, the last meals of the boy consisted of cultivated as well as of gathered plants. Most frequent were the seeds of *Linum usitatissimum* (flax). Apart from the whole seeds very many small pieces were sorted out, but only those with the characteristic upper end were counted; altogether they gave a minimum of 184 eaten seeds, which were accompanied by some capsule fragments. *Panicum miliaceum* (millet) was also common, of which well preserved hulled grains as well as glumes were retrieved. There were fewer records of *Hordeum vulgare* (hulled barley), only two complete hulled grains and 12 more or less complete internodes. A few epidermis remains of wheat could not be assigned to a species. The 18 broken spikelets which were found belong to either *Triticum dicoccum* or *T. spelta* (emmer or spelt). Some of these forks are so thick that they probably derive from *T. spelta*. Because we do not have any evidence that apples were already cultivated here at that time, the *Malus sylvestris* remains must have come from wild crab-apples. Apart from these, another five seeds of wild apples were previously recovered during the autopsy in 1952.

Most interesting were the large numbers of fruits and seeds from three herb species that must have been gathered: *Polygonum lapathifolium*, *Spergula arvensis* and *Chenopodium album*. All seeds of *Spergula arvensis* were covered with papillae; most of them were somehow twisted and they measured on average 1.2 mm. This means that they do not belong to var. *sativa* which is cultivated nowadays or to var. *linicola*, a weed of flax fields, but to *S. arvensis* var. *arvensis*, which is a common weed today.

Records of these three plants have earlier been considered to be gathered for human consumption, but the best proof for this is their occurrence in the human digestive system. Because this bog body is from a child, it may well have been that particularly children gathered and ate these small seeds. It is remarkable that the gut of this bog body did not contain a single specimen of other wild plants (apart from the contamination by a few species from the raised bog itself), which is in contrast to other bog bodies.

The assemblage of *Polygonum lapathifolium* from Bremen-Strom amounted to more than four litres of fruits, all of which were uncarbonized and well preserved. The closer examination of several subsamples showed that the find was extremely pure. The admixture of fruits and seeds from other species was less than 0.5%, consisting of *Chenopodium ficifolium* (6), *Chenopodium album* (1), *P. persicaria* (3), *Stellaria media* (3), *Cerastium* sp. (4), *Atriplex littoralis/hastata* (2) and *A. patula* (3). Most of the *Polygonum lapathifolium* fruits were broken. There can be no doubt that the fruits were gathered, probably for human consumption. It should be noticed that this gathering obviously concentrated on this one species, and it was no general gathering of edible wild herbs.

Table 1 Macro-remains from the gut of the Kayhausen bog body

Sample no. KAY	1	2	3	4	5	Sum
Linum usitatissimum, complete seeds	2	12	7	9	1	31
Linum usitatissimum, seed fragments (only points)	29	8	61	51	4	153
Linum usitatissimum, capsule fragments	2	3	1			6
Hordeum vulgare, grains		1	1			2
Hordeum vulgare, internodes	2	4	2	4		12
Triticum sp., testa fragments	7					7
Triticum dicoccum/spelta, half spikelets	2	7	7	2		18
Panicum miliaceum, grains	11	8	6	5		30
Panicum miliaceum, glumes	5	23	12	13	1	54
Malus sylvestris, seeds		1	1			2
Malus sylvestris, endocarp	4	5	6	9		24
Polygonum lapathifolium, complete fruits	24	16	34			74
Polygonum lapathifolium, fruit fragments	248	30	136	99		513
Spergula arvensis, seeds	4	8	10	3		25
Chenopodium album, seeds	2	18	47	26		93
Calluna vulgaris, stems	1	1		1		3
Calluna vulgaris, seeds	1					1
Erica tetralix, leaves	1	2	2			5
Erica tetralix, seeds	2					2
Juncus effusus-type, seeds	2	2				4

Discussion

In order to find out the various herb species which were gathered in prehistoric times and to estimate the role of this kind of food, a short compilation of comparable finds will be made below.

Although many bog bodies have been excavated so far, only few of them were investigated with respect to the contents of their intestines. The main reason is, apart from the fact that these parts were often missing, that most of these corpses were found many years ago when peat cutting was done by hand. In those days the scientific interest in these questions was low. Later on peat cutting was done with machines and therefore new finds of bog bodies are rare.

