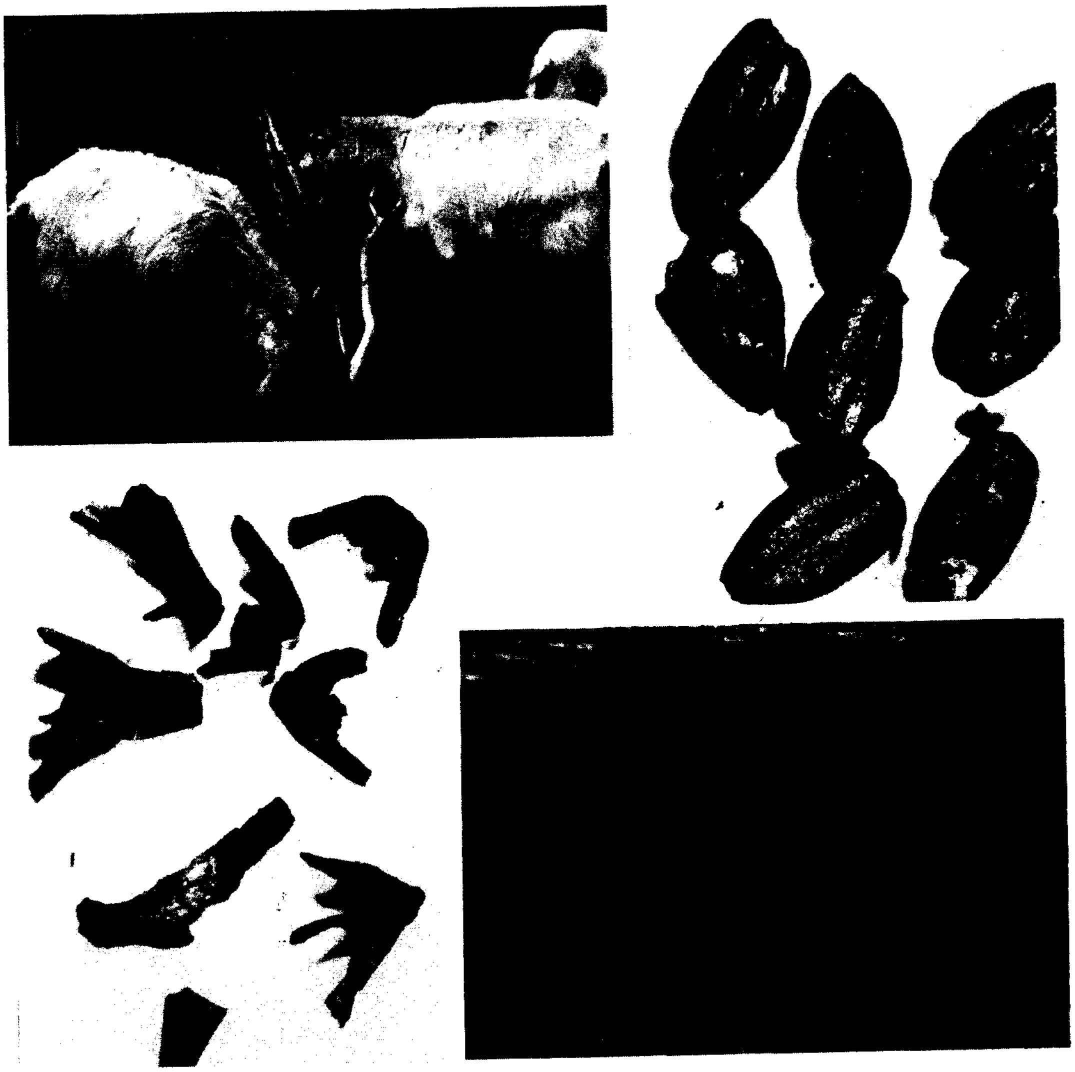
THESES AND PAPERS IN ARCHAEOLOGY N.S. A 6

ALVASTRA PILE DWELLING
Palaeoethnobotanical Studies

Hans Göransson



Lund University Press

THESES AND PAPERS IN ARCHAEOLOGY N.S. A 6

ALVASTRA PILE DWELLING

Palaeoethnobotanical Studies

Hans Göransson

with appendices by
Geoffrey Lemdahl
and
Birgitta M. Johansson

1995

Lund University Press

Abstract

Göransson, H. Alvastra Pile Dwelling – Palaeoethnobotanical Studies. Lund University Press – Chartwell Bratt Ltd. 1995. 101 pp. Monograph. ISBN 91-7966-302-8, 0-86238-407-9. The present study deals with the palaeoethnobotanical material from the occupation layer of the Alvastra pile dwelling. It is a continuation of my vegetational-historical work from that site (Göransson 1987). In the *rigid* system soil samples were taken at randomly chosen points while in the *flexible* system fruits and seeds were collected directly in the occupation layer when they were observed. A great many carbonized caryopses of naked four-row barley (*Hordeum vulgare* var. *nudum*) and emmer wheat (*Triticum dicoccum*) have been recorded. The cereals were probably cultivated on wandering arable fields in coppice woods. Permanent non-manured and manured fields may also have existed. *Artemisia vulgaris, Polygonum convolvulus* and *Chenopodium album* were common weeds. Pollen analysis of a goat dropping from the occupation layer hints that the goats were fed with twigs in late winter. *Ranunculus sceleratus* may show that the pile dwelling was impregnated with manure. The fossil insect remains (pupae of *Musca domestica*, for instance) do not contradict this suggestion.

Contents

Preface and acknowledgements

In the summer of 1976 I visited the Alvastra pile dwelling for the first time, invited by Mats P. Malmer, Stockholm. My work at the excavation site was to comprise pollen-analytical and stratigraphical investigations and examinations of fruits and seeds from the occupation layer. I started my work in May 1977 after having finished my thesis on the vegetational history of southern Östergötland.

During 1977–80 I worked in the field, in the laboratory and at the microscope in order to produce pollen diagrams from the Alvastra spring mire and its surroundings. At the same time I was straining the soil samples from the occupation layer and building up my reference collection of seeds and fruits.

The pollen diagrams produced during 1977–82 resulted in a publication (Göransson 1987). During the same period I acquired my first experience of palaeoethnobotany by visiting Hakon Hjelmqvist, Lund, who has supported me for more than 17 years. He has also scrutinized my account of the cultivated plants in the manuscript.

In September 1977 I attended Karl-Ernst Behre's course in palaeoethnobotany and in September–October 1980 I took part in Hilary H. Birks's course on macrofossils. Both courses were held in Lund. In March 1990 Krystyna Wasylikowa held a course in palaeoethnobotany, also in Lund. At that point I was able to demonstrate some of the fruits and seeds from the Alvastra pile dwelling for her.

Stephanie Jacomet and Marlies Klee, both of Basel, have helped me to determine some caryopses of barley and grasses. W. van Zeist, Groningen, has given me valuable information on barley.

Geoffrey Lemdahl, Lund, has taken all the microphotos of the seeds and fruits. Lemdahl also investigated the insect remains, wrote appendix 1 and sent the pupae of Muscidae to Peter Skidmore. Birgitta M. Johansson investigated the molluscs which I sent to her. She wrote appendix 2. Björn E. Berglund has allowed me the use of the Laboratory of Quaternary Biology, Lund.

Thomas Persson, Lund, has been of invaluable help to me since 1977. He has worked at the computer, drawn the histograms, the dimension tables, the seed diagrams figs. 57–65 and the pollen diagrams. The fair copies of the hand-drawn pollen diagrams were done by Christin Andreasson, SGU, Lund. Alan Crozier, Södra Sandby, has not only edited my English text but has also produced the large diagrams in tables 1–5 and taken care of the typesetting and layout of the whole book. The manuscript has been read by Mats P. Malmer, Anders Carlsson and Hans Browall.

My work has been interrupted many times by my participation in many other projects, both in Sweden and abroad. During the whole time Mats P. Malmer has relied upon my ability to fulfil my part of the Alvastra Project, and I owe a debt of gratitude to him.

The Alvastra Project was financed by the Swedish Council for Research in the Humanities and Social Sciences (HSFR). The very important investigations in the Mabo Mosse bog were carried out thanks to scholarships from Berit Wallenberg's Foundation, Magnus Bergwall's Foundation, the Uddenberg-Nordiska Foundation and grants from HSFR.

The investigation area

"The investigation area" was described by me in my pollen-analytical work on the Alvastra pile dwelling (Göransson 1987:11ff.). "The investigation area" is not equivalent to a "resource area" of a population living in the Alvastra pile dwelling, as the pile dwelling was a community centre for a rather large population living (scattered) in a region of a size that is not exactly known (Malmer, e.g. 1988:88, Browall 1986:156). "The investigation area" is an area within which intensive pollen-analytical, palaeoethnobotanical and mire-stratigraphical investigations have been performed. The position of this area is shown in fig. 1. The geology of the investigation area is shown in fig. 2. Fig. 3 is a topographical and hydrological map of the investigation area. As a synonym for the "investigation area" I sometimes use "the Alvastra area" or "western Östergötland".

As I have performed detailed pollen-analytical works also in the southern part of the province of Östergötland and in the adjacent part of the province of Småland (the Mabo Mosse bog in Northern Tjust) this part too may be said to belong to the investigation area. I mostly specify when I am referring to southern Östergötland and the Mabo Mosse bog. The kettle hole at Nässja which is situated immediately to the north of the "investigation area" of 1987 (and thus outside figures 1–3) ought, however, to be included in the investigation area of the present study (fig. 4). Browall's "resource area" is described at the end of the present paper.

"Götaland" is the area which lies to the south of an imaginary line running from the northern end of the island of Gotland through the northern part of Lake Vättern and on to the Norwegian border. The province of Östergötland is situated between Lake Vättern and the Baltic.

The C14-datings

Conventional C14-dates are used in the present paper (T½ = 5560, 0-year = A.D. 1950).

Sometimes calibrated dates are given in brackets. Conventional C14-dates should always be presented in archaeological and palaeobotanical schemes – otherwise correlation between archaeological sites and pollen diagrams is rendered impossible.

The discovery of the Alvastra pile dwelling and the first excavations

The Alvastra pile dwelling – which is situated in the Alvastra spring mire – was discovered in 1908 (Schnittger 1908). During the years 1909–17, 1919 and 1928–30 about 1000 m² of the pile dwelling were excavated under the leadership of Otto Frödin (Frödin 1910a,b). During these excavations great amounts of carbonized caryopses

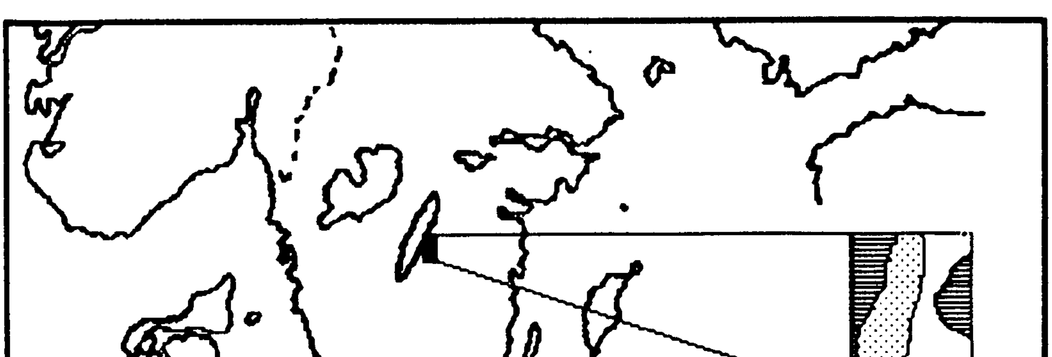


Fig. 1. The position of the investigation area. Computer drawing by U. Emanuelsson and C. Bergendorff, 1986.

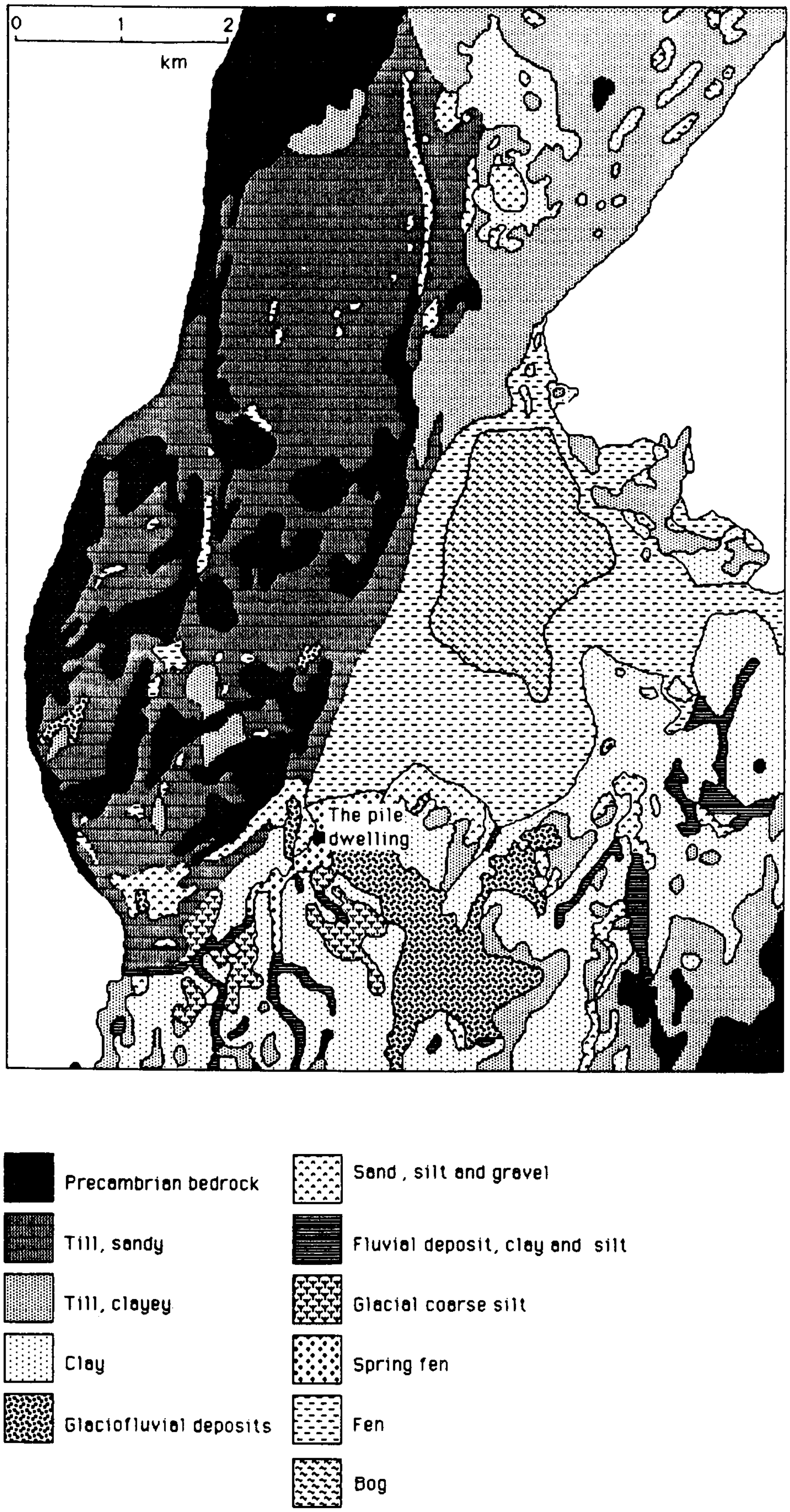


Fig. 2. A simplified computer-aided version of the geological map. U. Emanuelsson and C. Bergendorff 1986. The original geological map was produced by S.-I. Svantesson in 1981.

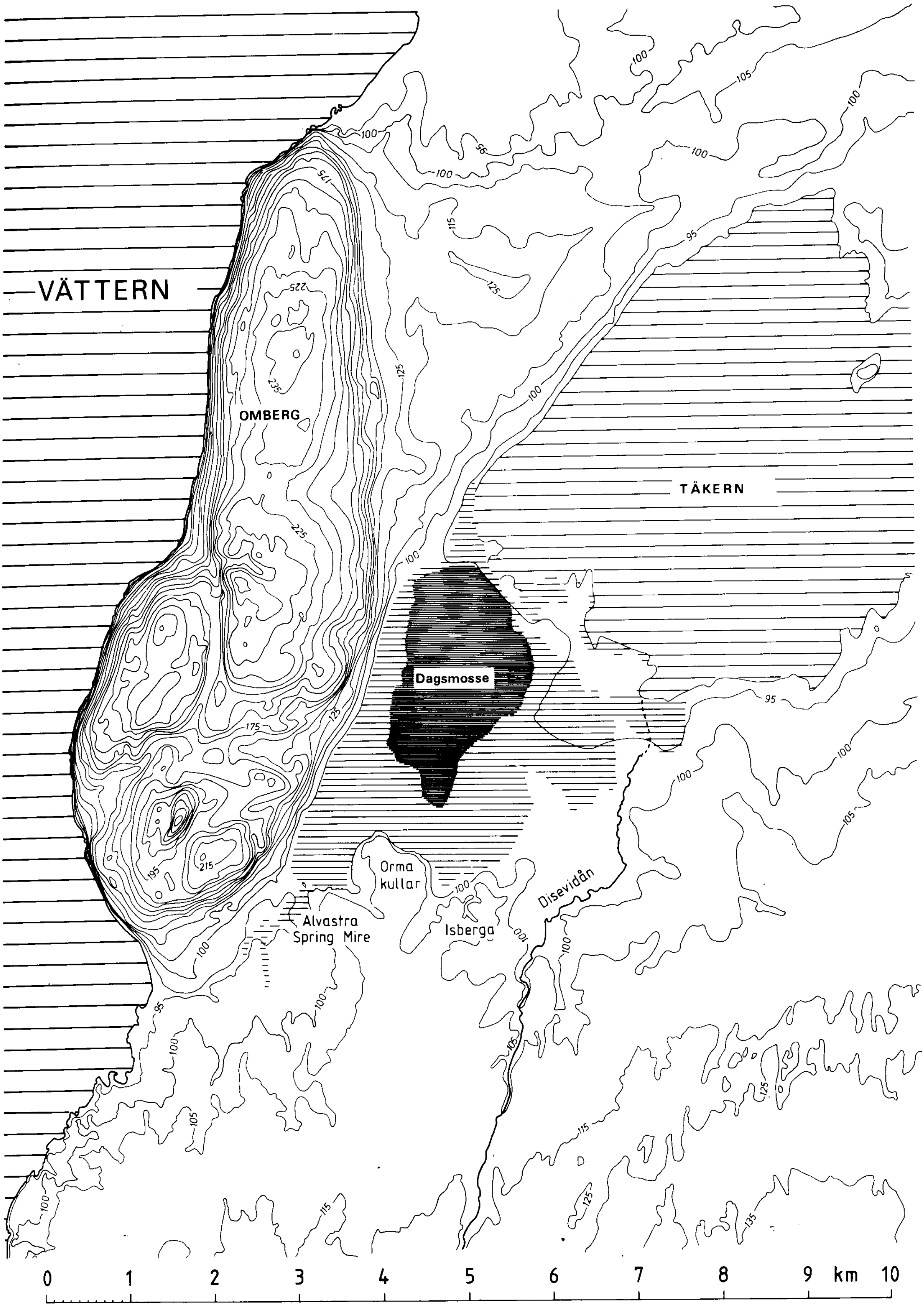


Fig. 3. Topographical and hydrological map of the investigation area. Drawing: R. Blidmo 1985.

of cereals and of carbonized and non-carbonized seeds and fruits* of weeds and other plants were collected. Browall measured the volume of this stored material (which also contains peat, bark, charcoal and wood) finding that it amounts to ca. 29 litres (Browall 1986:133). One sample, amounting to 5.5 litres, contained ca. 51,000 caryopses of cereals (ibid.).

