

SEEDS AND FRUITS FROM THE SWIFTERBANT S3 SITE

Final reports on Swifterbant IV

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1. INTRODUCTION

This paper constitutes the final report on the examination of seeds, fruits and other macroscopic plant remains, except charcoal and non-carbonized wood, from the Swifterbant S3 settlement site. Prior to the discussion of the palaeobotanical results a brief survey will be presented of the palaeogeography of the area and of the prehistoric habitation. The main objectives of this review are the following: 1) to focus attention on the unusual environmental conditions of the S3 site and other similar habitation sites in the area; 2) to provide information on the physical milieu of the area indispensable for the interpretation of the botanical data; and 3) to point at the particular conditions with respect to the preservation of plant remains at S3 and other sites. For more detailed information the reader is referred to the publications cited below.

1.1. Prehistoric geography and habitation of the Swifterbant area

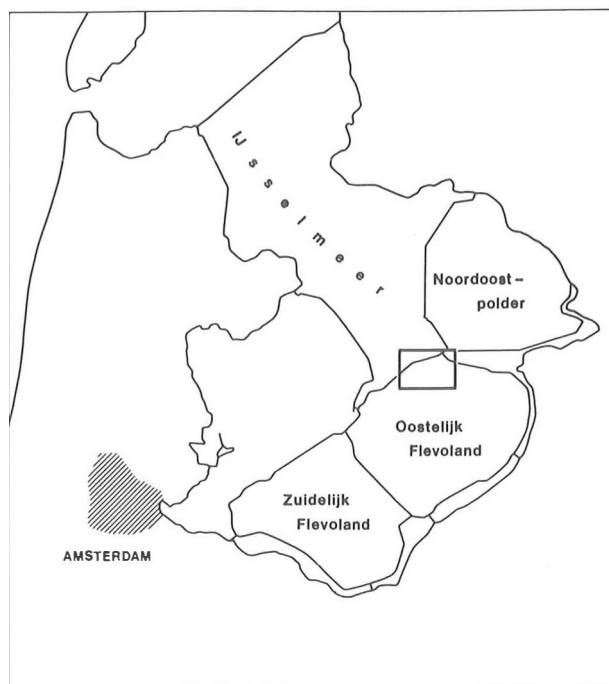


Fig. 1. Location of Swifterbant.

In the northern part of the Polder Eastern Flevoland (Oost Flevoland), near Swifterbant, municipality of Dronten (fig. 1), a prehistoric tidal estuary was discovered in the subsoil during geological investigations by the Research Division of the Polder Development Authority in 1961 and following years (Ente, 1976). Later on, systematic borings carried out by Hacquebord (1976) have for some particular areas refined the picture of the buried tidal delta landscape. A reconstruction of the landscape to the west and the north of the present town of Swifterbant around 3300 B.C., the period of relevance to the subject of this paper, is shown in fig. 2. The area was dissected by larger and smaller creeks bordered by natural levees. The levees were best developed along the large streams. Behind the levees were extensive, low-lying back-swamps. It was a fresh-water tidal estuary, in which the differences between high and low tide would usually have been no more than 10-20 cm (Ente, 1976). Ranges of late Pleistocene or early

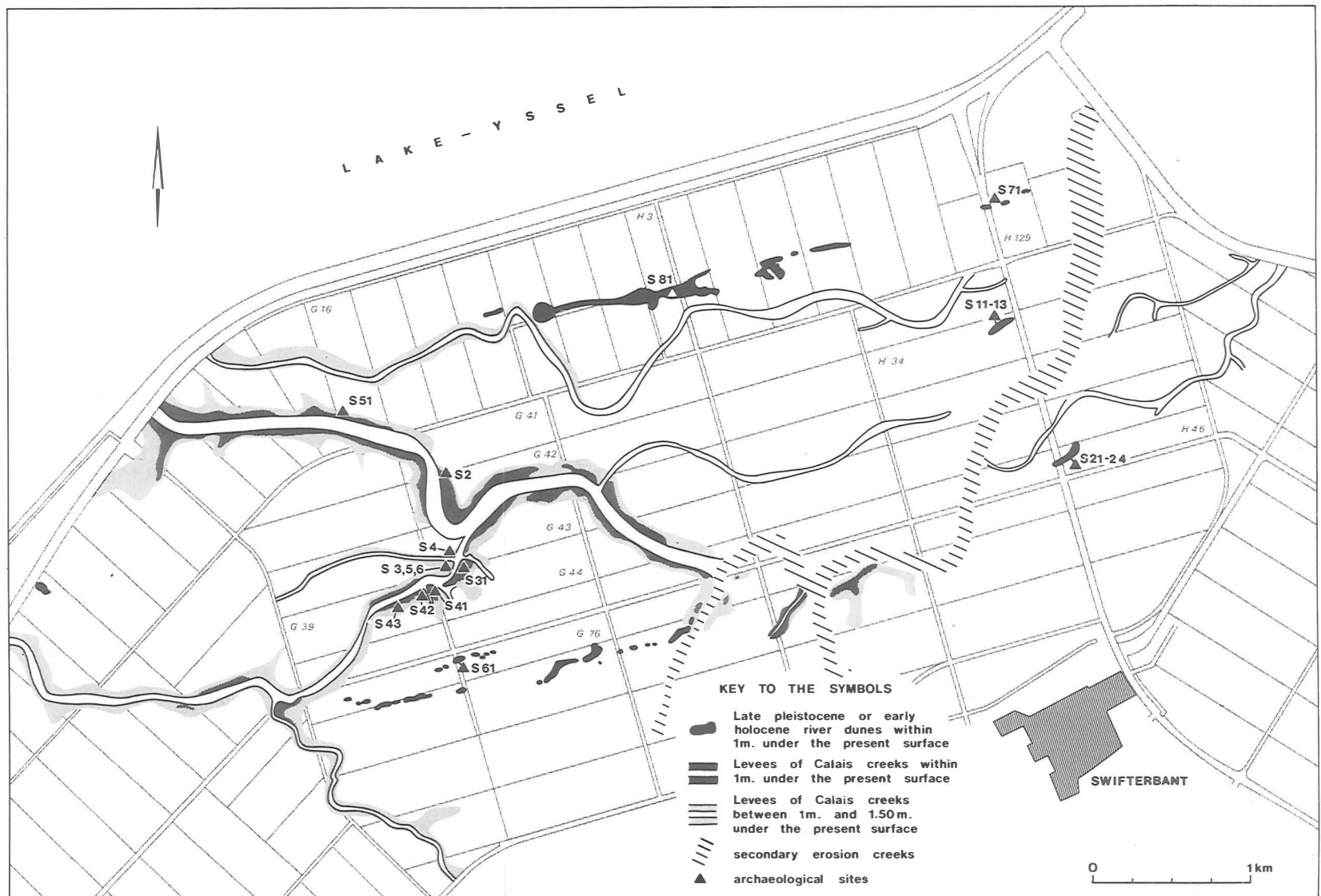


Fig. 2. Swifterbant area. Situation of creeks, levees and river-bank dunes and location of archaeological sites (after Deckers, 1979, fig. 1).

Holocene river-bank dunes delimited the valley in which the creek system developed to the north and the south.

In the course of the geological survey by the Research Division of the Polder Development Authority indications of human occupation on the highest parts of the natural levees along the creeks were established. Traces of human habitation were also found on the river-bank dunes (cf. Van der Waals & Waterbolk, 1976). Close-distance borings brought some more settlement sites to light (H. Fokkens, unpublished report). The river-bank dunes must have attracted prehistoric man over a long period. Radiocarbon dates and archaeological evidence point to an intermittent use of the dunes from c. 5800 B.C. to c. 3300 B.C. (Deckers *et al.*, 1980). On the dunes, traces of human occupation of various periods are found in the same level. The habitation on the natural levees embraced a much shorter period, viz. c. 3500-3200 B.C. The location of the prehistoric settlement sites in the Swifterbant area is indicated in fig. 2.

About 3000 B.C. the area became inundated, as a result of which marine clay, up to 30 cm thick, was deposited. This clay layer seals off the fresh-water tidal landscape and consequently also the occupation remains on the natural levees. Only the highest parts of the river-bank dunes still stuck out. These were eventually covered by peat formed in the extensive marshes which developed in the area after the deposition of the clay. The greater part of the peat was eroded by the rapidly extending Almere, the medieval predecessor of the Zuiderzee (cf. Deckers *et al.*, 1980).

Systematic investigations of the Swifterbant sites were started by the archaeological department of the Research Division of the Polder Development Authority. In 1962-1967, under the direction of G.D. van der Heide, excavations were carried out at the river-bank dune sites S21-22 and at the natural levee site S2 (cf. Van der Waals & Waterbolk, 1976). In 1971, the excavations were resumed, now by the Biologisch-Archaeologisch Instituut. In

addition, teams from the Museum of Anthropology of the University of Michigan (R. Whallon) and from the Department of Anthropology of the University of Wisconsin (T.D. Price) worked on Swifterbant dune sites (cf. Price, this volume).

1.2. The choice of the S3 site for botanical examination

In the sites on the river-bank dunes only charred plant remains are preserved. In the sites on the natural levees, conditions for the preservation of vegetable material are much better. As a matter of fact, the habitation layers consist here of dark clay rich in organic material. In contrast to the rather dry conditions on the dunes at the time of the habitation, the banks bordering the creeks constituted a moist environment. The levee sites were flooded regularly or occasionally, particularly in the winter season.

So far, eight settlement sites on natural levees have been localised: two (S2 and S51) alongside a major gully, the others on the banks of a smaller creek (S3, S5 and S6 are taken here as one site). On four of them excavations have been carried out. These sites were also tested for their suitability for palaeobotanical research. To this purpose, one litre samples of soil were systematically examined for numbers of seeds and fruits (for a description of the method see 2.1.). The samples from S51, S2 and S4 were poor or barren in seeds. On the other hand, at least a part of the samples from S3 yielded somewhat greater numbers of uncarbonized seeds. It must be left undecided here whether the scarcity of seeds and fruits in S2, S4 and S51 is of primary or of secondary nature; in other words, whether only few seeds were incorporated in the settlement layers or whether due to less favourable conditions most of the seeds originally present decayed in the course of time. As only the S3 site offered good prospects for palaeobotanical research, it was decided to confine a more detailed examination to this site.

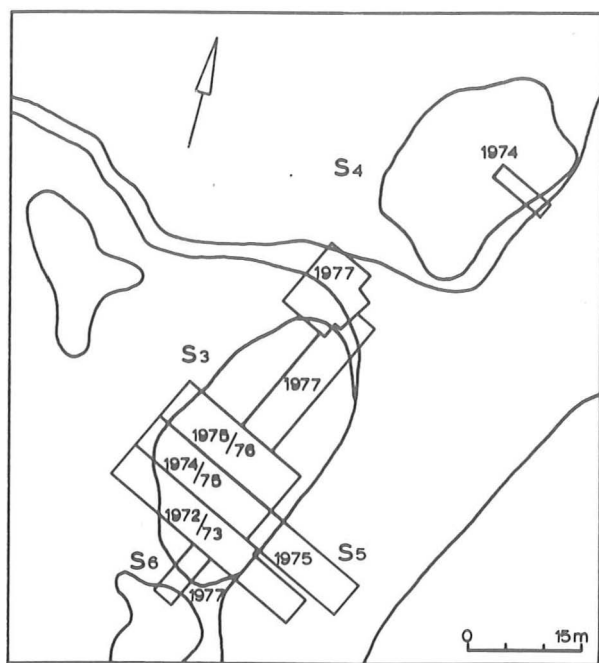


Fig. 3. Trenches excavated in successive years in site S3 and adjacent sites (after Deckers *et al.*, 1980, fig. 19).

1.3. The S3 site

The gully along which the S3 site was situated was initially a tributary creek which subsequently made contact with the southwestern creek, so that a break-through channel was formed (Hacquebord, 1976). It is likely that the natural levees along the break-through channel did not silt up as high as those along the major creek on which S2 and S51 were founded. The moister environment at the locality of the S3 site may have favoured the preservation of organic remains, thus contributing to the accumulation of the habitation deposit, up to 75 cm thick. In the field, layers of reed stems, scattered wood chips, bark and twigs were frequently observed.

The S3 site, on the western levee of the break-through channel, is more or less oval in outline. The length is c. 35 m and the width does not exceed 20 m. Excavations of the site were carried out in 1972-1977. In fig. 3 the areas excavated in the successive years are indicated. A deep trench through the creek

alongside S3 is designated as S5, although the finds from this cutting must have originated from S3. Numerous pottery sherds, flints, worked and unworked bone fragments, and, more rarely, beads and pendants occurred dispersed in the habitation layers. Of the structural elements, hearths and posts are mentioned. The remains of fire-places consisted of clay which was partly burnt and of layers of white ash. Remains of about 750 stakes and posts were found, but it was not possible to arrive at configurations of huts or other structures (Van der Waals, 1977; Deckers *et al.*, 1980).

Along the creek, settlement layers had been washed away at an early stage of the habitation. The erosion was soon followed by rapid sedimentation in the same zone, and thereupon the settlement expanded again towards the creek (Deckers *et al.*, 1980).

2. FIELD AND LABORATORY PROCEDURES

2.1. Field work

The excavations of the S3 site and of the other natural levee sites were performed in square metre parcels and per layer of c. 10 cm. The grid system over the S3 settlement is indicated in figs. 6-33. Thus, each square is designated by a Roman and an Arabic figure. The successive 10 cm layers are indicated by letters F up to and including K (figs. 6-15).

Systematic sampling for palaeobotanical examination started in 1973. During the 1973 campaign, all soil dug away per layer of c. 10 cm and per square metre was dissolved with water in a concrete mixer and subsequently washed through two sieves, with meshes of 2 and 1 mm respectively, placed one on top of the other. This method was applied in order to recover small finds which had escaped notice during the excavation. The organic fraction retrieved on both sieves, or part of it, was set apart for botanical examination in the laboratory in Gröningen. This method appeared to

be less satisfactory. It soon became clear that for practical reasons only a minor part of the great numbers of samples brought to the laboratory could be examined, and what is worse, that the choice of the samples to be examined had to be completely arbitrary. Some of the samples were fairly rich in seeds, whereas from others only small numbers could be recovered. Moreover, small seeds could have been washed through the 1 mm sieve, thus effecting the relative frequencies of the seed and fruit types.

The experience with the samples of the 1973 campaign and a modification in the field processing of the excavated soil induced us to apply another strategy with respect to the sampling for palaeobotanical research. The washing through the 1 mm sieve had turned out to be very time-consuming and cumbersome. For that reason it was decided to wash only through a 2 mm sieve from 1974 on. It became clear that most of the seeds were washed through the 2 mm sieve, so that the residues left on the sieve were not suitable for our purposes. From then on, unprocessed soil samples had to be taken to the laboratory. It would be most efficient if soil samples sufficiently rich in seeds and fruits could be selected for possible examination in the laboratory. For determining in the field the seed concentration of the excavated soil a kind of crash procedure was set up by W. A. Casparie and R. M. Palfenier-Vegter. This method, which turned out to be very satisfactory, is described below.

1. From the soil excavated per square metre and per 10 cm layer a one litre sample was soaked in water to which a detergent had been added for 24 hours.
2. The next day the sample was washed through three sieves, with meshes of 2.0, 0.5 and 0.2 mm respectively.
3. Thereupon, the fractions were examined under a binocular stereo-microscope for uncarbonized seeds and fruits and carbonized cereal grains. No identifications were made, but only the numbers of seeds and fruits were recorded. Moreover, an estima-

tion of wood and charcoal fragments was made. On an average, half an hour was spent per sample.

4. Based upon the numbers of seeds and fruits four categories of samples are distinguished:
 - 20 and more (rich in seeds)
 - 10-19 (moderately rich in seeds)
 - 1-9 (rather poor in seeds)
 - no seeds.

It should be emphasized that the terms rich and moderately rich in seeds are relative indications. Compared to the Iron Age coastal settlement sites, for instance, the Swifterbant material is poor in seeds and fruits. The seed frequencies per one litre form the basis of figs. 11-15 and 16-24 (section 6).

5. Of the soil from square metre layers which had turned out to be sufficient rich in seeds, a three litre sample was set apart for possible examination in Groningen. It is self-evident that this was unprocessed soil.

The palaeobotanical field work was carried out by R. M. Palfenier-Vegter (1974, 1975, 1976, 1977) and Y. M. Koster (1976). The one-litre samples from S51 were examined in Groningen, those from S2 in part. In washing the soil for retrieving small archaeological objects, also carbonized grains, fragments of hazelnut shells and other large botanical remains were recovered from the residues on the 2 mm sieve. These plant remains are included in the discussion (table 3, figs. 6-10). The samples concerned are referred to in this paper as "sieve residues".

2.2. Choice of samples to be examined

In the laboratory the samples were processed and subsequently examined for seeds, fruits and other plants remains according to the methods usual in the palaeobotany department of the Biologisch-Archaeologisch Instituut. For a rather detailed description of the laboratory treatment of similar samples the reader is referred to Van Zeist (1974, section 2.2.).

In spite of the greatly reduced numbers of samples brought to the laboratory, only a minor part of them could be examined, this because of the very time-consuming procedure. In the selecting of the samples it was attempted to comply with two conditions:

1. Of each of the layers F-K a representative number of samples should be analysed.
2. Per layer the samples should not all be derived from one and the same area, but they should be distributed as well as possible over the site.

The latter condition was curtailed by the fact that concentrations of metre squares with relatively great numbers of seeds occurred (see 6.1.1.), implying that the samples brought to the laboratory were not more or less evenly distributed over the site. The origin of the samples examined in the laboratory is indicated in figs. 25-33. It should be taken into account that the 10 cm levels of figs. 25-33 do not correspond to the layers F-K employed in the field. There are five "field" layers against nine 10 cm levels (see 6.1.2.). In spite of the fact that the spatial distribution as well as the numbers of the samples examined may be criticized, we believe that the study presented in this paper provides a fair picture of the plant species represented in the site.

2.3. Presentation of the results

The results of the analyses are presented in table 1. No numbers of seeds and fruits are shown but percentages. In this connection the following should be remarked. Only occasionally were all three fractions of one sample (2.0, 0.5 and 0.2 mm sieve) wholly analysed. Of the middle and fine fractions usually only a part was examined. Before adding the results of the three fractions together, the numbers of seeds and fruits found in a subsample of a fraction were converted to the total numbers for that fraction. The frequencies of the seed and fruit types are expressed as percentages of the total numbers of seeds and fruits per sample. A plus sign is given in the case of remains other than seeds and fruits or if only one or a

few seed fragments were found. The mosses are shown separately in table 2. The moss remains have been identified by Dr. H.J. During (Utrecht). As the volume of soil of all samples was approximately the same, viz. about 3 litres, the total numbers of seeds and fruits shown at the bottom of table 1 are directly comparable with one another.

2.4. Aims of the investigation

The aims of the palaeobotanical investigation of the Swifterbant S3 site are rather straightforward, namely:

- to assess the exploitation of the wild flora by the inhabitants of the site;
- to ascertain which plants were cultivated;
- to attempt a reconstruction of the vegetation;
- to look for possible indications of seasonal habitation.

No groundplans of huts or houses were recognized in the field. For that reason, in the selection of samples for palaeobotanical examination it was not possible to take account of possible activity areas, such as work- and living-floors. Nevertheless, in working out the results it turned out that certain correlations between seed content of the soil and the distribution of archaeological objects seem to exist (6.1.3., 6.2.1.).

The analyses of the samples were carried out by R.M. Palfenier-Vegter. Both authors are responsible for the identifications. W. van Zeist takes the sole responsibility for the interpretation of the results and for the text.

2.5. The preliminary report

In the preliminary report on the palaeobotany of Swifterbant (Casparie *et al.*, 1977) two pollen diagrams, one of them prepared for the upper layers of the fill of the creek along which the S3 site was situated, are presented. Since then no other pollen diagrams have been prepared for the area. In the same report the species identifications of wood and charcoal systematically collected from 39 metre squares

Sample number	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
Sample designation	I-17-	I-18-	II-16-H	III-14-G	III-20-F	III-20-G	IV-13-F	IV-17-G	IV-20-H	IV-24-F	IV-24-G	V-13-K	II-18-G	V-18-K	V-21-G	V-23	VI-25-K	VII-22-K	III-17-F	VIII-17-F	VIII-23-F	VIII-23-H	VIII-24-H
Agrostis spec															0.4	.	.	.	.	.	0.6	
Alisma plantago-aquatica									2.7		0.2												
Alnus glutinosa			0.1						2.7									0.3					
Alopecurus cf. geniculatus																							
Anthriscus sylvestris			0.1	2.1																			
Arctium cf. lappa	0.1		0.1			0.2			0.2					0.1		0.7		0.1				1.4	0.2
Artemisia vulgaris					2.1																		
Aster tripolium						1.2	0.3															0.6	0.1
Atriplex hastata/patula	6.9	8.3	9.1	6.2	55.6	30.9	1.0		9.1		26.5	3.6	36.3	24.8	5.1	16.8	9.4	2.5	13.1	3.6	4.4	12.9	10.6
Betula spec.			0.1																				
Bromus mollis/secalinus									19.3														
Caltha palustris														0.3									
Capsella bursa-pastoris														0.3									
Carduus crispus												0.8	0.5				0.1						
Carex disticha																							
Carex nigra-type			0.1																				
Carex paniculata			0.1			0.5																	
Carex pseudocyperus		0.1																					
Carex riparia				0.2																			
Carex rostrata/vesicaria			0.1		0.3				2.7					0.3									
Carex serotina-type																				2.2			
Carex spec.				0.5																			
Ceratophyllum submersum														0.1									
Chenopodium album	0.1	0.1	0.4		3.8	3.0	1.7	1.8		+	0.8	2.5	2.6	0.5	31.5	0.4		0.2	36.0	25.1	13.3	0.6	
Chen. rubrum/glaucum																						0.6	
Cirsium arvense			0.2						0.2							0.7							
Claodium mariscus	0.1		0.1			0.5	1.0	0.5		2.7							0.2		8.7		2.2		
Conium maculatum	0.1					0.3													2.2		2.2		
Corylus avellana	+		+			0.1													+		+		
Crataegus monogyna	0.1			+							6.4										26.6		
Eleocharis palustris																						0.6	
Galeopsis tetrahit/speciosa		0.1																					

[illegible]

Table 1 (continued).

Sample number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Sample designation	I-17-i	I-18-i	II-16-H	III-14-G	III-20-F	III-20-G	IV-13-F	IV-17-G	IV-20-H	IV-24-F	IV-24-G	V-13-K	II-18-G	V-18-K	V-21-G	V-23-i	VI-25-K	VII-22-K	III-17-F	VIII-17-F	VIII-23-F	VIII-23-H	VIII-24-H
Rumex hydrolapathum	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rumex maritimus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.6	.
Rumex spec.	.	0.1	.	.	.	.	0.3	.	.	.	0.4	.	.	.	.	.	.	.	.	.	.	.	.
Salicornia europaea	0.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scirpus lacustris ssp. lacustris	0.1	.	.	1.0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scirpus maritimus	.	.	.	0.5	0.3	.	.	0.5	.	.	0.4	0.2	0.3	.	.	.	.	0.2	4.4	.	.	0.6	0.3
Scirpus tabernaemontani	0.1	.	0.1	0.5	3.1	1.5	0.7	1.1	.	8.3	2.2	0.5	3.7	0.3	.	.	.	.	.	.	2.2	0.9	1.4
Sium erectum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.4	.	.	.	.	.	.	.
Sium latifolium	.	.	.	0.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Solanum dulcamara	0.1	.	.	.	.	.	0.3	.	.	.	0.4	.	0.5	.	.	.	.	.	.	7.2	.	.	.
Solanum nigrum	0.2	0.9	0.5	1.0	2.1	1.0	.	0.9	0.3	4.6	1.3	0.5	3.1	0.3	2.3	0.7	0.8	0.3	.	3.6	4.4	0.8	.
Sonchus asper	.	.	0.1	.	.	.	.	.	.	.	.	.	.	0.3	.	.	.	0.2	.	.	.	.	.
Sonchus palustris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stellaria media	0.1	.	0.1	49.0	.	.	34.5	.	0.2	2.7	4.9	26.6	32.3	0.6	3.7	0.4	.	0.2	.	3.6	.	1.2	0.1
Trifolium repens	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Triticum dicoccum	.	.	.	0.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Typha latifolia/angustifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.3	.	.	.	.	.	.
Urtica dioica	10.6	4.3	1.8	26.8	2.4	3.9	48.9	11.5	0.3	33.0	13.3	62.3	9.6	5.2	54.2	22.1	19.9	7.1	.	35.9	22.2	11.2	12.8
Zannichellia palustris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Numbers of species	22	12	28	22	17	18	14	12	14	16	15	11	18	19	8	16	13	17	9	10	12	22	15
Numbers of seeds counted	1418	747	1137	198	286	210	221	214	623	36	225	585	390	338	134	237	487	629	23	28	29	177	272
Total numbers of seeds per 3 litres of soil	9141	10402	2719	388	286	1014	597	8703	1822	109	225	2384	2321	1944	216	535	2489	5102	23	28	45	1289	2152

24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	Sample number
VIII-26-H	VIII-26-K	IX-14-G	IX-15-F	IX-19-F	IX-25-H	IX-29-F	X-15-G	X-22-F	XI-16-F	XI-23-K	XII-15-G	XIV-17-i	XIV-23-G	XV-19-K	XV-24-G	XV-27-G	XVI-25-G	XVIII-19-i	XX-19-i	XXIV-19-i	XXIX-18-F	XXXIII-18-F	Sample designation
.	.	.	0.6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	Rumex hydrolapathum
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	Rumex maritimus
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	.	.	Rumex spec.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	Salicornia europaea
.	.	.	.	.	.	.	0.2	.	.	.	.	.	0.8	0.1	.	.	.	.	.	.	.	.	Scirpus lacustris ssp.lacustris
.	.	0.4	0.6	1.4	1.6	0.7	.	.	0.8	.	.	2.8	34.4	0.5	0.6	.	.	0.5	0.8	0.1	.	.	Scirpus maritimus
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.0	0.8	0.2	3.2	.	Scirpus tabernaemontani
.	.	.	.	.	.	.	.	.	.	.	.	0.4	.	.	.	.	.	.	.	.	.	0.3	Sium erectum
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	Sium latifolium
0.7	.	0.4	.	1.4	.	.	0.2	.	.	.	.	1.0	.	.	.	.	.	.	.	1.1	.	0.5	Solanum dulcamara
.	.	3.6	7.0	.	.	.	1.1	11.3	0.8	0.2	4.4	2.4	5.9	0.8	0.6	4.7	2.8	1.8	1.2	.	1.7	1.2	Solanum nigrum
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	Sonchus asper
.	.	.	.	.	.	0.6	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	.	.	Sonchus palustris
0.4	0.3	10.6	11.6	2.8	.	5.9	9.5	2.5	7.3	0.5	6.9	4.0	1.7	82.4	.	18.7	14.0	40.7	35.0	32.0	0.6	4.5	Stellaria media
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	Trifolium repens
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	Triticum dicoccum
13.5	4.4	52.8	40.7	22.5	14.9	76.7	48.1	35.0	49.1	24.0	72.9	40.5	6.7	5.4	53.4	60.0	61.8	21.8	28.6	39.3	35.7	60.8	Typha latifolia/angustifolia
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.6	.	Urtica dioica
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	Zannichellia palustris
7	8	9	11	14	14	8	14	12	12	12	9	11	17	10	11	8	12	15	14	17	16	12	Numbers of species
256	684	270	190	92	237	179	521	40	252	432	392	241	120	1543	98	122	97	1143	1559	851	174	303	Numbers of seeds counted
790	9615	55710317	712	993	2526	1591	160	1042	3906	1168	499	358	6247	492	150	430	7032	6889	3551	683	1570	.	Total numbers of seeds per 3 litres of soil

during the 1975 campaign and of c. 250 posts are discussed. No more wood identifications have been carried out for the S3 site. In this paper the wood identifications will come up for discussion in the section on the reconstruction of the former vegetation (section 4; table 12).