In Europe there are only a dozen bog bodies where such investigations have been carried out with more or less care, starting with the famous papers of Helbæk (1951a, 1959). In Table 2, ten investigations from such corpses are

Table 2 Fruits and seeds of herbs out of the intestines of European bog bodies (selection)

Bog body	**Grauballe** [1]	**Tollund** [2]	**Borremose** [3]	**Huldremose** [4]	**Dätgen** [5]	**Kayhausen** [6]	**Oberlangen** [7]	**Zweelo** [8]	**Lindow II** [9]	**Lindow III** [9]
***Setaria* sp.**	+			+	+++					
Echinochloa crus-galli	++	+								
***Bromus* sp. (*secalinus*)**	++++									+
Rumex crispus-type	+	+							+	
Rumex acetosella	+++	+	+++				+			
Polygonum lapathifolium	++++	++++	+++	++	+++	++++	+	+	++	++
Polygonum aviculare	+		+							
Fallopia convolvulus	+++	+++	+						+	
Chenopodium album	+++	+++	+++		+	+++			+	++
Stellaria media	++	+					+			
Spergula arvensis	+++	+++	+++	++++	+++	+++		+		
Thlaspi arvense	+	+								
Capsella bursa-pastoris	++	+					+			
Erysimum cheiranthoides	+	+								
Brassica campestris-type		+	+				+	+	+	
Raphanus raphanistrum					++					+
Viola arvensis	++	+++								
Galeopsis tetrahit	++	++							+	
Plantago lanceolata	+++	+					+			
Lapsana communis	+								+	

+ = rare, ++ = occasional, +++ common, ++++ abundant

[1] Helbæk (1959), Roman Iron Age

[2] Helbæk (1959), pre-Roman Iron Age

[3] Helbæk (1954), early pre-Roman Iron Age

[4] Holden (1999), early Roman Iron Age

[5] Martin (1967), late pre-Roman Iron Age

[6] Behre (1999) and this paper, pre-Roman Iron Age

[7] Dieck (1975), Middle Ages

[8] Van der Sanden (1995), Roman Iron Age

[9] Holden (1995), both Roman period

compiled, in a reduced form, however, focussing on the question of deliberate gathering of certain herb species for consumption. This means that all remains from cultivated plants as well as from the classic gathered genera *Malus, Rubus* and *Corylus* are omitted here. To concentrate on the aim of this paper, all rare plants, which occurred in one corpse only and cannot be considered as having been purposefully gathered, as well as the probable contamination with raised bog species are left out. So in particular the long list from the Grauballe man, Denmark (Helbæk 1959) was reduced considerably. Also the bog bodies from Dröbnitz, Poland, Husbäke, Germany and Exloërmond, The Netherlands were left out because their few plant remains did not contain the species in question (Van der Sanden 1996).

The concentrated compilation as presented in Table 2 clearly indicates the species that can be regarded as having been deliberately gathered for human consumption. They are printed in bold and represent plants which can be gathered easily. Their seeds and fruits are rich in nutrients and due to their resistant walls they also can be stored for longer periods. Most common are three species: *Polygonum lapathifolium*, *Chenopodium album* and *Spergula arvensis*, exactly those plants which occurred in large numbers in the Kayhausen boy, as presented above.

To support this conclusion by other sources of evidence, the archaeobotanical literature was checked to trace assemblages of fruits and seeds from herbs that point in the same direction. This has been done, however, only roughly and some relevant finds may be missing.

Starting with *Polygonum lapathifolium* (pale persicaria), the new assemblage from Bremen-Strom, as described in the preceding chapter which contained more than 4 l of pure fruits, should be convincing. Another important find was a small vessel containing almost 1 l of pure *P. lapathifolium* fruits, found beside the fireplace in a house of the first century A.D. at Alrum/Jutland (Hatt 1943, quoted in Helbæk 1960). With respect to this species it is interesting that the related species *P. persicaria* with similar fruits is absent from Table 2. In connection with bog bodies it was mentioned only by Helbæk (1959) from Grauballe and Tollund, but he put it together with *P. lapathifolium*. As weed contamination in cereal samples, however, it is mentioned sometimes in great numbers, particularly in medieval samples (see for example Kučan 1979 from churches in Ostfriesland).