The new excavations at the Alvastra pile dwelling

In 1956 Mats P. Malmer carried out a small test excavation (ca. 0.5 m²) at the north-eastern edge of Frödin's trench. At the same time samples for pollen analysis were taken by E. Magnusson (Magnusson 1964). In 1976 Mats P. Malmer organized the research project "Alvastra pålbyggnad" ("Alvastra pile dwelling"). The excavations started in the spring of 1976 and ended in the autumn of 1980. Three trenches and two test trenches, together comprising ca. 90 m², were excavated.

In the rigid system (see below) series of samples were taken from a high position and downwards through the peat and the occupation layer at exactly the same coordinates. Then the following type of designation is necessary (for instance): EA1.99.24–11, EA1.98.98–81, EA1.98.72–70 etc. In the tables the coordinates are stated while in the text the coordinates are excluded.

The difference between the older and the new excavations

Frödin's fieldwork was extensive and aimed at investigating as large an area as possible (Browall 1986:18). Mats P. Malmer's (and his colloborators') fieldwork was intensive and, in the first hand, concentrated on stratigraphical documentation. The 1976–80 project began with "unprejudiced collecting of facts by fieldwork". The new project was to be "empirically independent" of the older project (Browall 1986).

*Here I use the term "fruits and seeds" as this phrase has a long tradition. The correct expression should be "seeds and other diaspores" (Jensen 1986).

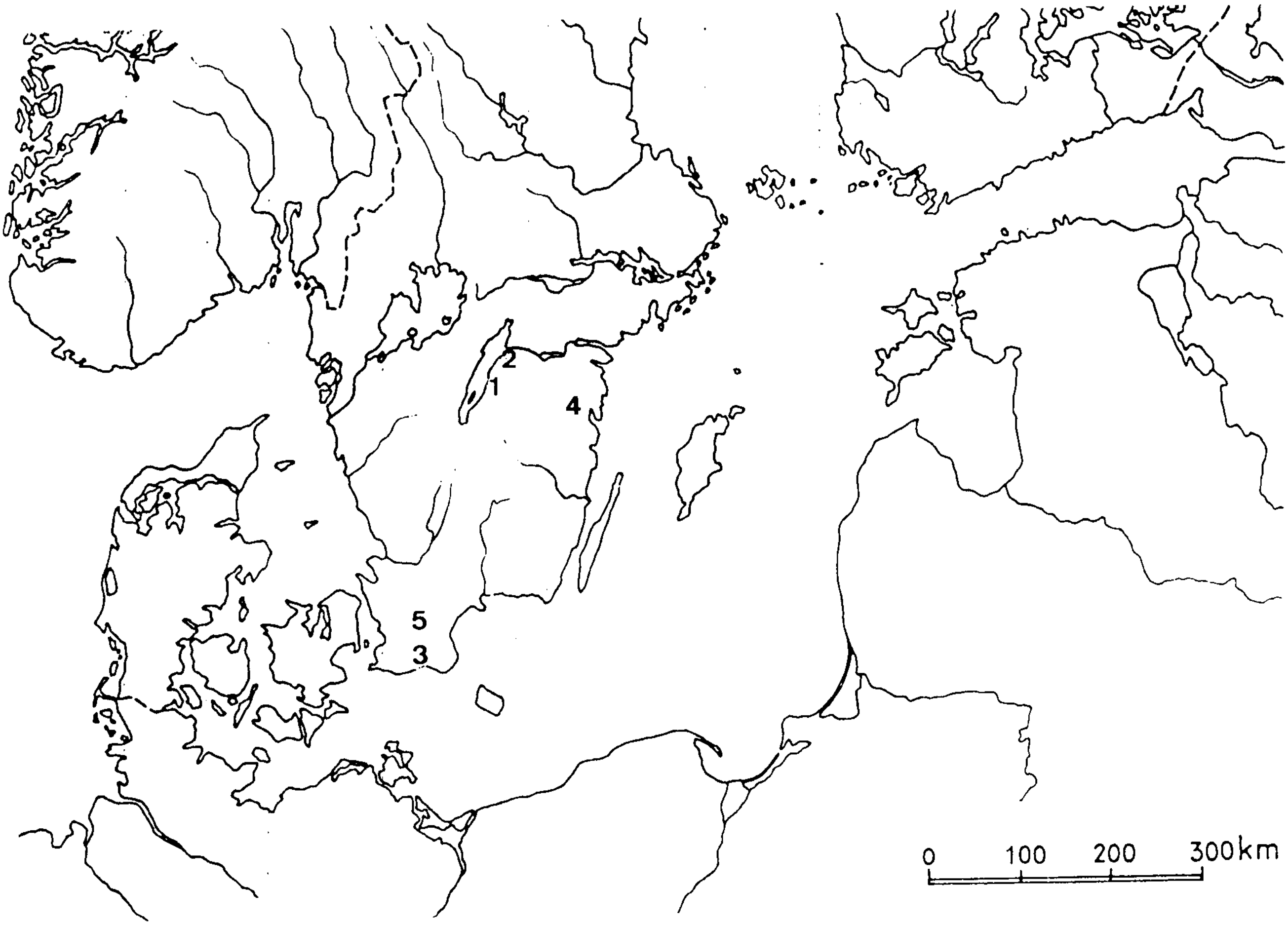


Fig. 4. The different localities mentioned in the text. 1. The Alvastra spring mire and the Dags Mosse bog. 2. The kettle hole at Nässja. 3. Lake Bjärsjöholmssjön. 4. The Mabo Mosse bog. 5. The Ageröds Mosse bog.

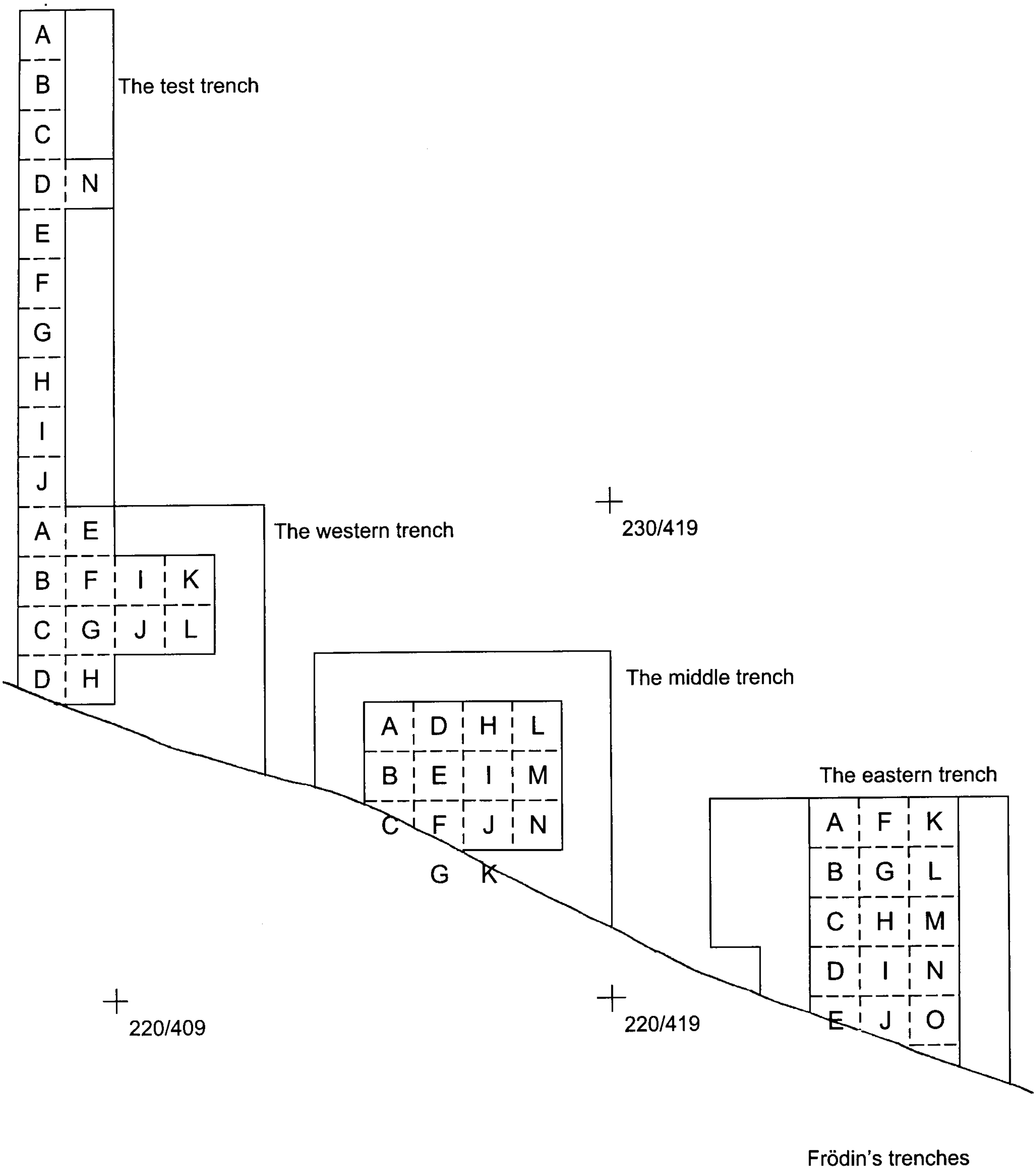


Fig. 5. The trenches excavated in 1976–1980 border directly on Frödin's large trench which was excavated in 1909–1930. Each trench is divided into square metres named A, B, C etc. The northwesternmost sample in each square is named 1, the following sample (to the east or south) in the same square is named 2, etc. Thus, for instance, "EA2" means "sample 2 in square A in the eastern trench". The test trench in which soil samples were taken is abbreviated "S".

Table 1. Table of fruits and seeds from all trenches in the rigid system.

Note
All cereal caryopses, rachis segments etc. are carbonized. Other seeds and fruits that are carbonized are marked with asterisks (*) in the tables.

	1. CULTIVATED OR COLLECTED	*Hordeum vulgare* (caryopses)	*Cornus sanguinea*	*Corylus avellana*	*Malus sylvestris* (pips)	*Prunus padus*	*Rubus* cf. *R. caesius*	*Rubus idaeus*	*Sambucus nigra*	2. WEEDS	*Fumaria officinalis*	*Galeopsis speciosa*	*Mentha arvensis*	*Polygonum convolvulus*	*Polygonum lapathifolium*	*Polygonum persicaria*	*Stellaria media*	3. RUDERAL SOILS	*Aethusa cynapium*	*Chenopodium album*	*Polygonum aviculare*	*Solanum dulcamara*	*Urtica dioica*
SB2.238/408/99.07-99.00		–	–	–	–	–	–	–	–		3	–	–	4	1	–	17		–	11	11	–	–
SB2.238/408/99.00-98.93		–	–	–	–	–	–	–	–		6	–	–	–	1	–	26		–	14	6	–	–
SB2.238/408/98.40-34		–	–	–	1	–	–	–	–		–	–	–	–	–	–	–		–	9	–	–	–
SB2.238/408/98.34-28		–	–	–	3	1	–	–	–		–	–	–	–	–	–	–		–	16	–	–	–
SD1.236/408/99.06-98.98		–	–	–	–	–	–	–	–		2	–	–	3	2	1	79		–	4	14	–	–
SD1.236/408/98.98-90		–	–	–	–	–	–	–	–		1	–	–	–	4	–	22		–	8	33	–	1
SD1.236/408/98.77-62		–	–	–	–	–	–	–	–		–	–	–	–	–	–	–		–	2	–	–	–
SD1.236/408/98.62-49		–	–	–	–	–	–	–	–		–	–	–	–	–	–	–		–	–	–	–	–
SD1.236/408/98.49-38		–	–	–	3	2	–	1	–		–	–	–	2	–	–	–		–	103	–	–	–
SH1.232/408/98.41-35		–	–	–	2	–	–	–	–		–	–	–	–	–	–	–		–	67	–	–	–
SH1.232/408/98.35-30		–	–	–	–	–	–	–	–		–	–	–	–	–	–	–		–	–	–	–	–
SJ5.230/408/99.16-02		–	–	–	–	–	–	1	–		1	–	–	4	9	2	46		–	18	13	–	–
WK2.228/411/98.57-49		5	–	–	–	–	2	–	–		–	–	–	–	–	–	1		–	5	–	–	–
MA1.226/414/98.74-61		1	–	–	–	–	–	–	–		–	–	–	–	–	–	–		–	–	–	–	–
MB1.224/414/98.67-55		3	–	–	–	–	–	–	–		–	–	–	–	–	–	–		–	11	–	–	–
MM2.224/417/99.11-05		–	–	–	–	–	–	3	1		–	1	–	7	–	1	3		–	4	–	–	–
MM2.224/417/99.02-98.88		–	–	–	–	–	–	1	–		–	–	–	–	–	–	2		–	6	–	–	–
MM2.224/417/98.88-74		–	–	–	–	–	–	–	–		–	–	–	–	–	–	–		–	1	–	–	–
MM2.224/417/98.74-57		–	–	–	–	–	–	–	–		–	–	–	–	–	–	1		1	–	–	–	–
MM2.224/417/98.63-50		–	–	–	–	–	–	–	–		1	–	–	–	1	–	10		–	8	–	1	–
MM2.224/417/98.58-52		1	–	–	–	–	–	1	–		–	–	–	–	–	–	–		–	2	–	–	–
EA1.224/423/99.24-11		–	–	–	–	–	–	–	–		1	–	1	–	4	–	324		–	16	17	–	–
EA1.224/423/99.11-98.98		–	–	–	–	–	–	–	–		2	–	–	–	15	–	56		–	15	–	–	–
EA1.224/423/98.98-81		–	–	–	–	–	–	–	–		–	–	–	–	–	–	23		–	1	–	–	–
EA1.224/423/98.72-70		–	–	–	–	–	–	–	–		–	–	–	–	–	–	2		–	–	–	–	–
EA1.224/423/98.70-60		–	–	–	–	–	–	–	–		–	–	–	–	–	–	1		–	–	–	–	–
EA1.224/423/98.60-47		–	–	–	–	–	–	–	–		–	–	–	–	–	–	–		–	7	–	–	–
EA1.224/423/98.47-43		–	–	–	–	–	–	–	–		–	–	–	–	–	–	–		–	–	–	–	–
EA1.224/423/98.43-34		–	–	–	–	–	–	–	–		–	–	–	–	–	–	–		–	–	–	–	–
ED4.220.30/423/98.67-63		2	–	1(*)	–	–	–	–	–		–	–	–	–	–	–	–		–	5	–	–	–
ED4.220.30/423/98.60-55		1	–	–	–	–	–	–	–		–	–	–	–	–	–	–		–	5	–	–	–
ED4.220.30/423/98.55-51		–	–	–	–	–	–	–	–		–	–	–	2*	–	–	–		–	–	–	–	–
ED4.220.30/423/98.51-43		–	–	–	–	–	–	–	–		–	–	–	1*	–	–	–		–	–	–	–	–
ED5.220.10/423/98.70-58		–	–	1	–	–	–	1	–		–	–	–	–	–	–	–		–	16	–	–	–
ED5.220.10/423/98.58-46		–	–	4	–	–	–	1	–		–	–	–	–	–	–	–		–	1	–	–	–
EK1.224/426/99.20-06		–	–	–	–	–	–	–	–		2	–	–	–	4	–	64		–	10	–	–	–
EK1.224/426/99.06-98.92		–	–	–	–	–	–	–	–		1	–	–	–	–	–	16		–	8	–	–	–
EK1.224/426/98.79-67		–	–	–	–	–	–	–	–		–	–	–	–	–	–	1		–	–	–	1	–
EK1.224/426/98.68-65		–	–	–	–	–	–	–	–		–	–	–	–	–	–	–		–	–	–	–	–
EK1.224/426/98.65-56		–	–	–	–	–	–	–	–		–	–	–	–	–	–	–		–	–	–	–	–
EK1.224/426/98.56-46		–	–	–	–	–	–	–	–		–	–	–	–	–	–	–		–	31	–	–	–
EL2.222/425/98.65-61		–	–	–	–	–	–	–	–		–	–	–	–	–	–	–		–	–	–	–	–
EL2.222/425/98.57-52		–	–	–	–	–	–	–	–		–	–	–	–	–	–	–		–	–	–	–	–
EL2.222/425/98.48-45		–	–	–	–	–	–	–	–		–	–	–	–	–	–	–		–	12	–	–	–
EL2.222/425/98.43-41		–	–	–	–	–	–	–	–		–	–	–	2	–	–	–		–	44	–	–	–
EL2.222/425/98.36-34		–	–	–	3	–	–	–	–		–	–	–	–	–	–	–		–	–	–	–	–
EL2.222/425/98.34-28		2	–	–	–	–	–	–	–		–	–	–	2*	–	–	–		–	16	–	–	–
EL2.222/425/98.26-19		–	–	–	–	–	–	–	–		–	–	–	–	–	–	–		–	–	–	–	–
EL4.222/426/98.67-62		–	–	–	–	–	–	–	–		–	–	–	–	–	–	2		–	–	–	–	–
EL4.222/426/98.62-53		1	1	–	–	–	–	–	–		–	–	–	–	–	–	1		–	3	–	1	–
EN3.220/426/98.60-53		–	–	–	1	–	–	–	–		–	–	–	–	–	–	–		–	288	–	1	–