A few plant names enumerated in table 5 (pp. 48-49) of the preliminary report need to be corrected. Thus, on closer inspection the seeds of *Veronica anagallis-aquatica* appeared to be of recent origin (modern contamination) and should be discarded. *Rumex obtusifolius* should read *Rumex* spec. The fruit initially identified as *Sonchus arvensis* is of *Sonchus palustris*.

3. DISCUSSION OF THE PLANT REMAINS

In this section some remarks will be made on the remains of wild plants recovered from Swifterbant except wood. The cereal grains will be treated in section 5. Most of the seeds and fruits found at Swifterbant have already been discussed in an earlier study (Van Zeist, 1974). For those types no descriptions will be given here, but the discussion will remain confined to presenting the measurements and to some remarks on the ecology of the species. For syntaxonomic units which are occasionally mentioned in this section but which form the basis of the reconstruction of the former vegetation (section 4) the reader is referred to Westhoff & Den Held (1969).

3.1. Musci

Moss remains are not particularly abundant at Swifterbant. Only 21 of the 46 samples processed in the laboratory yielded moss remains, generally in very small quantities (table 2). The scarcity and the incompleteness of the remains handicapped the identification of the mosses which has been carried out by Dr. H.J. During (Institute for Plant Taxonomy, State University of Utrecht). Many mosses represented at Swifterbant are epiphytic. Unlike our presen-

tation of data for the higher plants (Spermatophyta), for the mosses no families are given here. The mosses are discussed in alphabetical order of the genera. The data on the habitats of the moss species are after Landwehr (1966).

Anomodon viticulosus (Hedw.) Hook et Tayl.
On old tree trunks, particularly on elm but also on ash and lime. In 4 samples.

Antitrichia curtipendula (Hedw.) Brid.
On very old oak and beech trunks. In 1 sample.

Barbula convoluta Hedw.
This moss species occurs particularly in disturbed habitats; also in frequently trodden places. In 1 sample.

Brachythecium cf. *populeum* (Hedw.) Schimp.
Particularly on ash trunks, occasionally on those of hornbeam (not relevant for Swifterbant) and elm. In 1 sample.

Brachythecium cf. *rutabulum* (Hedw.) Schimp.
This species is found in a great variety of habitats, from dry to wet and from sunny to shaded. On mineral soils as well as on rotten tree stumps and on the roots and at the foot of deciduous trees. In 3 samples.

Brachythecium cf. *velutinum* (Hedw.) Schimp.
Particularly on rotten tree stumps, on the roots and at the foot of deciduous trees. Also on moist, shaded walls and roofs. In 1 sample.

Calliergonella cuspidata (Hedw.) Loeske
In various moist habitats. In 3 samples.

Drepanocladus cf. *aduncus* (Hedw.) Warnst.
In eutrophic to mesotrophic marsh vegetations. In 1 sample.

Eurhynchium striatum (Hedw.) Schimp.
In rather dry to moist deciduous forests. A characteristic species of the Fagetalia sylvaticae. In 1 sample.

Homalothecium sericeum (Hedw.) Schimp.

On tree trunks, particularly of elm, willow and ash. In 5 samples.

Hypnum cupressiforme Hedw.

A very variable species which is found in a great variety of habitats. Different varieties occur on tree trunks. In 4 samples.

Isoetecium myosuroides Brid.

On trunks of oak and beech. In 3 samples.

Leucodon sciuroides (Hedw.) Schwaegr.

On old trees, particularly on elm and willow. In 3 samples.

Neckera complanata (Hedw.) Hueb.

On tree trunks, particularly on beech, ash and elm. This species is relatively well represented at Swifterbant: in 7 samples.

Neckera crispa Hedw.

On shaded limestone rocks and on old trees. In 1 sample.

Philonotis cf. *fontana* (Hedw.) Brid.

In and along running water (clear-water brooklets, springs). The presence of this species at Swifterbant (in one sample) is surprising, and in none of the vegetation units postulated for the Swifterbant area can this moss species be placed.

Sphagnum imbricatum Hornsch.

In raised bogs. In 7 samples.

Sphagnum palustre L.

In bogs and in acid alder, birch and willow carr vegetations. In 2 samples.

Sphagnum papillosum Lindb.

In bogs. This species was found in 6 samples.

It is somewhat surprising that the typical raised bog species *Sphagnum imbricatum* and *papillosum* are comparatively well represented at Swifterbant. Remains of other species from raised bogs, such as *Eriophorum*, *Calluna* and *Erica*, have not been recovered. Moreover, the

assumption of a fresh-water tidal flat area makes the presence of raised bogs rather unlikely. One wonders whether the *Sphagnum* remains could have been of secondary origin, viz. from peat deposits which had been cut into by the creeks.

3.2. Alismataceae

Alisma plantago-aquatica

Of this species one damaged fruit and two "inner fruits" (the fruit wall of which had not been preserved) were recovered. Apparently, this species from fresh-water marsh vegetations is never well represented in settlement sites.

3.3. Betulaceae

Alnus glutinosa

Although *Alnus glutinosa* must have been a common tree in the Swifterbant area (see 4.2.), fruits of this species are not particularly numerous. Only five samples yielded one or a few fruits. Two well-developed, undamaged fruits measure: 2.7 x 2.4 and 2.3 x 2.2 mm. In addition, a small number of fruiting-cone remains (portions of the central axis with the basal parts of the scales) was recovered (table 3).

Betula spec.

Betula is represented by only one fruit. Because the wings have not been preserved, this fruit cannot be identified to the species level.

Corylus avellana

Carbonized and non-carbonized nutshell remains of *Corylus avellana* were found regularly. Particularly from the sieve residues fairly great numbers of shell fragments were recovered. One may assume that hazel-nuts were collected intensively by the inhabitants of the site.

3.4. Caryophyllaceae

Two caryophyllaceous species are represented by only one seed, viz. *Lychnis flos-cuculi* (0.8 x 0.7 mm; sample XXIX-18-F) and *Moehrin-*

Table 2. Moss remains from Swifterbant. Epiphytic mosses (growing on tree trunks) are indicated by an asterisk.

Sample number	1	3	5	6	8	10	12	13	14	16	18	19	21	22	23	28	30	32	39	41	45
Sample designation	I-17-i	II-16-H	III-20-F	III-20-G	IV-17-G	IV-24-F	V-13-K	II-18-G	V-18-K	V-23-i	VII-22-K	III-17-F	VIII-23-F	VIII-23-H	VIII-24-H	IX-19-F	IX-29-F	X-22-F	XV-24-G	XVI-25-G	XXIX-18-F
*Anomodon viticulosus	+	+	+	+
*Antitrichia curtipendula	+
Barbula convoluta	+
Brachythecium cf. populeum	+
Brachythecium cf. rutabulum	+	.	.	+	.	.	+
*Brachythecium cf. velutinum	+	+	+
Calliergonella cuspidata	+	+	+
Drepanocladus cf. aduncus	+	.	.	.
Drepanocladus spec.	+
Eurhynchium striatum	+	cf	.	.	.	.	.	.	.	.	.	.	.	.
*Homalothecium sericeum	+	+	+	.	+	+
Hypnum cupressiforme	.	.	.	+	.	+	.	.	+	.	+
*Isothecium myosuroides	.	+	.	+	+
*Leucodon sciurioides	+	+	.	+
*Neckera complanata	.	+	.	+	+	.	cf	.	+	+	+	.	.	.	.	.	.	.	.	.	.
*Neckera crispa	.	+
Philonotis cf. fontana	+	.	.	.
Sphagnum imbricatum	+	+	+	.	+	.	+	+	+
Sphagnum palustre	.	+	+
Sphagnum papillosum	+	+	.	+	.	+	+	+

Table 3. Total numbers of seeds, fruits and other plant remains recovered on 2 mm sieve (washing of soil for retrieving archaeological objects).

Hordeum vulgare var. nudum	1788
Triticum dicoccum	71
Triticum cf. aestivum	1
Corylus avellana	c. 30 + many fragments
Crataegus monogyna	24,5
Pyrus malus, pips	3
Pyrus malus, carbonized fruits	3
Cornus sanguinea	1
Phragmites australis, stem fragments	22
Alnus glutinosa, remains of fruiting-cones	16
Menyanthes trifoliata	3
Ceratophyllum submersum	1
Nymphaea alba	4
Galeopsis tetrahit/speciosa	1
Polygonum aviculare	1
Polygonum persicaria	1
Vicia spec.	1
Claviceps purpurea	1
Cenococcum geophilum	1

gia trinervia (1.1 x 0.8 mm; sample VIII-17-F). *Lychnis flos-cuculi* is found in wet grasslands. *Moehringia trinervia* grows in deciduous forests and in willow carr vegetations.

Stellaria media

The seeds of a third species of the Caryophyllaceae, viz. of *Stellaria media*, are quite frequent. This seed type was found in most of the samples, not infrequently in large numbers (up to 82.4%), suggesting that *Stellaria media*, a plant from fields, waste places and roadsides, was very common in the vicinity of the site.

The greatest diameter of *Stellaria* seeds in four samples from different layers does not show significant differences (table 4). On the other hand, the *Stellaria* seeds from Tritsum and Feddersen Wierde are larger, and those from Elisenhof distinctly smaller than the Swifterbant seeds. No obvious explanation can be presented for the size differences between the sites. Differences between Swifterbant and the other sites listed in table 4 could possibly be attributed to differences in environment: predominantly fresh water at Swifterbant and brackish conditions at the other sites. However, this leaves one with the question why the Elisenhof *Stellaria* seeds are nearly half the size of those from Tritsum.

3.5. Ceratophyllaceae

Ceratophyllum submersum

Fruits bi-convex, oval in outline (fig. 4:9). One carbonized fruit (in a sieve sample) and one non-carbonized specimen were recovered. The middle of the rounded apex is slightly pointed, indicating the place of attachment of the short apical spine. Dimensions: 4.4 x 2.5 mm (non-carbonized) and 3.6 x 2.6 mm (carbonized fruit).

Ceratophyllum demersum and *submersum* occur both in shallow basins with stagnant fresh or slightly saline water. At present *C. submersum* is a rare species in the Netherlands and largely confined to the coastal area, whereas *C. demersum* is rather common. It is possible that the late-Atlantic climate, with higher summer

temperatures and milder winters, favoured the growth of *C. submersum*.

3.6. Chenopodiaceae

Atriplex

No attempt has been made to distinguish between the seeds of *Atriplex hastata* and *A. patula*, and it is doubtful if this is at all possible. The seeds of *A. hastata/patula* were found in most of the samples, sometimes in large numbers. The greatest diameter of *Atriplex* seeds in 3 samples from different layers are shown in table 5. The Swifterbant seeds are, on an average, slightly larger than those from Tzummarum and Tritsum, with mean greatest diameter of 1.36 and 1.48 mm, respectively (Van Zeist, 1974, p. 268).

Körber-Grohne (1967, p. 268) claims that the seeds of *A. hastata* (1.0-1.9(1.3) mm, N = 50) can be separated from those of *A. patula* (1.3-1.9(1.5) mm, N = 50). For Elisenhof, Behre (1976, p. 95-96) distinguishes equally between *A. patula*-type (diameter: 1.2-2.1 (1.75) mm for 50 seeds) and *A. hastata/littoralis*-type (diameter: 1.1-2.3(1.46) mm for 50 seeds). However, we do not feel able to make a satisfactory distinction between both seed types. *A. hastata* and *A. patula* have about the same ecological requirements. They are both species from fields, waste places and other disturbed habitats.

One large *Atriplex* seed (diameter 2.8 mm) was met with (V-18-K). This seed is not necessarily of the halophytic taxa *A. littoralis* or *A. hastata* var. *salina*, but it can also have originated from an inland variety of *A. hastata* (Körber-Grohne, 1967, p. 268).

Chenopodium

Chenopodium album is represented in most of the samples examined, but this seed type is less numerous than the *Atriplex hastata/patula*-type. The greatest diameter of the seeds in four samples shows no significant differences (table 5). The *Chenopodium album* seeds from Swifterbant are, on an average, slightly smaller than those from Tritsum (1.55 mm) and Paddepoel

Table 4. Greatest diameter of *Stellaria media* from Swifterbant and other sites.

	<i>min.</i>	<i>aver.</i>	<i>max.</i>
Swifterbant IV-13-F (N = 50)	0.9	1.05	1.2
II-18-G (N = 50)	0.9	1.06	1.2
XVIII-19-i (N = 50)	0.9	1.07	1.2
XV-19-K (N = 50)	1.0	1.07	1.2
Tritsum (N = 100)	1.0	1.35	1.6
Elisenhof (N = 50)	0.6	0.76	1.0
Feddersen Wierde (N = 28)	1.0	1.2	1.4

Table 5. Greatest diameter of Chenopodiaceae from Swifterbant.

	<i>min.</i>	<i>aver.</i>	<i>max.</i>
<i>Chenopodium album</i>			
XI-16-F (N = 23)	1.3	1.43	1.6
X-15-G (N = 41)	1.3	1.43	1.6
XIV-17-i (N = 29)	1.3	1.45	1.8
XX-19-i (N = 50)	1.3	1.49	1.8
<i>Atriplex patula/hastata</i>			
III-20-F (N = 50)	1.2	1.59	2.1
XVIII-19-i (N = 50)	1.4	1.66	1.9
XV-19-K (N = 11)	1.4	1.69	2.0

(1.53 mm), but somewhat larger than those from Elisenhof (1.31 mm) (Van Zeist, 1974, p. 269; Behre, 1976, p. 96).

Chenopodium rubrum/glaucum seeds were found in only four samples. The seeds of these *Chenopodium* species which are both found in nitrate-rich habitats cannot be separated satisfactorily. Dimensions for 7 seeds: 0.9-1.1 mm (aver. 0.97 mm).

Attention should be drawn here to the conspicuous absence of *Chenopodium ficifolium* seeds at Swifterbant. This *Chenopodium* species is represented by great numbers of seeds in various coastal settlement sites (Behre, 1976, p. 97; Körber-Grohne, 1967, p. 271; Van Zeist, 1974, p. 269). The absence of *Chenopodium ficifolium* cannot be ascribed to unfavourable climatic or ecological conditions. The late-Atlantic climate must have been more favourable for this thermophilous species than that of early-Subatlantic times, and nitrate-rich habitats must have been common in and near the settlement. One may wonder whether in the second half of the fourth millennium B.C. *Chenopodium ficifolium* was already present in western Europe. One should consider the possibility that this species was introduced by prehistoric farmers, be it unintentionally. *Chenopodium ficifolium* is not reported for Bandkeramik settlement sites in the Rhineland area and South Limburg (Bakels, 1979; Knörzer, 1972, 1974, 1977, 1980). It is equally not represented in the Rössen site near Langweiler (Knörzer, 1971).

Salicornia europaea

One U-shaped seed of *Salicornia europaea* was counted. One should consider the possibility that this species, which is characteristic of salt-marsh vegetations, occurred in the Swifterbant area, be it rarely.

3.7. Compositae

Arctium cf. *lappa*

On the basis of the shape and the size, the *Arctium* achenes from Swifterbant have, with some reserve, been attributed to *A. lappa*.

Nine achenes from various samples measure 6.3(5.8-6.8) x 3.0(2.6-3.3) mm. *Arctium lappa* as well as other *Arctium* species are found in ruderal habitats.

Artemisia vulgaris

From two samples a few achenes of *Artemisia vulgaris* were recovered. The achenes are oblong in outline, tapering towards both ends (fig. 5:7). The surface is longitudinally striate. The longitudinal ribs and the annular ring at the apex are not preserved in the subfossil specimens. Dimensions: 1.7 x 0.7 and 1.6 x 0.6 mm. *Artemisia vulgaris* is a species from roadsides, fields and other disturbed habitats.

Aster tripolium

A few fruits of *Aster tripolium*, a species which is characteristic of halophytic vegetations, were found. As usual in subfossil, non-carbonized achenes of *Aster tripolium*, the outer wall and the annular ring at the apex have disappeared. Dimensions of three inner fruits: 3.0 x 0.9, 2.5 x 0.9 and 3.0 x 0.8 mm. The size of the *Aster tripolium* achenes from Swifterbant corresponds with those obtained for specimens from pre-Roman Iron Age Tritsum and Roman Iron Age Sneek, situated in a salt-marsh environment: 2.84 x 0.89 and 2.94 x 0.81 mm, respectively (Van Zeist, 1974, pp. 270-71).

Carduus crispus

Carduus crispus, the achenes of which distinguish themselves from those of *Cirsium* species by a fine transverse wrinkling of the fruit wall, is represented in a small number of samples. Dimensions for 3 achenes: 2.8 x 1.6, 3.0 x 1.1 and 3.0 x 1.2 mm. *Carduus crispus* is a species from disturbed habitats rich in nitrates.

Cirsium arvense

A few *Cirsium* achenes recovered from the Swifterbant samples are attributed to *C. arvense*. They differ from those of *C. vulgare* by the size and the more slender shape and from those of *C. palustre* by the absence of narrow longitudinal ribs. Dimensions for 4

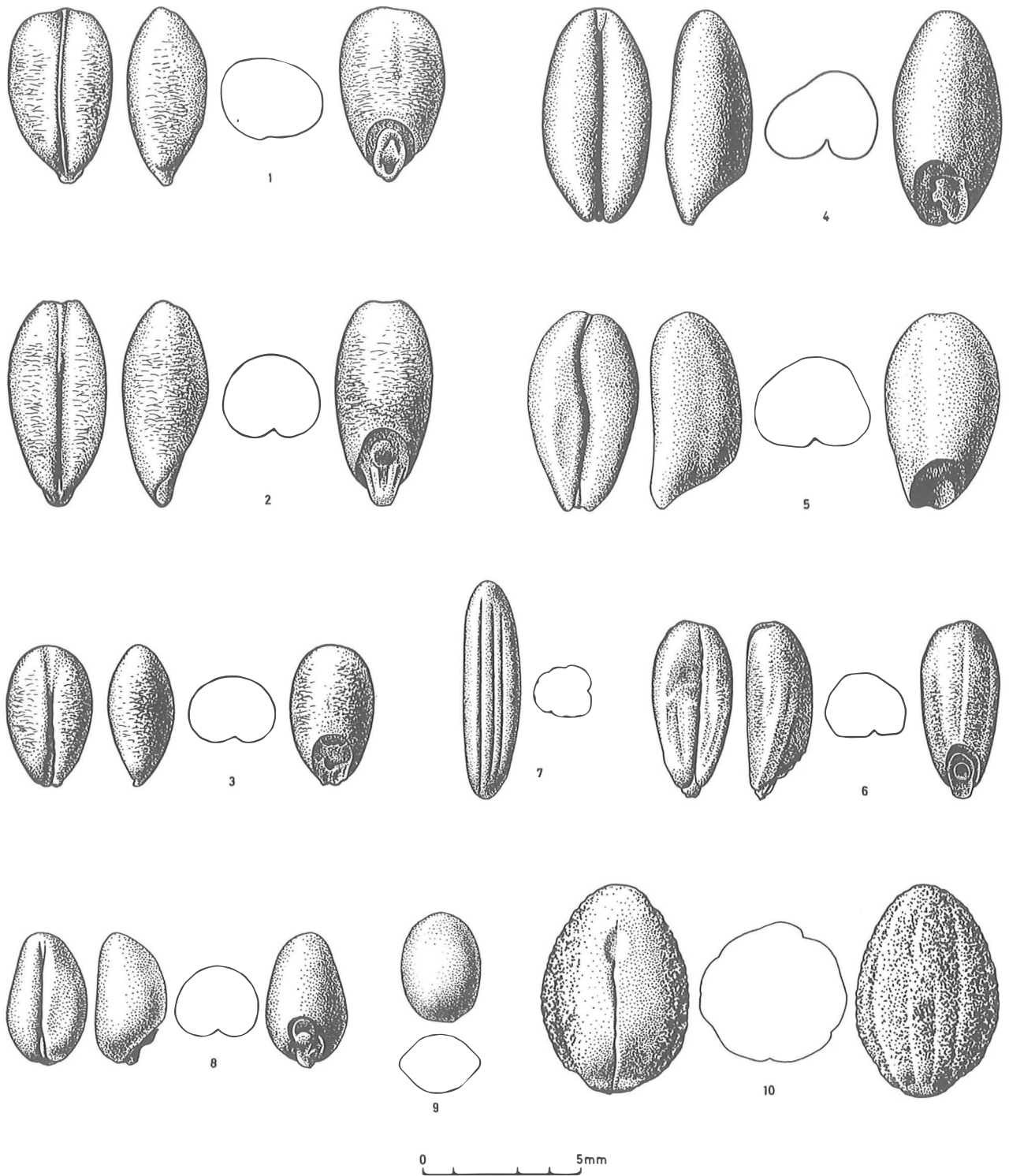


Fig. 4. 1-3: *Hordeum vulgare* var. *nudum* (VIII-21-i); 4: *Triticum dicoccum* (XII-19-F); 5: *Triticum dicoccum* (XII-22-F); 6: *Triticum dicoccum* (XVI-20-F); 7: *Claviceps purpurea* (XIII-19-i); 8: *Triticum* cf. *aestivum* (XII-15-i); 9: *Ceratophyllum submersum* (XV-20-F); 10: *Crataegus monogyna* (XVI-22-F).

specimens: 3.0 x 1.3, 3.4 x 1.4, 2.7 x 1.1 and 2.8 x 1.0 mm. *Cirsium arvense* is a species from fields and other disturbed habitats.

Lapsana communis

Lapsana communis, a species from fields and forest edges, is represented in two samples. The achenes are lanceolate, slightly curved, with a large number of longitudinal ribs. Dimensions: 4.6 x 1.3 and 4.0 x 1.0 mm.

Sonchus

Samples II-16-H, V-18-G and VII-22-K yielded each one fruit of *Sonchus asper*, a species from fields and waste places. The surface of the oblong, flat achenes is smooth. Dimensions: 2.8 x 1.0 and 2.7 x 1.1 mm.

One *Sonchus* fruit has been identified as *S. palustris* and one damaged specimen as probably *S. palustris*. The achenes of this species have 4 pronounced ribs; the fruit surface is transversely wrinkled. *S. palustris* is found in marsh vegetations.

3.8. Cornaceae

Cornus sanguinea

One non-carbonized fruit stone of *Cornus sanguinea* was recovered from a sieve residue. The almost globular fruit stone (greatest diameter c. 4 mm) shows longitudinal grooves which extend from the base to the apex of the stone. *C. sanguinea* is found in forest and shrub vegetations (Prunetalia spinosae, Fagetalia sylvaticae).

3.9. Cruciferae

Capsella bursa-pastoris

Cruciferae are represented at Swifterbant by altogether two seeds of *Capsella bursa-pastoris* (1.0 x 0.6 mm), a species from disturbed habitats, such as fields, waste places and roadsides.

3.10. Cyperaceae

Various cyperaceous species are represented at Swifterbant. The style base is not included in the measurements.

Carex

Carex fruits are conspicuously scarce in the samples examined, suggesting that sedges did not play a prominent part in the plant cover of the Swifterbant area. The following species or types have been distinguished:

Carex disticha in 1 sample (1.7 x 1.0 mm);

Carex nigra-type in 2 samples;

Carex paniculata in 2 samples (1.7 x 1.2 mm);

Carex pseudocyperus in 2 samples (1.8 x 1.0, 1.5 x 1.0 mm);

Carex riparia in 2 samples (3.5 x 2.3 mm);

Carex rostrata/vesicaria in 5 samples (2.6 x 1.2, 2.5 x 1.4; 2.2 x 1.3, 2.1 x 1.5 mm);

Carex serotina-type in 1 sample (1.1 x 0.8 mm).

One *Carex* fruit remained unidentified.

