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**Analecta Praehistorica Leidensia 39 / Excavations at Geleen-
Janskamperveld 1990/1991**

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Citation

Kamermans, H., Velde, P. van de, & Et al.,. (2007). Analecta Praehistorica Leidensia 39 / Excavations at Geleen-Janskamperveld 1990/1991, 278. Retrieved from <https://hdl.handle.net/1887/33079>

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Note: To cite this publication please use the final published version (if applicable).

ANALECTA
PRAEHISTORICA
LEIDENSIA 39

PUBLICATION OF THE FACULTY OF ARCHAEOLOGY
LEIDEN UNIVERSITY

EXCAVATIONS AT
GELEEN-JANSKAMPERVELD 1990/1991

EDITED BY
PIETER VAN DE VELDE



LEIDEN UNIVERSITY 2007

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ISSN 0169-7447

ISBN 978-90-73368-22-4

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and single volumes can be ordered exclusively at:

Faculty of Archaeology
P.O. Box 9515
NL-2300 RA Leiden
the Netherlands

The excavation of the Linearbandkeramik site of Geleen-Janskamperveld has revealed six crop plants: emmer wheat, einkorn wheat, pea, lentil, linseed and poppy. This is the normal set of plants for settlements founded in the north-western part of the Linearbandkeramik world. The earliest crops contained fewer weeds than the relatively later ones. The increase in weediness can be explained by permanent use of the same plots. Special areas for disposing of agricultural waste have not been detected.

6.1 INTRODUCTION

Books and articles dealing with the crops of the early neolithic Linearbandkeramik culture (LBK) are numerous. The cultural habit of digging pits and filling them with waste, when their original role had been fulfilled, has left us with much debris, including carbonized seeds and fruits. Such remnants could not fail to attract scientific attention. For the northwestern sphere of this European culture, to which Geleen-Janskamperveld belongs, I refer to, for instance, Bakels 1979, Bakels/Rousselle 1985, Knörzer 1997, Kreuz 1990, and Lüning 2000.

Because so much has already been written about the crops and agricultural waste of the LBK, specific questions can be formulated which might, at least partly, be answered by new excavations. The excavation at Geleen-Janskamperveld offered such an opportunity. The following questions are put forward:

1. When did opium poppy (*Papaver somniferum* var. *setigerum*) arrive to form part of the crop assemblage?
 2. Can changes be observed in the share of lentil (*Lens culinaris*) in the records?
 3. Are there any changes in the course of time where the amount and type of field weeds are concerned?
 4. Is there any difference in the waste associated with different types of houses?
 5. Was the carbonized debris thrown away in special areas?
- The background of these questions will be explained in the following text.

6.2 MATERIALS AND METHODS

To answer these questions, an intensive and systematic sampling programme was required in which every pit was

sampled. The elongated pits alongside the walls of the houses were sampled in such a way that at least their centre and both ends were covered. When the fill of pits showed layering, each layer was sampled separately. The only features not sampled were postholes, as I know from experience that postholes of LBK houses are commonly void of seeds and fruits, though they can contain charcoal.

In general the sample size was 2 dm³. The sediment was a sticky loessloam and had to be sieved by hand under gently running tapwater. The sieves used had meshes going down to 0.25 mm. The finest mesh was just fine enough to retain poppy seeds. Residues were slowly dried and then sorted with the aid of a Wild M5 microscope, after which the plant remains were identified and counted. As all sampled features were situated above groundwater level, only carbonized seeds had to be considered. Occasionally some uncarbonized seeds were found which were presumably introduced by soil fauna. Seeds of species which, when fresh, have a black or dark brown colour were cut in half to establish their carbonized state.

The complete procedure from the supervision of sampling to identification and counting was carried out by J. Goudzwaard. I did the necessary 'second opinion' identification of damaged specimens. All in all 444 samples were taken, processed and analysed.

The data set was processed by K. Fennema, who made tables and calculated the density of the finds.