4. GRASSLANDS	*Anthriscus sylvestris*	*Taraxacum*	5. WETLANDS AND WET MEADOWS	*Carex canescens*	*Epilobium hirsutum/palustre*	*Eupatorium cannabinum*	*Filipendula ulmaria*	cf. *Lychnis flos-cuculi*	*Lycopus europaeus*	cf. *Phalaris arundinacea*	*Potentilla palustris*	*Ranunculus sceleratus*	6. WELLS AND SPRING-MIRES	*Cladium mariscus*	*Scirpus Tabernaemontani*	7. FORESTS AND FOREST HERBS	*Betula pubescens* (seeds)	*Betula verrucosa* (catkin scales)	*Betula* undiff. (catkin scales)	*Betula* undiff. (seeds)	*Stachys sylvatica*	8. HEATHS	*Empetrum nigrum*	9. MISCELLANEOUS	Asteraceae	Brassicaceae	*Carex* two-sided	*Carex* three-sided	Caryophyllaceae	Cyperaceae
	–	–		2	–	–	–	–	–	–	–	–		–	–		–	–	–	25	–		–		–	–	–	–	–	–
	–	–		1	–	–	–	–	–	–	–	–		–	–		–	–	–	12	–		–		–	–	–	–	–	–
	–	–		4	10	–	–	–	–	–	–	23		1	88		–	–	–	3	–		2		–	–	–	10	–	–
	–	–		4	8	1	–	–	–	–	3	4		4	37		–	–	–	10	–		–		–	–	–	–	–	–
	–	–		–	–	–	–	–	–	–	–	–		–	–		–	–	–	11	–		–		–	–	–	–	–	–
	–	–		2	–	–	–	–	–	–	–	–		–	–		–	–	–	8	–		–		–	–	–	–	–	–
	–	–		2	–	–	–	3	–	–	–	–		1	–		–	–	–	2	–		–		–	–	–	18	–	–
	–	–		–	–	3	–	–	–	–	–	–		–	–		–	–	–	2	–		–		–	–	3	1	–	–
	–	–		1	–	3	–	–	–	–	–	301		–	–		–	–	–	–	–		–		–	–	–	–	–	–
	–	–		–	–	–	–	–	–	–	–	23		7	–		–	–	–	1	–		–		1	–	–	–	–	–
	–	–		–	–	–	–	–	–	–	–	–		18	–		–	–	–	2	–		–		–	–	–	–	–	–
	–	–		5	–	–	–	–	–	–	–	–		–	–		–	1	–	37	–		–		–	–	–	–	–	–
	–	–		46	–	1	20	–	–	–	–	4		–	–		–	–	–	20	–		–		6	–	–	–	11	–
	–	–		4	–	–	–	–	–	–	–	4		–	–		–	–	–	–	–		–		–	–	–	–	–	–
	–	–		48	3	–	–	–	–	–	–	–		17	–		–	–	–	–	–		–		–	–	–	–	–	–
	1	–		4	–	–	–	–	1	–	–	–		–	–		–	–	–	13	–		–		–	–	–	1	–	–
	1	–		6	–	–	–	–	–	–	–	–		1	–		–	–	–	1	–		–		–	–	–	–	1	–
	–	–		4	–	–	–	–	–	–	–	–		–	–		–	1	–	–	–		–		–	–	–	–	2	1
	–	–		–	–	6	4	–	–	–	–	–		–	–		–	–	–	8	–		–		–	–	–	–	–	–
	1	–		133	–	–	–	–	–	–	–	–		1	–		–	–	–	32	–		–		–	–	–	1	–	–
	–	–		2	–	–	–	–	–	1*	–	1		–	–		–	–	–	–	–		–		–	–	–	–	–	–
	–	–		–	–	–	–	–	–	–	–	1		–	–		–	–	–	56	–		–		–	–	–	–	–	–
	–	1		–	–	–	–	–	–	–	–	–		–	–		–	–	1	43	–		–		–	–	–	–	2	–
	–	–		–	–	–	–	–	–	–	–	–		–	–		–	–	–	1	–		–		–	–	–	–	–	–
	–	–		18	–	–	–	–	–	–	–	–		2	–		–	–	–	–	–		–		–	–	–	–	–	–
	–	–		4	–	–	–	–	–	–	–	–		–	–		–	–	–	–	–		–		–	–	–	–	–	–
	–	–		23	–	–	–	–	–	–	2	3		–	–		–	–	–	–	–		–		–	–	–	–	–	–
	–	–		3	–	–	–	–	–	–	–	5		–	–		–	–	–	–	–		–		–	–	–	–	–	–
	–	–		–	–	–	–	–	–	–	–	–		–	–		–	–	–	2	–		–		–	–	–	–	–	–
	–	–		20	–	–	–	–	–	–	–	14		–	–		–	–	–	1	–		–		–	–	–	1	–	–
	–	–		1	–	–	–	–	–	–	–	4		3	–		–	–	–	1	–		–		–	–	–	–	–	–
	–	–		–	1	–	–	–	–	–	–	–		2	–		–	–	–	–	–		–		–	–	–	1	–	–
	–	–		–	–	–	–	–	–	–	–	–		2	–		–	–	–	–	–		–		–	–	–	4	–	–
	–	–		70	–	–	–	–	–	–	–	2		–	–		–	–	–	–	–		–		–	–	–	–	–	–
	–	–		4	–	–	–	–	–	–	–	25		–	–		–	–	–	3	–		–		–	–	2	–	–	–
	–	–		2	–	–	–	–	–	–	–	–		–	–		–	–	–	11	–		–		–	1	–	–	–	–
	–	–		–	–	–	–	–	–	–	–	–		–	–		–	–	–	2	–		–		–	1	–	–	–	–
	–	–		4	1	–	–	–	–	–	–	–		–	–		–	–	–	1	–		–		–	–	–	–	–	–
	–	–		22	–	–	–	–	–	–	–	–		–	–		–	–	–	–	–		–		–	–	–	–	–	–
	–	–		3	–	–	–	–	–	–	–	–		–	–		–	–	–	–	–		–		–	–	–	–	–	–
	–	–		133	–	–	–	–	–	–	–	1		–	–		–	–	–	–	2		–		–	–	–	–	–	–
	–	–		12	–	1	–	–	–	–	–	–		–	–		–	–	–	–	–		–		–	–	–	–	1	–
	–	–		8	–	–	–	–	–	–	–	–		–	–		–	–	–	–	–		–		–	–	–	–	–	–
	–	–		80	–	2	–	–	–	–	–	–		–	–		–	–	–	–	–		–		–	–	–	–	–	–
	–	–		42	–	–	–	–	–	–	–	2		–	–		–	–	–	–	–		–		–	–	–	–	–	–
	–	–		–	–	–	–	–	–	–	–	51		–	–		–	–	–	–	–		–		–	–	–	–	–	–
	–	–		–	–	–	–	–	–	–	–	26		–	–		–	–	–	–	–		–		–	–	–	–	–	–
	–	–		–	–	–	–	–	–	–	–	–		2	–		–	–	–	5	–		–		–	–	–	–	–	–
	–	–		18	–	2	–	–	–	–	–	–		–	–		–	–	–	–	–		–		–	–	–	–	–	–
	–	–		16	–	2	–	–	–	–	–	–		–	–		–	–	–	1	1		–		–	–	–	–	–	–
	–	–		23	–	–	–	–	–	–	–	–		–	–		–	–	–	2	–		–		–	–	–	–	–	–

Table 1. Table of fruits and seeds from all trenches in the rigid system (continued).

	Galeopsis undiff.	*Geranium lucidum*	*Lamium* undiff.	*Melandrium* undiff.	Polygonaceae	*Polygonum* undiff.	*Potentilla* undiff.	*Rosa* undiff.	*Scrophularia* undiff.	*Silene* undiff.	*Valeriana* undiff.	*Veronica* undiff.	*Viola* undiff.	10.NOT DETERMINED	11.OTHER ARTEFACTS	Charcoal	Pottery fragments	Mineral particles, small stones	Bone remains
SB2.238/408/99.07-99.00	–	–	–	–	–	2	–	–	–	4	–	–	–	4		–	–	–	–
SB2.238/408/99.00-98.93	–	–	–	–	–	–	–	–	–	4	–	–	–	2		–	–	–	–
SB2.238/408/98.40-34	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–
SB2.238/408/98.34-28	–	–	–	–	–	–	–	–	–	–	–	–	–	–		+	–	–	–
SD1.236/408/99.06-98.98	–	–	–	–	–	5	–	–	–	2	–	–	–	–		–	–	–	–
SD1.236/408/98.98-90	–	–	–	–	–	7	–	–	–	2	–	–	–	2		–	–	–	–
SD1.236/408/98.77-62	–	–	–	–	–	–	2	–	–	–	–	–	–	–		–	–	–	–
SD1.236/408/98.62-49	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–
SD1.236/408/98.49-38	–	–	–	–	–	–	–	–	–	–	–	–	–	–		+	–	–	+
SH1.232/408/98.41-35	–	–	–	–	–	–	–	–	–	–	–	–	–	–		+	–	–	+
SH1.232/408/98.35-30	–	–	–	–	–	–	–	–	–	–	–	–	–	–		(+)	–	–	(+)
SJ5.230/408/99.16-02	2	–	2	–	–	18	–	1	–	2	1	2	–	2		–	–	(+)	–
WK2.228/411/98.57-49	–	–	–	–	–	–	–	–	1	–	–	–	–	–		+	+	+	–
MA1.226/414/98.74-61	–	–	–	–	–	–	–	–	–	–	–	–	–	–		+	+	+	+
MB1.224/414/98.67-55	–	–	–	–	–	–	–	–	–	–	–	–	–	–		+	+	–	–
MM2.224/417/99.11-05	–	–	–	–	–	–	–	1	–	–	–	–	–	–		+	–	+	+
MM2.224/417/99.02-98.88	–	–	–	–	–	–	–	1	–	–	–	–	–	–		(+)	–	(+)	–
MM2.224/417/98.88-74	–	–	–	–	–	–	5	–	–	–	–	1	–	–		+	–	–	–
MM2.224/417/98.74-57	–	–	–	–	–	–	–	–	–	–	–	–	–	–		+	–	+	–
MM2.224/417/98.63-50	–	2	–	–	–	2	–	–	–	–	2	–	–	–		+	–	+	–
MM2.224/417/98.58-52	–	–	–	–	–	–	–	–	–	–	–	–	–	–		+	+	+	+
EA1.224/423/99.24-11	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	(+)	–	–
EA1.224/423/99.11-98.98	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–
EA1.224/423/98.98-81	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–
EA1.224/423/98.72-70	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–
EA1.224/423/98.70-60	–	–	–	–	–	–	–	–	–	–	–	–	–	–		+	(+)	+	+
EA1.224/423/98.60-47	–	–	–	–	–	–	–	–	–	–	–	–	–	–		+	–	+	(+)
EA1.224/423/98.47-43	–	–	–	–	–	–	–	–	–	–	–	–	–	–		+	–	+	–
EA1.224/423/98.43-34	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–
ED4.220.30/423/98.67-63	–	1*	–	–	–	–	–	–	–	–	–	–	–	–		+	+	+	+
ED4.220.30/423/98.60-55	–	–	–	–	–	–	–	–	–	–	–	–	–	–		+	–	+	–
ED4.220.30/423/98.55-51	–	–	–	–	–	–	–	–	–	–	–	–	–	–		+	–	–	–
ED4.220.30/423/98.51-43	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–
ED5.220.10/423/98.70-58	–	–	–	–	–	–	–	–	–	–	–	–	–	–		+	+	+	+
ED5.220.10/423/98.58-46	–	–	–	–	–	–	–	–	–	–	–	–	–	–		+	–	+	+
EK1.224/426/99.20-06	–	–	–	–	–	–	–	–	–	2	–	–	–	–		–	–	–	–
EK1.224/426/99.06-98.92	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–
EK1.224/426/98.79-67	–	–	–	–	–	–	–	–	–	–	–	–	–	2		–	–	–	–
EK1.224/426/98.68-65	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–
EK1.224/426/98.65-56	–	–	–	–	–	–	–	–	–	–	–	–	–	–		+	–	+	+
EK1.224/426/98.56-46	–	–	–	–	–	–	–	–	–	–	–	–	–	–		+	–	+	–
EL2.222/425/98.65-61	–	–	–	–	–	–	3	–	–	–	–	–	–	–		–	–	–	–
EL2.222/425/98.57-52	–	–	–	–	–	–	–	–	–	–	–	–	–	–		+	+	–	+
EL2.222/425/98.48-45	–	–	–	–	–	–	–	–	–	–	–	–	–	–		+	–	+	+
EL2.222/425/98.43-41	–	–	–	–	–	–	–	–	–	–	–	–	–	–		+	+	+	–
EL2.222/425/98.36-34	–	–	–	–	–	–	–	–	–	–	–	–	–	–		+	–	+	–
EL2.222/425/98.34-28	–	–	–	–	–	–	–	–	–	–	–	–	–	–		+	+	–	+
EL2.222/425/98.26-19	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–
EL4.222/426/98.67-62	–	–	–	–	–	–	–	–	–	–	–	–	–	–		+	–	–	–
EL4.222/426/98.62-53	–	–	–	–	–	–	–	–	–	–	–	–	–	–		+	–	+	+
EN3.220/426/98.60-53	–	–	–	–	–	–	–	–	–	–	–	–	1	–		+	+	+	–

The palaeoethnobotanical material

The artefact and ecofact material is found in a 15–40 cm thick layer of *Cladium-Phragmites* peat which underlies a ca. 25 cm thick layer of magnocaricetum peat (that is, peat built up of tall-growing *Carex* species). Above the magnocaricetum peat a layer of parvocaricetum peat (that is, peat built up of low-growing *Carex* species), 20–40 cm thick, is found (Göransson 1987: fig. 13). This uppermost layer is highly humified and disturbed. The *Cladium-Phragmites* peat is underlain by a layer of lake marl (ibid.).

The occupation layer in the *Cladium-Phragmites* peat has *never* been disturbed by ploughing. Only at about four limited areas, mainly within Frödin's trench, have the excavated areas been disturbed by ditches, two pits and a "cow grave". These areas have been encircled and avoided by the archaeologists.

Already in the 1910s Frödin asked specialists to study the palaeoethnobotanical material (Frödin 1910a:64ff.). In the 1940s Dahl studied apples from the Alvastra pile dwelling (Dahl 1945). In 1943 Frödin sent 77 samples of fruits and seeds for analysis to Greta Berggren (Berggren 1956). These samples thus constituted a cross-section of all fruits and seeds collected during the years 1909–30 over an area of 1000 m^2. Hakon Hjelmqvist studied impressions of cereals in ceramics and also some carbonized ear fragments from the Alvastra pile dwelling (Hjelmqvist 1955).

The laboratory work

The peat samples taken in the field in the rigid system and most of the much smaller, peaty samples taken in the flexible system (see below) were left standing in 10% KOH for 14 days after which the dissolved material was strained in strainers with mesh widths of 3.15, 0.80 and 0.40 mm. At the beginning a strainer with the mesh width of 0.25 mm was also used. It soon became apparent, however, that it was not possible to strain the material in any realistic time by using the latter mesh width. (I determined not to use the 0.25 mm strainer after a discussion with Grethe Jørgensen, Copenhagen.)

The smaller samples taken in the flexible system were thus treated in the same way in the laboratory as those taken in the rigid system. In a few cases, however, I did not use KOH but tried to pick out and clean the ear, fruit or seed by using a preparation needle and a water-colour brush. This was very difficult, since the ears not infrequently fell into pieces and most often the peat was stuck to the seeds and fruits.

The rigid and flexible systems

During the excavation season 1976–80 the sampling for fruit and seed analysis was undertaken in two ways. The samples were taken in the rigid and the flexible systems.

In the *rigid* system peat samples were taken at randomly chosen spots, often from the surface of the spring mire and down to the bottom of the occupation layer or even down into the lake marl underlying the occupation layer. No consideration was given to the absence or presence of visible fruits or seeds. If the samples were larger than 250 cc then 250 cc were subsampled from the sample in the laboratory. In a very few cases the samples were smaller than 250 cc. Then the content of fruits and seeds in these samples was adjusted to 250 cc of peat (by multiplying) after the analysis was done.

The fruits and seeds identified and counted in the samples from the rigid system are listed in table 1. The numbers in this table can thus be subjected to statistical treatment (in future archaeological and palaeoethnobotanical studies) as they were taken at random and because the volumes of the samples are of the same size. In the *flexible* system the sampling was performed by fruits and seeds being collected directly in the field when they were observed – for instance, ears of barley, large amounts of caryopses of barley or emmer wheat, accumulations of nuts of *Chenopodium album* or of *Polygonum convolvulus*, apple pips, hazelnut shells etc.

The fruits and seeds identified and counted in the flexible system are listed in tables 2–5. Naturally, the numbers in these tables cannot be correctly statistically processed as the fruits and seeds were not randomly sampled and the volumes of the samples are of varying size (generally they are rather small). In spite of this, the information from the tables from the flexible system is of great value. Besides being important species lists, these tables give information on the levels in the occupation layer where the largest concentrations of fruits and seeds are found.

The grouping of taxa

The taxa (genera, species) recorded in the tables from the rigid and flexible systems are ordered into ten groups. These groups are in the main (but not completely) the same as those suggested by Jensen (Jensen 1986). Within each group the taxa are listed in alphabetical order – excepting group 1, "Cultivated or collected", which starts with the cereals.

Table 2. Table of fruits and seeds from the test trench in the flexible system.

	1. CULTIVATED OR COLLECTED: *Hordeum vulgare* (caryopses)	*Triticum dicoccum* (forks)	Cerealia undiff.	*Prunus padus*	*Rubus idaeus*	3. RUDERAL SOILS: *Chenopodium album*	5. WETLANDS AND WET MEADOWS: *Carex canescens*	*Eupatorium cannabinum*	*Ranunculus sceleratus*	6. WELLS AND SPRING-MIRES: *Chara* undiff	*Cladium mariscus*	7. FORESTS AND FOREST HERBS: *Betula* undiff. (seeds)	8. HEATHS: *Empetrum nigrum*	9. MISCELLANEOUS: *Carex* undiff.	*Polygonum* undiff.	*Potentilla* undiff.	*Solanum* undiff.
SA1. 239/407.34-48/98.37-32	–	–	–	–	–	–	–	–	–	–	2	2	–	–	–	–	–
SB1. 238/407.40-55/98.40-32	–	–	–	–	–	–	–	–	–	1	2	3	2	1	–	1	–
SI1. 231/407.23-31/98.44	–	–	–	–	–	–	2	–	3	–	–	1	–	3	–	–	–
SJ1. 230.52-58/407.20-25/98.41	–	–	–	–	–	4	2	–	2	–	–	–	–	–	–	–	–
SJ2. 230.48-65/407.68-90/98.58-53	1	–	–	1	5	60	11	–	2	–	–	–	–	–	–	–	–
SJ3. 230.48-54/407.61-66/98.57-53	–	1	1	–	1	6	44	1	2	–	–	–	–	–	–	–	1
SJ4. 230.37-39/407.48-55/98.55-53	–	–	–	–	–	5	17	–	5	–	–	–	–	–	1	–	–

Table 3. Table of fruits and seeds from the western trench in the flexible system.