There is no doubt that *Chenopodium album* (fat hen) has been gathered for a long time. Even in historical times during famines its seeds were mixed with rye and baked into the so-called Russian hunger bread [mentioned beside others by Tolstoi (in Die Hungersnot in Russland, quoted after Neuweiler 1905)], and analyses of such breads are given by Neuweiler (1905). This plant is very common in weed communities in and around settlements, particularly on fallow land, and produces huge numbers of seeds which can be gathered easily. Because of their durable walls, they are frequently recovered in archaeological sites. When eaten by cattle, the walls pass through the gut and can be recorded also in the faeces.

Most convincing evidence that the seeds of this species were gathered is the huge find from inside a burnt-down granary in the prehistoric village of Fjand in Jutland, dated to the first century A.D.. A heap of 1,670 cm^3 carbonized seeds of pure *Chenopodium album*, clearly separated from other heaps of barley and oats, was recovered there by Hatt (1957). Another Danish assemblage of this weed species was investigated by Helbæk (1951b): a small vessel from a burnt house of pre-Roman Iron Age on Görding Hede in northwest Jutland contained, beside 65 cm^3 grains of *Hordeum tetrastichum*, 18 cm^3 charred seeds of *Chenop-*

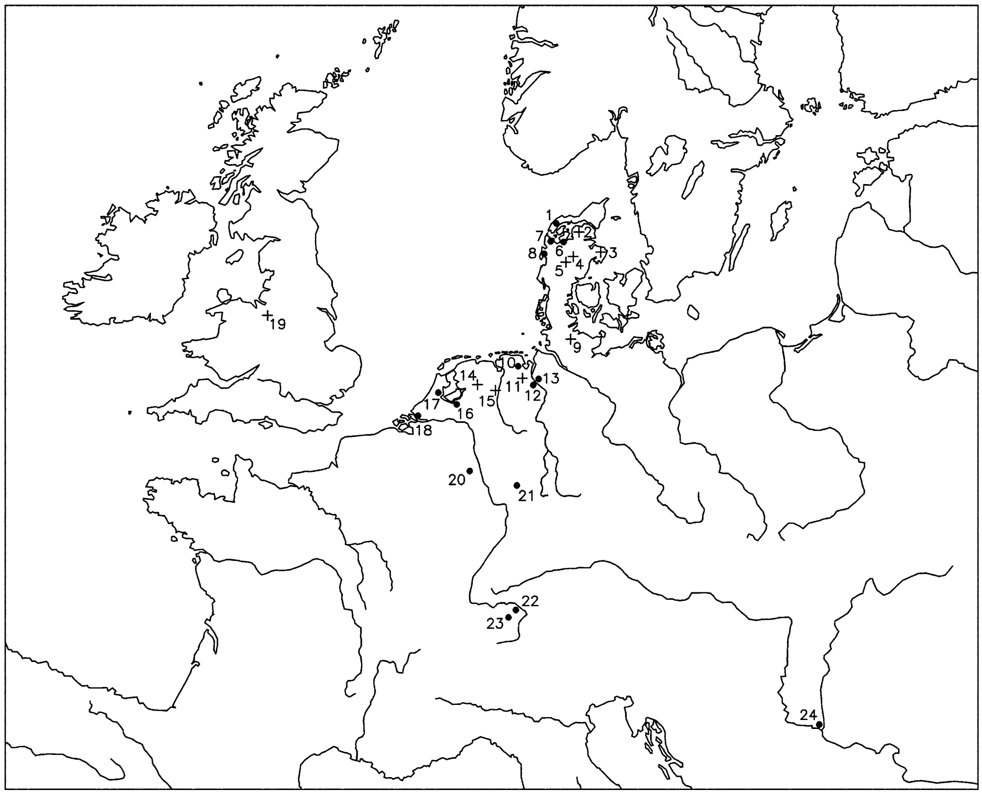

Fig. 2 Location of sites mentioned in the paper. *Filled circle* Seed assemblages, *plus sign* Bog bodies. **1** Ginderup/Dk; **2** Borremose/Dk; **3** Huldremose/Dk; **4** Grauballe/Dk; **5** Tollund/Dk; **6** Gørding Hede/Dk, **7** Fjand/Dk, **8** Alrum/Dk; **9** Dätgen/D; **10** Horsten/D; **11** Kayhausen/D; **12** Bremen-Strom/D; **13** Bremen/D; **14** Zweelo/NL; **15** Oberlangen/D; **16** Ermelo/NL; **17** Assendelft/NL; **18** Spijkenisse/NL; **19** Lindow/GB; **20** Lamersdorf/D; **21** Nieder-Mörlen/D; **22** Niederwil/CH; **23** Zürichsee/CH; **24** Feudvar/SCG

odium album. The author considered the seeds to be the remains of a meal.