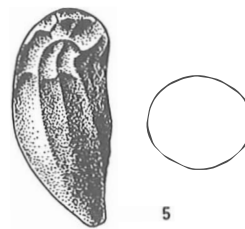
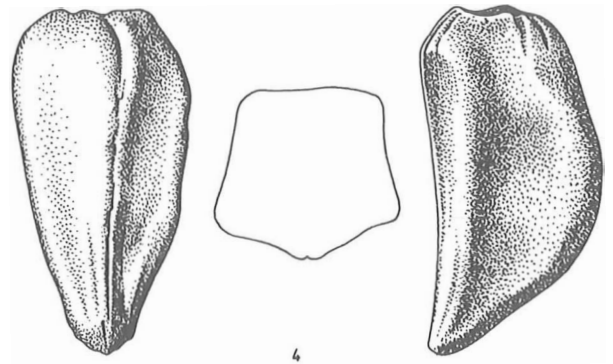
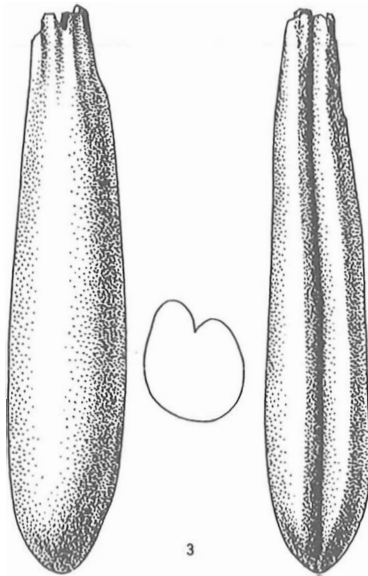
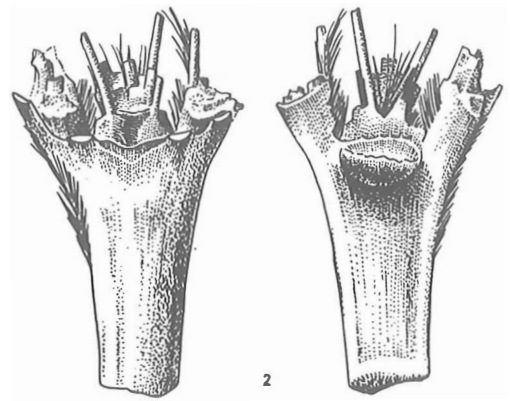
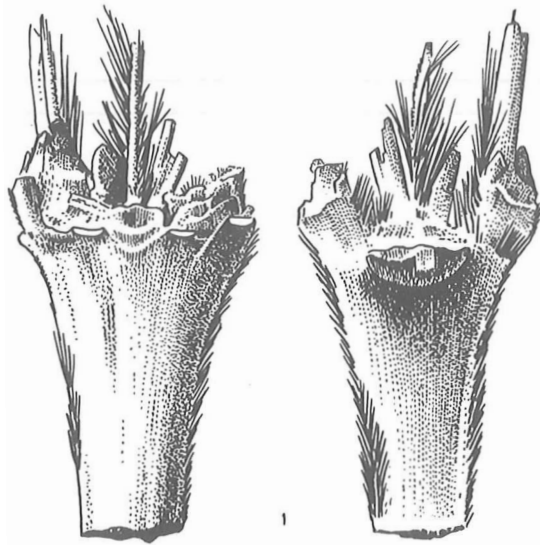
For descriptions of the *Carex* fruits listed above the reader is referred to Körber-Grohne (1967, pp. 248-255) and Van Zeist (1974, pp. 276-280). *Carex nigra*-type corresponds to the *Carex acuta*-type in Van Zeist (1974, pp. 276-277). *Carex riparia* has not been reported for the coastal sites examined previously (Van Zeist, 1974). This fruit is noticeably larger than most other *Carex* fruits.

Cladium mariscus

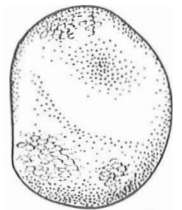
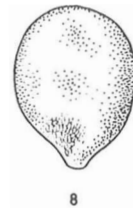
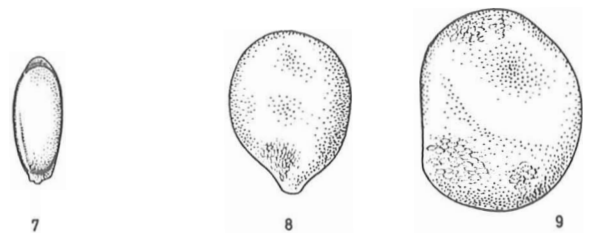
This species is represented in a rather great number of samples, but generally only by one or a few fruits. The dimensions of *Cladium* fruits are shown in table 6. They do not differ noticeably from those obtained for *Cladium* fruits from Sneek (2.05(1.7-2.3) x 1.48(1.2-1.7) mm; Van Zeist, 1974, p. 280). *Cladium mariscus* is a predominantly fresh-water species, but it is also found in a slightly brackish environment.

Eleocharis palustris

This species, represented in only three samples, must have played a very minor part in the marsh vegetations of the Swifterbant area. This in contrast to the fresh-water coastal sites of Vlaardingen and Schiedam, dated to the pre-Roman Iron Age, which yielded rather great numbers of *Eleocharis* fruits (Van Zeist, 1974, p. 280-81).



0 10mm



0 5mm

Scirpus

Of the *Scirpus* species established for Swifterbant, the fruits of *S. tabernaemontani* (*S. lacustris* ssp. *glaucus*) are most numerous. The bi-convex fruits of *S. tabernaemontani* are markedly smaller than those of *S. maritimus* (table 6). One may assume that this *Scirpus* species was a common constituent of the marsh vegetations in the Swifterbant area.

Scirpus maritimus, on the other hand, probably played a much more modest part in the local vegetation. This species is represented in a fairly great number of samples, but always by small numbers of fruits.

A third *Scirpus* species which could be established for Swifterbant is *S. lacustris* ssp. *lacustris*. Although in subfossil *Scirpus* fruits it may be difficult to determine whether they originate from *S. maritimus* or from *S. lacustris* ssp. *lacustris* (cf. Körber-Grohne, 1967, pp. 256-257), a few unmistakable fruits of the latter species were found. In *S. maritimus* the dorsal side is either domed or roof-shaped with a rounded median edge. In *S. lacustris* ssp. *lacustris* the median edge of the roof-shaped dorsal side is much sharper. Judging from the numbers of fruits, *S. lacustris* ssp. *lacustris* was not common in the vicinity of Swifterbant. For three fruits the dimensions have been obtained: 3.0 x 2.2, 3.1 x 2.0 and 2.9 x 1.8 mm.

Scirpus maritimus is common in brackish water. *S. tabernaemontani* occurs in fresh as well as in brackish water. *S. lacustris* ssp. *lacustris* is a predominantly fresh-water species, but it can tolerate slightly saline conditions.

3.11. Gentianaceae

Menyanthes trifoliata

The sediment samples yielded one seed of *Menyanthes trifoliata*, while a few more speci-

mens were recovered from the sieve residues. Dimensions of four seeds: 3.0 x 2.5, 2.5 x 1.9, 2.7 x 2.3, 2.9 x 2.4 mm. *Menyanthes trifoliata* is a constituent of marsh vegetations (Magnocaricion, Caricion curto-nigrae).

3.12. Gramineae

The crop-plant species *Hordeum vulgare* var. *nudum* and *Triticum dicoccum* will be discussed in section 5.

Among the caryopses of wild grasses, those of *Phragmites australis* (*P. communis*) are most numerous. Reed is represented in the majority of the samples, a few times by a fairly great number of fruits. Carbonized stem fragments of reed were recovered from the sieve residues and reed stems were frequently observed in the field. The dimensions of *Phragmites* caryopses (greatest length) in three samples from different layers are shown in table 7. One may assume that reed played a prominent part in the marsh vegetation of the Swifterbant area.

Poa pratensis/trivialis caryopses were found fairly regularly, but, except for one sample (XXIV-19-i), only in small numbers. The lengths of the Swifterbant caryopses are of the same order of magnitude as those obtained for *Poa pratensis/trivialis* in other sites (table 7).

In two samples a few *Bromus mollis/secalinus*-type caryopses were found (5.3 x 1.7, 4.6 x 1.7, 5.2 x 1.9, 4.5 x 1.5 mm). *Bromus secalinus*, a weed in grain fields, as well as *B. mollis*, which occurs in grassland, fields and ruderal habitats, come into consideration for Swifterbant.

Of *Agrostis* only two caryopses were recovered, suggesting that this grass was by no means common in the Swifterbant area. The same applies to *Alopecurus* represented by one damaged caryopsis (*A.* cf. *geniculatus*). One carbonized, slightly damaged fruit has been attributed to *Glyceria fluitans* (c. 3.4 x 1.3 mm). It is possible that *Glyceria* grains were collected intentionally by the Swifterbant people.

A few caryopses could not be identified (unident. Gramineae).

Fig. 5. 1-2: *Hordeum vulgare* var. *nudum*, rachis internodes (VIII-21-i); 3: *Anthriscus sylvestris* (XXIV-19-i); 4: *Rosa canina/rubiginosa* (XXIX-18-F); 5: *Caltha palustris* (V-18-K); 6: *Rubus fruticosus* (IX-19-F); 7: *Artemisia vulgaris* (XXIV-19-i); 8: *Solanum nigrum* (XVIII-19-i); 9: *Solanum dulcamara* (XXIV-19-i); 10: *Pyrus malus* (no. 23416).

Table 6. Dimensions of Cyperaceae from Swifterbant.

		<i>L</i>	<i>B</i>	<i>100L:B</i>
<i>Scirpus tabernaemontani</i>				
II-18-G N = 15	min.	1.9	1.3	114
	aver.	2.13	1.50	143
	max.	2.6	1.8	169
XIV-23-G N = 33	min.	1.7	1.1	133
	aver.	2.05	1.35	152
	max.	2.4	1.6	176
3 samples F and i layers N = 21	min.	1.8	1.2	130
	aver.	2.18	1.45	151
	max.	2.4	1.6	181
<i>Scirpus maritimus</i>				
various samples N = 7	min.	2.5	1.7	
	aver.	2.78	1.98	
	max.	3.2	2.3	
<i>Cladium mariscus</i>				
various samples N = 16	min.	1.4	1.0	
	aver.	1.88	1.33	
	max.	2.2	1.4	

Table 7. Greatest length of caryopses of *Phragmites* and *Poa* from Swifterbant and other sites.

	<i>min.</i>	<i>aver.</i>	<i>max.</i>
<i>Phragmites australis</i>			
Swifterbant IV-17-G (N = 50)	1.1	1.42	1.8
II-16-H (N = 50)	1.0	1.30	1.8
VIII-24-H (N = 50)	1.0	1.24	1.7
Ouddorp (N = 26)	1.1	1.39	1.7
Sneek (N = 15)	1.2	1.39	1.7
Elisenhof (N = 50)	0.65	1.18	1.6
<i>Poa pratensis/trivialis</i>			
Swifterbant XXIV-19-i (N = 50)	1.3	1.57	1.8
Paddepoel (N = 100)	1.1	1.76	2.3
Tritsum (N = 126)	1.2	1.47	2.3
Elisenhof (N = 50)	0.9	1.29	1.8

3.13. Juncaceae

Juncus

The only *Juncus* seed recovered from the Swifterbant samples is of *Juncus gerardii*, which is characteristic of salt-marsh vegetations. Whether *Juncus gerardii* actually occurred in the Swifterbant area at that time, be it very seldom, or whether the seed concerned had been carried in from the coastal salt marshes, e.g. by birds or by water during extremely high floods, must remain undecided.

The near-absence of *Juncus* at Swifterbant is very striking and not easy to explain. One may expect that habitats suitable for *Juncus bufonius*, *J. effusus* and *J. articulatus* were found in the vicinity of the site.

3.14. Labiatae

Galeopsis tetrahit/speciosa

This fruit type was met with in only two samples. One specimen has been measured: 3.6 x 3.0 mm. *Galeopsis tetrahit* and *G. speciosa* are both species from fields and ruderal sites.

Lycopus europaeus

A small number of mostly damaged fruits of *Lycopus europaeus* was recovered. Two fruits were suitable for measuring: 1.4 x 1.0 mm and 1.4 x 1.0 mm. *Lycopus* occurs in marsh vegetations.

Mentha cf. aquatica

Of the Labiatae, *Mentha cf. aquatica* is best represented at Swifterbant, viz. in 11 of the 46 samples, be it only occasionally by more than one fruit per sample. The subfossil fruits of *M. aquatica* and *M. arvensis* cannot be distinguished one from the other. It is most likely that *M. aquatica*, a species from marsh vegetations and wet grasslands, is concerned here. For 9 *Mentha* fruits the dimensions have been obtained: length 1.04 (0.9-1.1) mm, breadth 0.74 (0.7-0.8) mm.

3.15. Nymphaeaceae

Nymphaea alba

The seeds of *Nymphaea alba* are ovate in outline and more or less circular in cross-section. The base is rounded and the apex is pointed. A single, weakly developed longitudinal ridge is present. The upper layer of the seed wall consists of longitudinal rows of rectangular cells with thick, wavy cell walls. In subfossil seeds the surface pattern is often more distinct than in modern specimens.

Nymphaea alba is remarkably well represented. Most of the water-lily seeds were more or less seriously damaged. Only a few of them were complete and suitable for measuring: length 2.78 (2.3-3.2) mm; breadth 1.81 (1.6-2.1) mm for 8 specimens.

3.16. Papilionaceae

Trifolium repens

One *Trifolium* petal, recovered from sample III-14-F, has been attributed to *T. repens*. It is true that the subfossil petal is rather small, but the shape as well as the nervation match perfectly small specimens of *T. repens* petals from Paddepoel (Van Zeist, 1974, p. 295). *T. repens* is a plant from grasslands which is associated with grazing in prehistoric times.

3.17. Plantaginaceae

Plantago major

Compared to the Iron Age coastal settlement sites, *Plantago major* is rather poorly represented at Swifterbant. One or a few seeds of this plantain species were found in a comparatively small number of samples (8 of the 46 samples). In view of the good seed production of *Plantago major* one must assume that this species from trodden places and other disturbed habitats was not particularly abundant in the vicinity of the site. Five seeds measure: 1.32 (1.2-1.4) x 0.74 (0.7-0.8) mm.

Table 8. *Polygonum* species from Swifterbant.

		<i>L</i>	<i>B</i>	<i>100L:B</i>
<i>Polygonum aviculare</i>				
II-16-H	min.	2.4	1.2	128
N = 50	aver.	2.78	1.85	155
	max.	3.1	2.2	213
I-17-i	min.	2.4	1.5	130
N = 49	aver.	2.98	1.88	155
	max.	3.4	2.2	173
V-23-i	min.	2.4	1.5	134
N = 44	aver.	2.96	1.96	152
	max.	3.4	2.3	190
XI-23-K	min.	2.4	1.4	127
N = 46	aver.	2.80	1.86	151
	max.	3.1	2.2	177
<i>Polygonum lapathifolium</i>				
IV-20-H	min.	1.8	1.4	123
N = 50	aver.	2.33	1.64	142
	max.	2.7	2.1	160
I-18-i	min.	1.8	1.2	119
N = 50	aver.	2.28	1.58	145
	max.	2.8	1.8	171
VII-26-K	min.	1.8	1.2	119
N = 50	aver.	2.07	1.49	140
	max.	2.5	1.8	165
XI-23-K	min.	1.7	1.2	109
N = 50	aver.	2.21	1.60	139
	max.	2.6	2.1	160
<i>Polygonum persicaria</i>				
IV-20-H	min.	2.6	1.7	142
N = 23	aver.	2.89	1.88	155
	max.	3.2	2.0	174
I-17-i	min.	2.1	1.4	136
N = 38	aver.	2.80	1.84	153
	max.	3.4	2.2	178
I-18-i	min.	1.9	1.3	104
N = 49	aver.	2.65	1.76	148
	max.	3.2	2.2	181

3.18. Polygonaceae

Polygonum

Three *Polygonum* species, viz. *P. aviculare*, *lapathifolium* and *persicaria*, have been established for Swifterbant. Dimensions of the fruits of the *Polygonum* species are shown in table 8.

Polygonum aviculare is represented in more than half of the samples examined, sometimes by rather great numbers of fruits, suggesting that this species was common in the vicinity of the site. There are no significant differences in the dimensions and index values between samples from various levels. *P. aviculare* fruits from Tritsum are somewhat more slender (average L:B index of 182); those of Elisenhof are slightly smaller, on an average, than the Swifterbant fruits (table 9). *P. aviculare* is not only characteristic of the vegetation of frequently trodden places, but it occurs also in various other disturbed habitats.

Polygonum lapathifolium, a species from fields, waste places and other nitrate-rich habitats, must likewise have occurred frequently in the Swifterbant area. In sample III-20-F the distinction between *P. lapathifolium* and *P. persicaria* was not always satisfactory because the fruits were unripe. Some variation occurs in the average size of the *P. lapathifolium* fruits in the four samples for which measurements have been carried out. The fruits from Paddepoel and Vlaardingen (table 9) are of about the same length as those from Swifterbant, but they are broader (lower L:B index values). *P. lapathifolium* fruits from Elisenhof and Feddersen Wierde are larger as well as plumper than those from Swifterbant. In view of the differences in the local environments and of the presence of various subspecies of *P. lapathifolium* the variation in size and shape of the fruits is not surprising.

Polygonum persicaria is likewise well represented at Swifterbant, although somewhat less frequently and by smaller numbers of fruits than *P. lapathifolium*. The dimensions of the *Polygonum persicaria* fruits seem to be fairly large, on an average. They are larger than the *P. lapathifolium* fruits from Swifterbant

and also larger than the *P. persicaria* fruits from Vlaardingen and Paddepoel (table 9). The rather large size of the fruits makes one wonder whether *P. hydropiper* and not *P. persicaria* is concerned here. *P. hydropiper* fruits are usually larger than those of *P. persicaria*. However, the shape of the fruits as well as the glossy wall surface (in *P. hydropiper* dull and striate) point to *P. persicaria*. Moreover, the calyx remains which still adhere to some of the fruits do not show the glandular dots characteristic of *P. hydropiper*, whereas the venation corresponds wholly with that of the calyx of modern *P. persicaria* fruits. Consequently, there can be no doubt that the fruits are of *P. persicaria*. In this respect mention should be made of the *P. persicaria* fruits from Elisenhof which are of about the same average length as those from Swifterbant, but markedly broader. The *P. persicaria* fruits from Paddepoel and Vlaardingen are likewise comparatively broader (lower L:B index values) than those from Swifterbant. As in *P. lapathifolium*, also in *P. persicaria* the subfossil fruits display a rather great variation in size and shape.

The absence of *P. hydropiper* in the seed record of Swifterbant is striking. One must assume that wet, nitrate-rich habitats, in which *P. hydropiper* is found, were quite common near the Swifterbant S3 site. *Polygonum convolvulus*, a weed in fields the fruits of which often occur in charred grain samples, is equally not represented at Swifterbant.

Rumex

Rumex is scarcely represented at Swifterbant. One fruit from III-20-G enclosed by the valves (the inner three sepals) has been attributed to *Rumex conglomeratus*. Each of the three oblong, tongue-shaped valves bears a well-developed grain-like tubercle. The margin of the valves is entire. *R. conglomeratus* is a species from wet habitats, such as the sides of ditches.

Of the naked *Rumex* fruits, two specimens could be identified to the species level on the basis of the shape and the size: *R. maritimus* (1.6 x 0.8 mm) in IX-15-F and *R. hydrola-*

pathum in II-16-H. The species of the other naked *Rumex* fruits, measuring c. 1.9 x 1.3 mm, could not be determined.

3.19. Potamogetonaceae

Potamogeton

Only two *Potamogeton* fruits were found. One fruit (in VIII-24-H) has been identified as *Potamogeton crispus*. The greater part of the elongate acuminate beak, which is characteristic of *P. crispus*, is still preserved. Dimensions of the subfossil fruit (beak not included): 2.5 x 1.9 mm. *P. crispus* occurs in fresh as well as in brackish water.

The other fruit (XV-24-G) is too poorly preserved to allow a species identification.

Zannichellia palustris

One damaged fruit of *Zannichellia palustris* has been recovered (2.5 x 0.8 mm). Of the bristles on the dorsal side only the bases are still preserved. *Zannichellia palustris* is a species from brackish water (Ruppion maritimae), but occasionally it is also found in fresh water.

3.20. Ranunculaceae

Caltha palustris

One fruit of *Caltha palustris*, a species from fresh-water marsh vegetations, was found. The fruit is obliquely ovate in outline, pointed at the base and rounded at the apex. The upper part of the fruit is wrinkled (fig. 5:5). Dimensions: 2.8 x 1.3 mm.

Ranunculus

Two *Ranunculus* species have been established for Swifterbant, viz. *Ranunculus sceleratus* and *R. acris*. The fruits of *R. sceleratus* are characterized by the thickened margin of spongy tissue. They are rather small: length 1.06 (0.9-1.2) mm, breadth 0.86 (0.8-1.0) mm for 7 specimens from various samples. The identification of the *R. acris* fruits is based upon the shape of the fruits (they have a more sharply pointed lower end than in *R. repens*) and by the absence of a reticulate surface pattern. Four fruits have been measured: 2.4 x 1.8, 2.3

x 1.6, 2.0 x 1.4, 1.7 x 1.2 mm. *Ranunculus acris* is a species from grasslands as well as from roadsides.

3.21. Rosaceae

Crataegus monogyna

Mainly carbonized fruit stones of *Crataegus monogyna* were found in the sediment samples as well as in the sieve residues. The rather great number of hawthorn fruit stones must partly be ascribed to the fact that because of their size they were easily recognized with the naked eye in the sieve residues. The thick-walled fruit stones are oval in outline and more or less circular in cross-section. Characteristic are the longitudinal grooves (fig. 4:10). In the carbonized fruits a hole is sometimes present in one of the grooves. The surface of the fruit wall is rough. Dimensions for 13 carbonized fruit stones from various samples: length 6.16 (5.1-7.8) mm, breadth 4.86 (4.3-5.3) mm.

Crataegus monogyna is a constituent of shrub and forest vegetations (*Prunetalia spinosae*, *Fagetalia sylvaticae*).

Pyrus malus

The sediment samples as well as the sieve residues yielded pips of *Pyrus malus*, mostly non-carbonized. Only few pips were suitable for measuring: 4.9 x 2.7, 5.0 x 2.6, 6.2 x 3.4 and 7.4 x 4.5 mm. In addition, three carbonized crab apples were recovered (sample 23416, fig. 5:10). Dimensions: 2.3 x 2.1, 1.85 x c. 1.6 and 2.55 x 2.4 cm. *Pyrus malus* must have formed part of the deciduous forest which constituted the natural vegetation of the levees bordering the major creeks or/and of the river-bank dunes. For a discussion of the possible economic importance of wild apple see 5.4.

Rosa

A small number of *Rosa* fruit stones were recovered. The angular fruit stones are irregularly shaped: ovate to obliquely ovate in outline, triangular to quadrangular in cross-section (fig. 5:4). For 5 fruit stones the dimen-

sions have been obtained: 4.4 x 2.2 x 2.2, 4.6 x 3.1 x 2.5, 5.1 x 2.1 x 2.6, 4.6 x 2.4 x 3.0, 5.6 x 2.4 x 2.7 mm. The subfossil fruit stones correspond to those of *R. canina* and *R. rubiginosa*. Both rose species are found in forest and shrub vegetations.

One fruit stone fragment is reminiscent of *Rosa pimpinellifolia*. However, a satisfactory species identification is not possible, so this specimen is listed as *Rosa spec.*

Rubus fruticosus

Altogether 4 fruit stones of *Rubus fruticosus* were found. Blackberry fruit stones can be distinguished from those of *R. idaeus* by the shape. *R. fruticosus* fruit stones are rounded triangular to semi-circular in outline, the ventral side is straight to convex (fig. 5:6). *R. idaeus* fruit stones are more slender and the ventral side is straight to concave; they are more crescent-shaped in outline. For three *Rubus* fruit stones from Swifterbant the dimensions were obtained: 2.2 x 1.7, 2.5 x 1.8 and 2.2 x 1.7 mm.

3.22. Rubiaceae

Galium

The fairly large fruits of *Galium aparine* were recovered from sediment samples as well as from sieve residues. Only carbonized fruits of *Galium aparine* have been met with, which makes one wonder whether they became carbonized together with the cereal grains, implying that cleavers occurred as a weed in the grain fields of the Swifterbant farmers. Dimensions for 13 fruits from various samples: 3.19 (2.6-3.7) x 2.84(2.5-3.2) mm.

One small, nearly globular *Galium* fruit (1.4 x 1.2 mm) has been attributed to *G. palustre*, a species from wet habitats. The ventral side is largely taken up by a hole with a sharp edge: the indented hilum. The fruit surface is finely wrinkled.

3.23. Solanaceae

Solanum

Both *Solanum nigrum* and *S. dulcamara* have

been established for Swifterbant. The seeds of *S. nigrum* differ from those of *S. dulcamara* by the shape. In *S. dulcamara* seeds the lower end with the hilum is rounded, whereas in *S. nigrum* seeds the lower end is obliquely pointed (fig. 5:8 and 9). Moreover, as is clear from table 10, *S. dulcamara* seeds are, on an average, larger than those of *S. nigrum*. The differences in shape find also expression in the L:B index values.

Solanum nigrum, a species from disturbed habitats, such as waste places and fields, is represented by much greater numbers of seeds than *S. dulcamara*, which is particularly found in alder-brook forest and shrub vegetations of wet places.

3.24. Typhaceae

Typha spec.

Small, cylindrical fruits, tapering towards the base. In the subfossil fruits the apex is truncated. Two *Typha* fruits were found: 1.0 x 0.3 and 1.0 x 0.3 mm. It is doubtful whether the subfossil fruits of *Typha latifolia* and *T. angustifolia* can be distinguished one from the other. Both *Typha* species occur in fresh-water marsh vegetations (Phragmitetalia).

3.25. Umbelliferae

Anthriscus sylvestris

Linear-cylindrical fruits. The lower end is rounded; the apex is truncated (the thickened style base (stylopodium) is not preserved in the subfossil fruits from Swifterbant). The ventral side shows a deep groove, the dorsal side is semi-circular in cross-section. There are no longitudinal ribs or oil-tubes (fig. 5:3). The fruit wall is smooth, with an epidermis pattern of isodiametric cells.

Anthriscus sylvestris fruit remains were found in three samples. Two specimens have been measured: 7.1 x 1.4 and c. 6.0 x 1.6 mm. *Anthriscus sylvestris* is a species from moist forests and grasslands.

Conium maculatum

This species is represented in a rather great

Table 9. Average dimensions of *Polygonum* from Swifterbant and other sites.