6.3 RESULTS

6.3.1 General

The list of cultivated plants shows the entire (short) set of species commonly found in the settlements situated in the northwestern part of the LBK world. These plants are emmer wheat (*Triticum dicoccum*), einkorn wheat (*Triticum monococcum*), pea (*Pisum sativum*), lentil (*Lens culinaris*), linseed (*Linum usitatissimum*) and poppy (*Papaver somniferum* var. *setigerum*). Emmer wheat is far more common than einkorn wheat. A notable absent species is barley (*Hordeum* sp.), confirming this characteristic feature of the northwestern LBK crop assemblage.

Remains of gathered nuts and fruits are present as well. Fragments of hazelnut shell (*Corylus avellana*) are regularly

found, although concentrations of such remains are absent. Fruits are extremely rare. Two pits (24-026 and 44-012) contained fragments of apples (*Malus sylvestris*, parts of the fruit, cores and pips). One pit (59-007) revealed a sloe plum (*Prunus spinosa*, stone with adhering flesh). In another (32-025) a seed of elder (*Sambucus nigra*) was found.

A fruit of lime (*Tilia* sp.) was encountered in pit 17-050, but this is considered as not gathered for its own sake but as arrived together with the wood. Remains of other trees and shrubs, not considering charcoal, are absent. The other species are herbaceous and are interpreted as field weeds, except for bulrush (*Schoenoplectus* sp.) of which one seed was found. This rush may have been collected for basketry.

6.3.2 *Opium poppy (Papaver somniferum var. setigerum)*

The LBK opium poppy has drawn attention because the plant does not belong to the set of crop plants which came with the introduction of agriculture in central Europe. The other five crops mentioned in 6.3.1 are part of this set. Another characteristic is that until now finds are restricted to the, roughly, western half of the LBK world, a world which in its heyday reached from the river Dniestr in the east to far into the Paris Basin in the west (Bakels 1982, 1992). Occurrences of the wild ancestor of the opium poppy seem to be restricted to the western part of the mediterranean world, and the plant may have been brought into cultivation somewhere there and not in the Near East, which is the ultimate origin of the other five crops. The assumption that the wild opium poppy, which is growing today in the eastern mediterranean, is feral and not wild, is however not corroborated by genetic analysis. And recently poppy seeds have been reported from the Levant (Kislev/Hartmann/Galili 2004). Nevertheless, the LBK opium poppy is supposed to have been added to the list from southwestern, mediterranean sources, possibly the south of France. The plant arrived independently of the wheats, pulses and linseed.

The question is when did this plant arrive. The earliest LBK settlements did not reveal any traces of this crop (Kreuz 1990). So far, the finds date from the middle and late phases of the LBK, even in the area between the rivers Rhine and Meuse (contra Lüning 2000, p. 87). As a large part of the Geleen-Janskampveld settlement has been dated to an earlier phase, the so-called Flomborn phase, the opportunity presented itself to look for earlier finds.

Seeds of opium poppy were found in seven pits: 23-005, 27-027, 28-079, 31-096, 35-039, 40-067C, and 59-007 (fig. 6.1). Four of these could be attributed to a definite phase of occupation. The oldest is 59-007, which belongs to local phase 3, followed by 28-079, placed in local phase 5. Numbers 31-096 and 40-067C belong to phase 6. Phases 1-5 are of Flomborn age (period Modderman 1b-1c), and phase 6 corresponds to Modderman end 2c/beginning 2d, which is