As early as the Linearbandkeramik period there is an assemblage of *C. album* seeds, found in Lamersdorf, Rhineland (Knörzer 1967a). Here a separate layer in a pit contained 5,675 carbonized seeds of it, associated with 1,692 remains of cultivated plants (mainly *Linum*) and only 115 remains from 12 other wild species. This proportion and the fact that the seeds were carbonized suggest that they were gathered for consumption. Also from other LBK sites there are assemblages of *C. album* as in Nieder-Mörlen, Germany (charred; Kreuz 2007), while assemblages are absent from many other excavations of this period. A survey of 22 LBK sites from north of the Alps shows, however, that this species was by far the most frequent weed/wild plant, followed by *Bromus* cf. *secalinus* and *Phleum pratense* (Kreuz, *lit.cit*.). So it may well be the case that during the early Neolithic, seeds of *C. album* were deliberately gathered only at certain settlements, while other finds were accidental. The same is true for Neolithic and Bronze Age lake-shore settlements in Switzerland and southern Germany, where large numbers of these seeds were found. In Niederwil, Switzerland 54,518 seeds were found in a pot, which amounted to 96.2% of its whole contents (Van Zeist and Boekschoten-van Helsdingen 1991). At other lake-shore sites clear assemblages are absent, but because of the amount and the concentration of these seeds, gathering and consumption have been discussed in several publications, for example around Zürichsee, Switzerland (Jacomet et al. 1989).

If available, seeds from other *Chenopodium* species were also collected. An example is the find of pure carbonized *C. polyspermum* from within a house from the Bronze/Iron Age complex in Feudvar in Serbia, where Kroll (1990) recorded more than 260,000 seeds.

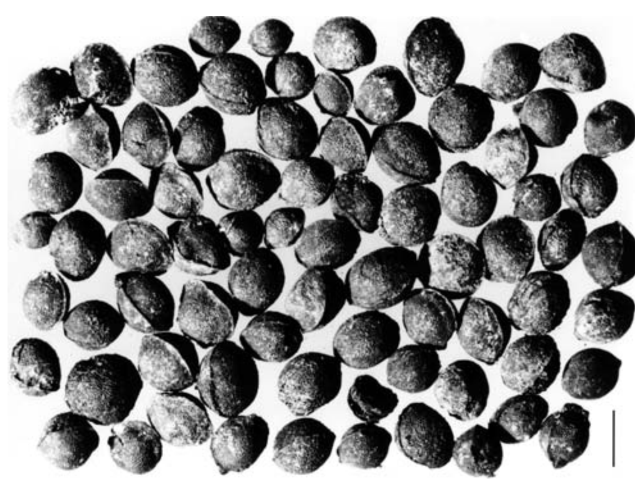

Fig. 3 Seeds of *S. arvensis* from the church of Horsten (15th century); scale bar = 1 mm000000000

Large pure assemblages were also discovered from *Spergula arvensis* (corn spurrey). The most important one is from Ginderup in Jutland, published in 1933 by Jessen. In a burnt house from the first century A.D. a heap of carbonized *Spergula arvensis* was excavated that amounted to 5.6 l. The author regarded it at least partially to belong to the var. *sativa* and supposed that it was even cultivated for animal fodder. Indeed, it is difficult to imagine that the seeds of this low plant (it produces rather few) were gathered. But *Spergula* was an abundant weed of corn fields and certainly was an important admixture of the crops after harvesting. Therefore it must be assumed that it was collected as a welcome by-product in the course of cereal processing. So *S. arvensis* was in a way a cultivated plant, though unintentionally. It is quite common mainly in Roman period and medieval cereal samples from areas with acid soils, as in large parts of Jutland, northwest Germany and the northern Netherlands. So in a late Medieval sample from the church of Horsten in Ostfriesland, 942 seeds of it (Fig. 3) represented 23.3% of the contents of a layer of carbonized *Secale* and *Avena* grains (Behre 1986). This is also reflected in the gut contents of the bog bodies (Table 2): those coming from these acid sandy regions are rich in *S. arvensis*. In modern times var. *sativa* reached the status of a crop plant

Also for *Fallopia (*syn. *Polygonum) convolvulus* (black bindweed), there are clear indications that its fruits were collected, at least sometimes. Because the fruit production of this species is not very high and *F. convolvulus* is an abundant weed in cornfields, climbing up the corn stalks, it is like *Spergula* a common by-product of crop processing. The same vessel mentioned above from Gørding Hede also contained 7 cm^3 charred fruits of *F. convolvulus* (Helbæk 1951b), which were obviously collected for human consumption. This is also indicated by a concentration of this species in Ermelo in The Netherlands from the early pre-Roman Iron Age (Van Zeist 1970).