	<i>L</i>	<i>B</i>	<i>100L:B</i>
<i>Polygonum persicaria</i>			
Paddepoel (N = 50)	2.49	1.97	127
Vlaardingen (N = 60)	2.52	2.03	124
Elisenhof (N = 32)	2.75	2.20	
Swifterbant IV-20-H (N = 23)	2.89	1.88	155
I-17-i (N = 38)	2.80	1.84	155
I-18-i (N = 49)	2.65	1.76	148
<i>Polygonum lapathifolium</i>			
Paddepoel (N = 45)	2.27	1.96	116
Vlaardingen (N = 100)	2.40	1.99	121
Elisenhof (N = 50)	2.75	2.21	
Feddersen Wierde (N = 20)	2.6	2.2	
Swifterbant IV-20-H (N = 50)	2.33	1.64	142
I-18-i (N = 50)	2.28	1.58	145
VII-26-K (N = 50)	2.07	1.49	140
XI-23-K (N = 50)	2.21	1.60	139
<i>Polygonum aviculare</i>			
Tritsum (N = 100)	3.00	1.66	182
Elisenhof (N = 50)	2.71	1.56	
Feddersen Wierde (N = 50)	2.6	1.0	
Swifterbant II-16-H (N = 50)	2.78	1.85	155
I-17-i (N = 49)	2.98	1.88	155
V-23-i (N = 44)	2.96	1.96	152
XI-23-K (N = 46)	2.80	1.86	151

Table 11. *Urtica dioica* from Swifterbant.

		<i>L</i>	<i>B</i>	<i>100L:B</i>
V-13-F N = 50	min.	1.0	0.7	130
	aver.	1.16	0.77	148
	max.	1.4	1.0	167
I-17-i N = 50	min.	1.0	0.6	127
	aver.	1.20	0.81	148
	max.	1.4	1.0	175
XII-15-G N = 50	min.	1.0	0.6	118
	aver.	1.12	0.76	145
	max.	1.4	1.0	175
XVIII-19-i N = 50	min.	1.0	0.6	127
	aver.	1.20	0.83	144
	max.	1.4	1.0	164
V-13-K N = 50	min.	1.0	0.6	125
	aver.	1.14	0.78	147
	max.	1.4	1.0	167

Table 10. *Solanum* from Swifterbant

		<i>L</i>	<i>B</i>	<i>100L:B</i>
<i>Solanum nigrum</i>				
various samples N = 30	min.	1.5	1.2	114
	aver.	1.85	1.42	131
	max.	2.0	1.8	150
<i>Solanum dulcamara</i>				
various samples N = 10	min.	1.7	1.5	107
	aver.	2.21	1.90	116
	max.	2.5	2.2	125

number of samples. In the subfossil fruits, the outer fruit wall with the longitudinal ribs is not preserved. The inner fruit wall shows long rows of transversally elongated cells. Behre (1976, pp. 107-108) has pointed out that the cell pattern of the inner fruit wall of *Aegopodium podagraria* resembles that of *Conium*. However, in *Conium* the short longitudinal cell walls are thicker than the transversal ones, whereas in *Aegopodium* no differences in thickness of the cell walls are observed. Moreover, in *Conium* the cells of the inner fruit wall are much narrower than in *Aegopodium*.

Three subfossil fruits were suitable for measuring: 3.3 x 1.8, 3.4 x 1.9 and 3.4 x 1.8 mm. *Conium maculatum* is found in waste places (*Artemisia vulgaris*).

Other Umbelliferae

Other umbelliferous species are scarcely represented at Swifterbant. Of *Oenanthe aquatica* two damaged split fruits were found, one carbonized and the other non-carbonized. *Sium latifolium* is represented by one somewhat deformed fruit. Three fruits of *Sium erectum* were recovered. One of the *Sium erectum* fruits, which are ovate in outline, with a pointed apex and with little pronounced longitudinal ribs, was suitable for measuring: 1.6 x 1.2 mm. The three species mentioned above are found in fresh-water marsh vegetations.

Finally mention should be made of two fruits of *Hydrocotyle vulgaris*. Both *Hydrocotyle* fruits are from samples which yielded predominantly poorly preserved seeds.

3.26. Urticaceae

Urtica

Urtica dioica, a species from waste places rich in nitrates, must have been a very common plant on and near the Swifterbant site. It is represented in all samples but one, often by great numbers of fruits. In various samples it is the dominant seed type (up to 72.9%). The dimensions and index values of *Urtica dioica* fruits from various levels show no significant differences (table 11).

In contrast to the frequent occurrence of *Urtica dioica*, *Urtica urens* is conspicuously absent at Swifterbant. In the Iron Age and early-medieval sites in the coastal area of the Netherlands and Northwest Germany *Urtica urens* fruits do occur, sometimes in fairly great numbers (Behre, 1976, p. 89; Körber-Grohne, 1967, p. 263; Van Zeist, 1974, p. 311).

4. THE RECONSTRUCTION OF THE VEGETATION

4.1. Introduction

The reconstruction of the vegetation in the vicinity of the Swifterbant S3 site is largely based upon the results of the examination of seeds and fruits presented in tables 1 to 3. In addition, the data provided by the examination of charcoal and uncarbonized wood carried out by W.A. Casparie and P.C. Struijk (Casparie *et al.*, 1977) play a prominent part in the reconstruction of the forest vegetations. The moss remains identified by H.J. During allow some very interesting conclusions concerning the trees in the Swifterbant area. The charcoal and wood samples are from squares V-13/25, VI-13/25 and VII-13/25; layers H, i and K. The seeds, fruits and moss remains were retrieved from samples more widely scattered over the excavated area (see figs. 25-33).

One may assume that in general the seeds, fruits and wood remains recovered from the site originate from herbs, shrubs or trees which were present in the vicinity of the settlement. For a few plant remains this may not be true, e.g. for those of the mosses *Sphagnum imbricatum* and *S. papillosum* for which it is suggested that they are derived from peat layers deposited before the time of the settlement (cf. 3.1.). It is superfluous to emphasize that it is not justified to convert relative frequencies of the plant macrofossils into a quantitative reconstruction of the vegetation. The seed pro-

duction shows large differences among the various plant species. Moreover, the seeds of some wild species may have been collected intentionally, or at least the plants may have been brought into the settlement on purpose, as a result of which the seeds concerned occur in large numbers in samples from the cultural fill. The seeds of various other species, on the other hand, must have arrived in the settlement by accident. Further, the chances of remaining preserved in a non-carbonized state are not the same for all seeds and fruits. The same applies to the wood remains (cf. Casparie *et al.*, 1977, p. 37).

For the reconstruction of the vegetation the results of all samples have been combined. One wonders whether this is justified, because in the course of the habitation, the vegetation in the vicinity of the site may have changed to a greater or lesser extent as a result of the activity of man and his domestic animals. Man-induced ruderal vegetation types would not have been found there before the arrival of the inhabitants of the site. Moreover, changes in the physical environment, *e.g.* changes in mean water-level, could have effected changes in the natural vegetation. On the other hand, the seed contents of samples from lower and upper levels show at most some quantitative differences (see table 20, section 6.2.2.), suggesting that during the period covered by the samples examined the vegetation did not change markedly. This, combined with the fact that the habitation of the site must have lasted 75 years at most, led us to the opinion that under the given circumstances the lumping together of all palaeobotanical data for a reconstruction of the plant cover is justifiable.

The reconstruction of the vegetation types is based upon the phytosociological affinity of the species demonstrated for the Swifterbant S3 site. A discussion of this method of determining vegetation types in the vicinity of prehistoric habitation sites is presented in an earlier paper (Van Zeist, 1974, pp. 331-32). Suffice it to remark the following. The basic syntaxonomic unit is the plant association or plant community, the name of which is indicated with

the suffix *-etum* behind the root of the generic name of the plant chosen as an index species. Syntaxonomically related plant associations are grouped into alliances (suffix *-ion*), which in turn are united into orders (suffix *-etalia*) and classes (suffix *-etea*).

In table 12 the syntaxonomic units arrived at for Swifterbant are shown. A plus sign indicates that at present the species concerned is found in the syntaxonomic unit at the top of the table. Preferably, the presence of a vegetation type should only be concluded if a greater number of species characteristic of or common in the syntaxonomic unit concerned is represented in the site. However, in some instances it was not possible to meet this requirement: we are concerned here with syntaxonomic units which are poor in species. For the reconstruction of the vegetation types in the Swifterbant area the work of Westhoff & Den Held (1969) on plant communities in the Netherlands was extensively consulted. To that publication the reader is also referred for further details.

In attempting to reconstruct the vegetation of more than 5000 years ago one should not yield to the temptation to go too far into detail. Through natural causes, such as a change in climate or a slow rate of migration, plants may have appeared or disappeared from the area, in this case the Netherlands, while man is responsible for the intentional or unintentional introduction of a great many species. Consequently, the composition of the vegetation units deduced for Swifterbant would not have been exactly the same as that of the present-day.

Although the reconstruction of the vegetation types is primarily based upon the botanical data, the former topography of the Swifterbant area is also taken into consideration. Moreover, the topography gives indications where the prehistoric vegetation types may have been found. The area was dissected by larger and smaller creeks bordered by natural levees. Behind the levees low-lying backswamps were found. At a distance of 1 km and more from the site river-bank dunes emerged as

islets above the surroundings (Ente, 1976; Hacquebord, 1976; see also 1.1.).

As for the figures and other indications given in front of the plant names in table 12 the following should be remarked. The kind of palaeobotanical evidence is indicated with a letter: S for seeds and fruits, W for wood and Ma for other macrofossil remains. The sample frequency (second column) is the number of samples in which the species concerned was found, expressed as a percentage (total number of samples is 46). No sample frequency is given for species which are represented by wood or charcoal only. One fruit-stone of *Cornus sanguinea* was recovered from the sieve residues. The mean percentage was obtained by dividing the sum of the percentages of a species by the number of samples in which the species concerned is represented. For instance, the sum of the *Cladium mariscus* percentages is 30.9% and the number of samples in which seeds of this type were found in 13. This gives a mean percentage of 2.38% (30.9% divided by 13). The "weighed" percentage (fourth column) for *Cladium mariscus* is 0.67%, viz. 30.9% divided by 46 (the total number of samples). In the "weighed" percentage the relative importance of the species with respect to the whole of the plant macrofossil evidence should find expression. No mean and "weighed" percentages are given for mosses. The relative importance of wood remains is indicated with a symbol (after Casparie *et al.*, 1977, table 5). This symbol is placed in brackets if of the tree concerned also seeds or fruits were found. No mean percentage of *Corylus* is shown because only fragments of hazelnut shells were recovered.

4.2. Forest vegetations

The palaeobotanical evidence indicates that deciduous forest vegetations were found in the vicinity of the site. Oak (*Quercus*), elm (*Ulmus*), ash (*Fraxinus*), linden (*Tilia*), crab apple (*Pyrus malus*) and poplar (*Populus* spec.) must have formed part of the tree canopy, whereas of the understorey shrubs,

in addition to hazel (*Corylus avellana*), dogwood (*Cornus sanguinea*), rose (*Rosa canina/rubiginosa*) and hawthorn (*Crataegus monogyna*) are represented at Swifterbant. Alder (*Alnus glutinosa*) was very likely also found in this deciduous forest type, although this small tree must have had its main distribution in the alder carr vegetations (see below). Without being more specific the deciduous forest inferred for the Swifterbant area is attributed to the order of the Alno-Padion, which syn-taxonomic unit includes forest vegetations along rivers and rivulets, on young soils rich in nutrients which are periodically flooded (Westhoff & Den Held, 1969, p. 263). The highest parts of the levees bordering the major creeks may have been covered by Alno-Padion forests. The river-bank dunes must likewise have supported deciduous forest, but this forest type must have been of different composition. At least, the soil conditions on the dunes (sand and no periodical flooding) differed markedly from those on the levees.

Some doubt has been cast on the assumption that well developed forest would have occurred in the Swifterbant area. The posts and pegs found in the site have only small diameters. If they were of the trunks, and not of branches, the felled trees would at most have been 50 years old, and in most cases they would have reached an age of only 10 to 20 years (Casparie *et al.*, 1977, p. 39). Moreover, in spite of the favourable conditions for preservation no remains (trunks, root systems) or other indications of the former presence of large trees were observed underneath the settlement deposits. Prior to the occupation no well developed forest would have grown at the locality of the S3 site. This leaves one with the question whether perhaps only young deciduous forest was found in the area, suggesting that it was not until some decades prior to the habitation that conditions had become favourable for the establishment of this forest type. However, in the case of exclusively pioneer forest vegetations one would not have expected the great variety in arboreal species established for Swifterbant.

[illegible]

Table 12 (continued).

type of remains	sample frequency	mean percentage	'weighed' percentage		Alno-Padion	Alnion glutinosae	Salicion albae	Molinietalia	Magnocaricion	Scirpo-Phragmitetum	Scirpetum maritimi	Potametea	Ranunculo-Rumicetum maritimi	Lolio-Plantaginatum	Artemisietalia	Polygono-Chenopodietalia	Sisymbrietalia
S	2.2	2.2	0.05	Carex serotina-type	.	.	.	+	.	.	.	.	.	.	.	.	.
S	23.9	4.05	0.97	Poa pratensis/trivialis	.	.	.	+	.	.	.	.	.	.	.	.	.
S	4.4	5.85	0.25	Ranunculus acris	.	.	.	+	.	.	.	.	.	.	.	.	.
Ma	2.2	+		Trifolium repens	.	.	.	+	.	.	.	.	.	.	.	.	.
S	4.4	0.5	0.02	Agrostis spec.	.	.	.	+	.	.	.	.	.	+	.	.	.
S	4.4	0.75	0.03	Hydrocotyle vulgaris	.	.	.	+	.	.	.	.	.	.	.	.	.
S	2.2	0.8	0.02	Galium palustre	.	.	.	+	+	.	.	.	.	.	.	.	.
S	4.4	0.35	0.02	Sonchus palustris	.	.	.	+	.	+	.	.	.	.	.	.	.
S	2.2	0.6	0.01	Lychnis flos-cuculi	.	.	.	+	.	+	.	.	.	.	.	.	.
S	2.2	0.3	0.006	Caltha palustris	.	.	.	+	.	+	.	.	.	.	.	.	.
S	4.4	0.6	0.03	Carex nigra-type	.	.	.	?	.	.	.	.	.	.	.	.	.
S	2.2	0.1	0.002	Alopecurus cf. geniculatus	.	.	.	?	.	.	.	.	.	.	.	.	.
S	4.4	0.4	0.02	Carex riparia	.	.	.	.	+	.	.	.	.	.	.	.	.
S	28.3	2.38	0.67	Cladium mariscus	.	.	.	.	+	.	.	.	.	.	.	.	.
S	10.9	0.8	0.09	Carex rostrata/vesicaria	.	.	.	.	+	.	.	.	.	.	.	.	.
S	4.4	0.3	0.01	Menyanthes trifoliata	.	.	.	.	+	.	.	.	.	.	.	.	.
S	2.2	0.1	0.002	Carex disticha	.	.	.	.	+	+	.	.	.	.	.	.	.
S	26.1	0.49	0.13	Mentha aquatica	.	.	.	.	+	+	.	.	.	.	.	.	.
S	6.5	0.53	0.03	Eleocharis palustris	.	.	.	.	+	+	.	.	.	.	.	.	.
MaS	67.4	9.85	6.64	Phragmites australis	.	.	.	.	.	+	+	.	.	.	.	.	.
Ma	6.5	+		Calliergonella cuspidata	.	.	.	.	+	+	.	.	.	.	.	.	.
Ma	2.2	+		Drepanocladus cf. aduncus	.	.	.	.	+	+	.	.	.	.	.	.	.
S	2.2	0.6	0.01	Glyceria fluitans	.	.	.	.	.	+	.	.	.	.	.	.	.
S	6.5	0.33	0.02	Scirpus lacustris ssp. lacustris	.	.	.	.	.	+	.	.	.	.	.	.	.
S	4.4	0.35	0.02	Typha angustifolia/latifolia	.	.	.	.	.	+	.	.	.	.	.	.	.
S	4.4	0.35	0.02	Oenanthe aquatica	.	.	.	.	.	+	.	.	.	.	.	.	.
S	37.0	0.61	0.22	Scirpus maritimus	.	.	.	.	.	.	+	.	.	.	.	.	.
S	60.9	2.70	1.64	Scirpus tabernaemontani	.	.	.	.	.	.	+	.	.	.	.	.	.
S	10.9	0.48	0.05	Aster tripolium	.	.	.	.	.	.	+	.	.	.	.	.	.
S	2.2	2.3	0.05	Juncus gerardii	.	.	.	.	.	.	?	.	.	.	.	.	.
S	2.2	0.1	0.002	Salicornia europaea	.	.	.	.	.	.	?	.	.	.	.	.	.
S	43.5	1.0	0.43	Nymphaea alba	.	.	.	.	.	.	.	+	.	.	.	.	.
S	6.5	0.47	0.03	Potamogeton crispus/spec.	.	.	.	.	.	.	.	+	.	.	.	.	.
S	2.2	0.1	0.002	Ceratophyllum submersum	.	.	.	.	.	.	.	+	.	.	.	.	.
S	2.2	0.6	0.01	Zannichellia palustris	.	.	.	.	.	.	.	+	.	.	.	.	.
S	4.4	0.6	0.03	Rumex maritimus	.	.	.	.	.	.	.	.	+	.	.	.	.
S	13.0	2.87	0.37	Ranunculus sceleratus	.	.	.	.	.	.	.	.	+	.	.	.	.
S	19.6	0.86	0.17	Plantago major	.	.	.	.	.	.	.	.	.	+	.	.	.

Convincing evidence for the presence of full-grown deciduous trees at not too great a distance from the site is provided by the moss remains. A relatively great number of the moss species demonstrated for Swifterbant grow on tree trunks (see table 2), and for some of these mosses it is specifically mentioned in the literature (Landwehr, 1966) that they are found on old trees, e.g. *Anomodon viticulosus*, *Antitrichia curtipendula*, *Neckera complanata* and *Leucodon sciuroides*. One may assume that the mosses were brought into the settlement adhering to the bark which must have been collected on purpose. Small pieces of bark were frequently observed in the culture layer.

There is hardly any doubt that well developed forest with full-grown trees was found in the Swifterbant area, although the area covered by this vegetation type was of very limited extent. The locality chosen for the foundation of the S3 site, on a levee along a secondary creek, may not have supported bigger trees because it was too wet. This levee had not silted up high enough. The absence of big trees may have been one of the factors which determined the choice of the site for habitation. Subsequently, the wet conditions forced the inhabitants to raise the level of occupation and/or to achieve some insulation from the damp subsoil by carrying in substantial amounts of plant material, such as reed and stems.

Alderwood vegetations (*Alnion glutinosae*) must particularly have been found in the transitional zone between levee and back-swamp. Alder is by far the most common wood type in the site (Casparie *et al.*, 1977, fig. 6) suggesting that *Alnus glutinosa*, and hence alder carr, were quite common in the area. Of the herbs represented at Swifterbant, *Carex pseudocyperus*, *C. paniculata* (two sedge species), *Solanum dulcamara* (bittersweet) and, to a lesser extent, *Lycopus europaeus* are characteristic of *Alnion glutinosae* vegetations.

The presence of willow carr (*Salicion albae*) is concluded on the basis of the rather frequent occurrence of wood and charcoal of *Salix* in the site. Of the other species with a plus sign in the column of *Salicion albae*, none grows ex-

clusively or predominantly in willow carr. Willow shrub must have covered a part of the back-swamp areas, the other part of which was the domain of open vegetations (4.3.).

4.3. Marsh and aquatic vegetations

In addition to willow carr, *Magnocaricion* and *Scirpo-Phragmitetum* vegetations were found in the back-swamps. These syntaxonomic units are attested by fairly great numbers of species, but as is clear from table 12 most of the species are poorly represented in the site (low sample frequencies and low weighed percentages). *Cladium mariscus* and *Mentha aquatica* show somewhat higher sample-frequency percentages, but it is reed (*Phragmites australis*) that is really well represented in the seed record, particularly if one takes into consideration that this species is very likely seriously under-represented by its fruits. The many reed-stem fragments observed in the occupational fill do not find expression in the weighed percentage value. The poor representation of most back-swamp plants can be explained in two ways. It is possible that dense willow and reed vegetations dominated the back-swamps, preventing a more luxurious growth of other marsh plants. On the other hand, willow and reed were exploited by the inhabitants of the site. Willow wood and reed stems were carried in on purpose, whereas most of the other species from the back-swamps must have arrived in the settlement by accident. In the natural succession, the *Scirpo-Phragmitetum*, which is found in places with shallow water, is succeeded by *Magnocaricion* vegetations.

Scirpo-Phragmitetum vegetations may also have bordered on to the creeks. However, the frequent occurrence of fruits of *Scirpus tabernaemontani* (*S. lacustris* ssp. *glaucus*) and the fairly good representation of *Scirpus maritimus* suggest that the *Scirpetum maritimi*, another vegetation type found in and near creeks, was not rare in the Swifterbant area. This vegetation points to brackish water in the creeks, at least temporarily. At high storm floods, salt water must have penetrated into the area

through the creek system which was in open connection with the sea. Marine influence in the Swifterbant area is also suggested by the presence of *Aster tripolium*, *Juncus gerardii* and *Salicornia europaea*. The plant evidence does not suggest that the area was more or less regularly flooded with brackish water. On the contrary, brackish-water conditions must generally have been confined to the creeks.

It was more or less a surprise to find that a fairly great number of species demonstrated for Swifterbant are found in Molinietales vegetations. Except *Poa trivialis/pratensis*, all possible Molinietales species are poorly represented. The order of the Molinietales includes wet meadows which owe their origin and their continued existence to the activity of man, viz. to the cutting of tree stands and a subsequent non-intensive exploitation of the vegetation. It is feasible that at Swifterbant Molinietales vegetations developed in places where alder carr had been cut.

A few species from open water are attributed to the Potametea, which syntaxonomic unit includes vegetations in fresh and slightly saline water. Of these aquatics, only *Nymphaea alba* (water-lily) is well represented at Swifterbant, although the distribution of its seeds poses some questions (6.2.1.). *Zannichellia palustris*, *Potamogeton crispus* and *Ceratophyllum submersum* occur in fresh as well as in brackish water. *Nymphaea alba*, on the other hand, is a typical fresh-water species which may have been found in cut-off secondary creeks and in the lowermost parts of the backswamp areas with permanent open water.

4.4. Synanthropic vegetations

A great number of species from Swifterbant is most common in vegetations which are due to the interference of man. Of synanthropic vegetations not only many species could be established for Swifterbant, but quite a few species from this group of syntaxonomic units show high sample frequencies and weighed percentage values, such as *Urtica dioica*, *Polygonum aviculare*, *Polygonum lapathifolium*, *Chenopo-*

dium album, *Stellaria media* and *Atriplex hastata/patula*. The high frequencies of seeds and fruits of these species must have been the result of the activity of the inhabitants who dumped these weeds in the site (see 6.1.1.). Nevertheless, the great numbers of seeds indicate clearly that the species concerned must have been quite common in the immediate vicinity.

Plantago major, *Polygonum aviculare* and *Capsella bursa-pastoris* point together to the presence of the Lolio-Plantaginietum, which vegetation type is found in frequently trodden places. The moss species *Barbula convoluta*, which in table 12 has been assigned to the Lolio-Plantaginietum, grows in various disturbed habitats. It is, of course, no great surprise to find indications of a vegetation from more or less heavily trodden places. Such places must have been common in the vicinity of settlement sites.

The evidence for the presence of the Ranunculo-Rumicetum maritimi is rather meagre. The only species of this plant association from wet places rich in nitrates found in Swifterbant are *Ranunculus sceleratus* and *Rumex maritimus*, and both are scarcely represented. One must assume that this vegetation type was not particularly common in the Swifterbant area, which is somewhat surprising in view of the wet environment. The absence of *Bidens tripartitus*, another species from wet, nitrate-rich habitats, should be mentioned. This species is well represented in the Iron Age sites of Vlaardingen and Schiedam, both situated in a moist, fresh-water environment. The differences in soil conditions, clay at Swifterbant and predominantly peaty soils at Vlaardingen and Schiedam, could perhaps provide an explanation. *Bidens tripartitus* seems to prefer more peaty soils. These differences in soil conditions cannot be adduced to explain the absence of *Juncus bufonius* at Swifterbant, whereas at Vlaardingen and Schiedam this species is very well represented. *Juncus bufonius*, which is a characteristic species of vegetations on moist to wet, bare soils is rather undemanding as to the kind of soil it grows on. One wonders whether in the fourth millennium B.C. this species did

not yet occur in the Netherlands.

Mention should also be made of the absence of the *Chenopodio-Urticetum urentis*. At least *Urtica urens* and *Chenopodium ficifolium*, which are the most characteristic species of this plant community from muck-heaps and other nitrate-rich habitats, are conspicuously absent at Swifterbant (see also 3.6. and 3.26.).

The presence of *Artemisietales vulgaris* vegetations is suggested particularly by *Artemisia vulgaris*, *Conium maculatum*, *Arctium* cf. *lappa* and *Carduus crispus*. This syntaxonomic unit includes vegetations from a large variety of natural and man-made nitrate-rich habitats, e.g. along streams, roads and fields, in farmyards and in neglected gardens. *Artemisietales vulgaris* vegetations are quite common in the vicinity of habitation sites. The relatively good representation of *Conium maculatum* (Poison Hemlock) in the seed record is striking. At present this highly poisonous plant is far from common. It cannot wholly be excluded that this species was collected on purpose. From *Conium* not only a powerful poison can be prepared, but in lower concentrations the alkaloids extracted from the plant act as a sedative.

Of the *Polygono-Chenopodietalia* and *Sisymbrietalia*, relatively small numbers of species have been established for Swifterbant, but quite a few of them show high to very high frequencies, suggesting that the plants concerned were found in great numbers. Both syntaxonomic units mentioned above belong to the *Chenopodietea* which class comprises exclusively synanthropic plant communities: weed associations in fields and other ruderal vegetations of predominantly annual and bi-annual species. One wonders whether it is justified to distinguish between *Polygono-Chenopodietalia* and *Sisymbrietalia* for vegetations from more than 5000 years ago. It may also be questioned whether the modern weed associations compare with those in Neolithic times. Consequently, no attempt has been made to arrive at a somewhat more detailed reconstruction of *Chenopodietea* weed vegetations in the vicinity of Swifterbant. It may only be concluded that

these vegetations were present and that very probably they were quite common.

From the above it will be clear that no suggestions concerning the composition of the flora in the grain fields of the Swifterbant farmers can be presented. All *Chenopodietea* species demonstrated for this site could have been found in the fields, but typical field weeds are almost completely lacking. Only if *Bromus mollis/secalinus* fruits are of *B. secalinus*, a typical grain-field weed would be represented. *Polygonum convolvulus*, the seeds of which are frequently found in charred grain samples, has not been established for Swifterbant.