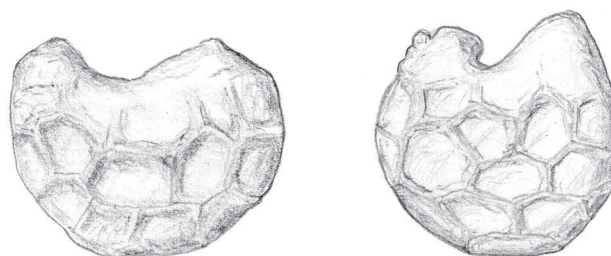


Figure 6.1 Opium poppy (*Papaver somniferum* var. *setigerum*), 40 x, drawing W.J. Kuijper

late LBK. Two of the finds are therefore early. This implies that opium poppy was an early addition to the crops grown. As much earlier LBK settlements are hardly present in the region, poppy is supposed to have been grown from the earliest occupation onwards at least in this part of the LBK world. The finds provide new arguments that the plant was obtained from the elusive pottery-using societies, which were contemporaneous with the LBK in the west and had connections with France. But as long as no new information on early poppy in France and especially from early neolithic southeastern, mediterranean France, the route by which the LBK obtained poppy remains obscure.

6.3.3 *Lentil (Lens culinaris)*

The problem with lentil is that this pulse disappears from the records in the cultures following the LBK. This is at least the case in the area between the rivers Rhine and Meuse (Knörzer/Gerlach 1999, p. 80). Of the pulses grown by the LBK farmers, lentil is the most difficult to cultivate. The plant requires a climate with mediterranean traits, and, notwithstanding the conditions of the climatological optimum prevailing during the Atlantic Period in which the LBK flourished, may have reached its northern limits in the Rhine-Meuse region.

Dendrological research, carried out in Cologne, has provided a tree-ring calendar valid for western Germany, which shows a serious climatological dip around 5050 cal BC. The climate became drier, which may not have affected lentil, but also colder (Schmidt/Gruhle 2005). It is therefore possible that the decline in lentil growing had set in already during the LBK, and that early LBK farmers grew more lentil than their successors living after 5050 cal BC.

The settlement at Geleen-Janskampveld provided an opportunity to test this, because the terrain showed two periods of occupation, an early and a late one with a time gap in between. The early occupation is dated before 5100 cal BC, the late one after this date.

Seven pits have provided lentils (fig. 6.2). Four of them belong to the earliest phase of the early occupation: 32-100,



Figure 6.2 Lentils (*Lens culinaris*), 10 x, photo J. Pauptit

40-073, 57-020, and 57-041. Two belong to the late period of occupation, local occupational phase 6: 18-055 and 40-67C. And one, 34-041, could not be dated with certainty. Because pits belonging to the early period are more numerous than pits belonging to the late period, the ratio of two to four cannot be regarded as proof of a decline in lentil growing. It is quite possible that the dating of the last occupation is not precise enough for this kind of analysis. Another possibility is that the disappearance of lentil had no climatological background.

6.3.4 Crops and weeds

An earlier analysis of seeds and fruits retrieved from LBK settlements taught us that assemblages fall into six distinct categories: grain not yet dehusked either with many or almost without weed seeds mixed in, chaff with or almost without weeds, dehusked grain and *Chenopodium album* seeds (Bakels 1991). An assemblage is defined as a concentration of finds which cannot be explained by chance. The density of remains in the various samples (number of seeds, chaff and fruits per dm³ of soil) commonly follows a Poisson distribution, which implies that the individual remains got together by chance. Densities which do not fit into this kind of distribution are not caused by just chance. The

constituents of these lots were probably thrown away together and must be regarded as the result of one charring event. But of course such lots are not closed finds and can contain independent elements as a kind of noise.

In the Geleen-Janskamperveld set of data, densities equal or higher than 80 remains per dm³ of pit filling do not really follow the Poisson distribution valid for this site. There are 27 of such assemblages. Concentrations of *Chenopodium album* are absent. Remains of crops other than wheat are so rare that they have to be considered as noise, when they turn up in the concentrations. This also applies to hazelnut shell fragments.