According to Neuweiler (1905), at the beginning of the 19th century in Pomerania, the fruits were still used for flour and called ''wild buckwheat''.

The large caryopses of *Bromus secalinus* (chess) are common and often abundant in Neolithic and also Bronze Age cereal samples, while their frequency decreases in later periods. Knörzer (1967b) compiled several sites from the Rhineland and offered good arguments in favour of its cultivation by the Linearbandkeramik farmers, however not separately, but mixed with *Triticum.* Hjelmqvist (1955, pp. 52 f.) also discusses its cultivation on the basis of large numbers of imprints in pottery from Neolithic sites in Sweden. Willerding (1986) points to the fact that modern forms of this weed have lost the brittle rachis of wild grasses and are adapted to the cereals by having a tough rachis, so their dispersal is linked to that of the host cereals. A reasonable idea seems to be that *B. secalinus* was unintentionally spread in the early cereal fields, but was harvested intentionally because its large grains provided reasonable food, and also because it was very difficult to separate them from the grain during crop processing. The large proportion of *Bromus* grains in the harvest was certainly not a serious problem for the early farmers. This was the way in which *Secale cereale* later developed from a weed into a crop plant on its own (Behre 1992), but *B. secalinus* did not reach this stage and remained a field weed.

It should be mentioned that the separation of caryopses of *B. secalinus* from *B. mollis* is very difficult and the attribution is often made because of ecological considerations. The large number of *Bromus* remains in the stomach of Grauballe man, which supports its use as food, was tentatively called *B. mollis* by Helbæk (1959), but it may well have been *B. secalinus* which was still common in winter crops at that time.

As far as the author knows, other wild plants/weeds such as *Setaria* sp. (bristle grass) and *Rumex acetosella* (sheep's sorrel) which occurred in the intestines of bog bodies (Table 2) and are regarded as food plants, too, have not yet been found in large pure assemblages.

Remains of other plants that have not yet been found in bog bodies, but in cesspits far away from their natural habitat, may also indicate human consumption. An example is *Glyceria fluitans* (flote-grass or manna-grass), of which 68 caryopses were found in medieval cesspits in Bremen (Behre 1991). From this area there is also written evidence that this wild grass used to be collected with sieves in the water where it grew until about the 19th century (Kohl 1864). Other sources for East Prussia and Silesia show that collection and human consumption of *G. fluitans* was quite common until the end of the 19th century (Hegi 1935) and is also well documented for other parts of Poland (Dembinska 1976). For the prehistoric period this is supported by the recovery of a large number of caryopses from a middle pre-Roman Iron Age hearth at Spijkenisse, The Netherlands. There 480 caryopses, most of them carbonized, which were accompanied by remains of four different crop plants and a few seeds of other weeds and wild plants, which makes the use of manna-grass for human diet very probable (Brinkkemper 1993).

There are, however, sometimes small finds of pure seed material from other species that may have been collected more or less intentionally during crop processing but which do not indicate systematic collection. As an example, there is a vessel from Roman period Assendelft, west of Amsterdam, with nothing else than 58 carbonized seeds of *Stellaria media* which were probably meant as food (Groenman-van Waateringe and Pals 1983). However, its occurrence also in bog bodies (Table 2) does not give a clear answer whether *S. media* has generally been collected for human consumption.

Looking at the map with the localities of the finds discussed above (Fig. 2), it is noteworthy that most of the sites where assemblages of gathered plants were found are situated in areas with poor sandy soils in Denmark, northern Germany and the Netherlands. This may indicate difficulties in being able to grow enough food in these regions.

The collection of the seeds and fruits took place in different ways. Probably the oldest one was the picking of ripe seeds and fruits in the field, maybe with the help of nets or sieves. Fallow fields close to the settlements would have been very suitable for this activity, where some species with high seed production, such as *Chenopodium album*, were common.