5. THE PLANT HUSBANDRY

5.1. Cultivated plants

Charred cereal grains were recovered from the sediment samples and in particular from the sieve residues. At least two and probably three cereal crop plant species are represented at Swifterbant. The total numbers of grains found of each species are shown in table 13.

So far, the crop plant remains from Swifterbant constitute a rather isolated case. The Rössen sites in the Rhineland area of West Germany come most into consideration for a comparison. The habitation of the Swifterbant S3 site, dated to 3400-3300 B.C., falls within the time limits of the Rössen culture: 3800-3350 B.C. (cf. Laning & Mook, 1977, fig. 4). The Rhineland area is not too far away from Swifterbant, and, moreover, charred crop plant remains are reported for those sites (Knörzer, 1971; Schieman, 1954).

5.1.1. *Hordeum vulgare* var. *nudum*

Fairly large numbers of barley grains, altogether nearly 2000 specimens (table 13), were recovered. The kernels show the characteristics of naked barley: they are rounded in cross-section, and in various grains a fine transverse wrinkling on the surface can be observed (fig.

4:1-3). Many grains are more or less distinctly lop-sided indicating that six-rowed barley is concerned here. Thus, the morphology of the grains points clearly to *Hordeum vulgare* var. *nudum*. This conclusion is supported by the rachis internode remains.

A few fragmentary rachis internodes were recovered from the sediment samples and the sieve residues, but of particular interest are the internode remains found in a small hand-picked sample of 'vegetable material' from VIII-21-i. This sample turned out to consist of charred threshing remains of barley. In addition to unidentifiable ashes and fragments of glumes, bracts and rachillas, the sample yielded a small number of grains and rachis internodes of barley. One should be grateful to the keen-eyed, unknown volunteer who noticed the plant remains at "his/her" square metre parcel. On the other hand, it is to be regretted that it was not until many months afterwards that the nature of the vegetable material was discovered. Otherwise a much larger sample could perhaps have been taken.

The internode remains (fig. 5:1-2) are characteristic of free-threshing, six-rowed barley. At the distal end of the internodes the basal parts of three spikelets (a median spikelet and two lateral ones) can be observed. Remains of the glumes, the lemma (the lower bract) and the hairy rachilla are still present on some of the internodes. It should be mentioned that the lateral spikelets were not sessile as in modern six-rowed barley, but that they were pedicellate. The Swifterbant rachis internodes show short, stout stalks which formed the base of the lateral spikelets. Similar pedicellate lateral spikelets are described and depicted by Knörzer (1971, fig. 3:1b) for naked barley from the Rössen site near Langweiler, in the Rhineland area. Villaret-von Rochow (1967) pays special attention to the phenomenon of the short-stalked lateral spikelets in hulled and naked barley from Neolithic Burgäschisee-Süd in Switzerland. This author raises the question to what extent the pedicellate lateral spikelets should be considered as a primitive feature.

The Swifterbant internode remains confirm

the conclusion arrived at on the basis of the grains, viz. that naked, six-rowed barley is concerned here. A few almost complete internodes point to the lax-eared variety (the nodding spike type). This is of course no proof that the dense-eared variety would not have been cultivated. Moreover, plump kernels (short and broad specimens) suggest that the dense-eared variety is equally represented at Swifterbant. It is likely that a mixture of both varieties was grown, the lax-eared type being the predominant one. The latter conclusion is based upon the fact that slender grains are significantly more numerous than plump ones.

Of four comparatively large barley samples, grains have been measured. As a large proportion of the grains had been more or less seriously affected by the carbonization, only relatively small numbers of kernels were suitable for measuring. For that reason, in table 14 the dimensions and index values of grains from two adjacent squares, viz. from VIII-21-i and VIII-22-i and from XVI-24-i and XVI-25-i, respectively, have been taken together. It is likely that in both cases the grains originated from the same supply. The grains from XVI-24/25-i are, on an average, slightly smaller than those from VIII-21/22-i, but the index values do not show significant differences. Below (5.2.) the dimensions of the Swifterbant barley will be compared with those from other sites.

5.1.2. *Triticum dicoccum*

Of *Triticum dicoccum* only small numbers of grains were found. There is a rather great variety in shape; fairly slender as well as plump specimens occur (fig. 4:4-6). The L:B index values of 20 grains from various samples (table 14) demonstrate that, on the whole, the grains are rather plump. Of emmer wheat grains from other prehistoric sites in the Netherlands, only those from Neolithic Vlaardingen show a mean L:B index value (182) which is as low as that obtained for the Swifterbant grains. The grains from the other sites listed in table 64 of Van

Zeist ((1968) 1970) are more slender, on an average. In addition to the grains, one spikelet base and one glume base were found in the sediment samples. There may have been many more spikelet forks and glume bases in the settlement layers, but they were not retained on the rather large-meshed sieve through which the soil was washed.

5.1.3. *Triticum cf. aestivum*

Among the *Triticum* grains, one specimen (4.3 x 2.6 x 2.4 mm) from sieve sample XII-15-i is strongly reminiscent of *T. aestivum*. As is clear from fig. 4:8 this grain shows the greatest width in its lower part, which feature is characteristic of *T. aestivum*. Moreover, the surface of the grain suggests a free-threshing wheat. It is clear that only one grain is no particularly firm evidence of bread wheat at Swifterbant. Thus, it cannot be excluded that this grain is a deformed emmer wheat kernel. On the other hand, Knörzer (1971) reports a small number of bread wheat (club wheat) grains for the Rössen site near Langweiler. In that case a few rachis remains confirm the presence of free-threshing wheat.

It is not likely that *T. aestivum* was grown intentionally, but at most it may have constituted an admixture to emmer wheat.

5.1.4. *Claviceps purpurea*

One carbonized sclerotium of *Claviceps purpurea* (ergot) was met with (fig. 4:7). The sclerotium is lanceolate, tapering at both ends, with longitudinal grooves. Dimensions: 7.2 x 1.9 mm. *Claviceps purpurea* is a parasitic fungus on cereals as well as on wild grasses. The Swifterbant specimen is of about the same size as the *Claviceps* sclerotia from the Rössen site near Langweiler (8.1 x 1.1 x 1.3 mm; Knörzer, 1971). Knörzer argues that these sclerotia are too small for *Claviceps* on barley or wheat, but that wild grasses with medium-sized grains come rather into consideration. In this connection it should be mentioned here that 10 non-carbonized sclerotia of *Claviceps* on *Triticum*

monococcum grown on an experimental plot at Orvelte measure 10.1 (9.0-12.0) x 2.5 (2.0-2.8) mm. They are considerably smaller than the *Claviceps* sclerotia on *Secale* (18.9 x 3.3 x 4.4 mm) to which Knörzer refers. As wild grasses with medium-sized grains are hardly represented at Swifterbant, it is tempting to assume that in spite of the rather small size of the sclerotium concerned barley or wheat was nevertheless the host plant.

5.2. Plant cultivation at Swifterbant

The barley and wheat grains from Swifterbant do not in themselves necessarily imply that these cereals were grown locally. In view of the local situation, with only very little potential arable land, one may wonder whether crop plants were actually grown there. One could imagine that the crops had been grown elsewhere, on the higher soils of the Land van Vollenhove, the Veluwe or the coastal dune area, and that the people who spent a part of the year at Swifterbant had brought the grains with them. However, as has already been mentioned before (Casparie *et al.*, 1977), the threshing remains of barley from VIII-21-i indicate that the crop plants were grown in the vicinity of the site. If the plants had been cultivated at a great distance from the site, threshed grains would have been transported because they are much less bulky than unthreshed ears.

Thus, one must assume that plant cultivation was practised locally. Fields can only have been laid out on the highest parts of the levees bordering the major creeks and possibly on the river-bank dunes, at a distance of at least 1 km from the site. In spite of the rather extreme edaphic conditions the quality of the crop was not exactly poor. At least, the average size of the Swifterbant barley grains is larger than that obtained for naked barley from other sites in the Netherlands and from the Rössen site near Langweiler (table 15). The size of the emmer wheat grains equally does not suggest a poor crop (cf. Van Zeist, (1968) 1970, table 64). It is striking that the *Triticum dicoccum*

Table 13. Total numbers of cereal grains from Swifterbant.

	<i>Hordeum vulgare nudum</i>	<i>Triticum dicoccum</i>	<i>Triticum cf. aestivum</i>
sediment samples	179 (99.4%)	1 (0.6%)	—
sieve residues	1788 (96.1%)	71 (3.8%)	1 (0.05%)
totals	1967 (96.4%)	72 (3.5%)	1 (0.05%)

Table 14. Dimensions in mm and index values of cereal grains from Swifterbant.

		<i>L</i>	<i>B</i>	<i>T</i>	<i>100 L:B</i>	<i>100 T:B</i>
<i>Hordeum vulgare nudum</i>						
VIII-21/22-i	min.	4.9	2.9	2.2	144	71
N = 50	aver.	5.86	3.32	2.77	170	82
	max.	6.8	4.2	3.3	208	91
XVI-24/25-i	min.	4.8	2.7	1.9	143	68
N = 46	aver.	5.55	3.25	2.55	172	79
	max.	6.8	4.2	3.0	197	90
<i>Triticum dicoccum</i>						
various samples	min.	4.8	2.4	2.0	155	70
N = 20	aver.	5.62	3.08	2.59	184	84
	max.	6.8	3.9	3.2	227	100

Table 16. Samples from inside or near flint concentration areas (group I) and from outside those areas (group II).

<i>Group I in/near activity areas</i>		<i>Group II outside activity areas</i>	
no. 15	V-21-G	no. 1	I-17-i
no. 19	III-17-F	no. 2	I-18-i
no. 20	VIII-17-F	no. 3	II-16-H
no. 21	VIII-23-F	no. 4	III-14-G
no. 26	IX-14-G	no. 5	III-20-F
no. 27	IX-15-F	no. 6	III-20-G
no. 28	IX-19-F	no. 7	IV-13-F
no. 30	IX-29-F	no. 8	IV-17-G
no. 31	X-15-G	no. 9	IV-20-H
no. 32	X-22-F	no. 10	IV-24-F
no. 33	XI-16-F	no. 11	IV-24-G
no. 35	XII-15-G	no. 12	V-13-K
no. 36	XIV-17-i	no. 13	II-18-G
no. 37	XIV-23-G	no. 14	V-18-K
no. 39	XV-24-G	no. 16	V-23-i
no. 40	XV-27-G	no. 17	VI-25-K
no. 41	XVI-25-G	no. 18	VII-22-K
no. 45	XXIX-18-F	no. 22	VIII-23-H
no. 46	XXXIII-18-F	no. 23	VIII-24-H
		no. 24	VIII-26-H
		no. 25	VIII-26-K
		no. 29	IX-25-H
		no. 34	XI-23-K
		no. 38	XV-19-K
		no. 42	XVIII-19-i
		no. 43	XX-19-i
		no. 44	XXIV-19-i

Table 15. Average dimensions in mm and index values for *Hordeum vulgare nudum* from various sites.

	<i>L</i>	<i>B</i>	<i>T</i>	<i>L:B</i>	<i>T:B</i>
Ur-Fulerum (N = 50)	5.8	3.1	2.5	187	81
Zandwerven (N = 8)	4.3	2.5	1.9	178	77
Eeserveld (N = 100)	4.58	2.58	1.99	179	77
Emmerhout (N = 25)	4.46	2.41	1.80	188	76
Angelsloo (N = 100)	4.36	2.36	1.66	186	70
Elp 98 (N = 100)	5.34	2.64	1.93	204	73
Elp 69 (N = 69)	4.78	2.74	2.15	176	79
Bovenkarspel (N = 49)	4.69	2.82	2.13	166	76
Langweiler (N = 17)	4.66	2.56	2.01		

grains from Neolithic Vlaardingen, where the edaphic conditions must have been comparable to those of Swifterbant, are even somewhat larger than those of the latter site. It is true that only some information on the quality, that is on the size, of the grains is available and not on the yields in kilogrammes per unit area (and on the frequency of crop failures), but nevertheless it seems that the conditions for grain growing were not particularly unfavourable, although the cultivated acreage must have been of very limited extent. It is unlikely that cereals could have constituted the main food of the inhabitants of the Swifterbant site; they may at most have been a welcome addition to a diet of predominantly fish and meat (Clason & Brinkhuizen, 1978).

The Rössen site near Langweiler (Knörzer, 1971, table 1) shows about the same ratio between naked barley and emmer wheat as the Swifterbant S3 site, viz. c. 25 to 1. In both sites *Triticum aestivum* is represented, but at Langweiler free-threshing wheat seems to have been of nearly equal importance as emmer wheat. At Langweiler, *Triticum monococcum* is the predominant wheat species: the ratio between einkorn and emmer wheat is nearly 4 to 1. At Swifterbant, on the other hand, *Triticum monococcum* is conspicuously absent. It should be emphasized that an identical crop-plant assortment was not to be expected for two settlement sites of different archaeological cultures and with different environmental conditions. Moreover, both Rössen sites in the Rhineland area, for which archaeobotanical data have been published, show already striking differences. Thus, for Ur-Fulerum (Schiemann, 1954) no *Triticum monococcum* is reported, whereas there the barley was predominantly of the hulled type.

5.3. The distribution of cereal grains in the site

Only once were charred grains observed *in situ* during the excavations (VIII-21-i). The density of the cereal grains was generally low. The sediment samples consisting of 3 litres of soil yielded mostly only a few charred grains. On the

other hand, from a few samples, viz. from IV-20-H, IX-19-F and VIII-22-K, somewhat greater numbers of cereal grains were recovered, suggesting that the grains were not very evenly distributed through the archaeological deposits. This suggestion is supported by the numbers of charred grains recovered from the sieve residues. From the latter category of samples it appears that small concentrations of charred grains must have occurred.

In figs. 6-10, for levels F to K, the numbers of charred grains found in the sieve residues of the square metre quadrants are shown. A cross indicates that other plant remains but no cereal grains were recovered from that particular quadrant.

In evaluating the data presented in fig. 6-10 the following should be taken into consideration. The quality of the data varies considerably because the recovery of botanical remains depended in no small measure upon the interest and the attentiveness of the people who on that particular day were carrying out the soil-washing operation. If greater numbers of vegetable remains were present on the sieve they should certainly have been observed by the person who was in charge of recovering the archaeologically important items from the sieve (see 2.1.). However, if only a few charred grains or other plant remains, such as hazelnut shell fragments and *Galium* seeds, were present they may easily have been overlooked if the person concerned did not pay particular attention to possible archaeobotanical material.

The greatest uncertainty concerns the quadrants for which no vegetable remains are reported. In some instances there may actually have been no plant material on the sieve, but in many others it must have remained unnoticed. If the majority of a consecutive series of quadrants yielded plant remains, but for a few quadrants no mention is made of seeds one may assume that, indeed, no seeds were present. In that case it is very likely that the same person or group of persons handled the whole series of quadrants. In the other instances one is left with the uncertainty to what extent a blank in figs. 6-10 is due to the absence of

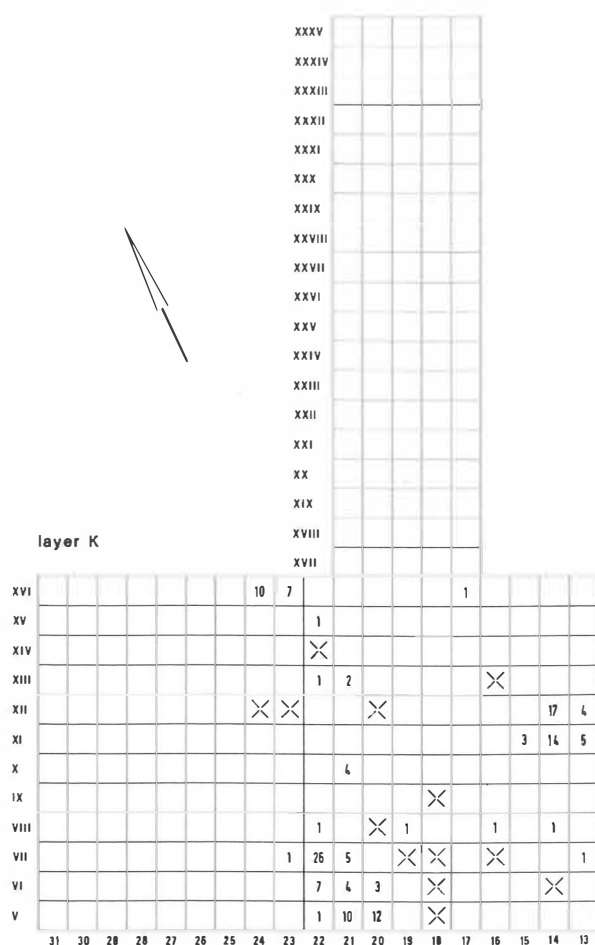


Fig. 6. Numbers of cereal grains recovered from sieve residues, layer K. For discussion of figs. 6-10, see 5.3.

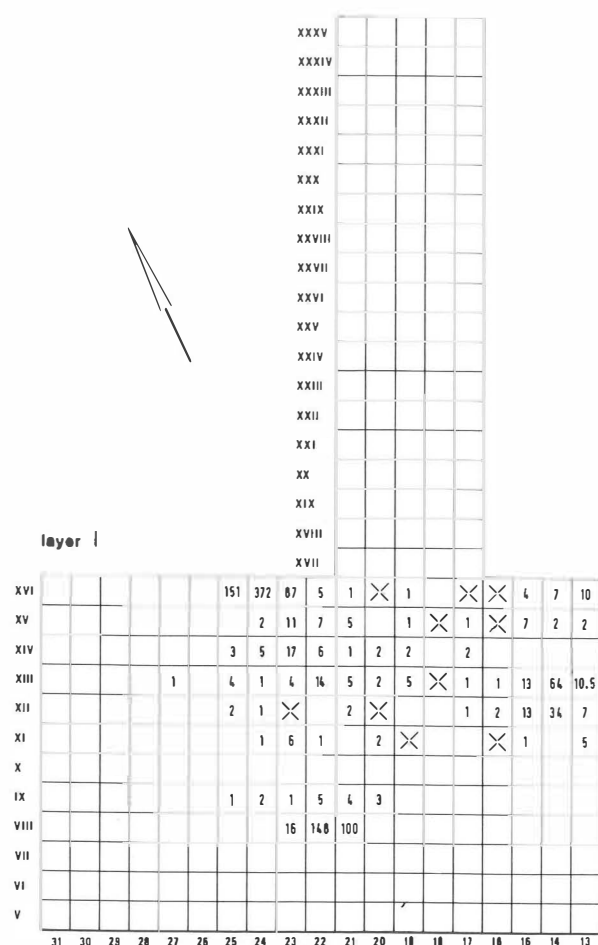


Fig. 7. Numbers of cereal grains recovered from sieve residues, layer i.

plant remains or to the attitude of the excavation volunteer concerned.

Nevertheless, in spite of the many uncertainties and particularly of the fragmentary nature of the data presented in figs. 6-10, the numbers demonstrate at least that concentrations of charred grains occurred, that is to say, that in some areas charred grains were considerably more numerous than in the rest of the archaeological deposit. Obvious concentrations have been established for XI-14-F, XI-21/22-G, VIII-21/22-i, XII/XIII-14-i and XVI-23/24/25-i. One may assume that these concentrations are due to specific activities of the inhabitants of the site. In one instance it is clear to

what kind of activity a charred grain concentration must be ascribed. We are concerned here with the concentration in quadrants VIII-21-i and VIII-22-i. From one of the quadrants (VIII-21-i) the sample with the threshing remains of naked barley originates (5.1.1.). Other concentrations may likewise have come from places where charred threshing refuse had been dumped, but the sieve residues are not informative on this matter. The small rachis and glume fragments must practically all have been washed through the sieve, and the few remains which may already have stayed on the screen would generally have remained unnoticed in the field.

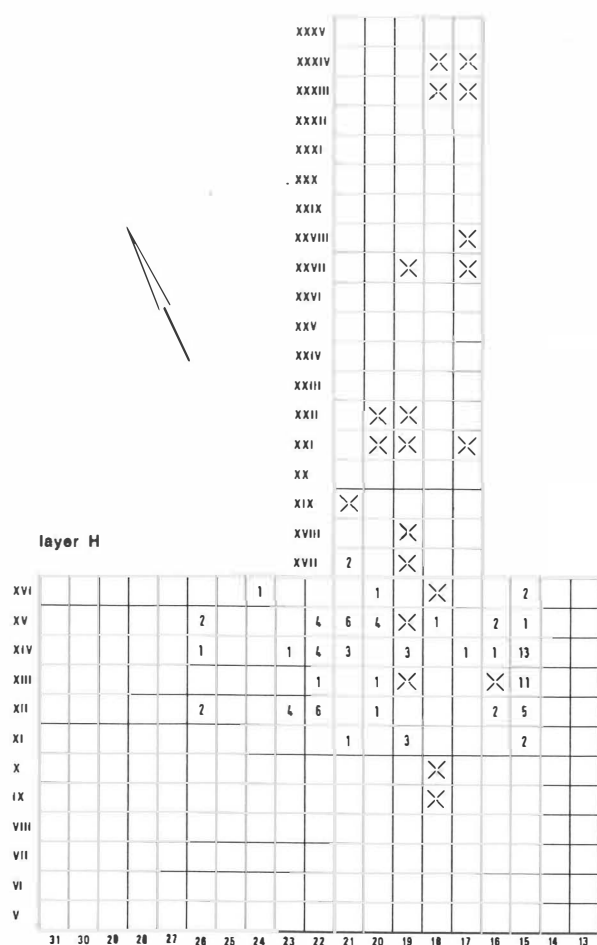


Fig. 8. Numbers of cereal grains recovered from sieve residues, layer H.

It is likely that threshing remains were used as fuel. It is true that these remains burn up rapidly, but they give high temperatures. Threshing refuse could also have been used to light or to revive the hearth fire. However, cereal grain concentrations certainly do not always represent threshing remains. Thus it is possible that charred grains accumulated near the fire place where the meals were prepared. One could also imagine that if the people were tidy, the rubbish including occasional charred grains was swept out of the room and deposited at a place outside the house. As the archaeological remains do not provide indications of the location and the outline of houses

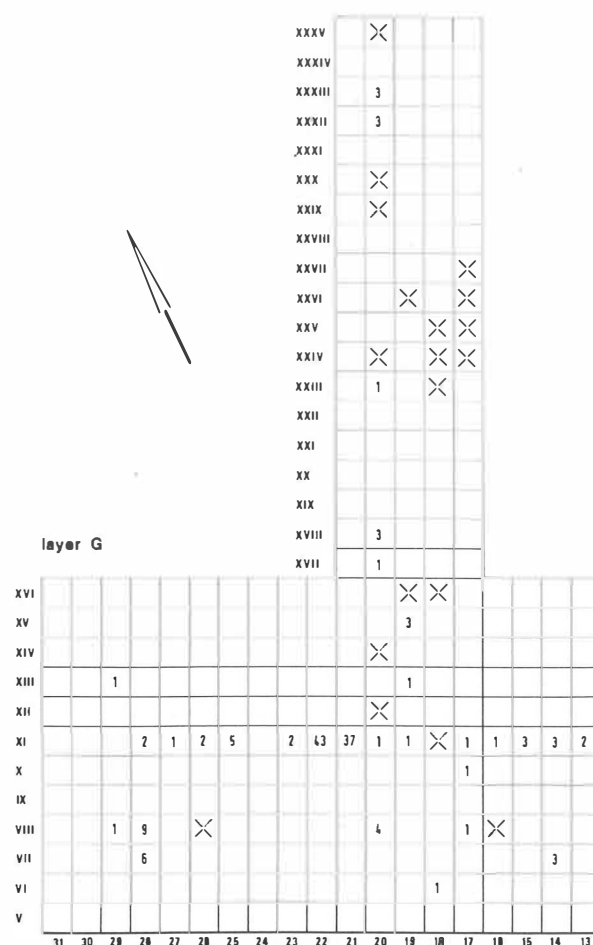


Fig. 9. Numbers of cereal grains recovered from sieve residues, layer G.

or huts, it cannot be tested whether there is, indeed, any relation between charred grain concentrations and house sites.

It has been examined whether the charred grain accumulations suggested by the sieve residues possibly correlate with distinct features observed in the field, such as fire places and ash patches. In this connection it should be mentioned that a feature map and an accompanying list with information on the type, the shape and the size of the feature, the location within the grid system and the level has been composed (by Mr. D. Kielman). Corresponding information on the location within the site is available for the sieve residues, so that it was

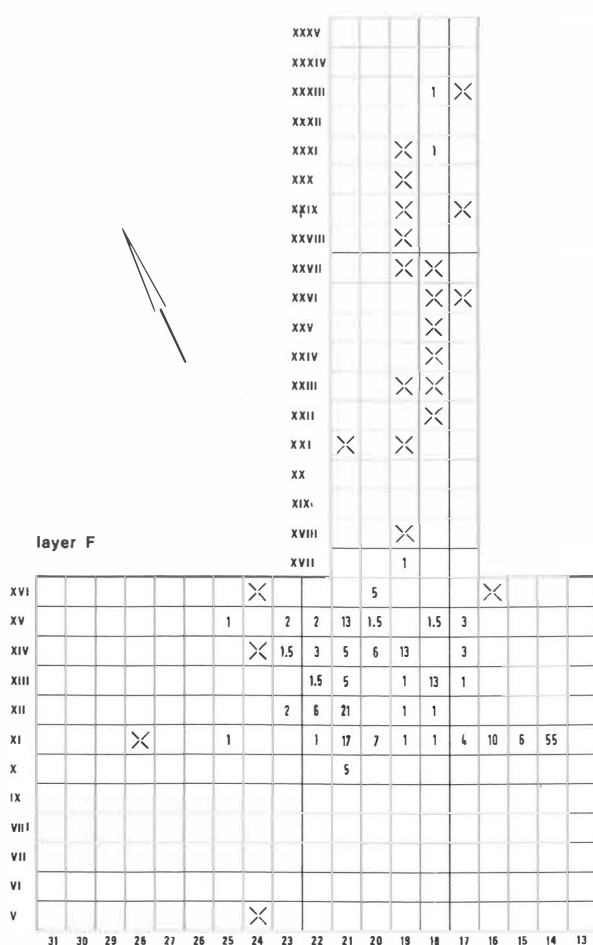


Fig. 10. Numbers of cereal grains recovered from sieve residues, layer F.

possible to determine whether charred grain concentrations are from places where a feature was observed. This has been done for 12 samples with more than 20 charred grains (21 to 372 kernels) and for 15 samples with 11-20 specimens. The result is distinctly negative. Only the concentration in VIII-21-i is from a square for which a patch of carbonized seeds and ashes is reported. In the same metre quadrant a concentration of fish remains was observed. It is from this feature that the hand-picked sample of threshing remains was recovered. It is likely that the charred threshing remains were not confined to VIII-21-i, but that they extended over the adjoining square VIII-22-i which likewise yielded a relatively

great number of cereal grains. None of the charred grain accumulations is from an area with a fire place.