In not-yet-dehusked emmer the ratio grain / glumes is 1 to 1, and in einkorn 1 to 2. In the LBK finds the hulls are always found separately, even if they were originally attached to the grains. After charring, hulls are brittle and tend to separate from the grain, aided in this by taphonomic processes. The glumes, still held together by a part of the central axis of the ear, are found as 'spikelet forks', and if broken apart, as 'lemma bases'. In lots of emmer and einkorn in the husk, the proportion should approach the ratio mentioned above. If the hull remains (chaff) far outnumber the grain, the assemblage is considered to be waste of dehusking. If the grain outnumbers the chaff, the grain was dehusked.

All three kinds of concentrations have been encountered in Geleen-Janskamperveld. But, as found in the analysis mentioned above, within these three a second characteristic turns up, namely the status with or without weeds. The explanation was sought in either crops cleaned or not cleaned before dehusking, or in crops from well-weeded versus badly-weeded fields, or fields without weeds versus weed-infested fields. The third hypothesis seemed to be supported by the fact that 'clean' assemblages belonged to earlier phases of occupation of a territory and those with weeds to later phases. Virgin forests do not have seeds of potential field weeds in their soils, at least not in serious quantities. Weeds are introduced with the sowing seed or see an opportunity when parts of the forest are kept open for a number of years. Newly laid-out fields will contain fewer weeds than old fields.

To check this hypothesis, the 27 concentrations present in Janskamperveld were checked once again for their weed content. Two clusters were observed. Ten concentrations held 10 percent or less herbs. All species could have been field weeds. They are found again and again in connection with LBK wheat (Knörzer 1971; Bakels/Rousselle 1985). Nine concentrations contained 55 percent or more weeds. The remaining eight are dispersed in between. When the samples in the clusters are dated, it is striking that all concentrations with a low weed content belong to the early phases of occupation of the terrain. Even when taking into account that

four assemblages come from the same pit (although from different places and layers), the fact remains that the late phase 6 is absent. The late phase turns up in the cluster with high amounts of weeds (table 6.1). With this result, the Geleen-Janskampveld site provides new indications that the age of the fields is linked to a weedy or non-weedy condition. It is presumed that LBK fields were permanent (Bakels 1978, p. 49).

Another approach to the weediness of fields is to see whether the number of weed species increases between the early phases and the much later local phase 6. To this end, the frequency in which the weed species occur in the samples was compared (table 6.2). The frequency is here the percentage of samples in which the plant was found. The table gives no reason to conclude that the composition of the weed flora developed from a simple flora during the early, Flomborn, LBK into a much richer flora in the late LBK (local phase 6).

weeds %	≤ 10	>10 < 50	≥ 50
	local phase		
<i>Grain in the husk</i>			
13.100.01.03	.	1	.
15.005.02.02	.	1	.
17.020.04.03	.	.	5
20.027.19.01	1	.	.
32.100.05.03	1	.	.
32.100.06.01	1	.	.
32.100.10.01	.	1	.
32.100.12.01	1	.	.
24.065.02.02	.	.	1
40.067B.02.01	.	.	6
40.076C.02.04	.	.	6
48.021.08.02	.	.	6
<i>Chaff</i>			
32.100.08.03	1	.	.
32.100.16.03	.	1	.
32.142.05.02	4	.	.
35.039.03.03	1?	.	.
44.012.02.02	1	.	.
52.017.04.03	2	.	.
52.017.04.02	.	.	2
<i>Grain dehusked</i>			
52.051.04.02	1	.	.
28.079.4.2.01	.	.	5
59.006.02.00	.	.	2

Table 6.1 The weed content of cereal concentrations. Only those with

It may be argued that the forest had returned in the time between the first and second period of occupation. In that case the starting point of the second, late LBK set of fields may have been almost identical to the first. But this is probably not true. Although occupation ended after local phase 5 on the Geleen-Janskampveld terrain to return only much later, occupation has been proved for the time interval on terrains nearby. It is highly probable that the forest was given no opportunity at all to return. The conclusion must be that the increased weediness of fields cannot be attributed to an increase in weed species but must be sought in a more abundant growth of species already present.