Another way was collecting seeds and fruits from field weeds in the course of crop cleaning. In general, cereal fields in the past were full of weeds. How many of these weeds were picked up depended on the harvesting method. If only the heads of the cereals were cut, tall growing species like *Bromus secalinus* or climbing ones such as *Fallopia convolvulus* would have been constituents of the harvested crop. Harvesting near the ground by scythe or by machines (as early as Celtic and Roman times!) collects the low-growing species such as *Spergula arvensis* as well. The amount of weeds in prehistoric and medieval crops was high and people developed various methods of crop cleaning (Hillman 1984; Jones 1984). This had also to be done to extract poisonous grains such as ergot (*Claviceps purpurea*) or seeds of *Agrostemma githago*, but in most crops there was a considerable yield of edible weeds as a residue of cleaning, which advanced to by-products.

Although these species were not deliberately grown as crops, they were welcome as supplements for the human diet, which was poor at those times. Because of their close link with intentionally cultivated cereals, plants like *Bromus secalinus* and *Spergula arvensis* gained the status of secondary cultivated plants. While *S. arvensis* was later cultivated on its own, *B. secalinus* did not reach this status and more or less disappeared from the fields. Another weed, *Fallopia convolvulus* and sometimes other species, too, were retrieved during crop processing in order to supplement the diet.

On the basis of archaeobotanical finds and ethnobotanical knowledge, several authors have presented lists of plants which were expected to or which may have been used for consumption. So Knörzer (1971) gave a list of possibly gathered plants, based on frequent records in archaeobotanical samples, altogether 27 species apart from fruits, berries and nuts; an even longer catalogue was published by Renfrew (1973) and other lists are from Willerding (1986) and Jacomet et al. (1989).

All these assumptions are only possibilities or even speculations and have to be supported by hard facts. For leaves and stems, taken as vegetables and salads, this proof is extremely difficult, because generally they are not preserved. The record of seeds and fruits of gathered plants does not generally imply that their leaves were utilized as well, because these are not edible or fresh any more, when their seeds are ripe in the later part of a year.

One has to be very careful with the interpretation even of large numbers of certain seeds as having been gathered deliberately if they are mixed with other species. So for instance *Chenopodium album*, abundant in many samples, was growing as a ruderal plant in the settlements themselves and produces huge numbers of seeds, up to 200,000 per plant (Dobrochotov 1961), and is often present everywhere in the archaeobotanical material. Another important fact is that most of the diaspores in question have thick and durable walls, which improves their preservation even under bad conditions and leads to overrepresentation in the analyses (Brinkkemper 2007). On the other hand this quality makes them suitable for storing over some time.

Conclusion

There are numerous wild plants that in prehistoric and medieval times may have been gathered for human consumption, and certainly many of them were really used. Most of them were eaten as vegetables or salads; others were used to flavour the food and drinks or were taken as medicine or even hallucinogens. However, the record of their fruits and seeds does not allow us to assume the use of their vegetative parts.

Here only the use of seeds and fruits from wild plants/weeds, apart from fruit, berries and nuts are considered. For the acceptance of a species as having been intentionally gathered in this way and used for food, two main criteria are necessary: the occurrence of pure assemblages of their remains, separated from other species, or their regular occurrence in the intestines of corpses like bog bodies or in sure human faeces. In particular, bog bodies are key sources for the certain recognition as intentional food. New examples for both ways are presented and discussed here and compared with the records of other authors.

The seeds and fruits from six herbs are regarded here as having been certainly deliberately collected and used for human consumption in prehistoric times: *Polygonum lapathifolium*, *Chenopodium album*, *Spergula arvensis, Fallopia convolvulus*, *Bromus secalinus* and *Glyceria fluitans*; another two plants probably belong also to this group: *Setaria* sp. and *Rumex acetosella.*

The plants described above are not the only ones that were deliberately gathered. During famines and under extreme conditions every plant which was regarded as edible was eaten. A good example for the latter is the stomach content of the Grauballe man, where Helbæk (1959) identified remains from as many as 56 wild species. This is much more than from all other bog bodies.

Some species, however, such as those on which this article is focussed, were gathered intentionally and regularly under normal conditions and were firmly established in the human diet. The main precondition for these was that they could be gathered easily, because their seed production was high or because they were collected as a by-product during crop cleaning; in the latter way some species behaved like secondary cultivated plants. Another important point was that they were suitable for storage, for which thick seed walls are an advantage.