	1. CULTIVATED OR COLLECTED: *Hordeum vulgare* (caryopses)	*Hordeum vulgare* (rachis segments)	*Hordeum vulgare* (ear fragments)	*Hordeum vulgare* (lemma/palea)	*Triticum dicoccum* (caryopses)	*Triticum dicoccum* (forks)	Cerealia undiff.	*Malus sylvestris* (chips)	*Malus sylvestris* (pips)	*Rubus idaeus*	2. WEEDS: *Artemisia vulgaris*	*Circium arvense*	cf. *Lolium temulentum*	*Polygonum convolvulus*	*Polygonum lapathifolium*	*Stellaria media*	3. RUDERAL SOILS: *Chenopodium album*
A1. 229.60-74/407.00-08/98.46-42	52	1	–	–	26	–	–	–	–	–	–	1*	–	–	–	–	1
A2. 229.60-80/407.13-35/98.46-43	159	–	–	–	145	11	–	2*	–	–	1*	–	–	2*	–	1	3
A3. 229.43-52/407.60-69/98.465-440	174	–	–	–	153	30	15	–	1*	–	–	–	–	6*	–	–	27
A4. 229.68/407.84/98.47	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
A5. 229.50-65/407.38-55/98.46-43	108	–	–	–	125	38	–	–	2*	–	–	–	–	2*	–	–	4
A6. 229.43-55/407.51-62/98.49-41	91	–	–	–	98	1	–	–	–	–	–	–	–	2*	–	–	1*
B1. 228.56-64/407.60-75/98.48-44	1341	1	–	–	86	–	40	–	4*	–	–	–	–	2*	1*	–	–
B2. 228.57/407.80/98.46	306	–	–	–	21	–	–	–	–	–	–	–	1*	–	–	–	5
B3. 228.02-07/407.82-88/98.45	22	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1
C1. 227.43-47/407.765-805/98.51-49	125	22	–	+	–	–	–	+	5+	–	–	–	–	–	–	–	1
C2. 227.40-50/407.68-90/98.49-45	632	50	–	–	–	–	–	–	2*	–	–	–	–	2*	–	–	3
C3. 227.40/407.85/98.44	13	+	2	+	–	–	–	–	–	–	–	–	–	–	–	–	–
C4. 227.37/407.88/98.46	27	4	4	+	–	–	–	+	–	–	–	–	–	–	–	–	–
D1. 226.90-50/407.34-66/98.53-49	1211 + x	28	–	–	–	–	–	–	–	–	–	–	–	3*	–	–	8
E1. 230.02/408.15-20/98.52-50	2	–	–	–	3	–	1	–	–	–	–	–	–	–	–	–	–
E2. 222.41-32/408.01-11/98.46	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1306+x
F1. 228.87/408.44/98.56	–	–	–	–	–	–	–	–	–	5	–	–	–	–	–	1	> 100
G1. 227.43-54/408.63-77/98.52-50	322	23	1	36	–	–	–	–	–	–	–	–	–	–	–	–	–
G2. 227.57-61/408.42-57/98.53-52	158	7	4	21	–	–	–	2*	5*	–	–	–	–	4*	–	–	2*
K1. 228.10-18/411.00-03/98.60-58	–	–	–	–	–	–	–	5*	–	–	–	–	–	–	–	–	1
L2. 227.40-30/411.20-10/98.56-52	40	4	–	–	–	–	–	–	1	–	–	–	–	1*	–	–	–
L3. 227.44-58/410.51-63/98.57-54	148 + x	23	–	3	7	–	–	2*	3*	–	–	–	–	3*	–	–	5*
L4. 227.40/411.00/98.49	13	5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

All taxa from the ten groups – from the rigid and flexible systems – are described below. Also most of the species identified by G. Berggren (1956) are discussed below, as are those which were identified by H. Hjelmqvist in the 1940s and 1950s (Hjelmqvist 1955).

1. Cultivated or collected

Barley (*Hordeum vulgare*)

In Neolithic occupation layers in Scandinavia we may expect to find dense-eared and lax-eared six-row barley. The former barley type is most often called six-row barley and the latter type is called four-row barley. The ears of six-row barley have very short internodes. The central axis of a spike of barley or wheat is called the rachis. It is divided into segments (internodes) which bear the spikelets. Both barley types belong to the species *Hordeum vulgare*.

Six-row barley and four-row barley may be hulled or naked. Thus four types of *Hordeum vulgare* may be found in prehistoric occupation layers: naked six-row barley, hulled six-row barley, naked four-row barley and hulled four-row barley. The naked form of six-row and four-row barley is named *Hordeum vulgare* var. *nudum.*

It is very difficult or almost impossible to decide which type of barley is present if only single grains are found. *Grain* and *caryopsis* are used as synonyms below. The surface of the caryopsis/grain consists of the fused pericarp and testa. In the present paper the surface of the grain is named the *grain wall.* The two bracts which enclose the caryopsis are named lemma and palea. The *lemma* lies over the dorsal side of the caryopsis while the *palea* lies over the ventral side.

During the seed-analytical work I found more than 7300 non-fragmentary carbonized caryopses of barley. Furthermore, some ear fragments, about 250 complete and broken rachis segments and a great deal of light chaff (awns, glumes, lemmas and paleas) have been picked out from the soil.

Table 3. Table of fruits and seeds from the western trench in the flexible system (continued).

Solanum dulcamara	4. GRASSLANDS	*Anthriscus sylvestris*	*Luzula campestris/multiflora*	*Medicago lupulina*	*Trifolium/Oxytropis*	5. WETLANDS AND WET MEADOWS	*Carex canescens*	*Epilobium hirsutum/palustre*	*Eupatorium cannabinum*	*Filipendula ulmaria*	*Poa nemoralis/palustris*	*Ranunculus sceleratus*	6. WELLS AND SPRING-MIRES	*Cladium mariscus*	7. FORESTS AND FOREST HERBS	*Betula verrucosa* (catkin scales)	*Betula verrucosa* (seeds)	*Betula* undiff. (seeds)	*Stachys sylvaticus*	*Trifolium medium*	9. MISCELLANEOUS	Asteraceae	*Carex* (two-sided)	*Carex* undiff.	Cyperaceae	*Stellaria* undiff.
–		–	–	–	1		2	–	2	–	–	26		–		–	–	–	–	1		1	–	–	–	–
–		–	–	–	–		–	–	–	–	–	39		1		–	–	5	–	–		–	–	–	–	–
–		–	–	–	–		1	2	–	–	–	1		–		–	–	–	2	–		1	–	–	–	–
–		1	–	–	–		–	–	–	–	–	–		–		–	–	–	–	–		–	–	–	–	–
2		–	–	–	–		4	24	–	–	–	21		–		–	–	–	–	–		–	–	–	–	–
–		–	–	–	–		4	5	–	–	–	4		–		–	–	–	–	–		–	–	–	–	–
–		–	–	–	–		–	–	–	–	1	2		–		–	–	–	–	–		–	–	–	–	–
1		–	–	–	–		1	–	–	–	–	426		1 + 1*		–	–	–	–	–		–	–	–	–	–
–		–	–	–	–		1	–	–	–	–	–		–		–	1	–	–	–		–	–	–	–	–
–		–	–	–	–		–	–	–	–	–	88		–		–	–	–	–	–		–	–	–	–	–
–		–	1*	–	–		1	–	–	–	–	161		–		1	3	–	–	–		–	–	1	–	–
–		–	–	–	–		–	–	–	–	–	–		–		–	–	–	–	–		–	–	–	3	–
–		–	–	–	–		–	–	–	–	–	–		–		–	–	–	–	–		–	–	–	–	–
–		–	–	1	–		16	–	–	–	–	–		–		–	–	–	–	–		–	–	–	–	–
–		–	–	–	–		–	–	–	–	–	–		–		–	–	–	–	–		–	–	–	–	–
–		–	–	–	–		–	–	–	–	–	–		–		1	–	–	–	–		–	–	–	–	–
–		–	–	–	–		3	–	–	–	–	2		–		–	–	–	–	–		–	–	–	–	–
–		–	–	–	–		–	–	–	–	–	–		–		–	–	–	–	–		–	–	–	–	–
–		–	–	–	–		–	–	–	–	–	–		–		–	–	–	–	–		–	–	–	–	–
–		–	–	–	–		131	–	14	1	–	–		–		–	–	–	–	–		–	–	–	–	6
–		–	–	–	–		2	–	–	–	–	2		–		–	–	–	–	–		–	–	–	–	–
–		–	–	–	–		2	–	1	–	–	3		–		–	–	1	–	–		–	1	–	–	–
–		–	–	–	–		–	–	–	–	–	–		–		–	–	–	–	–		–	–	–	–	–

It is, as mentioned, very difficult to decide which type of barley is found when single grains are studied. Most often the lemma and/or palea are attached to the grain wall of the barley from the Alvastra pile dwelling. When the ventral furrow of the caryopsis can be observed, the ridge that is characteristic of naked barley – in the middle of the furrow – is almost always present. In most cases the grain wall has – also when the lemma and the palea cover the largest part of the grain – minute transverse wrinkles which characterize naked barley. We may thus assume that at least the majority of the barley found in the Alvastra pile dwelling is of the naked type, *Hordeum vulgare* var. *nudum*.

Almost all the roughly 250 rachis segments (complete and broken) registered are "stalked". This means that the stalks (pedicels) of the lateral spikelets are not broken off from the internodes (Helbæk 1958, fig. 2e). Only about 1.6% of the rachis segments were not stalked. According to Jacomet, the lateral spikelets of naked four-row barley are stalked ("gestielt") (Jacomet 1987:22). Thus the majority of the rachis segments also prove that the barley from the Alvastra pile dwelling is naked. Further, the stalked rachis segments tell us, as mentioned above, that the barley was of the *four-row* naked type.

Most of the lemmas studied have horseshoe-shaped depressions at their bases, a phenomenon which characterizes four-row barley (the lemmas of six-row barley have narrow splits at their bases. (There do, however, exist transitional forms between the four-row horseshoe-shaped depressions and the six-row splits, see Jacomet 1987: Tab. 3., van Zeist 1970:51.)

The ears of six-row barley have, as mentioned earlier, very short internodes which, according to Hunter, are 1.7–2.1 mm long (fresh material) (Hunter 1952, cited in Renfrew 1973:73), while Helbæk suggests that the rachis segments of six-row barley vary between 1.5 and 2.7 mm (Helbæk 1958:92). According to Villaret-von Rochow,

Table 4. Table of fruits and seeds from the middle trench in the flexible system.

	1. CULTIVATED OR COLLECTED	*Hordeum vulgare* (caryopses)	*Hordeum vulgare* (rachis segments)	*Hordeum vulgare* (ear fragments)	*Triticum dicoccum* (caryopses)	*Triticum dicoccum* (forks)	cf. *Triticum compactum*	*Corylus avellana*	cf. *Crataegus*	*Glyceria fluitans*	*Malus sylvestris* (chips)	*Prunus padus*	2. WEEDS	*Agropyron repens*	*Artemisia vulgaris*	*Polygonum convolvulus*	*Polygonum lapathifolium*	*Stellaria media*	*Veronica hederifolia*	3. RUDERAL SOILS	*Chenopodium album*
A1. 226.00/414.40-48/98.62-59		64	9	–	–	–	–	–	–	–	–	–		–	71*	4*	–	–	–		8
A2. 226.00/414.70-80/98.61-59		22	4	–	–	–	–	–	–	–	–	–		–	26*	3*	–	–	–		32* + x
A3. 226.00/414.85-95/96.61		59	16	–	–	–	–	–	–	–	–	–		–	–	–	–	–	–		26
A4. 225/414/2 = 98.64		176	19	–	6	6	–	1	–	1*	–	–		–	57*	13*	–	–	–		14(*)
C1. 224/414-413/98.66-64		75	9	–	–	–	–	–	–	–	–	–		–	–	–	–	–	–		4*
D1. 226/415/98.60-59		56	6	5	–	–	–	–	–	–	–	–		–	–	–	–	–	–		–
E1. 224.73/415.81/98.64-61		> 62	5	–	9	1	–	–	–	–	–	–		–	54*	4*+1	–	–	–		9* + 6
E2. 224.48/415.55/98.66-63		51	6	–	121	10	–	1	–	–	–	–		1	18*	9*	1	–	–		10* + 4
E3. 224/415/98.68		16	–	–	288	51	–	–	–	–	–	–		–	32*	–	–	–	–		1
E4. 224/415/98.64		160	11	–	154	10	1	–	–	–	–	–		–	200*	6*	–	–	–		6*
F1. 223.82/415.34/98.64-60		–	–	–	–	–	–	–	–	–	–	–		–	–	–	–	–	–		5
H1. 226.00-05/416.25-30/98.66-61		45	2	–	1	–	–	–	–	–	–	–		–	–	–	–	–	–		1
H2. 225.80-95/416.10-80/98.67-64		583	–	–	6	–	–	–	1	–	–	–		–	–	1	–	–	–		–
H3. 225.84/416.13/98.60-58		–	–	–	–	–	–	–	–	–	–	24		–	–	–	–	–	–		–
H4. 225.24/416.16/98.625-620		6	3	–	–	–	–	–	–	–	–	–		–	–	2*	–	–	–		–
J1. 223.24/416.38/98.62-60		4	–	–	–	–	–	–	–	–	–	–		–	–	–	–	–	–		–
L1. 225.80/417.21/98.57-53														Probable touch wood							
M1. 224.85/417.20/98.55-54		1	–	–	–	3	–	–	–	–	–	–		–	–	–	–	1	–		4
N1. 223.90-95/417.50-60/98.64-60		376 + x	11	–	–	–	–	–	–	–	–	–		–	–	1	–	–	–		45
N2. 223.40/417.35/98.66		≥ 150	1	–	–	–	–	2*	–	–	++	–		–	–	2*	–	–	1*		1*
N3. 223.10/417.10/98.67		10	–	–	2	1	–	–	–	–	3*	–		–	–	1*	–	1	–		–
O1. 222.44/418.02/98.63		–	–	–	1	–	–	–	–	–	–	–		–	–	–	–	–	–		–

rachis segments of barley which are longer than 2.4 mm are likely not to belong to the six-row type (Villaret-von Rochow 1967, cited in Jacomet 1987:31). Rachis segments of four-row barley have a length-breadth (L/B) index ratio which is larger than or equal to 2.9, and the six-row type has an L/B-ratio which is less than 2.0 (Piening 1981, cited in Jacomet, 1987).

The measuring of the complete (not broken) rachis segments from the Alvastra pile dwelling demonstrates that 93% of the segments are longer than 2.4 mm. Seventy-seven per cent of the rachis segments have an L/B index ratio which is larger than 2.9, and about 97% of the segments have an L/B-index ratio which is larger than 2.0. Thus about 97% of the measured rachis segments are likely not to be of typical the six-row type (see above).

It must be underlined that the rachis segments differ in length within one and the same ear (see, for instance, Jacomet, 1987:26f.). This means that if only very few rachis segments are found in an occupation layer it may be difficult to draw far-reaching conclusions. In the Alvastra pile dwelling quite a number of complete rachis segments of barley have been registered and measured. In spite of this I want to make the following reservation: what I try to do when I describe the barley from the Alvastra pile dwelling is, so to speak, to present strong probablities rather than absolutely irrefutable facts.

The conclusion that the majority of the barley from the Alvastra pile dwelling is of the four-row, naked type seems to be confirmed by the study of single ear fragments. It is not unlikely that the ear fragments found in sample MD1, 98.60–59 originate from very few (perhaps only three) ears. The ear bunch was found below a carbonized floor log. It fell – when picked out from the soil – into three culm-tops, five ear fragments (containing 10 caryopses), 56 loose caryopses, six loose, stalked rachis segments, and some lemmas and paleas. A total of 66 caryopses were thus collected from the supposed

Table 4. Table of fruits and seeds from the middle trench in the flexible system (continued).

4. GRASSLANDS	*Anthriscus sylvestris*	*Medicago lupulina*	cf. *Vicia augustifolia*	5. WETLANDS AND WET MEADOWS	*Carex canescens*	*Eupatorium cannabinum*	*Ranunculus sceleratus*	6. WELLS AND SPRING-MIRES	*Cladium mariscus*	*Scirpus Tabernaemontani*	7. FORESTS AND FOREST HERBS	*Betula pubescens* (catkin scales)	*Betula verrucosa* (catkin scales)	*Betula verrucosa* (seeds)	*Betula* undiff. (seeds)	*Stachys sylvatica*	9. MISCELLANEOUS	*Carex* three-sided	10. NOT DETERMINED
	–	–	–		–	–	++		–	–		–	–	–	–	–		–	–
	–	–	–		–	1	++		–	–		–	–	–	–	–		–	–
	–	–	–		–	–	41		–	–		–	–	–	1	–		–	–
	–	–	–		1	–	1		–	–		–	–	–	1	–		–	–
	–	–	–		1	–	–		–	–		–	–	–	–	–		–	–
	–	–	–		–	–	–		–	–		–	–	–	–	–		–	–
	–	–	–		–	2	22		1*	–		–	–	–	–	–		–	–
	–	–	–		2	–	1		–	–		–	3	–	2	–		–	1*
	–	1*	–		–	–	–		–	–		–	–	–	–	–		–	–
	–	–	–		2	–	1		–	–		1	2	–	4	1		–	–
	–	–	–		5	–	1		–	–		–	1	10	1	–		–	–
	–	–	–		–	–	40		–	–		–	–	–	–	–		–	–
	–	–	–		–	–	++		–	–		–	1	–	–	–		–	–
	–	–	–		–	–	2		–	–		–	–	–	–	–		–	–
	–	–	–		–	–	–		–	–		–	–	–	–	–		–	–
	–	–	–		4	–	4		2	–		–	–	–	–	–		–	–
	–	–	–		–	–	–		6	–		–	–	–	5	–		–	–
	1	–	–		2	–	–		–	1		–	–	–	–	–		–	–
	1	–	–		21	–	12		1	–		–	–	–	–	1		1	–
	–	–	1		1	–	2		–	–		–	–	–	–	–		–	2
	–	–	–		–	–	–		–	–		–	–	–	–	–		–	–
	–	–	–		–	–	–		–	–		–	–	–	–	–		–	–

Note
In 1990 I sent a list of *all* the analysed samples to the archaeologist responsible for each trench. The apparent discrepancy between that preliminary list and the final tables published here is due to the fact that two or more samples from the same X/Y position may have been merged into one sample with, so to speak, a prolonged Z level. There thus appear to be fewer samples in the final tables.

Table 5. Table of fruits and seeds from the eastern trench in the flexible system.