6.3.5 House types and crops

LBK farmhouses come in three types. They are composed of three modules, which, according to their place in the always NW-SE oriented buildings, are called the NW, the central and the SE part. Large houses of type 1 consist of all three modules. Medium houses, type 2, are composed of the NW and central module. Houses of type 3 have only a central part.

In the LBK settlements on the Aldenhovener Platte (Germany), some 30 km east of Geleen-Janskampveld, it

	early	late
<i>local phase</i>	1-5	6
<i>N samples</i>	229	65
<i>Chenopodium album</i>	72	83
<i>Bromus secalinus</i>	56	78
<i>Fallopia convolvulus</i>	37	57
<i>Atriplex patula/prostrata</i>	7	6
<i>Lapsana communis</i>	6	9
<i>Persicaria lapathifolia/maculosa</i>	6	8
<i>Vicia hirsuta/tetrasperma</i>	4	5
<i>Bromus sterilis/tectorum</i>	3	3
<i>Chenopodium polyspermum</i>	3	2
<i>Phleum sp.</i>	2	8
<i>Poa pratensis/trivialis</i>	2	3
<i>Galium aparine/spurium</i>	2	9
<i>Veronica hederifolia</i>	2	0
<i>Rumex sp.</i>	0	5
<i>Setaria verticillata/viridis</i>	1	3
<i>Echinochloa crus-galli</i>	1	3
<i>Cruciata laevipes</i>	1	0
<i>Vicia cracca</i>	1	2
<i>Solanum nigrum</i>	0	2
<i>Trifolium sp.</i>	0	2

Table 6.2 The frequency of weed taxa in the waste.

was found that the waste of people living in all three house types contained dehusked grain, but that chaff was mainly to be found in pits associated with houses of type 1 (Lüning 1988, p. 81). Type 1 is characterized by having the SE module, which is the part with the heaviest foundations. It is interpreted as the part where heavy and bulky products were stored, for instance cereals. The fact that chaff was found mainly near this kind of building gave rise to the idea that the grain was dehusked there and perhaps distributed from there.

The Geleen-Janskamperveld excavation provided an opportunity to look into this hypothesis again. Table 6.3 shows the concentrations of the three kinds of cereal

	<i>house nr</i>	<i>type</i>	<i>situation</i>
<i>Grain in the husk</i>			
13.100.01.03	12	2	N
15.005.02.02	56	2	L-E
17.020.04.03	–	–	–
20.027.19.01	49	2	L-W
22.020.00.04	37	1b	L-W
24.065.02.02	–	–	–
27.027.01.01	–	–	–
28.102.02.02	6?	1b	L-E
32.100.05.03	35	1a	L-E
32.100.10.01	35	1a	L-E
32.100.06.01	35	1a	L-E
32.100.12.01	35	1a	L-E
35.029.05.02	40	3	N?
40.064A.01.03	–	–	–
40.067B.02.01	8	1b	L-W ?
40.076C.02.04	8	1b	L-W ?
48.021.08.02	39	1a	L-E
<i>Chaff</i>			
32.100.08.03	35	1a	L-E
32.100.16.03	35	1a	L-E
32.142.05.02	–	–	–
35.039.03.03	40	3	N?
44.012.02.02	14	1b	L-W
52.017.04.03	17	3	L-E
52.017.04.02	17	3	L-E
<i>Grain dehusked</i>			
28.079.4.2.01	8	1b	L-E
52.051.04.02	18	1a?	L-E
59.006.02.00	44	1b	L-E

Table 6.3 Concentrations of cereal remains, house types and position of the finds. N = north, L-E = along the eastern wall, L-W = along the western wall.

products mentioned in 6.3.4 in connection with the house types. Concentrations of chaff are present near houses of type 1 (1a and 1b are subdivisions of this type) and type 3. Dehusked grain is present near houses of type 1. Not-yet-dehusked grain is encountered near all three types. In the case of Geleen-Janskamperveld it is therefore not possible to conclude that dehusking took place exclusively in or near type 1 houses. It is more probable that dehusking took place in every household, probably on a day-to-day basis as is customary in many societies which grow emmer and einkorn wheat (see for instance Hillman 1984).