Acknowledgments I wish to thank Prof. Dr M. Frechen, Hannover, who provided the ^{14}C dates, M. Spohr for preparing the map and D. Kučan and T. Reiser for taking the photographs. This contribution is dedicated to Prof. Dr Corrie Bakels on the occasion of her 65th birthday with cordial thanks for long-lasting and fruitful cooperation.

References

Behre K-E (1986) Kulturpflanzen und Unkräuter des Mittelalters—Funde aus der Kirche von Horsten/Ostfriesland. Abhandl Westfäl Mus Nat 48:441–456

Behre K-E (1991) Die ersten Funde von Nahrungspflanzen aus dem Mittelalter Bremens. Bremisches Jahrb 70:207–227

Behre K-E (1992) The history of rye cultivation in Europe. Veget Hist Archaeobot 1:141–156

Behre K-E (1999) Die letzte Mahlzeit des 'Jungen von Kayhausen': Eine Untersuchung der Speisereste aus dem Darmtrakt. Schriftenr Staatl Mus Naturk Vorgesch Oldenburg 1, Beiheft 10:76–78

Behre K-E, Kučan D (1994) Die Geschichte der Kulturlandschaft und des Ackerbaus in der Siedlungskammer Flögeln, Niedersachsen, seit der Jungsteinzeit. Probl Küstenforsch südl Nordseegebiet 21, Isensee, Oldenburg

Brinkkemper O (1993) Wetland farming in the area to the south of the Meuse estuary during the Iron Age and Roman Period. Analecta Prehistorica Leidensia 24

Brinkkemper O (2007) Study of the preservation quality of archaeological sites using botanical macro-remains. Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek 46:303–314

Dembinska M (1976) Wild corn plants gathered in the 9th–13th centuries in the light of paleobotanical materials. Folia Quaternaria 47:97–103

Dieck A (1975) Darmuntersuchungen bei europäischen Moorleichen. In: Festschrift Schneider: Moor und Torf in Wissenschaft und Wirtschaft. Bad Zwischenahn, pp 33–42

Dobrochotov WN (1961) Samen der Unkrautpflanzen (in Russian). Moscow

Groenman-van Waateringe W, Pals JP (1983) The Assendelver polders project: integrated ecological research. BAR Int Ser 181:135–161

Grohne E (1934) Bericht über die Ausgrabung der Hove-Warf im Niedervieland bei Bremen. Abhandl Vortr Bremer Wiss Ges 8/9:1–14

Hatt G (1943) Jydsk Bondeliv i ældre Jernalder [Jutish farmers' life in the older Iron Age]. Globus, Copenhagen

Hatt G (1957) Nørre Fjand, an early Iron Age village site in West Jutland. Arkaeolog Kunsthist Skr Dansk Vidensk Selskab SA 2:2 København

Hayen H (1964) Die Knabenmoorleiche aus dem Kayhausener Moor 1922. Oldenburger Jb 63:19–42

Hegi G (1935) Illustrierte Flora von Mitteleuropa 1, 2nd edn. München

Helbæk H (1951a) Tollundmandens sidste Maaltid. [Botanical studies of the stomach contents of the Tollund Man, in Danish with English summary]. Aarböger Nordisk Oldkyndighed Historie 1950:311–341

Helbæk H (1951b) Ukrudtsfrö som naeringsmiddel [Seeds of weeds in the fore-Roman Iron Age, in Danish with English summary]. Kuml 1951:65–74

Helbæk H (1954) Prehistoric food plants and weeds in Denmark. Danmarks Geologiske Undersögelse II. Række 80:250–261

Helbæk H (1959) Grauballemandens sidste Maaltid [The last Meal of Grauballe Man]. Kuml 1958:83–116

Helbæk H (1960) Comment on *Chenopodium album* as a food plant in prehistory. Ber Geobot Inst Rübel Zürich 31:16–19

Hillman G (1984) Interpretation of archaeological plant remains: the application of ethnographic models from Turkey. In: van Zeist W, Casparie WA (eds) Plants and ancient man. Balkema, Rotterdam, pp 1–41

Hjelmqvist H (1955) Die älteste Geschichte der Kulturpflanzen in Schweden. Opera Botanica 1:3, Almqvist & Wiksell, Stockholm