	1. CULTIVATED OR COLLECTED	*Hordeum vulgare* (caryopses)	*Hordeum vulgare* (rachis segments)	*Triticum dicoccum* (caryopses)	*Triticum dicoccum* (forks)	*Cornus sanguinea*	*Corylus avellana*	cf. *Glyceria maxima*	*Malus sylvestris* (pips)	*Rubus idaeus*	*Viscum album*	2. WEEDS	*Artemisia vulgaris*	*Polygonum convolvulus*	*Stellaria media*	3. RUDERAL SOILS	*Chenopodium album*	*Polygonum aviculare*	*Rumex longifolius*	*Solanum dulcamara*	4. GRASSLANDS	cf. *Milium effusum*
A2. 223.22/423.61/98.60-56		–	–	–	–	–	–	–	–	–	–		–	–	–		–	–	–	–		–
A3. 223.07/423.73/98.59-53		–	–	–	–	–	–	–	–	–	–		–	–	–		33	–	–	–		–
C1. 221.35-70/423.20-58/98.55-49		–	–	–	–	–	1	–	–	–	–		–	–	–		–	–	–	–		–
C2. 221.04/423.07/98.53		–	1	–	–	–	–	–	–	–	–		1*	–	–		–	–	–	–		–
C3. 221.10/423.80-87/98.50		–	–	–	–	–	1*	–	–	1*	–		–	–	–		–	–	–	–		–
D1. 220.60/423.95/98.57		–	–	–	–	–	1	–	–	–	–		–	–	–		–	–	–	–		–
D2. 220.75/423.40/98.50-43		–	–	–	–	–	–	–	3	–	–		–	–	–		2	–	–	–		–
D3. 220.90/423.90/98.50-48		1	16	–	2	–	–	–	–	–	–		–	–	–		–	–	–	–		–
D6. 220/423-424/98.45-40		–	–	–	–	–	–	–	–	–	–		–	–	–		–	–	–	–		–
D7. 220.70/423.70/98.55-53		1?	–	–	–	–	8(*)	–	2*	–	–		–	–	–		1	–	–	–		–
F1. 223.66/424.29/98.41		–	–	–	–	–	–	–	–	–	–		–	–	–		–	–	–	–		–
F2. 223.05/424.12/98.44		–	–	–	–	1	–	–	–	–	–		–	–	–		–	–	–	–		–
F3. 223/424.10-00/98.44-40		–	–	–	–	–	–	–	–	–	1*		–	–	–		–	–	–	–		–
G1. 222.60/424.71/98.41-40		–	–	1	–	–	1	1*	1(*)	–	–		–	–	–		2	–	–	–		–
G2. 222/424.10/98.45-40		–	–	–	–	–	1	–	–	–	–		–	–	–		–	–	–	–		–
G3. 222.06/424.53/98.45		–	–	–	–	–	1	–	–	–	–		–	–	–		2	–	–	–		–
H1. 221.86/424.23/98.43		–	–	–	1	–	–	–	–	–	–		–	–	–		–	–	–	–		–
H2. 221.88/424.47/98.43		–	–	–	–	–	–	–	–	–	–		–	–	–		–	–	–	–		–
H3. 221.40/424.20/98.45-37		–	–	–	–	–	–	–	8	–	–		–	–	–		9	–	–	–		–
I1. 220.96-99/424.80-85/98.56-54		–	–	–	–	–	30	–	–	–	–		–	–	–		1	–	–	–		–
I2. 220.63-69/424.86-91/98.55-54		–	–	–	–	–	–	–	–	–	–		–	–	–		124	–	–	–		–
I3. 220.17/424.15/98.62-57		–	–	–	–	–	1*	1*	2*	–	–		–	–	–		–	–	–	–		–
I4. 220.25/424.25/98.63-57		–	–	–	–	–	8	–	–	–	–		–	–	–		–	–	–	–		13
I5. 220.25/424.25/98.57-53		–	–	–	–	–	8 + 1*	–	8*	–	–		–	–	–		1	–	–	–		–
I6. 220.02-07/424.67-73/98.53-50		–	–	–	–	–	12	–	–	–	–		–	–	–		–	–	–	–		–
J1. 219.95/424.60/98.54		–	–	–	–	–	–	–	–	–	–		–	–	–		–	–	–	–		–
J2. 219/424/98.68†		1	–	–	–	–	–	–	–	–	–		–	1*	1		2	–	–	–		–
J3. 219/424/98.68‡		–	–	2	–	–	1*	6*	–	–	–		–	–	–		–	–	–	–		–
J4. 219/424/98.56		2	–	–	–	–	6*+15	–	–	–	–		–	–	–		7	–	–	–		–
K2. 223.13/425.08/98.50-45		–	–	–	–	–	–	–	1	–	–		–	–	–		92	1	2	–		–
K3. 223.30/425.70/98.45		–	–	–	–	–	1	–	–	–	–		–	–	–		66	–	–	–		–
K4. 223/425/98.44-40		–	–	–	–	–	–	–	9*	–	–		–	–	–		–	–	–	–		–
L1. 222.94/425.58/98.40-38		–	–	–	–	–	1*	–	2	–	–		–	–	–		–	–	–	–		–
L3. 222/425/98.30-25		–	–	–	–	–	–	–	–	–	–		–	–	–		–	–	–	–		–
M1. 221.20/425.05/98.38		–	–	–	–	–	–	–	–	–	–		–	–	–		–	–	–	–		–
M2. 221.23/425.43/98.39-36		1	–	1	–	–	1	–	–	–	–		–	1*	–		2	–	–	–		–
M3. 221/425/98.51		1	–	–	–	–	–	–	–	–	–		–	–	–		42	–	–	1		–
N1. 220.90/425.25/98.50-48		–	–	–	–	–	–	–	–	–	–		–	–	–		2	–	–	–		–
N2. 220/425.85-99/98.35-30		–	–	–	–	–	–	–	–	–	–		–	–	–		19	–	–	–		–
O1. 219.90/425.75/98.48		–	–	–	–	–	1	–	–	–	–		–	–	–		–	–	–	–		–

† J2 = hearth, uppermost layer
‡ J3 = hearth, "white layer"

5. WETLANDS AND WET MEADOWS	*Carex canescens*	*Epilobium hirsutum/palustre*	*Eupatorium cannabinum*	*Ranunculus sceleratus*	*Stachys palustris*	6. WELLS AND SPRING-MIRES	*Cladium mariscus*	7. FORESTS AND FOREST HERBS	*Betula pubescens* (seeds)	*Betula* undiff. (seeds)	8. HEATHS	*Potentilla erecta*	9. MISCELLANEOUS	cf. *Agrostis* sp.	Asteraceae	Brassicaceae	*Carex* undiff.	cf. *Circium* undiff.	Cyperaceae	Fabaceae	*Melandrium* undiff.	*Polygonum* undiff.	*Stachys* undiff.	10. NOT DETERMINED	12. DROPPINGS	Mouse droppings	Goat droppings
	2	–	–	–	–		–		–	–		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	4	–	–	–	–		–		–	–		–		–	–	–	–	–	1	–	–	–	–	–		–	–
	–	–	–	–	–		–		–	–		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	–	–	–	283	–		–		–	–		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	–	–	–	–	–		–		–	–		–		1*	–	–	–	–	–	–	–	–	–	–		–	–
	–	–	–	–	–		–		–	1		–		–	–	–	–	–	–	–	–	–	–	1*		–	–
	1	5	–	–	–		4		–	2		–		–	1	–	–	–	–	–	1	–	–	–		–	–
	–	–	–	1	–		–		–	1		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	–	2	–	277	–		–		–	–		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	1	–	–	–	–		–		–	–		–		–	–	1	1	–	–	–	–	–	–	–		–	–
	–	–	–	–	–		–		–	–		–		–	–	–	–	–	–	–	–	–	–	–		–	5
	–	–	–	–	–		–		–	–		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	–	–	–	–	–		–		–	–		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	8	–	1	3	–		1		–	–		–		–	–	–	–	–	–	–	–	–	–	–		1	–
	–	–	–	–	–		–		–	–		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	4	–	–	28	–		–		–	–		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	–	–	–	54	–		–		–	–		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	–	–	–	7	–		–		–	–		–		–	–	–	–	–	–	–	–	–	–	1*		–	–
	–	–	–	–	–		1		1	–		–		–	–	–	1	–	–	–	–	1	–	–		–	–
	5	–	–	–	–		–		–	1		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	–	–	–	–	–		–		–	–		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	1	–	–	1	–		–		–	–		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	2	–	–	–	–		–		–	–		1		–	–	–	–	–	–	–	–	–	–	–		–	–
	1	–	–	–	–		–		–	–		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	13	–	–	–	–		–		–	–		–		–	–	–	–	–	–	–	–	1	–	–		–	–
	–	–	4	4	–		–		–	–		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	3	–	–	–	–		–		–	–		–		–	–	–	–	–	–	1*	–	–	–	–		–	–
	1	–	–	–	–		–		–	–		–		–	–	–	–	–	–	–	–	–	–	1*		–	–
	15	–	–	–	–		–		–	2		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	191	–	–	–	1		–		–	1		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	7	–	–	4	–		–		–	–		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	–	–	–	–	–		–		–	–		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	–	–	–	–	–		–		–	1		–		–	–	–	–	1	–	–	–	–	–	–		–	–
	–	–	–	–	–		6		–	–		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	–	1	–	2	–		–		–	–		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	–	++	15	>1000	–		–		–	3		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	56	–	–	–	–		–		–	1		–		–	–	–	–	–	–	–	–	2	1	–		–	–
	–	–	–	–	–		–		–	–		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	–	–	–	–	–		–		–	–		–		–	–	–	–	–	–	–	–	–	–	–		–	–
	–	–	–	–	–		–		–	–		–		–	–	–	–	–	–	–	–	–	–	–		–	–

three ears – the number of the lost (not found) caryopses is, of course, unknown. Two caryopses fell out from one ear fragment before my eyes during the cleaning work, leaving the lemmas and paleas attached to the rachis segment. Below we will look a little more closely at some of these ear fragments.

The ear fragment reproduced in fig. 9a and b consists of one rachis segment which is rather short and broad (L: 2.71 mm, B: 1.23 mm, L/B: 2.20). At this segment one median grain and one lateral grain are attached. The lateral caryopsis is totally enclosed by the lemma and the palea, while the grain wall of the apical part of the median grain is distinctly seen in the ventral view (fig. 9a). The grain wall has minute transverse wrinkles and there is a ridge in the ventral furrow. On the dorsal side of the ear fragment the horseshoe-shaped depression at the lemma base of the median grain is visible (fig. 9b). The ear fragment is consequently of the four-row, naked barley type.

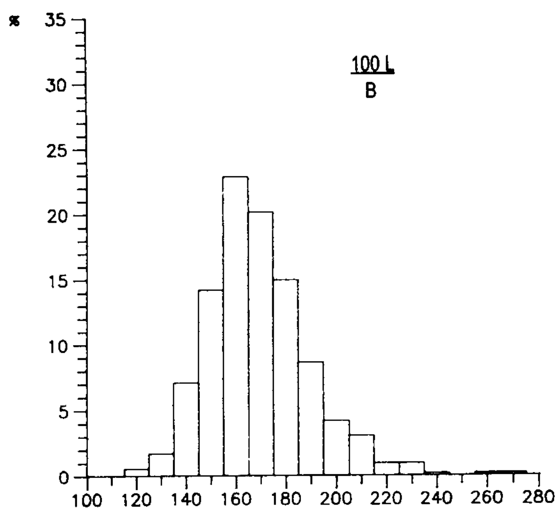
Four other rachis segments from the sample described above have the following dimensions:

1) L: 2.71 mm, B: 1.23 mm, L/B: 2.20
2) L: 3.21 mm, B: 1.11 mm, L/B: 2.89
3) L: 3.27 mm, B: 0.71 mm, L/B: 4.61
4) L: 2.46 mm, B: 0.49 mm, L/B: 5.02

As all caryopses and rachis segments from the sample described above quite likely derive from very few (perhaps only three) ears, the rachis segments ought to have come from different parts of the ears. The basal part of one ear is seen in fig. 11. This basal part of the ear consists of one rachis segment (stalked!) which is attached to the top of the culm. The very slender rachis segment seen in fig. 12 (L: 2.46 mm, B: 0.49mm, L/B: 5.02) may belong to the apical part of a broken ear.

Some beautiful ear fragments have been found in sample WG2, 98.53–52. The ear fragment reproduced in fig. 13 consists of three rachis segments and five caryopses. The middle rachis segment is complete (not broken) and has the measurements L: 2.82 mm, B: 1.03 mm and L/B: 2.74. The rachis segments are distinctly stalked and the caryopses are naked, even if remains of the lemma bases and most of the paleas hide the grains.

The next ear fragment from the same sample consists of two rachis segments and five caryopses (fig. 14). It has not been possible to measure the rachis segments with accuracy as they are damaged. They seem, however, to be of almost the same size as the one described above. We can observe that the two lateral caryopses to the right are distinctly twisted, which is characteristic of four-row barley. Three grains are of the naked type (wrinkled grain wall, ridge in the ventral furrow) although remains of lemmas and paleas are attached to the grain.



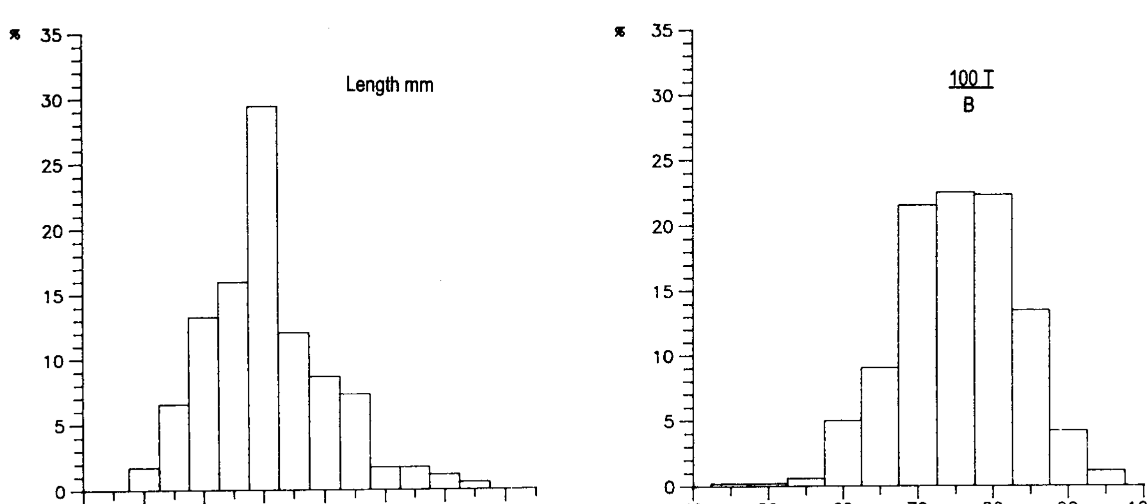


Fig. 6. Histogram of caryopses of *Hordeum vulgare* var. *nudum* (in the main naked four-row barley). Some caryopses of hulled six-row type *may* be included (according to earlier investigations – see text). (N = 521.)

The third ear fragment from the same sample is seen in fig. 15. It consists of one broken, distinctly stalked rachis segment and one complete segment with an attached caryopsis. This complete rachis segment is of a distinct naked four-row barley type – it is stalked and has the following measurements: L: 3.11 mm, B: 0.99 mm and L/B: 3.14. The caryopsis is thus of the naked type, even if there are remains of the lemma and the palea attached to the grain. The lemma base has a horseshoe-shaped depression at the base.

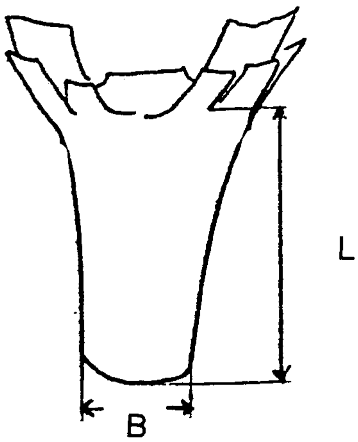
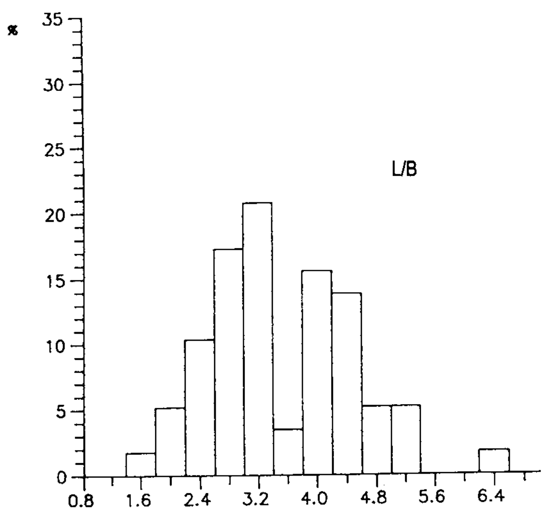


Fig. 7a Rachis segments of *Hordeum vulgare*. L = length of internode, B = breadth of internode. After Jacomet 1987.

Fig. 8. Rachis segments of naked four-row barley from sample WD1, 98.53–52.



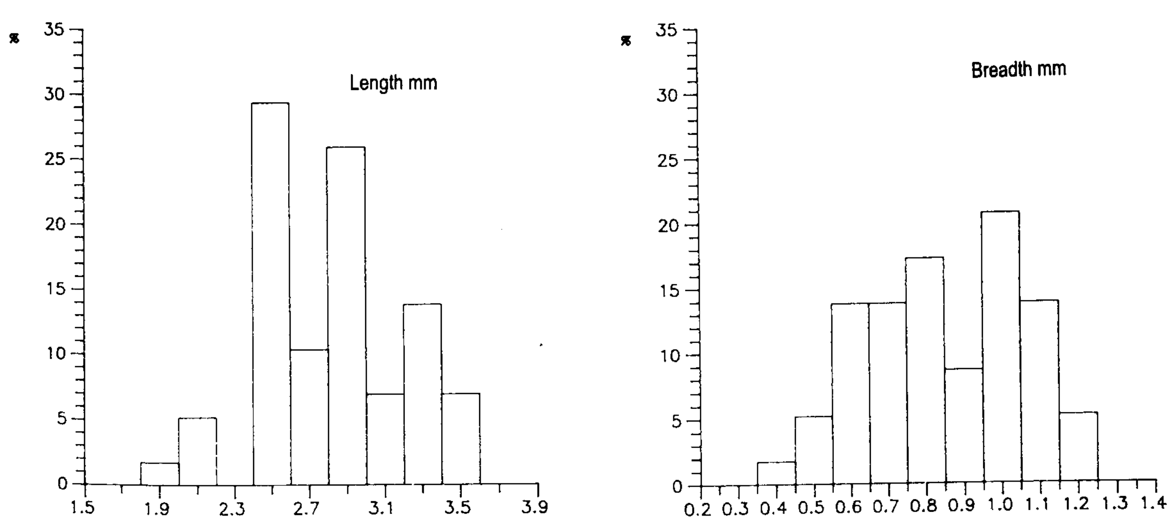


Fig. 7b. Histograms of internodes of *Hordeum vulgare* var. *nudum*. (N = 58.)