As will come up for discussion in chapter 6 the flint material shows distinct distribution patterns in the successive 10 cm levels. Areas of concentration of flint material suggest activity areas. No correlation between the charred grain accumulations and the distribution of the flint material could be established. Fairly great numbers of grains were recovered from metre squares in or near areas of flint concentrations as well as from those outside these activity areas, viz. 16 and 11 samples, respectively.

In summary, it may be remarked that at least one cereal grain concentration represents threshing residues. The origin of the other accumulations remains unclear. Verly likely none of the concentrations constitutes *in situ* remains of a grain supply. In that case one would have expected a cache of charred seeds which had certainly been observed in the field. One must assume that most if not all of the cereal grain concentrations are from refuse that had been dumped in the settlement area.

5.4. Food collecting

The conclusion that plant cultivation was probably of secondary economic importance at Swifterbant (5.2.) leads more or less automatically to the question of the possible role of wild plants in the diet of the inhabitants of the site. The factual evidence indicates that various fruits and nuts were collected: *Corylus avellana* (hazelnut), *Pyrus malus* (crab apple), *Crataegus monogyna* (hawthorn), *Rosa* (rose-hips) and *Rubus fruticosus* (blackberry). In addition to the uncarbonized pips, three carbonized crab apples were found (dimensions: 2.3 x 2.1, 1.85 x c. 1.6, 2.55 x 2.4 cm). There are no indications of the drying of apples, a preservation method that has been reported for various pre-historic sites in Europe (cf. Helbaek, 1952). It is true that the specimen depicted in fig. 5:10 is half an apple, but this is not due to the intentional cutting into two halves. Schieman (1954) reports five carbonized, whole crab

apples for the Rössen site of Ur-Fulerum in the Rhineland area. One wonders whether the presence of carbonized apples could point to the roasting of these fruits, which treatment may have improved the taste. Hawthorn fruits, rosehips, blackberries and (non-roasted) apples were a source of vitamin C but of only little caloric value. On the other hand, hazelnuts, with a high content of fat (c. 60%), must have constituted a valuable additional food. Remains of acorns were not recovered at Swifterbant. Acorns, which in addition to starch contain a fairly high content of fat, must have been collected for human nutrition in prehistoric times as is attested by the finds of the carbonized fruits in various sites (cf. Jørgensen, 1978). The absence of acorn remains at Swifterbant cannot be ascribed to a non-availability of this potential source of food. For the rather frequent occurrence of oak charcoal at Swifterbant (Casparie *et al.*, 1977) indicates that the trees must have been found at not too great a distance from the site.

Much more difficult than in the case of wild fruits and nuts is the evaluation of the possible exploitation of other potential wild food plants, even if one considers only those species the seeds of which could have been used for human consumption. Thus, the great numbers of seeds of *Chenopodium album*, *Polygonum lapathifolium* and *Polygonum aviculare* in various samples could be interpreted as human food waste. There is convincing evidence that prehistoric man harvested the seeds of *Chenopodium album* and *Polygonum* species, in particular for Iron Age Denmark (Helbaek, 1951, 1960). However, *Stellaria media* and *Urtica dioica* are likewise represented by considerable numbers of seeds although it is unlikely that these seeds were eaten by the inhabitants of the site. At most the leaves of these species were used as vegetables. The seeds of *Nymphaea alba* (water-lily) occur rather regularly, albeit never in great numbers. However, it is unlikely that these fairly large seeds were collected on purpose. Of water-lily, it is the rhizomes, rich in starch, that have been eaten in northern Europe.

It will be clear that the seed evidence from Swifterbant does not provide clues as to the possible role of wild food plants in the diet of the inhabitants. It may only be concluded that various plants which could have contributed to the demand for carbohydrates were quite common in the Swifterbant area. Whether or not these species were exploited as such by the inhabitants of the site must remain unanswered. Another possible explanation for the great numbers of seeds of various plants will be discussed below (6.1.1.).

6. THE DISTRIBUTION OF SEEDS AND FRUITS IN THE SITE

6.1. The distribution of the seed frequencies

6.1.1. Seed frequency distribution per layer

In section 2 it has been stated that during the campaigns of 1974-1977, of each square metre parcel one litre of soil was examined for seeds in the field. (In the following the term seeds includes also fruits although from a morphological point of view this is not correct.) Depending on the numbers of seeds recovered from the samples four categories were distinguished. This procedure which had been set up with the aim of selecting samples for possible examination in the laboratory had an interesting additional result. It turned out not only that the numbers of seeds in the occupational fill vary considerably, as was already known, but also that areas of concentrations of seeds can be distinguished.

In figs. 11-15 the seed frequencies are plotted per layer. The seed frequencies are classified here into three groups, viz. no or few seeds (less than 10), fairly numerous (10-19 seeds) and numerous (20 and more seeds). A blank means that from that particular square no sample was examined for seeds. Figs. 11-15 point to the presence of distinct concentrations of seeds. Squares with a rather high seed content are not randomly distributed,

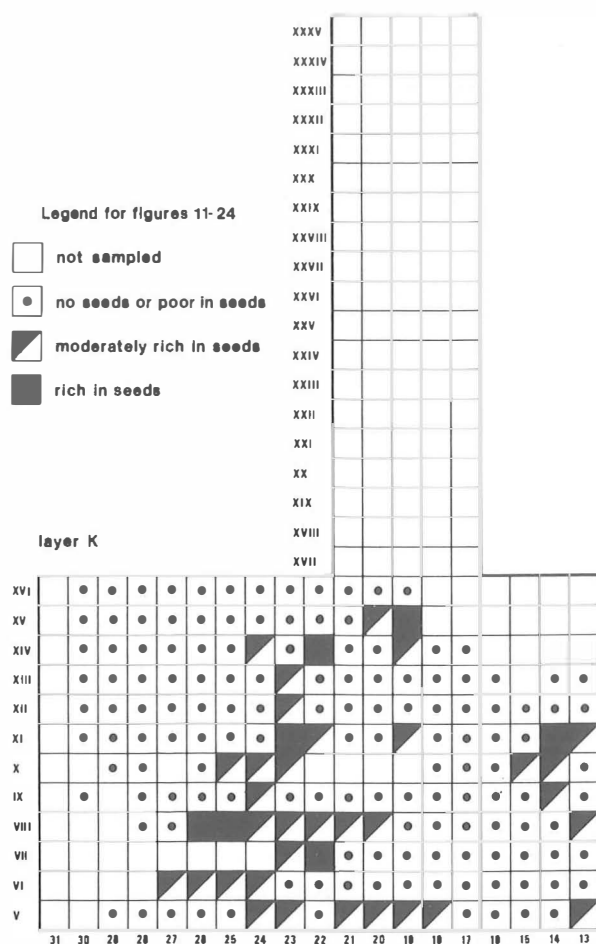


Fig. 11. Seed frequency distribution chart for layer K. For discussion of figs. 11-15, see 6.1.1.

but they show a kind of clustering. In each level areas of predominantly fairly numerous to numerous seeds contrast with those in which seeds are absent or scarce.

Although a fairly great number of seed types has been established for Swifterbant, of only rather few species were considerable quantities of seeds found: *Atriplex hastata/patula*, *Chenopodium album*, *Polygonum aviculare*, *Polygonum lapathifolium*, *Stellaria media*, *Urtica dioica*. It is the seeds of these species which largely determined the seed frequencies in the one litre samples. As for the explanation of the presence of the great numbers of seeds, in an earlier paper (Casparie *et*

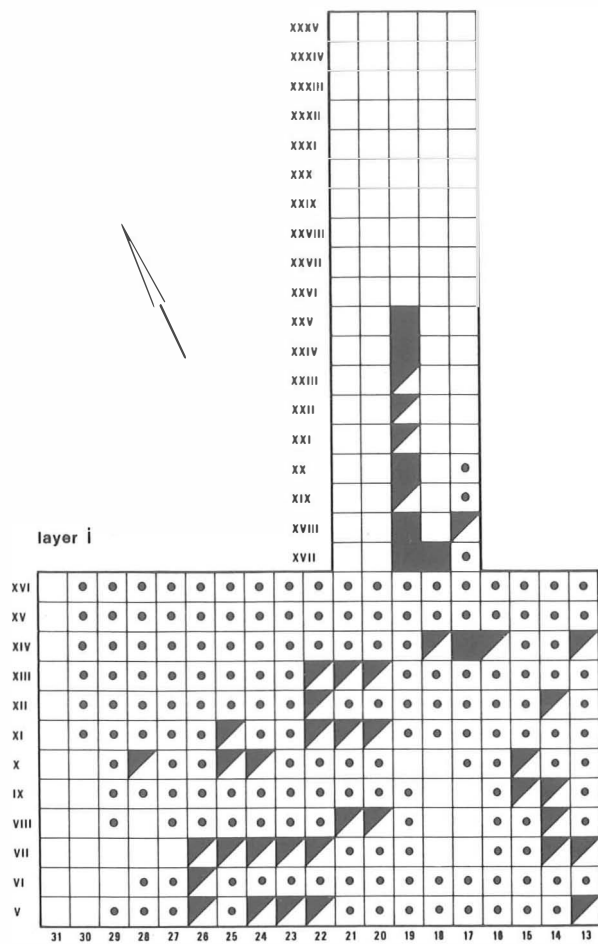


Fig. 12. Seed frequency distribution chart for layer i.

al., 1977, p. 53) it has been advocated that the plants concerned had grown on the spot, that is to say, in the settlement itself. This would only have been possible if the site was not inhabited each year. In the case of seasonal habitation, the above would imply a non-annual return of the inhabitants to the summer occupation site. Leaving aside questions concerning seasonal or year-round habitation and possible temporary abandonment of the settlement, we now take another line for the explanation of the great numbers of seeds. If in periods of non-habitation the whole of the site was covered by weed vegetations mainly consisting of one or more of the species mentioned above, one

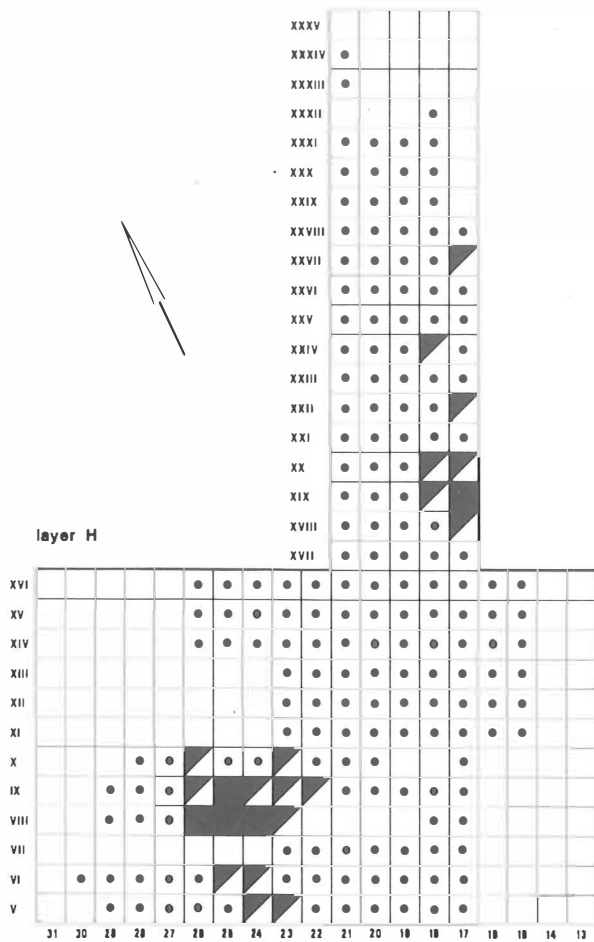


Fig. 13. Seed frequency distribution chart for layer H.

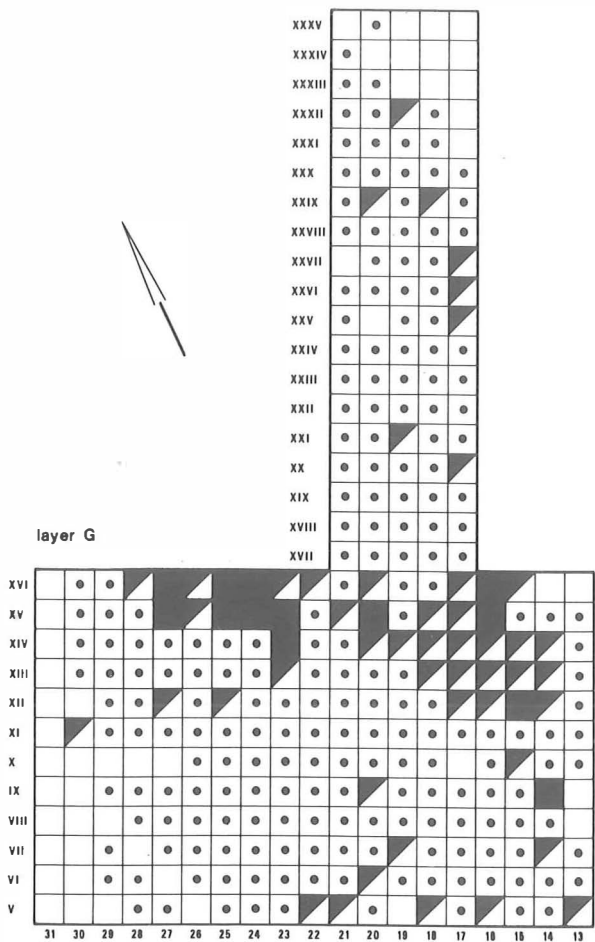


Fig. 14. Seed frequency distribution chart for layer G.

would have expected a less patchy distribution of the squares with higher seed concentrations. The seed frequency distribution patterns shown in figs. 11-15 indicate rather that man must have been responsible for the great quantities of these seed types. These seeds do not so much constitute the remains of human food, in other words, the seeds may not have been collected on purpose, but the plants concerned were dumped on the spot. In this connection it should be remembered that the culture layer consisted of clay with much organic material. Huge quantities of vegetable material must in the course of time have been carried in by the inhabitants of the site. In the field, fragments

of reed stems were frequently observed. It is self-evident that not only the plants of which great numbers of seeds were found were brought to the site, but also many other plant species. One may safely assume that most of the seeds and fruits arrived in the site adhering to the plants. At places where plants with a prolific seed production had been dumped the cultural fill is comparatively rich in seeds.

6.1.2. Seed frequency distribution per 10 cm level

If the inhabitants of the site were primarily responsible for the differences in the seed fre-

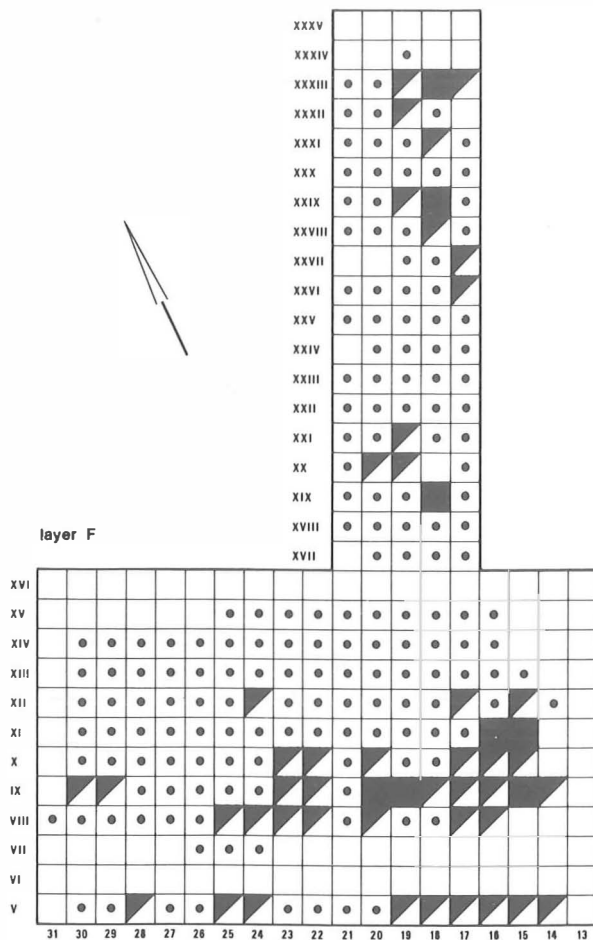


Fig. 15. Seed frequency distribution chart for layer F.

quencies, albeit unintentionally, the question arises to what extent the seed frequency distribution patterns correlate with other indications of human activity. Although a great number of posts or remains thereof have been excavated it has not been possible to reconstruct ground-plans of houses. Consequently, no possible relations between house sites and areas of seed concentration can be determined. Better prospects in this connection are offered by the artifacts. For the flint material as well as for the pottery sherds, studied by Mr. P.H. Deckers and Mrs. J.P. de Roeper, respectively, distribution maps have been prepared. The distribu-

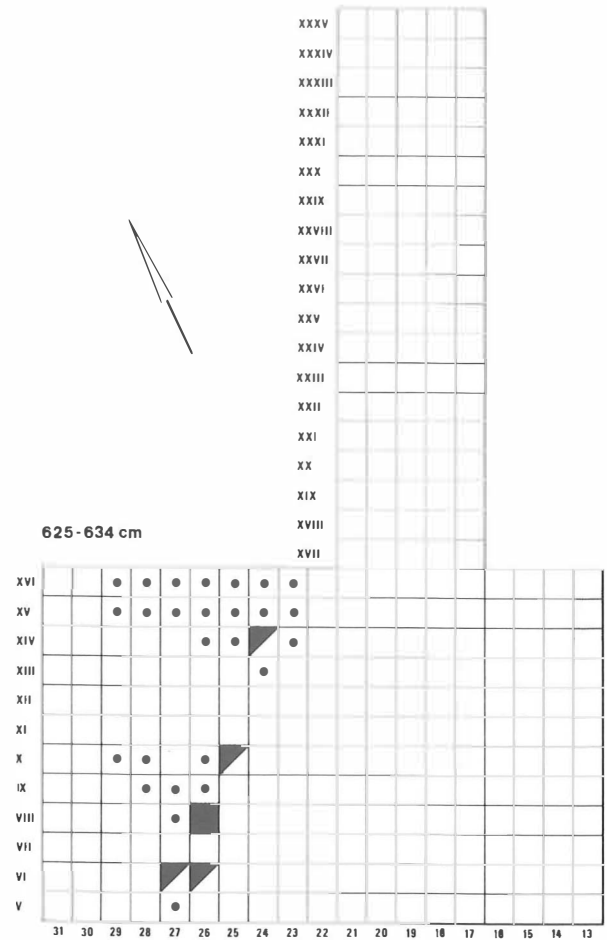


Fig. 16. Seed frequency distribution chart for 625-634 cm level. The contour lines delimit areas of concentrations of unburnt flint material (so-called activity areas). For discussion see 6.1.2.

tion of the unburnt flint material, which largely corresponds to the distribution of the burnt flint material and of the pottery, has been chosen for comparison with the botanical data. Mr. Deckers kindly placed the flint distribution data, which have not yet been published, at our disposal.

The distribution of the artifacts is given per 10 cm level, *e.g.* for the levels of 565-574, 575-584 cm etc. below N.A.P. (mean sea-level). This was possible because all finds had been registered three-dimensionally (Van der Waals & Waterbolk, 1976). The seed frequency distributions are per layer. Under ideal circum-

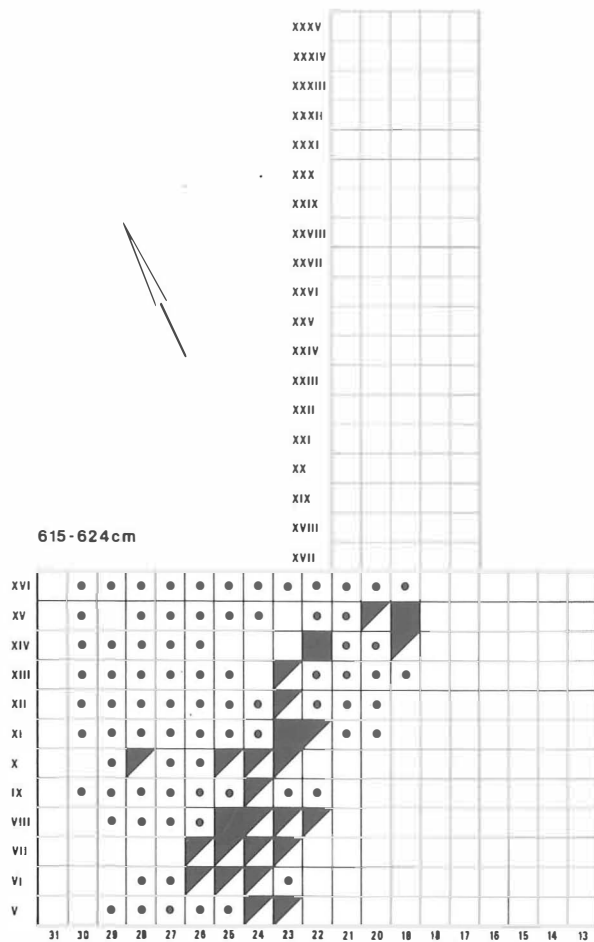


Fig. 17. Seed frequency distribution chart for 615-624 cm level. See caption of figure 16.

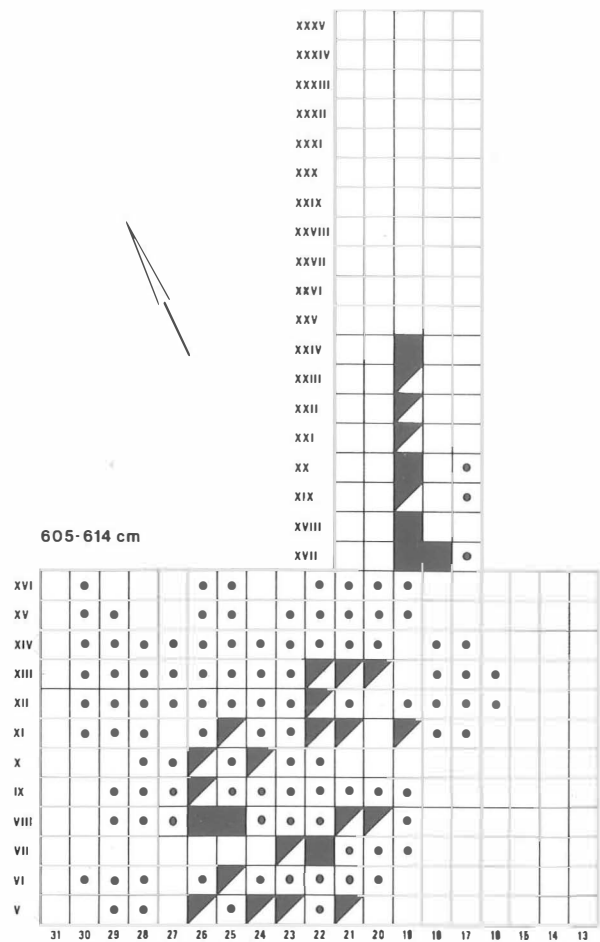


Fig. 18. Seed frequency distribution chart for 605-614 cm level. See caption of figure 16.

stances, the 10 cm levels could have been made corresponding with the layers employed in the field. However, these layers are often more than 10 cm thick and, moreover, the absolute height of one and the same layer may vary quite considerably over the excavated area. In this respect it should be mentioned that per metre square the upper and lower limits of each layer were levelled. For a comparison of the distribution of seed frequencies with that of the flint material it was necessary to convert the botanical data obtained for layers F to K to the 10 cm levels mentioned above. The re-

arrangement was performed on the basis of the average height (the mean of upper and lower limit) of each layer per metre square. Thus, this average height determines to which 10 cm level the sample concerned has been attributed. If of a layer only one height measurement is available (of the lowermost layer in general only the upper limit has been levelled), an estimation of the average height has been made. The seed frequency distributions per 10 cm levels are presented in figs. 16-24.

With respect to this re-arrangement a few remarks should be made. This procedure inevi-

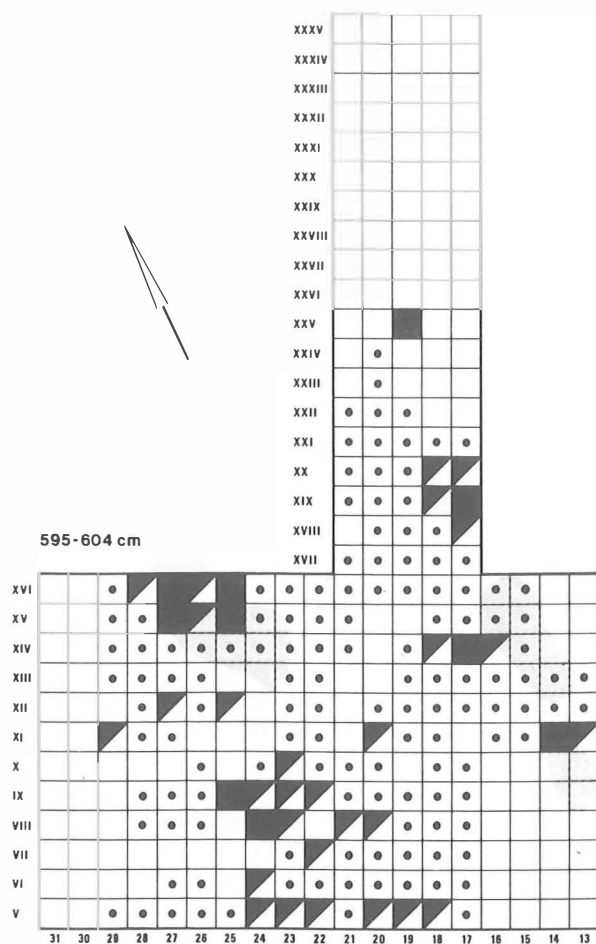


Fig. 19. Seed frequency distribution chart for 595-604 cm level. See caption of figure 16.