6.3.6 *The disposal of cereal waste, especially chaff*

The farmhouses of the LBK were surrounded by yards, which were not so much defined by boundary structures as by a certain clustering of pits around the buildings. There are oblong pits parallel to the long walls and a number of other pits in a more scattered position. Pits are absent from the area in front of the southeastern end of the house. The pits must have served different purposes but most of them ended up as rubbish pits. The composition of the waste can vary however. A. Kreuz (1990) found that most of the chaff was to be found in the scattered pits. K.-H. Knörzer (1988) discovered that even the fill of the scattered pits was not uniform, but that the largest amounts of burnt chaff turned up in pits situated to the north and west of the houses.

Since then I have looked for such trends in more settlements than the Langweiler 8 settlement analysed by Knörzer and found them in the settlements of Schwanfeld and Meindling, both in Germany (Bakels 1995). Schwanfeld was reported to have burnt chaff in pits east of the houses, but a recent study has changed the attribution of those pits to yards, and the same pits are now pits west of houses (Lüning pers. comm. 2006). The inhabitants of the second site, Meindling, had thrown their chaff in western pits as well, though not in scattered pits but in the oblong pits near the wall. A third site, Cuiry-lès-Chaudardes in France, proved not to be suitable because local taphonomic conditions are adverse to the preservation of brittle carbonized matter.

Geleen-Janskamperveld offered another opportunity. The analysis of the site has failed to reconstruct yards. Most pits are of the wall-accompanying type. Scattered pits are present but not as numerous and more difficult to ascribe to individual buildings. Table 6.3 presents the pits in which concentrations of chaff have been found. Four out of seven turned up along the eastern side of the house wall, one along the western side, one was a pit of the 'scattered' type north of a house, and the last was a solitary pit which could not be attributed to a definite household. The conclusion is that Geleen-Janskamperveld does not reveal the western position of disposal of chaff as earlier predicted by the situation in the three sites mentioned above.

The same table shows the position of the other two kinds of cereal waste. Dehusked grain lies near eastern walls and not-yet-dehusked grain alongside both eastern and western walls. An analysis of the position of the different kinds of waste in connection with the exact place along the walls did not result in the detection of preferred places. If these had been found, they could perhaps have marked the location of a door or window. As it is, the inhabitants of Geleen-Janskampveld showed a tendency to discard their waste east of their houses, but it is just a tendency.

6.4 CONCLUSIONS

According to the fruits and seeds, Geleen-Janskampveld corresponds to the average Linearbandkeramik settlement as found in the region between the rivers Rhine and Meuse. The six usual crop plants, emmer wheat, einkorn wheat, pea, lentil, linseed and poppy are all present. The fact that emmer wheat is far more important than einkorn wheat gives the site perhaps a minor distinction. As usual, remains of gathered products are scarce.

The five questions, put forward in the introduction, have got their answers.

Opium poppy was part of the crop assemblage from the beginning. The finds indicate that the plant has been cultivated from at least the Flomborn phase of the Linearbandkeramik culture onwards.

Lentil does not disappear from late Linearbandkeramik contexts, at least not in Geleen-Janskampveld.

New fields in an area not cultivated before may have given fewer problems with weed growth than fields which had already been tilled for several generations.

There is no difference between the different types of houses as far as cereal waste is concerned. Houses of type 1 do not stand out because of disproportionate amounts of chaff, nor of other kinds of cereal waste.

The west side of buildings was not the preferred place to burn chaff or to dump burnt chaff. If there is a preference at all, it is the east side.

Acknowledgments

Without the infinite patience of Johan Goudzwaard, the 444 samples would never have been taken, processed and sorted. Without the meticulousness of Kelly Fennema the data would not have been as accessible as they are. My thanks to them both.

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