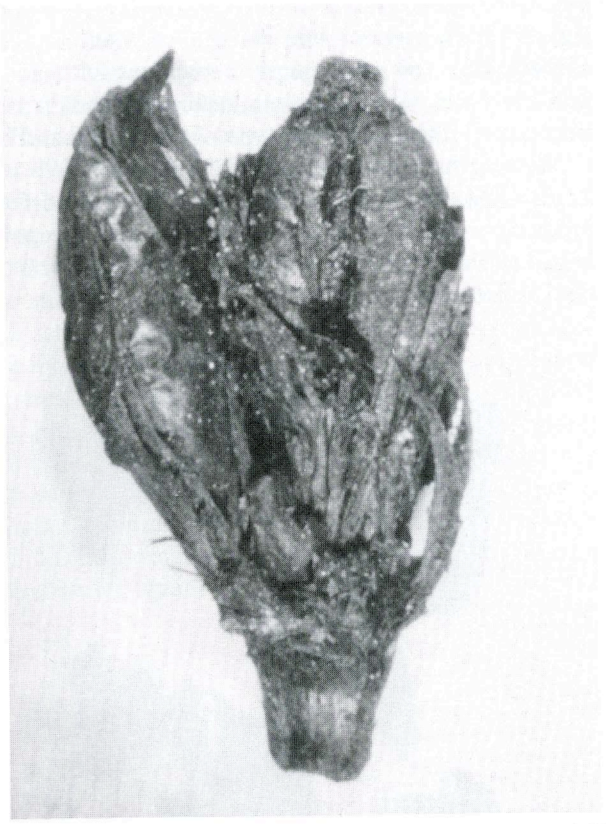


Fig. 9a. Ear fragment of naked four-row barley from MD1, 98.60–59. Ventral view.

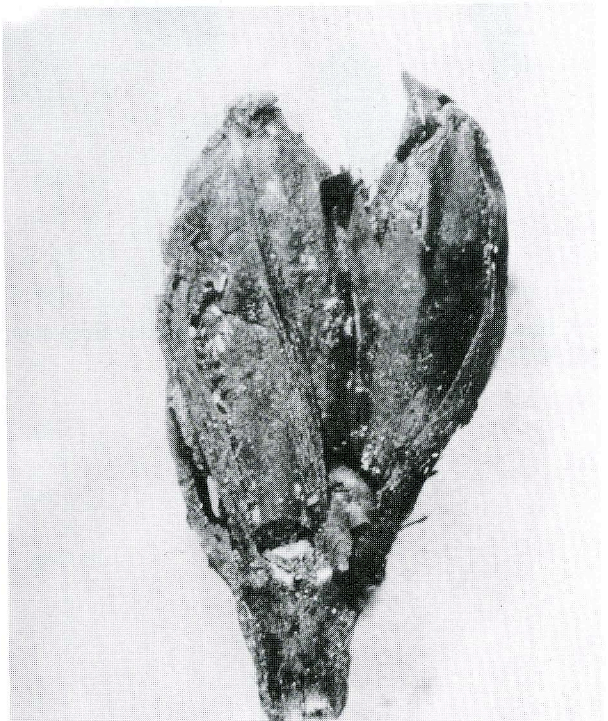


Fig. 9b. The same as 9a, dorsal view.

Fig. 10. Three caryopses of naked four-row barley from the same sample as 9 (MD1, 98.60–59).

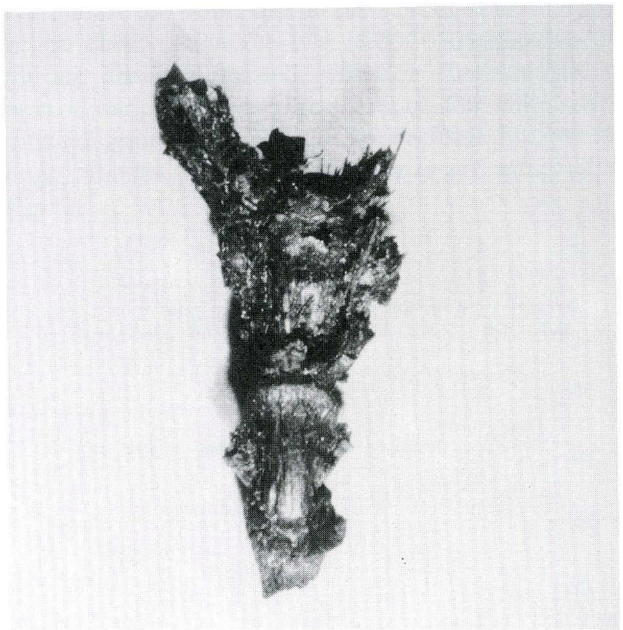


Fig. 11. Basal part of an ear fragment from the same sample as figs. 9–10.

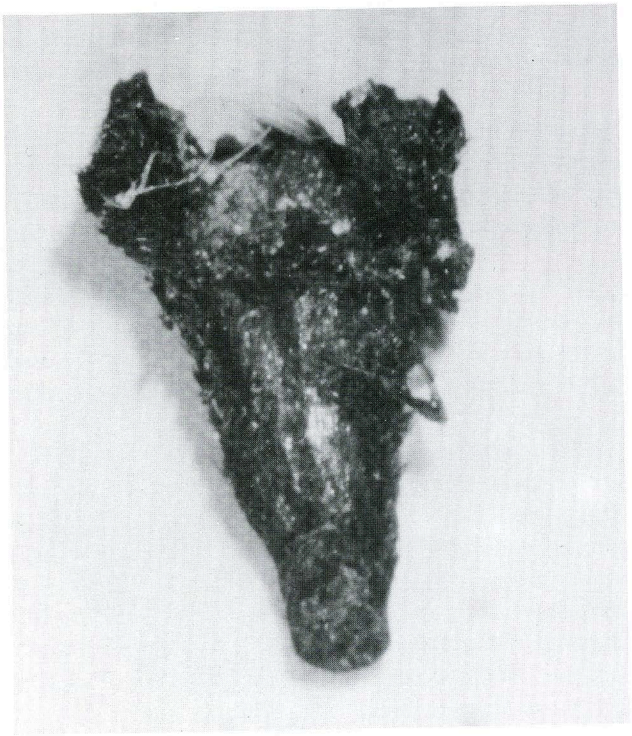


Fig. 12. Rachis segment from the upper part of an ear from the same sample as figs. 9–11.

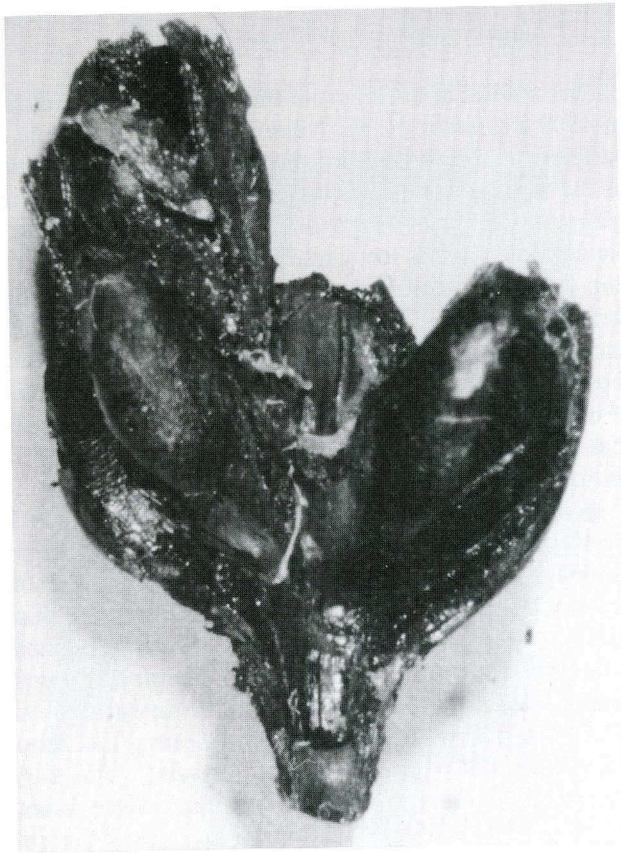


Fig. 13. Dorsal view of an ear fragment from sample WG2, 98.53–52.

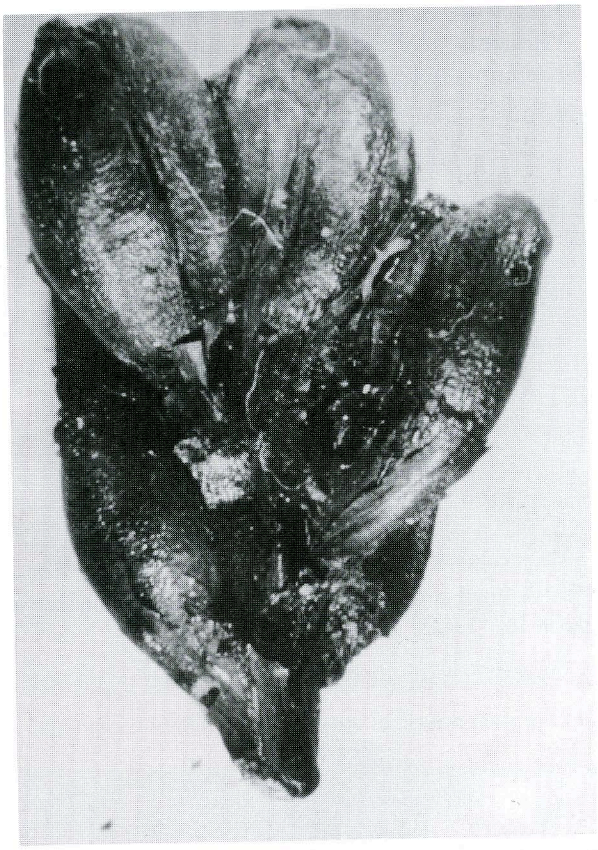


Fig. 14. Another ear fragment from sample WG2, 98.53–52. Ventral view, twisted lateral grains.

Fig. 15. Ear fragment of naked four-row barley from the same sample as figs. 13 and 14.

Fig. 16a shows small (4.74 mm) grain from the same sample. The ventral side (fig. 16a) has minute wrinkles and a ridge in the furrow. The dorsal view (fig. 16b) shows a beautiful horseshoe-shaped depression at the base of the lemma. Two other ear fragments from the same sample show the same *nudum*-features. Of all loose caryopses found in this sample from WG2, 182 are almost totally naked while 18 have paleas and lemmas –

the latter with horseshoe-formed depressions. Thus all ear fragments and all caryopses found in this sample derive from naked four-row barley.

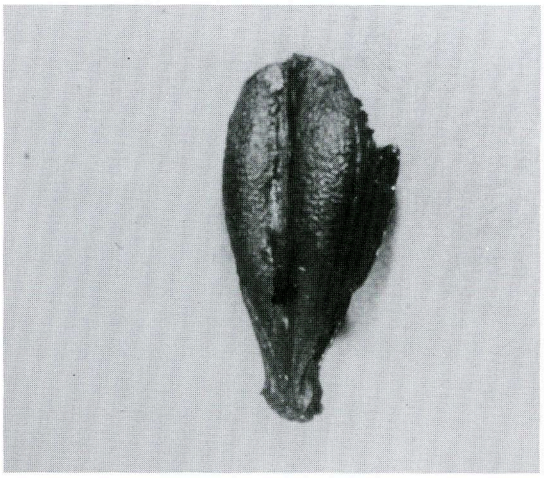


Fig. 16a. A small grain of naked four-row barley from the same sample as figs. 13–15. Ventral view.

Fig. 16b. The same as 16a, dorsal view.

A few barley grains seem not to be completely carbonized or they were not carbonized in a "normal" way. The grain wall is not black but brown while the inner parts are black. The caryopses were probably very swollen before they were heated. The grain wall in most cases has burst at the side of – and parallel to – the ventral furrow (fig. 17). The grains are naked and very large, for instance L: 8.46 mm, B: 5.54 mm and H: 4.10 mm. They are preserved in "Hantzsch's solution" (alcohol + water in the proportion of 1 to 5 with a little glycerine and some thymol crystals added) and thus the swelling is maintained.

Fig. 17. Large caryopsis of naked four-row barley.

Earlier studies of barley from the Alvastra pile dwelling
In 1909 Professor N. H. Nilsson received a sample of barley from Dr O. Frödin, the leader of the excavation of the Alvastra pile dwelling. "More than probably the grains derive from *Hordeum hexastichum* ... strangely enough, the chaff is lost while the grain proper – with its thin-walled, starch-filled parenchym – is so astonishingly well preserved. ... The grains were, however, probably enclosed from the beginning by the chaff which came loose when the barley was charred" (Nilsson in Frödin 1910:65, freely translated by me). Nilsson thus suggested that the barley from the Alvastra pile dwelling was of the six-row hulled type.

In his Bundsø paper K. Jessen (1939) mentions N. H. Nilsson's pictures of the barley from the Alvastra pile dwelling. Jessen comes to the conclusion that "Nilsson's supposition is not probable" (1939:79). Jessen thinks that the barley from the Alvastra pile dwelling is naked.

In 1943 O. Frödin sent about 75 samples containing "mainly corn" to Statens Centrala Frökontrollanstalt (The National Swedish Central Seed Testing Institution) (Berggren 1956). According to Berggren, "the barley was, in the main, not naked". The lemmas were, according to the Seed Testing Institution, of "six-row *erectum* alfa- and beta-type" (Berggren 1956:100). As far as I know it was demonstrated already in the middle of the 1950s that it is not possible to distinguish any alfa- or beta-types of barley by studying the teeth of the lemmas of barley (Osvald 1959:103). In my opinion, most of the caryopses reproduced by Berggren are of the naked type and not of the hulled type. It seems as if Berggren did not perform the determination of barley herself. Probably she asked the Seed Testing Institution to do this work.

Hjelmqvist studied both carbonized cereal grains and impressions in ceramics of cereals from the Alvastra pile dwelling (Hjelmqvist 1955). He concluded that the majority of the carbonized barley grains belong to the naked type.

Hjelmqvist also studied some ear fragments of barley from the Alvastra pile dwelling and he summarizes: "Zwei Typen waren hier unterscheidbar: der eine, gewöhnlichere, hauptsächlich aus losen Gliedern bestehend, zeigte eine Gliederlänge von 3–4 mm, der zweite, der ungewöhnlicher war, kam oft in grösseren Ährenpartien vor und wies eine Gliederlänge von ca. 2–2.5 mm auf. Der erstere Typus muss zur 4-zeiligen, der letztere zur 6-zeiligen Gerste gehören. In einem Falle fanden sich an einer Partie des 4-zeiligen Typus mit langen Gliedern teils leere Spelzen, teils ein Korn mit lockerem Schluss der Spelzen. Dadurch zeigte sich also, dass der 4-zeilige Typus hier zur Nacktgerste gehörte, wie dies auch von einem zweiten Fragment gezeigt wurde. In einem anderen Falle fand sich an einem Ährenstück vom 6-zeiligen Typus ein Ährchen mit teilweise vorhandenen, fest schliessenden Spelzen. Hier handelte es sich folglich um die Spelzgerste. Es ist also klar, dass die Nacktgerste wenigstens teilweise vom 4-zeiligen Typus und die Spelzgerste wenigstens zum Teil 6-zeilig war."

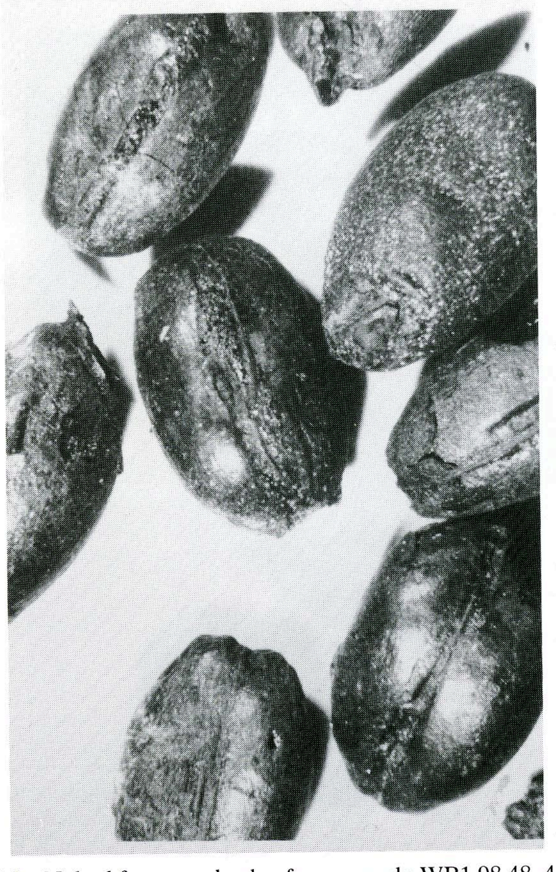


Fig. 18a. Naked four-row barley from sample WB1,98.48–44.

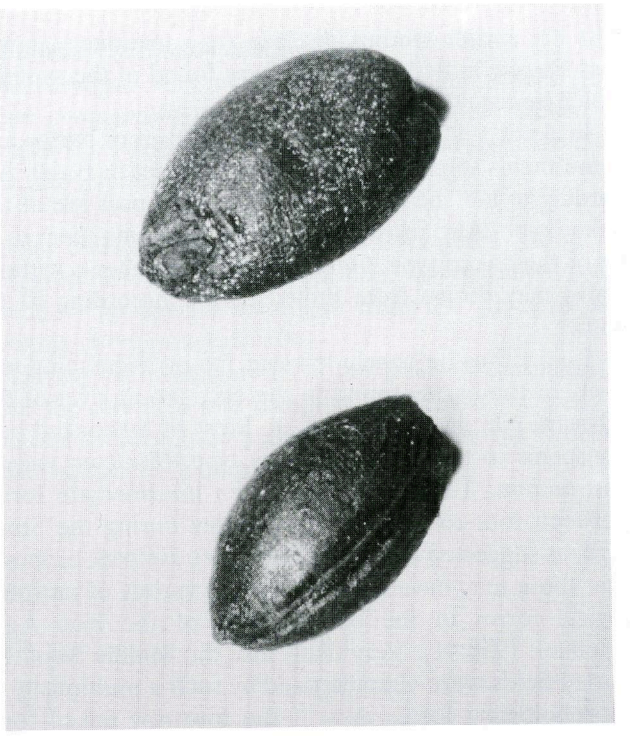


Fig. 18b. Naked four-row barley from the same sample as 18a.