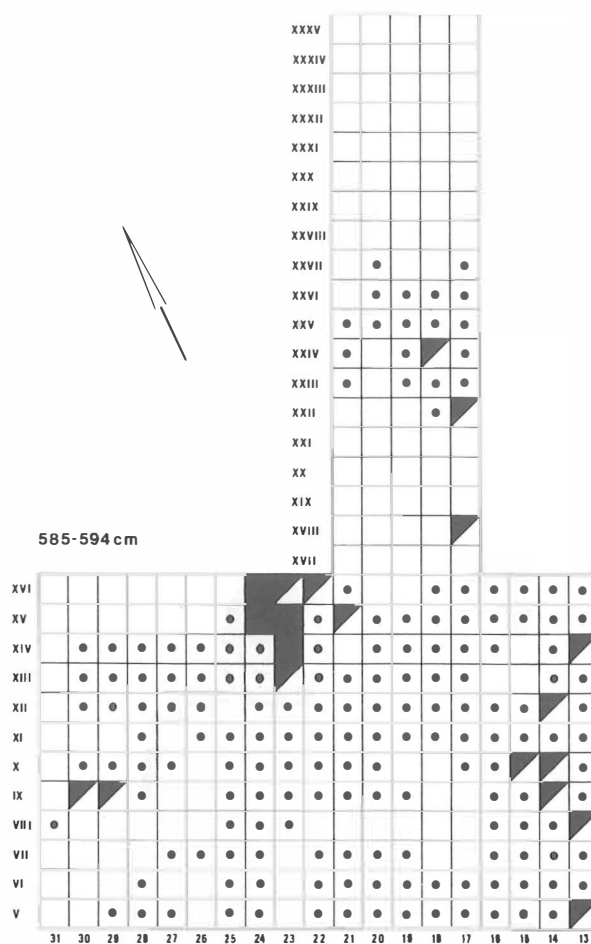


Fig. 20. Seed frequency distribution chart for 585-594 cm level. See caption of figure 16.

tably leads to inaccuracies and gaps in the seed record. Thus, it could happen that of two samples from adjacent squares in the same layer one ended up in another 10 cm level than the other, although the difference in average height was only 1 or 2 cm. The absolute height of the top of the subsoil and the thickness of the culture layer vary quite markedly. As a result, ten 10 cm levels are distinguished, whereas only five layers were employed in the field. It is self-evident that the splitting up must result in a considerable increase in the numbers of blank squares on the distribution charts. In

some cases this has led to distribution patterns of examined and of non-examined metre squares which are real and quite informative (see 6.1.3.). In other instances blank squares constitute distinct gaps in the seed record, although happily they do not drastically reduce the significance of the distribution charts. Examples of the latter category are level 555-564 cm, squares 16-19, VI-XI (fig. 23) and level 565-574 cm, squares VI-VII, 20-25, VIII-XI, 19-21 (fig. 22). The data for levels 535-544 and 545-554 cm have been combined (fig. 24).

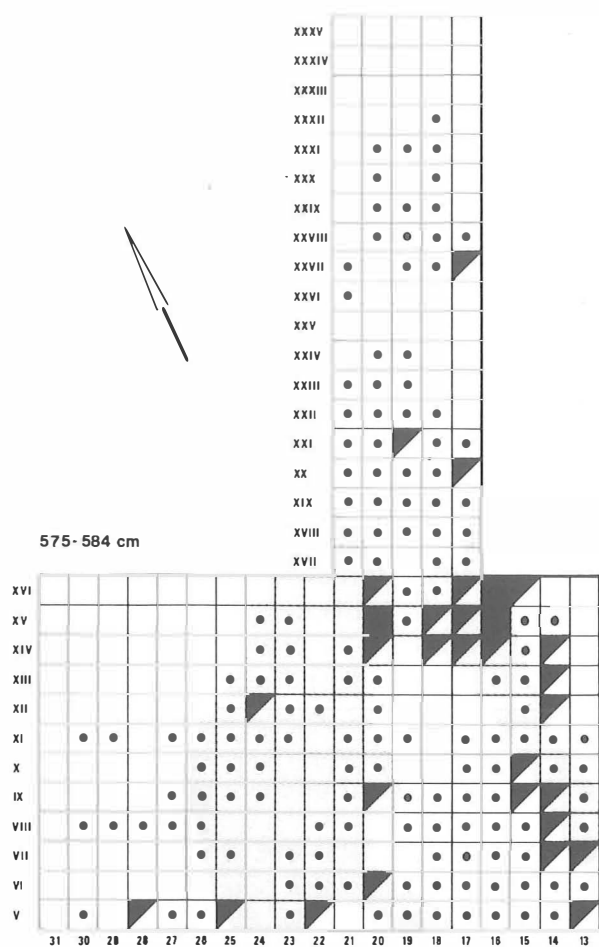


Fig. 21. Seed frequency distribution chart for 575-584 cm level. See caption of figure 16.

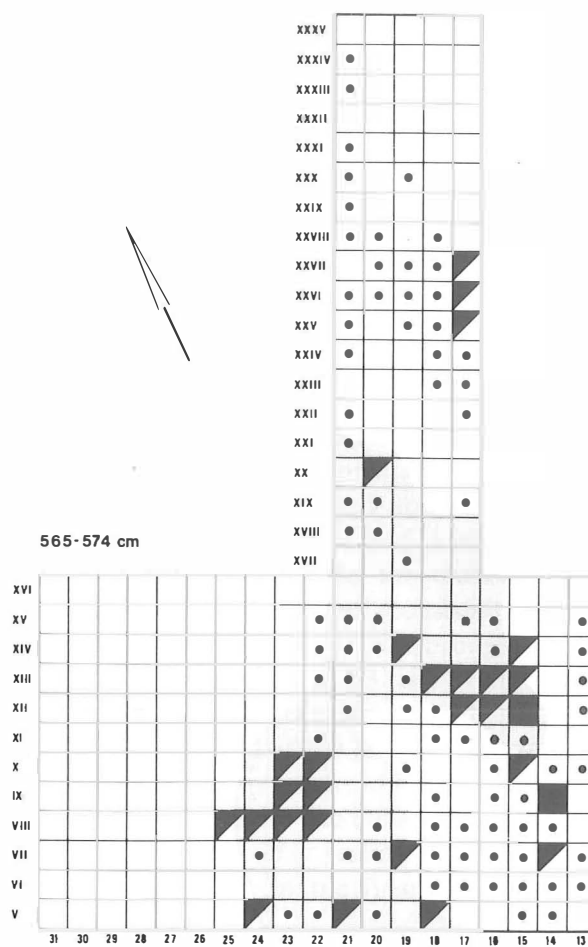


Fig. 22. Seed frequency distribution chart for 565-574 cm level. See caption of figure 16.

6.1.3. Seed frequency distribution and activity areas

The contour lines of the areas in which unburnt flint material was found, the so-called activity areas, are indicated in figs. 16-24 which show the seed frequency distributions. As for these activity areas, not all flint material is confined to these areas, but scattered specimens were also recovered outside them. However, inside the areas delimited by the contour lines flint material was distributed more or less continuously, and one can speak

of flint concentration areas. From figs. 16 - 24 it appears that there is no correlation between activity areas and areas of high seed frequencies. In figs. 21-24 squares with high seed frequencies fall predominantly within the limits of the activity areas, whereas in figs. 17-19 distinct concentrations of seeds occur outside the areas of regular distribution of flint material.

With regard to the distribution of seed frequencies and flint material per 10 cm level, no correlation, either negative or positive, seems to exist. However, this by no means implies

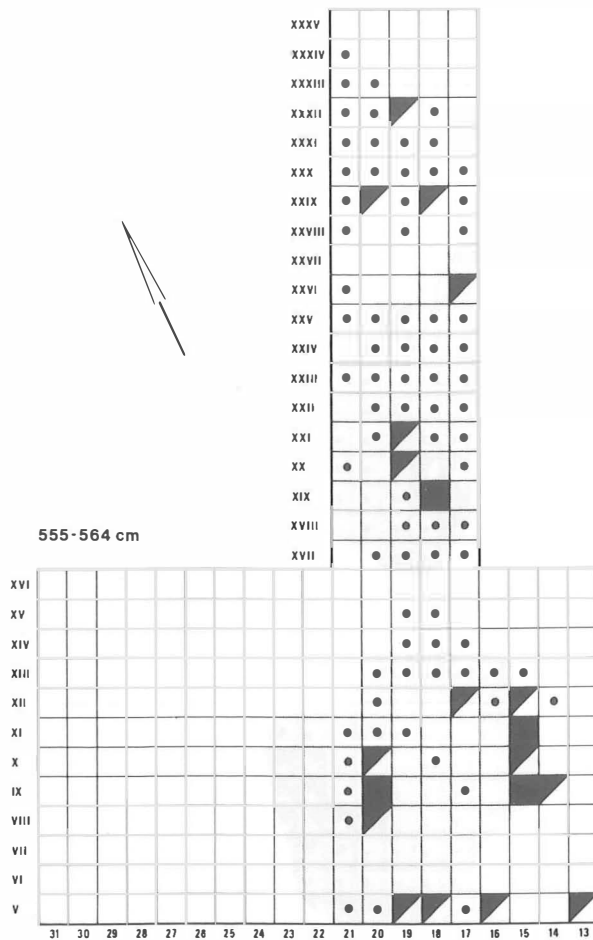


Fig. 23. Seed frequency distribution chart for 555-564 cm level. See caption of figure 16.

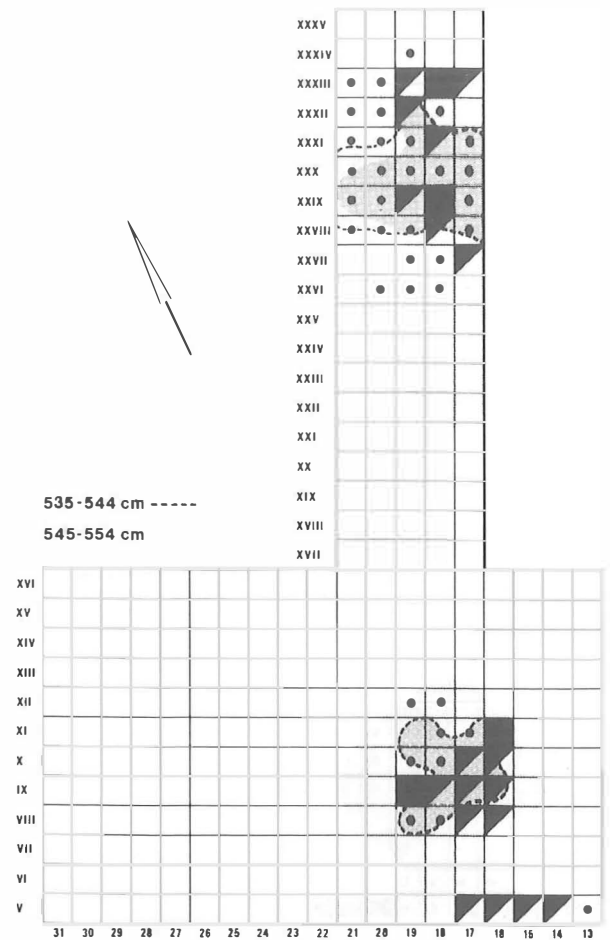


Fig. 24. Seed frequency distribution chart for 535-544 and 545-554 cm levels. See caption of figure 16.

that there would be no relation at all between the occurrence of seed concentration areas and the activity of man. Above (6.1.1.) it has been pointed out that the high seed frequencies must have been the result of the carrying in of plant material by the inhabitants of the site. However, all vegetable remains in the culture layer, irrespective as to whether seeds are frequent or not, have been brought in by man. For that reason, all squares examined in the field for seeds, and not only those with high to fairly high seed frequencies, will be considered in the following discussion. In this connection

it should be mentioned that all samples examined for plant remains are from dark occupational soil layers.

At the level of 625-634 cm (fig. 16) the distribution of the metre squares examined for seed frequencies shows two patches of culture soil. At the succeeding level (615-624 cm, fig. 17) the occupational fill covers a much greater area. The fact that no metre squares were examined from the southeastern part of the excavation area indicates that there the surface of the subsoil was higher; it was there that the highest part of the levee bordering the north-

south oriented gully was found. At the lowermost levels factual evidence of the activity of man has, indeed, only been established for the presumably highest part of the creek ridge, although the flint concentration areas at the levels of 625-634, 615-624 and 605-614 cm (see figs. 16-18) are quite small. Moreover, according to Mr. P.H. Deckers (oral communication) the flints would not have lain there *in situ*. However, it is conceivable that the people who dumped plant material and perhaps other refuse in the areas indicated in figs. 16-18 nevertheless had their work-floor on the levee along the creek. For it was in this area that in an early stage of the habitation a part of the site had been washed away (Van der Waals, 1977; Deckers *et al.*, 1980; cf. section 1.3.). Be this as it may, the deposition of organic material must have resulted in a gradual filling up of the lower-lying area to the west of the levee. At least this is suggested by the expansion of the area covered by squares examined for seeds in an easterly direction, towards the crest of the levee.

At the level of 595-604 cm (fig. 19) accumulation of organic material had started also on the highest part of the levee. A flint concentration in squares XIV-XV/24-26 indicates that the inhabitants had extended their activities to the formerly low-lying area which by now had been filled up. In the succeeding level, 585-594 cm (fig. 20), the latter activity area had already expanded quite markedly. It is likely that the activity areas have always protruded to some extent above the rest of the site (see below), implying that within a 10 cm level the soil inside and near an activity area must have been deposited somewhat earlier than that at some distance from the flint concentration areas. At the level of 575-584 cm (fig. 21) the activity area in the southern section of the excavation area had reached its greatest extent. One may assume that from here the deposition of organic material in the northern section (XVII-XXXII/17-21) was carried out. In fig. 21 the blank squares in the middle of the northern section are mainly due to the fact

that here a layer of culture soil more than 10 cm thick was excavated per operation. The distribution of the metre squares examined for seeds in fig. 20, representing the underlying level of 585-594 cm, is nearly complementary to the area of blank squares in fig. 21.

The raising of the surface in the northern section of the excavation area was followed by a partial shift of the activity area to that section, which finally resulted in two separate flint concentration areas (figs. 23 and 24).

In the uppermost levels, metre squares examined for seeds are confined to both activity areas (fig. 24). This demonstrates clearly that these activity areas emerged above the rest of the site. At the levels of 545-554 and 535-544 cm (fig. 24), outside the areas of flint concentration the sediment consisted of clay deposited by the floods which brought to an end the habitation of the S3 site. In the southwest section of the area shown in figs. 16-24 this clay was found at the level of 555-564 cm (fig. 23) and perhaps already at the level of 565-574 cm (fig. 22). The differences in height of the base of the clay sealing off the culture layers suggest that in the final phases of the habitation the level of the work floors was 20 to 30 cm above that of the rest of the site. In this figure of 20-30 cm no allowance has been made for the possible effects of differential soil compaction and of local erosion of top layers of occupational fill.

6.2. The distribution of seed types

Table 1 shows that the seed composition of the samples examined in the laboratory varies considerably. There are great differences in relative frequencies as well as in absolute numbers of seeds. This variation in seed content gives occasion to two questions. In the first place one wonders whether there is any relation between seed composition and origin of the sample. Secondly, the question arises whether differences in seed content correlate with the stratigraphical position of the samples.

6.2.1. Seed composition and origin of samples

As for the question to what extent the seed content of the culture soil may have depended on the location within the site, it has been examined whether a possible relation exists with the activity areas discussed above. In figs. 25-33 the location of the samples is indicated on the 10 cm level charts with the contour lines of the activity areas (concentrations of unburnt flint material). From these charts it appears that some samples are clearly from outside activity areas, particularly but not exclusively in the lower levels. Other samples originate from inside or close to areas of flint concentration. It may be needless to say that for the choice of the samples to be analysed in the laboratory, the position with regard to activity areas played no part. It was not until the botanical examination had been finished that this point of view was taken into consideration. For the discussion below the samples are divided into two groups. The samples taken from and near activity areas (group I) and those from well outside these areas (group II) are listed in table 16.

In re-arranging the results of the botanical examination into both groups mentioned above, some striking differences become obvious. These differences are best visualized in table 17, in which for both groups mean and weighed percentages and sample frequencies (see 4.1.) of a selected number of species are shown. Only species represented in more than 10 (of the 46) samples are included in table 17, except *Arctium* cf. *lappa* which was found in only 8 samples. From this table it is clear that the seeds of some species are most frequent in samples from outside the activity areas, whereas other species are much better represented in the samples from inside or near flint concentrations. The species which show a clear preference for one of both groups of samples are framed by a solid line. In determining whether a species may be considered to be more or less "characteristic" of one of both groups of samples, the weighed percentage (the relative importance) played a decisive part. In this

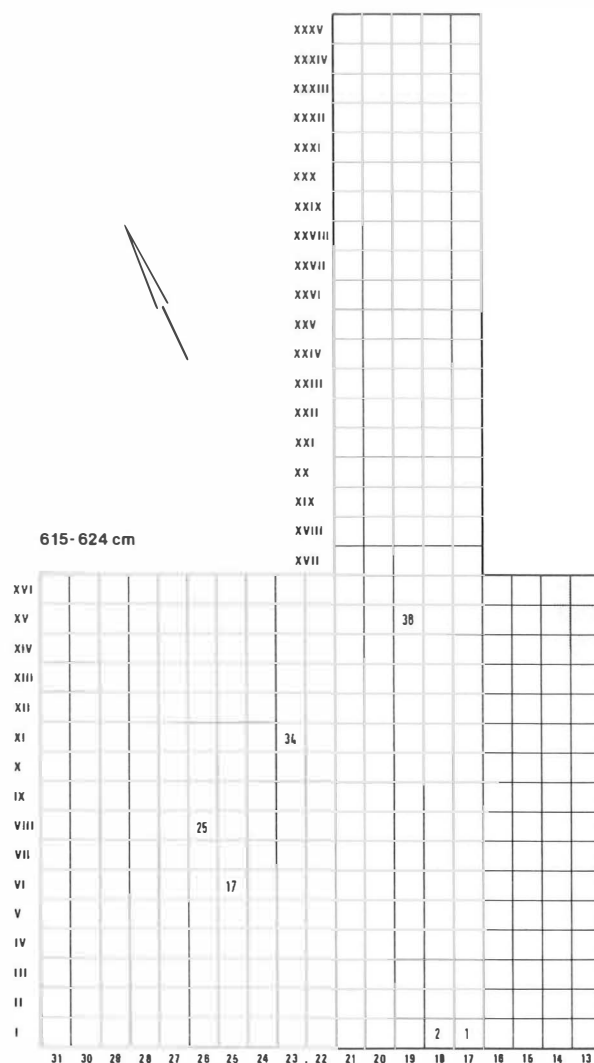


Fig. 25. 615-624 cm level. Location of samples examined (table 1) and flint concentration areas. For discussion of figures 25-33, see 6.2.1. and 6.2.2.

connection it should be mentioned that in general no weighed percentages between species should be compared, because this figure depends, among other things, on the production and dispersal of seeds which vary greatly among the various taxa. On the other hand, weighed percentages of the same species may provide useful information on possible differences between groups of samples.

The differences between both groups of

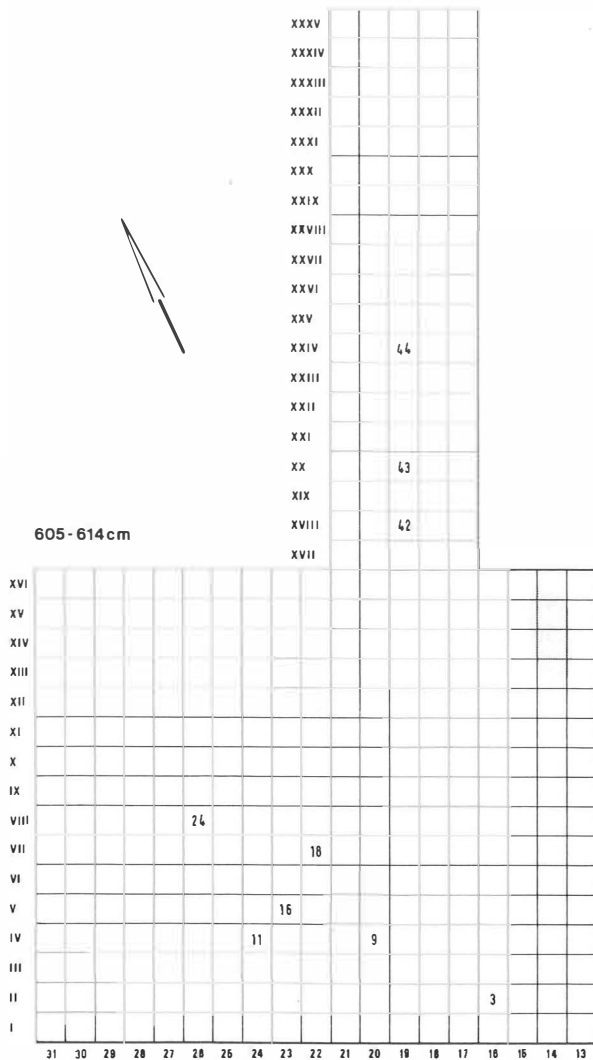


Fig. 26. 605-614 cm level. Location of samples examined (table 1) and flint concentration areas.

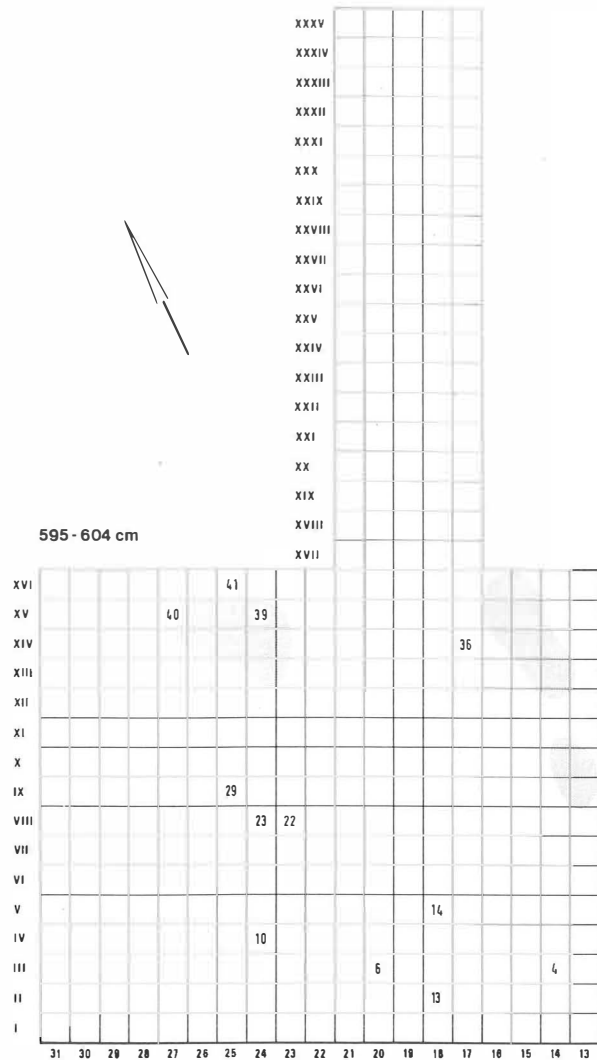


Fig. 27. 595-604 cm level. Location of samples examined (table 1) and flint concentration areas.

samples in table 17 are not always of identical nature. Thus, *Chenopodium album*, *Solanum nigrum* and *Urtica dioica*, the seeds of which are by far most numerous in the samples from activity areas, show high sample frequency values also in group II, the differences being determined by the much lower mean and weighed percentages. On the other hand, the representation of *Polygonum* species in both groups of samples differs not only in terms of

mean and weighed percentages, but these species score also low sample frequencies in group I. Very striking is the behaviour of *Nymphaea alba* which is fairly well represented in group II, but not a single seed of which was found in the samples from activity areas.

The numbers of seeds per 3 litres of soil are, on an average, significantly greater in the samples from outside activity areas than in those from group I. The same applies to the numbers

Table 17. Representation of some selected species in samples from inside or near flint concentration areas (group I) and from outside these areas (group II). For discussion see 6.2.1.

	Group I			Group II		
	sample frequency N = 19	mean percentage	weighed percentage	sample frequency N = 27	mean percentage	weighed percentage
Chenopodium album	100	27.70	27.70	70	1.83	1.29
Hordeum vulgare nudum	89	2.49	2.23	48	0.89	0.43
Solanum nigrum	84	3.61	3.04	81	1.09	0.88
Urtica dioica	95	46.01	43.63	100	17.00	17.00
Cladium mariscus	32	4.30	1.36	26	0.73	0.19
Scirpus maritimus	21	1.48	0.31	48	0.34	0.16
Scirpus tabernaemontani	53	4.71	2.48	67	1.58	1.05
Conium maculatum	47	1.43	0.68	11	0.17	0.02
Mentha aquatica	21	0.55	0.12	30	0.46	0.14
Poa pratensis/trivialis	11	4.50	0.47	33	1.75	0.59
Solanum dulcamara	32	1.78	0.56	19	0.48	0.09
Atriplex hastata/patula	74	5.06	3.73	93	14.97	13.86
Polygonum aviculare	11	0.50	0.05	93	16.88	15.63
Polygonum lapathifolium	21	3.35	0.71	85	22.90	19.51
Polygonum persicaria	5	0.6	0.03	70	3.25	2.29
Stellaria media	84	6.74	5.68	78	16.39	12.75
Arctium cf. lappa	—	—	—	30	0.38	0.11
Nymphaea alba	—	—	—	74	1.00	0.74
Phragmites australis	37	3.25	1.20	89	11.78	10.47
	<i>min.</i>	<i>mean</i>	<i>max.</i>	<i>min.</i>	<i>mean</i>	<i>max.</i>
number of seeds	23	1269	10317	109	3431	10402
number of species	8	11.4	17	7	15.5	28

Table 18. Dominance of one or two species (for explanation see 6.2.1.).