Holden TG (1995) The last meals of the Lindow bog men. In: Turner RC, Scaife RG (eds) Bog bodies. British Museum Press, London, pp 76–82

Holden TG (1999) Food remains from the gut of the Huldremose bog body. J Danish Archaeol 13:49–55

Jacomet S, Brombacher C, Dick M (1989) Archäobotanik am Zürichsee. Ber Zürcher Denkmalpflege, Monographien 7, Orell Füssli, Zürich

Jessen K (1933) Planterester fra den ældre Jernalder i Thy. [Pflanzenreste aus der älteren Eisenzeit in Thy (Jylland)]. Botanisk Tidsskift 42:257–288

Jones GEM (1984) Interpretation of archaeological plant remains: ethnographic models from Greece. In: van Zeist W, Casparie WA (eds) Plants and ancient man. Balkema, Rotterdam, pp 43–61

Knörzer K-H (1967a) Subfossile Pflanzenreste von bandkeramischen Fundstellen im Rheinland. Archaeo-Physika 2:3–29

Knörzer K-H (1967b) Die Roggentrespe (*Bromus secalinus* L.) als prähistorische Nutzpflanze. ArchaeoPhysika 2:30–38

Knörzer K-H (1971) Genutzte Wildpflanzen in vorgeschichtlicher Zeit. Bonner Jahrbücher 171:1–8

Kohl JG (1864) Nordwestdeutsche Skizzen 1. Schünemann, Bremen

Kreuz A (2007) Archaeobotanical perspectives on the beginning of agriculture north of the Alps. In: Colledge S, Conolly J (eds) The origins and spread of domestic plants in southwest Asia and Europe. Left Coast Press, California (in press)

Kroll H (1990) Melde von Feudvar, Vojvodina. Praehistorische Zeitschrift 65:46–48

Kučan D (1979) Mittelalterliche Kulturpflanzen und Unkräuter aus ostfriesischen Kirchen. Probl Küstenforsch südl Nordseegebiet 13:23–38

Martin O (1967) Bericht über die Untersuchung der Speisereste in der Moorleiche von Dätgen. Offa 24:77–78

Mohr R (1990) Untersuchungen zur nacheiszeitlichen Moor- und Vegetationsentwicklung im nordwestlichen Niedersachsen mit besonderer Berücksichtigung von *Myrica gale*. Vechtaer Arbeiten zur Geographie und Regionalwissenschaft 12

Neuweiler E (1905) Die prähistorischen Pflanzenreste Mitteleuropas. Vierteljahrsschr Naturforsch Ges Zürich 50:1–111
Nitz H-J, Riemer P (1987) Die hochmittelalterliche Hufenkolonisation in den Bruchgebieten Oberstedingens (Wesermarsch). Oldenburger Jb 87:1–34
O'Connell M (1986) Pollenanalytische Untersuchungen zur Vegetations- und Siedlungsgeschichte aus dem Lengener Moor, Friesland (Niedersachsen). Probl Küstenforsch südl Nordseegebiet 26:171–193
Pieper P, Behre K-E, Möhlenhoff P, Parpatt PM, Schübel F, Schübel J (1999) Moor-Leichen. Schriftenr Staatl Mus Naturk Vorgesch Oldenburg 1, Beiheft 10:63–79
Renfrew JM (1973) Palaeoethnobotany. The prehistoric food plants of the Near East and Europe. Methuen, London
Van der Sanden W (1995) Bog bodies on the continent: developments since 1965, with special reference to the Netherlands. In: Turner RC, Scaife RG (eds) Bog bodies. British Museum Press, London, pp 146–165
Van der Sanden W (1996) Mumien aus dem Moor. Die vor- und frühgeschichtlichen Moorleichen aus Nordwesteuropa. Batavian Lion, Amsterdam
Van Zeist W (1970) Prehistoric and early historic food plants in the Netherlands. Palaeohistoria 14:41–173
Van Zeist W, Boekschoten-van Helsdingen AM (1991) Samen und Früchte aus Niederwil. In: Waterbolk HT, van Zeist W (eds) Niederwil, eine Siedlung der Pfyner Kultur. Haupt, Bern, pp 49–113
Willerding U (1986) Zur Geschichte der Unkräuter Mitteleuropas. Göttinger Schr Vor- Frühgesch 22, Wachholtz, Neumünster