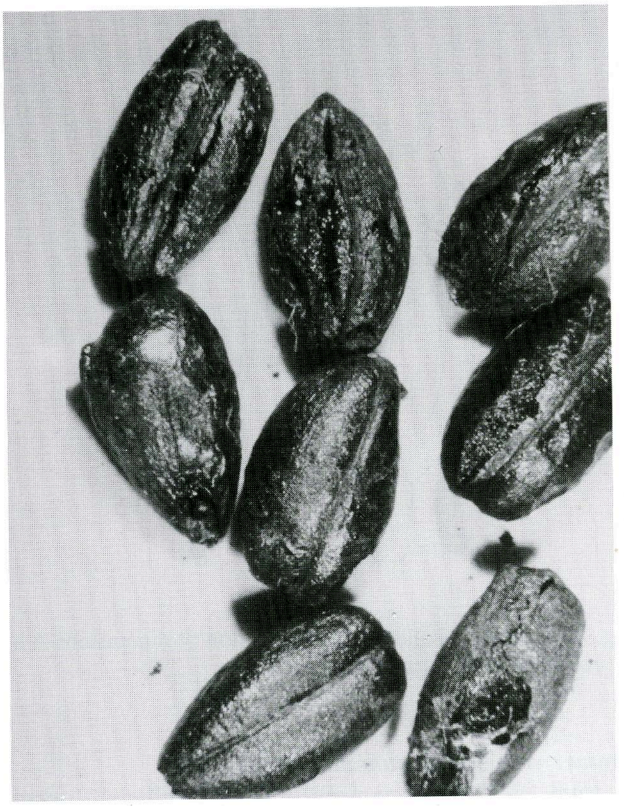


Fig. 19. Naked four-row barley from sample MN1, 98.62–60.

By studying impressions of barley in ceramics from the Alvastra pile dwelling Hjelmqvist came to the conclusion that the impressions derive from four-row, naked barley. Almost all caryopses of barley which I have shown Hjelmqvist predominantly belong to the naked type, according to him. Hjelmqvist, however, underlines that his earlier studies disclose (as mentioned above) that six-row hulled barley also was found in the samples which he received in the 1950s.

In April 1990 I sent about 25 caryopses of barley and some rachis segments to Stefanie Jacomet in Basel. According to her the main part of the caryopses are of the naked type. Also most of the rachis segments seem to to be of the naked type. Only one or two segments without stalks may derive from hulled barley, according to Jacomet.

It may thus be concluded that the overwhelming majority of the barley found in the occupation layer of the Alvastra pile dwelling is naked. Most of this naked barley seems to be of the four-row type, *Hordeum vulgare* var. *nudum*. There may have been intermediate forms between four-row and six-row barley during the Stone Age, as suggested by Jessen (1939:79). Helbæk proposes that there may have existed "a great variety of morphological forms in the barley fields of the Iron Age" (Helbæk 1958:91). Very likely also the Middle Neolithic barley fields were characterized by such a multiplicity of morphological forms even if the four-row naked form seems to have dominated in the Alvastra area.

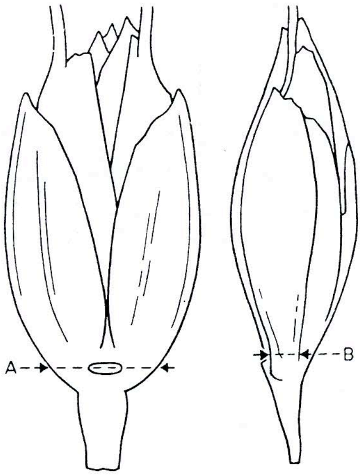


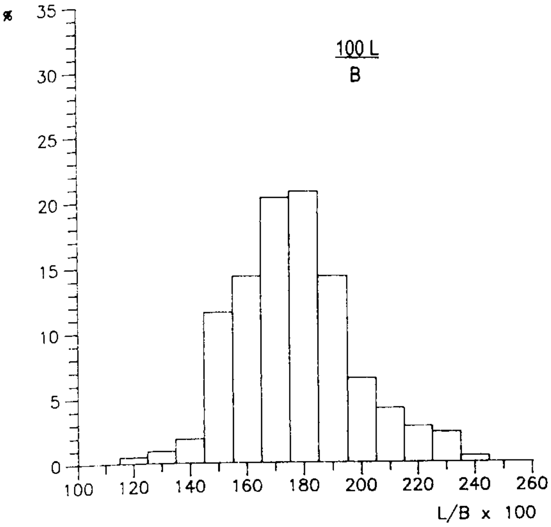
Fig. 20. Emmer spikelet with the location of dimensions A and B (van Zeist 1968, after Helbæk 1952).

Emmer wheat (*Triticum dicoccum*)

A total of 1256 caryopses and 156 spikelet forks of emmer wheat (*Triticum dicoccum*) were found during my analysis of the seeds. The caryopses are of very typical emmer form, as are the spikelet forks. As in the case with the barley caryopses, a few emmer caryopses seem not to be completely carbonized (or carbonized after having been saturated?). They are very large – for instance 7.69 × 4.36 × 3.46 mm (in sample ME4). They are stored in Hantzsch's solution (cf. above). If dried they probably would shrink considerably.

Fig. 21. *Triticum dicoccum* from sample ME4, 98.68.

Fig. 22. *Triticum dicoccum* from sample WA1, 98.46–42.



Club wheat (*Triticum compactum*)
One caryopsis very much resembling club wheat (*Triticum compactum*) was found in the middle trench in sample E3. Hjelmqvist also refers this caryopsis to club wheat in a letter to me (12.12.90).

Earlier finds of *Triticum* in the Alvastra pile dwelling
Berggren has recorded "*Triticum* sp." as the only type of wheat in her species catalogue from the Alvastra pile dwelling (Berggren 1956:104).

During his investigations in the 1950s of the material from the Alvastra pile dwelling Hjelmqvist recorded a find of a spikelet and a spikelet fork of einkorn (*Triticum monococcum*) (Hjelmqvist 1955:32).

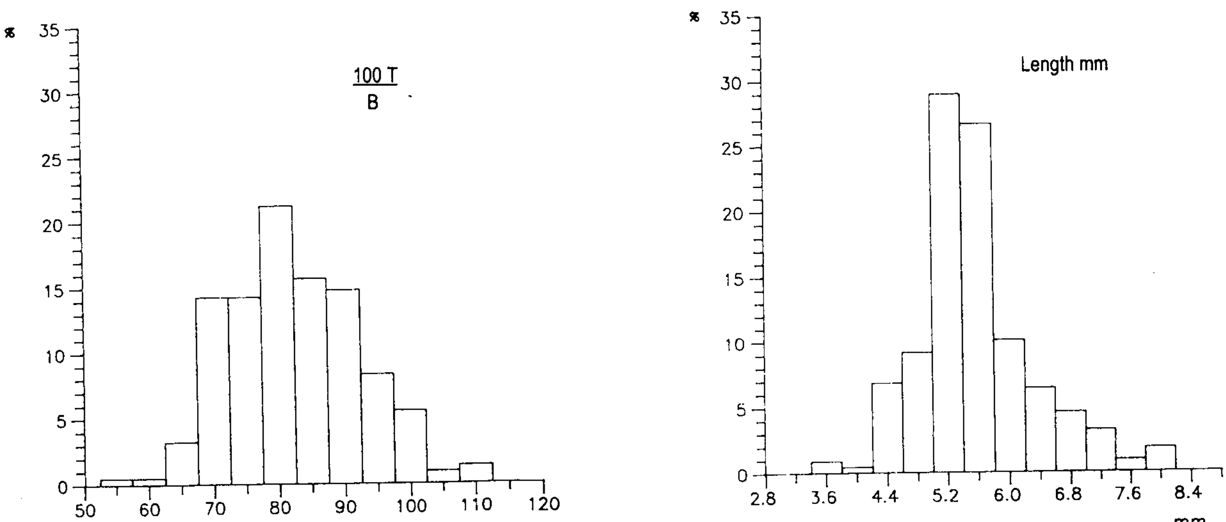


Fig. 23. *Triticum dicoccum* caryopses (N = 218).

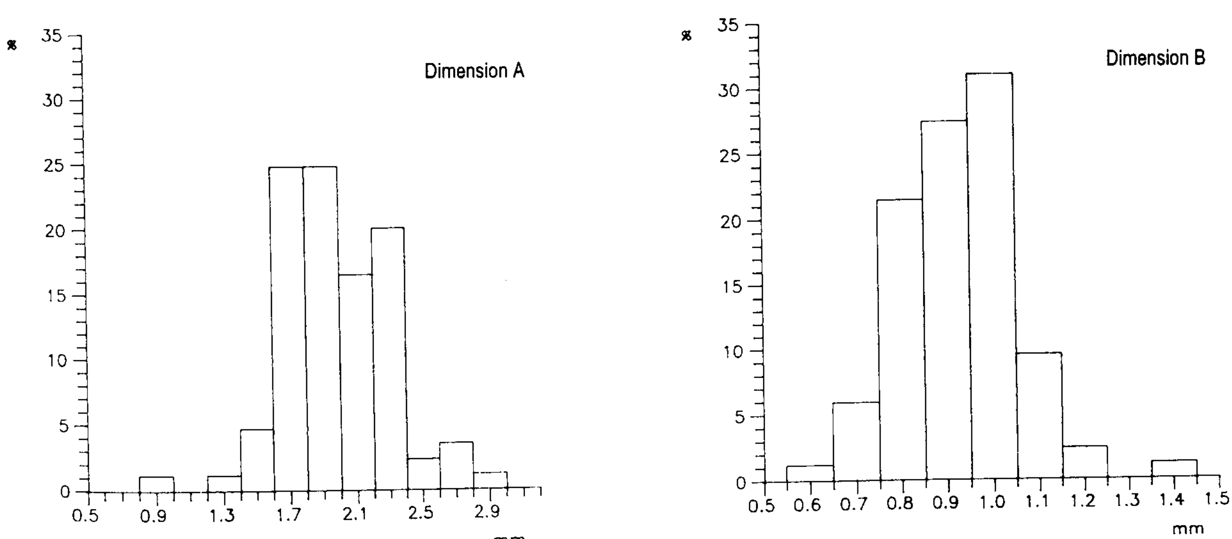


Fig. 24. *Triticum dicoccum*. Spikelet forks, dimension A (N = 85) and dimension B (N = 84).

Fig. 25. *Triticum dicoccum*, spikelet forks from sample ME 4, 98.68.

Fig. 26. *Triticum dicoccum,* spikelet forks from sample WA3, 98.465–440.

Rye (cf. *Secale cereale*)

Berggren reported two caryopses of cf. *Secale cereale* from the occupation layer of the Alvastra pile dwelling. I myself found a few caryopses which very much resembled *Secale.* Hjelmqvist scrutinized these caryopses and came to the conclusion that they most likely were caryopses of naked barley "imitating" *Secale.*

The earliest finds of *Secale* in Sweden have been made by Hjelmqvist, who found carbonized rye caryopses in an occupation layer of Late Neolithic age at Piledal in Scania (Hjelmqvist 1992). (Rye grew as a weed in the Late Neolithic fields.) Hjelmqvist thinks that in the future we may expect finds of *Secale* which are older than the Late Neolithic (Hjelmqvist, pers. comm.). Berggren's observations may thus be correct.

Cereals not determined (Cerealia undifferentiated)

The cereals registered in the column "Cerealia undiff." all originate from caryopses which were badly damaged when they got charred. The majority of these undifferentiated cereals – to all appearances – originate from both *Hordeum vulgare* and *Triticum dicoccum.*

Dogwood (*Cornus sanguinea*)

Two non-carbonized stone fruits of dogwood (*Cornus sanguinea*) were found in the eastern trench in two different samples (F2 and L4). Berggren has reported about a dozen non-carbonized stone-fruits of dogwood from the Alvastra pile dwelling. "According to Hegi (1926) the fleshy perianth as well as the stone fruits contain 35–45 per cent of a very liquid oil which has been used in certain areas, until recent times, as a fuel oil. It has also been tried as a cooking oil. Arduino, for instance (*Leipziger Intelligenzblatt* 1769), kept the fruits for some time on the ground until they got dry after which he crushed them. Then he placed the crushed fruits in a bag which for a short time was placed in gently boiling water. After that he pressed out with his hands 1.5 kilos of oil from 3.5 litres of fruits. The flavour was like that of industrial olive oil" (Berggren 1956:102f.). Jankuhn (1969:228) suggests that fruits of dogwood were used as food.

Arrow-shafts were made of shoots of dogwood during prehistoric time (Hjelmqvist pers. comm.). One of the Swedish names for *Cornus sanguinea* is "hårdved" ("hardwood") – the wood of this bush being extremely hard, tough and even.

Hawthorn (cf. *Cratægus*)

A non-carbonized stone-fruit of possible hawthorn (cf. *Cratægus*) was found in the occupation layer in sample H2 in the middle trench. Fruits of hawthorn have been used as a substitute for meal (Ingmanson 1983:167). The fruits may also have been eaten directly (Jankuhn 1969:228).

Hazelnuts (*Corylus avellana*)

A great many both carbonized and non-carbonized hazelnut shells have been registered in the species tables. Most of the nuts were cracked. In the tables 7.5 g of wet nutshells correspond to 8 whole, wet and empty nuts. The archaeologists have found hazelnut shells in all trenches (except the test trench) but they have, of course, not collected all these small fragments.

Only whole (not cracked) hazelnuts were collected in the field (a total of four whole nuts were given to me). Thus in the species lists most of the nuts registered derive from crushed shells picked out from the soil samples which were sent to me. According to the species tables, most nuts were found in the eastern trench. One of the whole nuts has been gnawed by a mouse.

Berggren has registered two whole nuts and "considerable amounts of nutshells". During his first excavation year Frödin found "great amounts of crushed hazelnut shells" (1910a:50).

Fig. 27. Hazelnuts and nutshells from the occupation layer.

Fig. 28. Carbonized, probable *Glyceria maxima* from sample EJ3, 98.68, from a hearth layer.

Great water grass (cf. *Glyceria maxima*), sweet-grass (cf. *G. plicata*) and flote-grass (*Glyceria fluitans*)

In the eastern trench eleven carbonized grass caryopses were found in sample J3 in a "white layer" (ashes?) in a hearth (fig. 28) and in sample G1 another caryopsis of the same type was found. I delivered them to Hjelmqvist, who studied the grains in detail. Hjelmqvist suggests that these caryopses may derive from great water grass (*Glyceria maxima*). Another carbonized grass caryopsis was found in the same trench (in sample I3). It was sent to Marlies Klee, who told me that the determination was very difficult but that the caryopsis might have come from sweet-grass (*Glyceria plicata*).

In the middle trench (sample A4) a carbonized caryopsis of *Glyceria fluitans* was found together with *Hordeum vulgare*, *Triticum dicoccum*, *Polygonum convolvulus* etc. The determination was done by H. Hjelmqvist. It seems very likely that all the suggested caryopses of the *Glyceria* species found in the occupation layer were collected. They are thus placed in group 1, "Cultivated or collected".

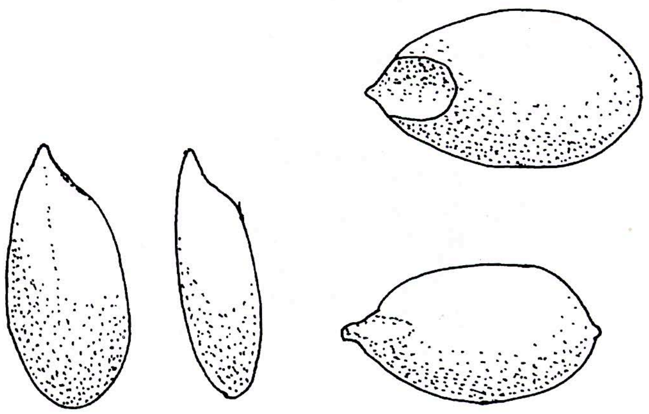


Fig. 29. Probable *Glyceria maxima* from sample EJ3, 98.68. Drawing: H. Hjelmqvist 1991.

Magnusson has not reported any pollen grains of *Glyceria* type from the occupation layer (Magnusson 1964).

Genuine semolina (Swedish "mannagryn") is today produced from seeds of *Glyceria fluitans* and *Glyceria plicata*.

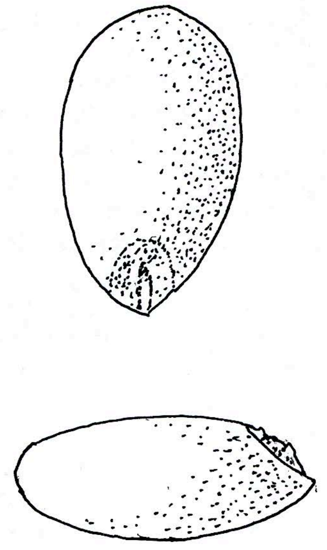


Fig. 30. Recent *Glyceria maxima* (*G. spectabilis*). Drawing: H. Hjelmqvist 1991.

Apple (*Malus sylvestris*)
Several finds of both carbonized and non-carbonized seeds (pips) of wild apple (crab apple) (*Malus sylvestris*) have been made during the excavation season 1976–80. Also some carbonized cores and slices of wild apple were found. Sometimes ears of barley were pasted on a carbonized porous mass of "apple-sauce". Such material is pressed out from fresh apples when they are heated and carbonized. Berggren also reported several finds of both non-carbonized and carbonized apple pips, a carbonized apple core and carbonized apple skin from the Alvastra pile dwelling (Berggren 1956: 108). Hjelmqvist also found some apple pips (Hjelmqvist 1955: 33).

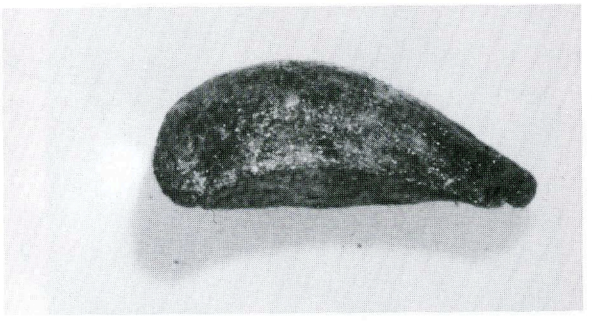


Fig. 31. Carbonized apple pip (*Malus sylvestris*) from WA3, 98.465–440.

During the excavation season of 1909–1917 several carbonized apple slices were found in the lower part of the occupation layer and on the floor and between the logs. These apple slices were studied by Thorild Wulff, who writes: "The material consists of carbonized slices of apple fruits, partly smaller fragments, partly halved fruits. They are so well preserved that fruit-skins, pulps, cores (with their parchment walls) and pips could be easily discerned. The pips seem to have been fully developed and the fruits thus have been collected in full-ripe conditions. One has the distinct impression that the fruits were intentionally cut into slices, probably in order to dry and to do duty as winter supply. In most cases the apples were longitudinally sliced; only in a few cases were the apples cut straight across. The cores were never removed; they were, on the contrary, left on all the apples. One gets the impression that the apples were dried before getting charred, because it can be observed that the fruit-flesh and the fruit-skin of the most well-preserved apple-pieces shrivelled before the carbonization, in the same way as fruits shrivel by air-drying. Fruits which are carbonized in a fresh condition keep – after the carbonization – a smooth sectional area and a smooth skin. All observations here recorded are almost point-by-point of the same type as those Oswald Heer (Heer 1865) found typical of the apples found in the Swiss and North Italian pile dwellings" (Wulff in Frödin 1910a:66f.).

Fig. 32. Carbonized apple pips (*Malus sylvestris*) from MN3, 98.67. In the pip to the left a carbonized larva can be seen.