Group	I	II
Phragmites	•	2
Atriplex	•	1
Atriplex/Polygonum aviculare	•	1
Polygonum aviculare	•	1
Polygonum lapathifolium	•	6
Stellaria	•	1
Stellaria/Urtica	•	3
Urtica	8	1
Urtica/Chenopodium	6	•
no dominance	5	11

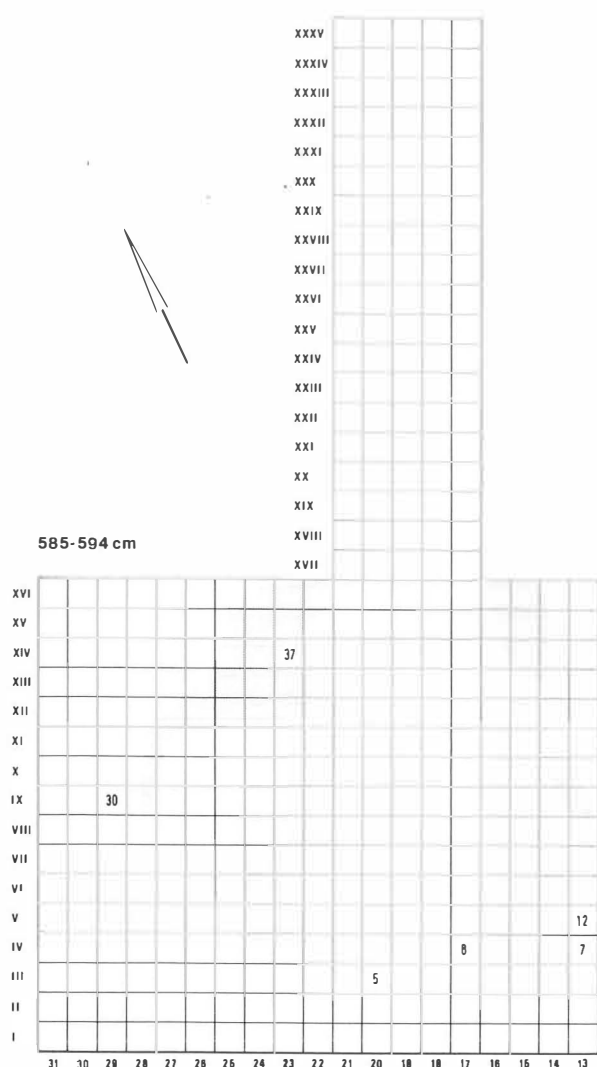


Fig. 28. 585-594 cm level. Location of samples examined (table 1) and flint concentration areas.

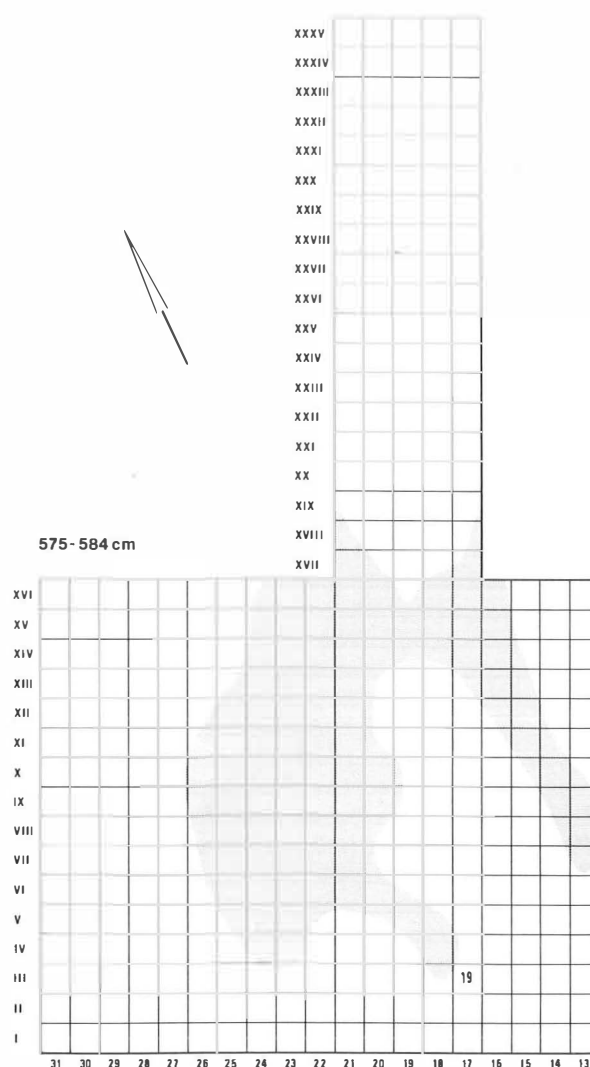


Fig. 29. 575-584 cm level. Location of samples examined (table 1) and flint concentration areas.

of species represented per sample. Thus, the soil from flint concentration areas is poorer in absolute numbers of seeds as well as in species. Differences between both groups of samples also find expression in the following approach. It has been determined for which samples there is a question of dominance of one or at most two species. If one species accounts for more than 50% of the seeds in a particular sample, this sample is considered to be dominated by

that species. If no species is represented by more than 50%, but two species score together more than 70%, the sample is dominated by these two species. As is shown in table 18 various species are dominant in one or more samples, either alone or in combination with another species. Table 18 shows also very marked differences in dominant species or species combinations between both groups. As a matter of fact, only the *Urtica* dominance

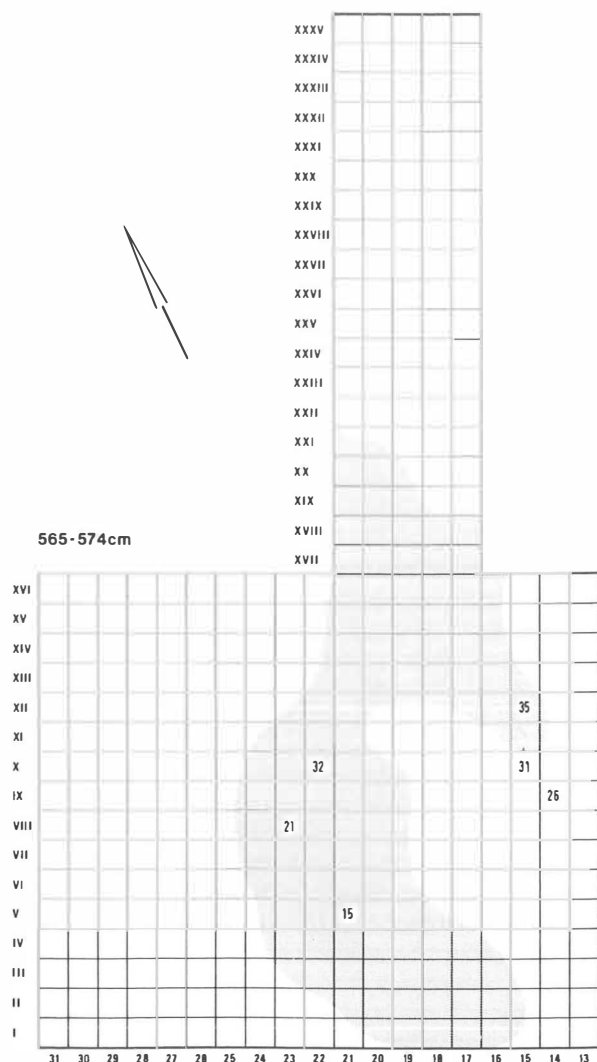


Fig. 30. 565-574 cm level. Location of samples examined (table 1) and flint concentration areas.

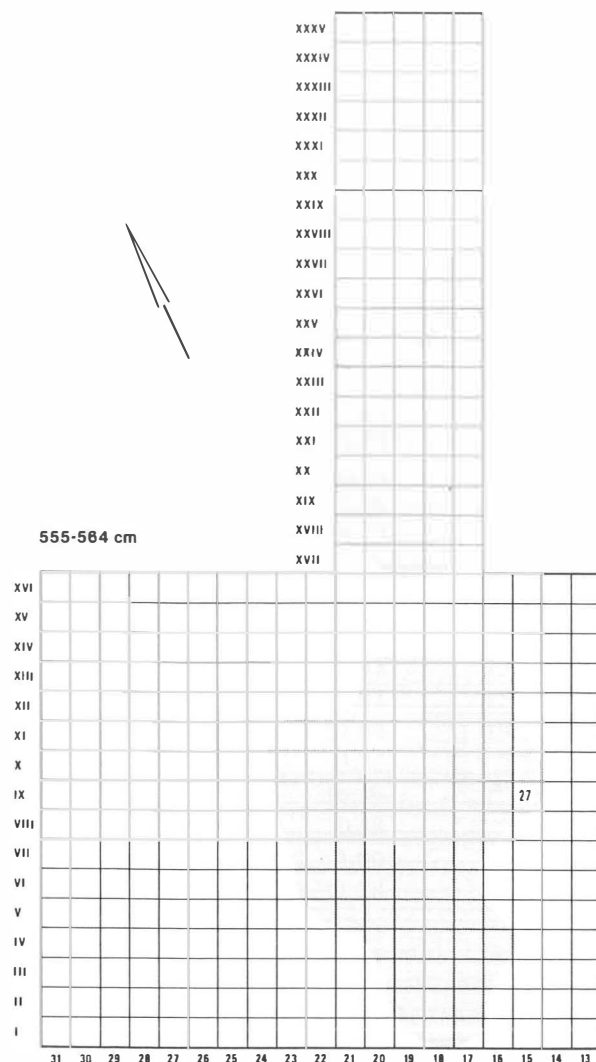


Fig. 31. 555-564 cm level. Location of samples examined (table 1) and flint concentration areas.

is found in both groups, and here there is a conspicuous difference in frequency: common in group I and present only once in group II. Moreover, in more samples of group II (41%) no dominance of one or two species occurs than in those of group I (26%). From table 18 the predominant role of *Urtica* in the samples from activity areas is again clearly apparent.

Thus, tables 17 and 18 demonstrate, along different lines, the differences in seed content

between both groups of samples. Illustrative of these differences may also be the fact that of the samples of group II, only one (no. 12: V-13-K) should on the basis of the seed content rather belong to group I. Now, the question forces itself, as it were, as to how far the observed differences can be explained. The differences in the numbers of seeds per soil volume could be due to differences in the conditions for preservation. The activity areas

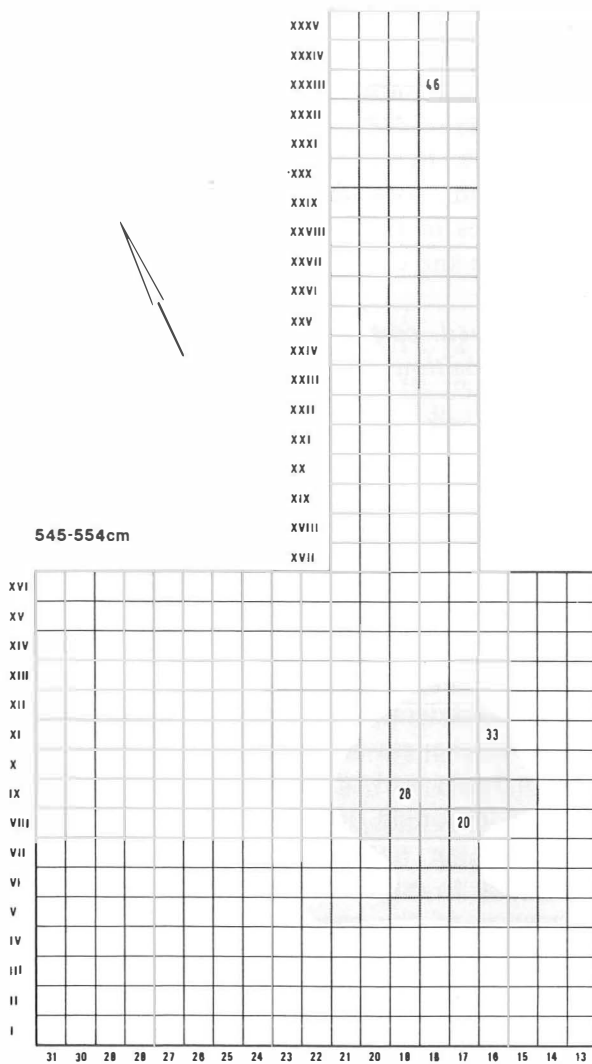


Fig. 32. 545-554 cm level. Location of samples examined (table 1) and flint concentration areas.

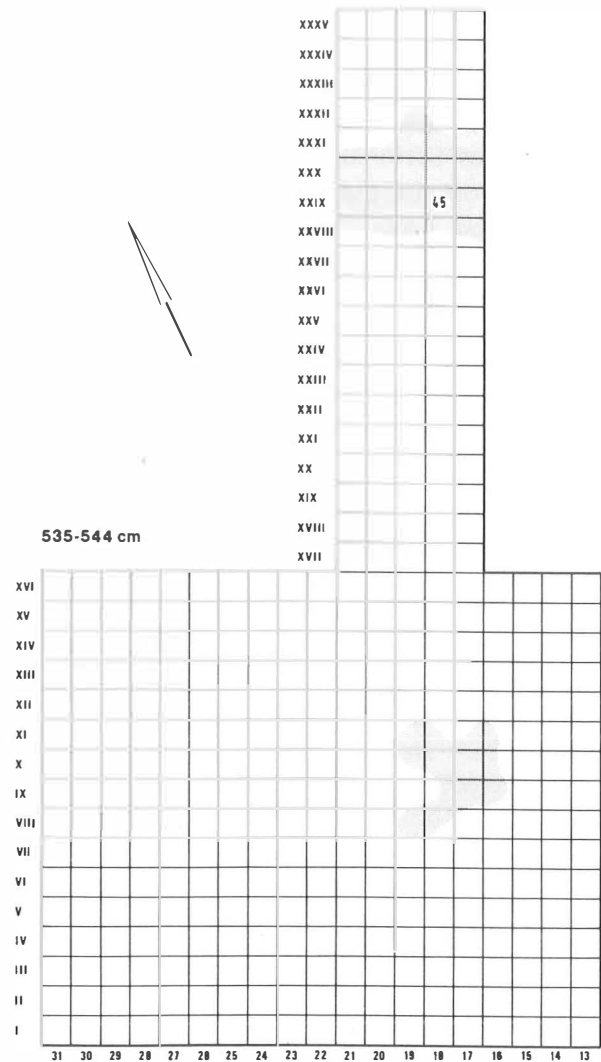


Fig. 33. 535-544 cm level. Location of samples examined (table 1) and flint concentration areas.

protruded above the rest of the site and were consequently better drained, implying slightly drier conditions. Moreover, in the activity areas treading must have been more severe than in other places. These factors could have resulted in much greater losses of seeds (breakage, corrosion, biological destruction) in activity areas than elsewhere within the site. However, in general the differences in the relative frequencies of the seeds cannot be explained in

this way. One could imagine that the very good representation of *Chenopodium album* in group I was due to the fact that even under rather poor conditions the seed wall of this species remains preserved. However, in that case it is difficult to understand why *Atriplex* does not equally show its highest frequencies in group I. The seeds of *Solanum nigrum* are not particularly sturdy, but nevertheless this species is best represented in group I. The seed

wall of *Nymphaea alba* is rather thick, but curiously water-lily is not represented in group I. Only in the case of *Phragmites australis*, one could argue that the differences in mean frequencies between both groups were due to preservation. In the activity areas, the small, thin-walled seeds of reed could particularly have suffered from the assumed less favourable preservation conditions. Although it is very well possible that differential preservation of seeds had some effect, one must assume that the observed differences in the seed composition are largely of primary nature, due to the action of the inhabitants of the site.

Unfortunately, the above conclusion is not very helpful in understanding the why and wherefore. The apparent preference of barley grains (*Hordeum vulgare nudum*) for activity areas is not particularly surprising as this is an unmistakable food plant. One could perhaps argue that the high frequencies of *Chenopodium album* in group I samples are connected with the intentional harvesting of these seeds for human consumption. However, in that case one wonders why knotweed (*Polygonum*) species, the seeds of which are likewise known as potential food of prehistoric man (cf. 5.4.), are by far better represented in the samples from outside activity areas. The berries of black nightshade (*Solanum nigrum*) are poisonous, and of stinging nettle (*Urtica dioica*) the leaves and not the seeds are consumed. It is striking that not a single seed of water-lily (*Nymphaea alba*) was recovered from the group I samples, whereas this plant is rather well represented in the samples of group II. It is true that of this species not the seeds but the root-stocks are a well-known wild food, but if water-lily had been prepared by the inhabitants of the site in the activity areas, one would have expected at least some seeds in group I samples.

As has been discussed above (6.1.1.) it is very likely that by far most of the seeds had arrived in the settlement adhering to the plants, which were deposited there to raise the level of habitation and to fill up low-lying areas. But this assumption leaves one with the question why, for instance, *Chenopodium album* and

Urtica dioica were so much preferred for raising the level of the activity areas, whereas *Atriplex* and various *Polygonum* species particularly were dumped in other parts of the settlement. In conclusion, no hypothesis can be brought forward to explain the striking differences in the seed content of the culture soil inside and outside the activity areas.

6.2.2. Seed composition and stratigraphical position of samples

One wonders to what extent the differences in seed composition discussed above (6.2.1.) relate to the stratigraphical position of the samples. Moreover, in the course of the habitation the vegetation in the vicinity of the site may have changed to some degree, which could have found expression in the composition of the plant material brought to the settlement. These considerations occasioned us to examine whether changes in the seed composition between lower and upper layers occur, irrespective of the origin of the samples (from an activity area or not). To that end, it was first necessary to establish the chronostratigraphical sequence of the samples examined. The (assumed) stratigraphical position of the samples is shown in table 19. As for the sequence suggested in this table, the following should be remarked. The basis of determining the most likely chronostratigraphical sequence is formed by the 10 cm level charts of figs. 25-33 on which the locations of the samples are indicated. The stratigraphical order of the samples from outside flint concentration areas (to the left in table 19) is based upon the successive 10 cm levels from which the samples originate. This may lead to inaccuracies due to the fact that the layers employed in the field do not coincide with the 10 cm levels (6.1.2.). Also if samples are scattered over a large area they may not all be of the same period although they are from the same 10 cm level. Samples at some distance from most of the others in a 10 cm level are shown in brackets.

The same procedure was applied to the samples from or near activity areas (table 19,

Table 19. Chronostratigraphical sequence of samples.

		<i>Group II</i> <i>outside activity areas</i>		<i>Group I</i> <i>in/near activity areas</i>	
younger ↑				20, 28, 33, (46)	(545-554 cm)
				27	(555-564 cm)
				15, 21, 32, 26, 31, 35	(565-574 cm)
				19	(575-584 cm)
	(585-594 cm)	5, 8, 7, 12			
	(595-604 cm)	4, 6, 10, 13, 14, 22, 23, 29			
older ↓	(605-614 cm)	3, 9, 11, 16, 18, 24, (42), (43), (44)		30, 37	(585-594 cm)
	(615-624 cm)	17, 25, 34, 38, (1), (2)		39, 40, 41, (36)	(595-604 cm)

to the right). One may assume that the stratigraphical sequences established for both groups of samples are, in broad outline, correct. However, how do both sequences correlate? A complicating factor in this respect is the fact that the activity areas are supposed to have emerged above the rest of the site, implying that there is no synchrony of the 10 cm levels in and outside the areas of flint concentrations. Fortunately, there is at least one reliable stratigraphic datum for correlating both sequences. At the levels of 575-584 and 565-574 cm (figs. 29 and 30) the activity area expanded considerably in the southern section of the site. Here the fill of the flint concentration area must definitely be younger than the underlying culture soil. This implies that samples 19 (575-584 cm) and 15, 21, 32, 26, 31, 35 (565-574 cm) are younger than samples 5, 8, 7, 12 (585-594 cm), from directly underneath the activity area fill. There remains the chronostratigraphical relation of activity area samples 36, 39, 40, 41 (595-604 cm) and 30, 37 (585-594 cm) to the samples at the left side of table 19. The assumption that the level of the activity areas was higher than that in the rest of the site implies that samples 30 and 37 (from a flint concentration area) must chronologically be placed below samples 5, 8, 7, 12 from the same level (585-594 cm). In their turn samples 30 and 37 lie stratigraphically above samples 39, 40 and 41, from the underlying level in the same activity area (fig. 27). The latter samples

must chronostratigraphically be placed below samples 4 to 29 from the same 10 cm level (595-604 cm). It is not possible to determine exactly where the 6 stratigraphically lowermost samples from activity areas should fit into the sequence established for the samples of group II. In table 19, this uncertainty finds expression by a broken line indicating the possible chronostratigraphical range of these 6 samples.

As appears from table 19, most of the samples from activity areas examined for plant remains are chronostratigraphically younger than those of group II. Only 6 samples of group I fall within the time range of the samples from outside flint concentration areas. It is clear that these 6 samples should be particularly informative with regard to the question of a possible relation between seed content and stratigraphical position of the samples. In this connection it must be remembered that it was to be examined whether the differences in seed composition between both groups of samples should rather be ascribed to the relative age of the samples and not so much to the origin (from an activity area or not).

To determine possible time-stratigraphic changes in the seed content of the occupational deposits, for both groups the samples have been divided into those from lower and upper levels. For group I it was obvious to combine the 6 lowermost samples to one sub-group (lower levels), although this implies that the other sub-group has a much greater number of

Table 20. See caption of Table 17. Within both groups of samples a subdivision is made between samples from lower and upper levels. For discussion see 6.2.2.

	Group I						Group II					
	upper levels			lower levels			upper levels			lower levels		
	sample frequency N = 13	mean %	weighed %	sample frequency N = 6	mean %	weighed %	sample frequency N = 12	mean %	weighed %	sample frequency N = 15	mean %	weighed %
Chenopodium album	100	31.01	31.01	100	20.53	20.53	75	1.83	1.38	67	1.82	1.21
Hordeum vulgare nudum	100	2.98	2.98	67	0.90	0.60	67	0.79	0.53	33	1.06	0.35
Solanum nigrum	85	3.76	3.18	83	3.28	2.67	75	1.59	1.12	87	0.75	0.65
Urtica dioica	92	44.16	40.76	100	49.85	49.85	100	20.21	20.21	100	14.43	14.43
Cladium mariscus	38	4.72	1.82	17	2.2	0.37	33	1.18	0.39	20	0.10	0.02
Scirpus maritimus	15	2.30	0.35	33	0.65	0.22	58	0.39	0.23	40	0.28	0.11
Scirpus tabernaemontani	46	1.40	0.66	67	9.63	6.42	100	1.97	1.97	40	0.80	0.32
Conium maculatum	62	1.56	0.96	17	0.4	0.07	8	0.3	0.03	13	0.10	0.01
Mentha aquatica	23	0.40	0.09	17	0.1	0.02	25	1.07	0.27	33	0.10	0.03
Poa pratensis/trivialis	15	4.50	0.70	—	—	—	33	0.40	0.13	33	2.84	0.95
Solanum dulcamara	38	1.94	0.75	17	1.0	0.16	17	0.40	0.07	20	0.53	0.11
Atriplex hastata/patula	77	3.92	3.02	67	7.93	5.28	83	19.59	16.33	100	11.89	11.89
Polygonum aviculare	8	0.2	0.02	17	0.8	0.13	83	12.35	10.29	100	19.91	19.91
Polygonum lapathifolium	31	4.95	1.52	—	—	—	92	6.69	6.13	80	37.76	30.21
Polygonum persicaria	8	0.6	0.05	—	—	—	75	2.71	2.03	67	3.74	2.49
Stellaria media	85	5.78	4.89	83	8.86	7.38	67	18.38	12.25	87	12.75	11.05
Arctium cf. lappa	—	—	—	—	—	—	25	0.60	0.15	33	0.24	0.08
Nymphaea alba	—	—	—	—	—	—	75	1.56	1.16	73	0.55	0.40
Phragmites australis	23	3.20	0.74	67	3.30	2.20	83	23.92	19.93	93	3.10	2.89
	min.	mean	max.	min.	mean	max.	min.	mean	max.	min.	mean	max.
numbers of seeds	23	1394	10317	150	999	2526	109	1848	8703	226	4698	10402
numbers of species	8	11.5	16	8	11.2	17	11	16.5	22	7	14.7	28

samples and covers a thicker culture layer. A subdivision of the samples of group II is laid between levels 605-614 and 595-604 cm (see table 19). In table 20, the sample frequencies, mean and weighed percentages are presented of the same species as in table 17, but now for the sub-groups. For group II, table 20 shows some differences in the seed composition of lower and upper levels. Most striking are the much higher frequencies of *Phragmites* in the samples from the upper levels. Does this mean that in later stages of the habitation more reed was brought in or could it have something to do with the time of the year when the reed was cut? Similarly no obvious explanation can be presented for the lower frequencies of *Polygonum aviculare* and *P. lapathifolium* in the upper levels. Another striking difference between the samples from lower and upper levels in group II is constituted by the mean numbers of seeds per unit of soil volume. The samples from the lower levels contain, on an average, 2½ times more seeds than those from the upper levels. Above (6.2.1.) it has been argued that the lower numbers of seeds in samples from activity areas, as compared to those from outside flint concentration areas, could be due to poorer preservation conditions. If this hypothesis is correct it would imply that in the upper levels of the culture soil outside the activity areas, conditions for the preservation of seeds were less favourable than in the lower levels. The fact that precisely in those upper levels *Phragmites* seeds show the highest frequencies invalidates in no small measure the suggestion that the poorer representation of reed in the samples from activity areas was due to poorer preservation conditions (6.2.1.). Again, more problems are raised than are solved in attempting to analyse the results of the botanical examination.

As for the samples from flint concentration areas (group I), no conspicuous differences are found between those from lower and upper levels, taking into account that the sub-group "lower levels" consists of only 6 samples. Particularly interesting is the fact that these 6 samples not only compare well with those of

the other samples from activity areas, but also that they differ markedly from the largely synchronous samples from outside flint concentration areas. This demonstrates that the differences in seed content established between both groups of samples are related primarily to the location of the samples with respect to the activity areas. The chronostratigraphical position of the samples plays at most a minor part in the composition of the seeds. Consequently, one must assume that certain plants were preferred for raising the level of the activity areas, whereas the plant material deposited elsewhere in the site was of a different composition. It remains puzzling what may have determined the preference.

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