Heer found two types of apples in the lakeside dwellings, the smaller wild apple (crab apple) and the larger "cultivated" form ("Pfahlbauapfel"). Wulff was also able to report two orders of sizes of apple from the Alvastra pile dwelling, namely, the small wild apple with a length of 15–24 mm and a breadth of 18–27 mm and the larger, round "pile-dwelling apple" with a length of 29–32 mm and a breadth up to 30 mm.

During Frödin's subsequent excavation many more carbonized and non-carbonized apples and apple fragments were found in the occupation layer of the Alvastra pile dwelling. These finds were examined by the pomologist C. G. Dahl (1945:253ff.): "Even if the characters of the apples do not completely conform to the characters which Heer – and after him Wulff – state as secure indications that the apples were dried before the carbonizaton, it cannot be doubted that these fruits were once dried in order to be kept as a foodstuff."

Fig. 33. Carbonized apple pips from WB1, 98.48–44.

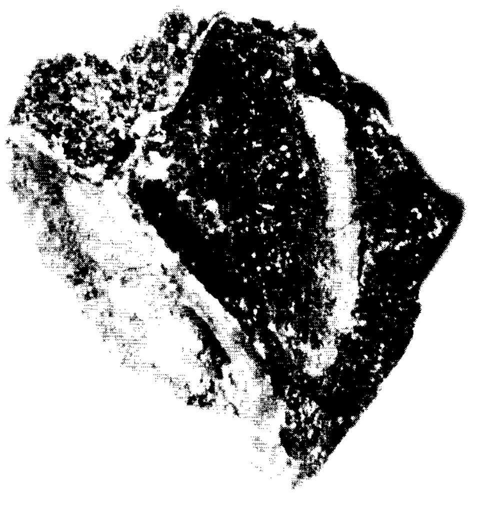


Fig. 34. Carbonized apple-core with an imprint of a pip. WC1, 98.51–49.

Dahl found that there were no sharp limits between "small" and "larger" apples. According to him there may, if anything, be three size groups, namely: a) 24 × 24 mm (N = 22), b) 30 × 27 mm (N = 10) and c) 33 × 29mm (N = 5) (Dahl 1945:255). Dahl was able to demonstrate that the largest apple found in the Alvastra pile dwelling ought to have been about 55 × 44 mm in fresh condition.

Dahl's observations mean that rather big apples were found during the Early Middle Neolithic in Southern Sweden. Helbæk noticed that there was a great variety in size of wild apples which grow on Bornholm today, some as large as the "Pfahlbauäpfel" (Helbæk 1952). Thus the big apples found in Alvastra and in other "pile dwellings" most probably were wild apples (crab apples) which came from crab apple trees with large fruits. This supposition has also been underlined by Villaret-von Rochow (1969:201f.).

Dahl suggested that the Middle Neolithic farmer might have been able to graft twigs of large-fruited trees on to other wild-apple trees – in the vicinity of the settlements – with the aid of clay (as inocculent) and lime bast. Bertsch, however, underlines that German words to do with grafting all derive from monastic Latin. Thus real fruit-growing ought to have been introduced into Central Europe during the 7th or 8th century (Bertsch 1947:102).

According to Bertsch, the apple pips pass man's intestinal canal without being destroyed. In this way the apple pips were "planted" in a well-manured environment in the vicinity of the settlements. As Neolithic man preferred the largest and most palatable fruits, a sort of a selection thus took place which favoured large-fruited trees at certain places (Bertsch 1947:96). The probability that the crab apples were actively maintained in the vicinity of the pile dwelling seems to be confirmed by Bartholin's investigations (see below).

That apple slices were dried on the warm hearthstones in the Alvastra pile dwelling is an important observation. If offerings to the higher divinities were the only activities carried on at that site then the drying work seems an unnecessary occupation. It thus seems as if also rational activities took place in the pile dwelling. This suggestion is also confirmed by the archaeological studies (Browall 1986).

Table 6. Dimensions in mm for pips of *Malus sylvestris* (carbonized and non-carbonized) from Alvastra pile dwelling.

	min.	aver.	max.
carbonized			
length (N=6)	6.09	6.44	6.79
breadth (N=7)	2.56	3.26	3.97
non-carbonized			
length	4.10	6.28	7.95
breadth	2.56	3.82	4.62

Wild apples (crab apples) are good to eat after having been roasted. I myself have many times eaten crab apples after putting them into aluminium foil and placing them on an open fire or live coal. "Wines" were probably also produced by fermenting sauce of wild apples, as suggested by Keller (referred to in J. Renfrew 1973: 138).

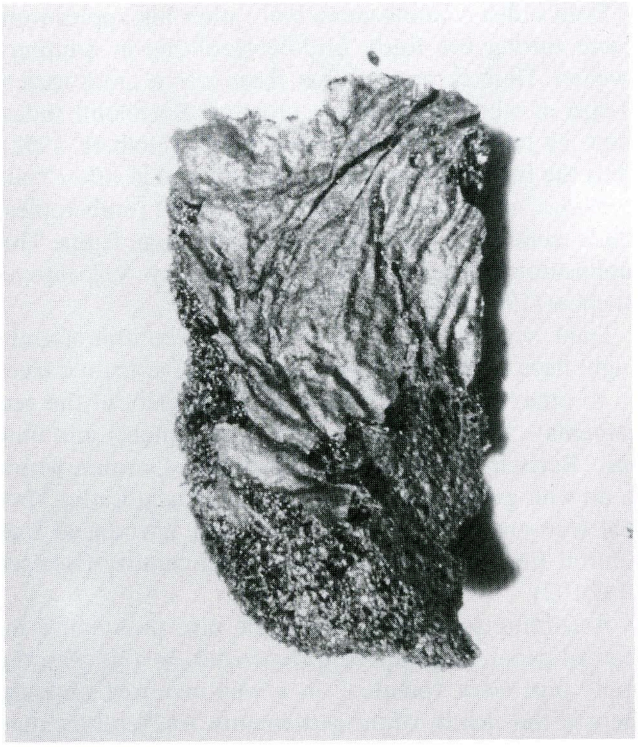


Fig. 35. Carbonized slice of apple with crumpled skin. The slice was probably dried before being heated – only dried apples get such a shrivelled skin. WC1, 98.51–49.

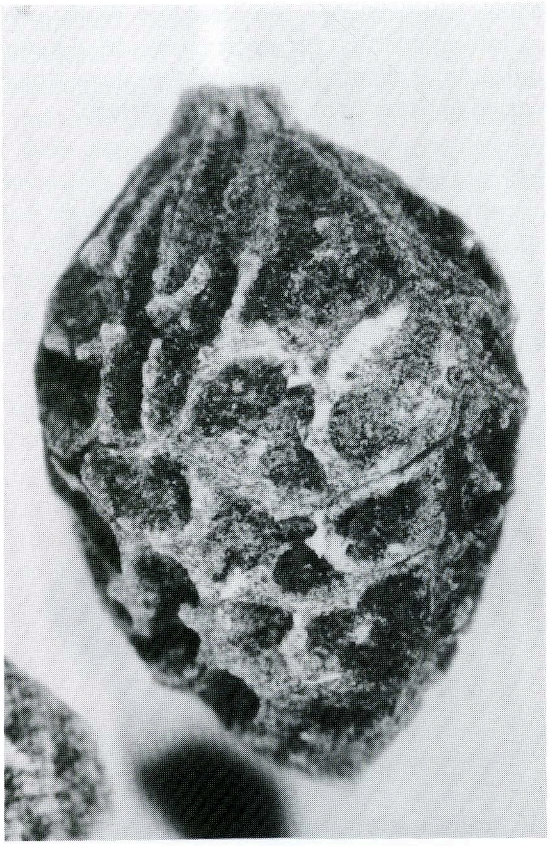


Fig. 36. A non-carbonized fruit-stone of bird-cherry (*Prunus padus*) from sample MH3, 98.60–58.

Bird cherry (*Prunus padus*)

A little heap of 24 non-carbonized fruit-stones of bird cherry (*Prunus padus*) was found in the middle trench in sample H3 on bark and twigs (fig. 36). This heap cannot be the remains of a ripe raceme that fell from a tree. It could be the dissolved remains of a berry-eating animal's dropping. More probably this sample suggests that bird cherry was collected by the Middle Neolithic forest farmer. The berries are edible and even tasty after they have been frost-bitten. A few other non-carbonized stone-fruits of bird cherry were found in the test trench.

Table 7. Dimensions in mm for *Prunus padus* (non-carbonized) from Alvastra pile dwelling (N=4).

	min.	aver.	max.
length	6.41	7.05	8.21
breadth	4.62	5.07	5.77

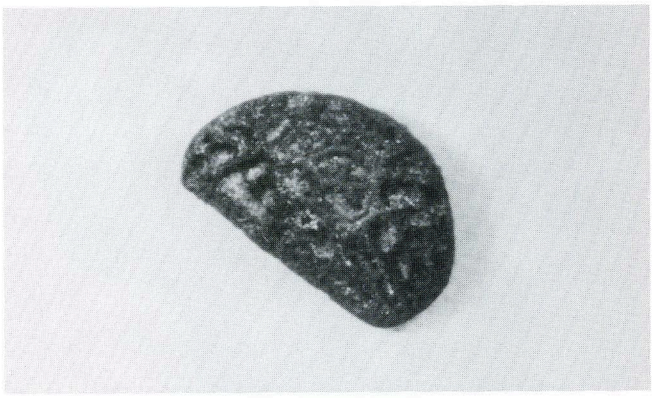


Fig. 37. A carbonized stone-fruit of raspberry (*Rubus idæus*) from sample EC3, 98.50. Dimension: 1.85 × 1.16 mm.

Raspberry (*Rubus idæus*)

Twenty non-carbonized seeds (stone-fruits) of raspberry (*Rubus idæus*) have been recorded. Raspberry has grown on the pile-dwelling area in recent times too, and five seeds of probable recent age were found in the peat overlying the occupation layer in the test trench and in the middle trench. The other raspberry stone-fruits clearly belong to the occupation layer, and one was carbonized (fig. 37).

Table 8. Dimensions in mm for *Rubus idæus* ((non-carbonized) from Alvastra pile dwelling (N=6).

	min.	aver.	max.
length	1.80	2.23	2.56
breadth	1.11	1.31	1.53

Two stone-fruits may derive from dewberry (*Rubus cæsius*), the seeds of which are larger than those of raspberry (see, for instance, Fredskild 1978). These two possible dewberry seeds are referred to as *Rubus* cf. *R. cæsius* in the species table. Berggren recorded six non-carbonized seeds of raspberry from the Alvastra pile dwelling (Berggren 1956:108).

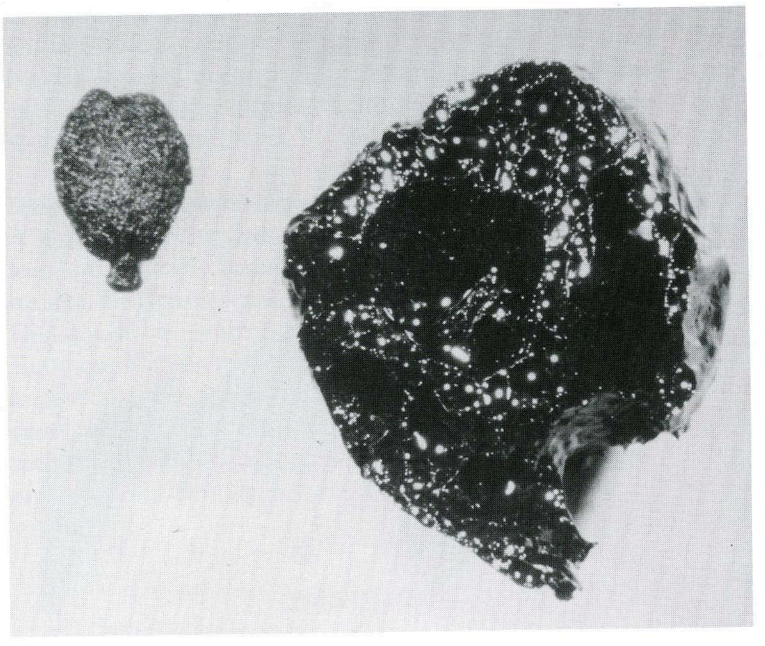


Fig. 38. Mistletoe (*Viscum album*), sample EF3, 98.44–40. To the right the carbonized fruit in which the carbonized seed (to the left) was found.

Mistletoe (*Viscum album*)
A carbonized berry of mistletoe (*Viscum album*) with a well-preserved carbonized seed was picked out from the occupation layer by the archaeologists (fig. 38). The determination was performed by H. Hjelmqvist. This very unusual find demonstrates that mistletoe played some role in Middle Neolithic man's life and conceptual world. Bartholin found many twigs of mistletoe on the floor of the pile dwelling (Bartholin 1983: 27).

The pollen diagrams from the pile dwelling give abnormally high values of *Viscum* (Magnusson 1964, Göransson 1987). Besides being a cult plant, mistletoe has also been used as a fodder plant (Troels-Smith 1960, Rasmussen, e.g. 1993) (see further below).

Crowberry (*Empetrum nigrum*)
Two non-carbonized seeds (stone-fruits) of crowberry (*Empetrum nigrum*) were found in the occupation layer in the test trench (fig. 39). As the seeds occurred together with a crab apple pip and nuts of fat hen (*Chenopodium album*), they might have been collected. The berries are edible and can be used together with other more palatable berries.

As crowberry grows on heaths and *Sphagnum* bogs, these two seeds thus reflect the presence of small heath-like areas or bogs (Dags Mosse!) situated not too far from the pile dwelling. For that reason *Empetrum nigrum* is placed in group 8.

Earlier finds of species belonging to group 1
During her investigations of the seeds from the Alvastra pile dwelling in the 1940s Berggren found one carbonized acorn (*Quercus* undiff.). Acorns have been found in many archaeological deposits in Europe from Neolithic Time (see, for instance, Renfrew 1973:154f., Jørgensen 1977). "If acorns are cooked several times until the water is no longer bitter the acorns may be used in several ways. Meal of acorn can be mixed with ordinary meal and baked into bread. 'Acorn bread' has a 'wild' taste which cannot be described" (Ingmanson 1983:222).

Berggren also found quite a few carbonized nuts of *Rosa* sp., not unlikely *R. rubiginosa* and *R. majalis*. Both these dog-rose bushes produce very good rose hips. In my childhood we called the hips which we collected from *Rosa majalis* bushes "butter hips".

Berggren has registered a find of a fragmentized berry of rowan (*Sorbus aucuparia*). Rowan-berries are edible after having been frost-bitten.

Fig. 39. Non-carbonized stone-fruits of crowberry (*Empetrum nigrum*) from sample SB1, 98.40–32. Length: 1.80 and 1.85 mm.

2. Weeds

Common couch [*Agropyron (Elytrigia) repens*]
One non-carbonized caryopsis of common couch [*Agropyron* (*Elytrigia*) *repens*] was found in sample E2 in the middle trench in a split in a floor log together with carbonized cereals. Berggren recorded two caryopses of this grass species from the Alvastra pile dwelling. *Agropyron repens* is a many-formed species which today is common in cultivated and waste ground. In former days it was a serious weed in the crops. The grass may very well have grown on newly cleared and slightly burnt coppice wood ground and it may have followed the harvested corn to the pile dwelling.

Magnusson, who studied 2511 cereal pollen grains in one pollen sample from the occupation layer of the pile dwelling, found that 2087 pollen grains were of *Hordeum* type, 312 of *Triticum* type, 101 of *Hordeum* or *Triticum* type and 10 of *Agropyron* type (Magnusson 1964:39).

Mugwort (*Artemisia vulgaris*)
More than 460 carbonized complete seeds of mugwort (*Artemisia vulgaris*) were picked out during the seed-analytical work (fig. 40). The seeds are extremely brittle, and it is indeed remarkable that so many were not cracked during the treatment in the laboratory. Probably there were originally thousands of mugwort seeds in the soil samples from the occupation layer. No mugwort seeds are found above the occupation layer. The correctness of my determination of the seeds to the species *Artemisia vulgaris* was confirmed by H. Hjelmqvist and K. Wasylikowa in 1991.

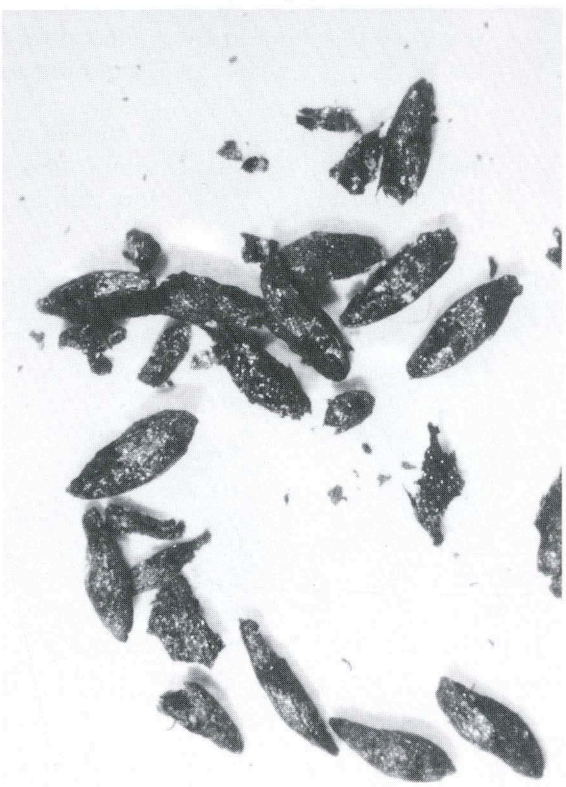


Fig. 40. Carbonized seeds of mugwort (*Artemisia vulgaris*) from sample ME3, 98.64.

Table 9. Dimensions in mm for *Artemisia vulgaris* (carbonized) from Alvastra pile dwelling (N=11).

	min.	aver.	max.
length	1.23	1.36	1.70
breadth	0.32	0.46	0.54

Artemisia also has extremely high values in the pollen diagrams from the occupation layer of the Alvastra pile dwelling (fig. 73 – see also Magnusson 1964: fig. 4). The seeds of *Artemisia vulgaris* only occur together with *Hordeum vulgare* or *Hordeum vulgare + Triticum dicoccum.* Thus *Artemisia vulgaris* – like *Polygonum convolvulus* – grew as a weed on the cleared and slightly burnt coppice wood fields ("wandering arable lands") (Göransson 1987:65). Andersen also suggests that *Artemisia vulgaris* grew in cleared and burnt coppice woods during the Middle Neolithic (Andersen 1993).

Fig. 41. Carbonized seeds of mugwort (*Artemisia vulgaris*) from sample ME3, 98.64.

The only irrefutable evidence of the presence of *Artemisia vulgaris* in the Early Middle Neolithic are the seeds from the Alvastra pile dwelling. As *Artemisia vulgaris* may have grown on cleared coppice wood areas (which were slightly burnt) this species could also have been placed in group 4.

Creeping thistle (*Circium arvense*)
A most beautiful carbonized fruit of creeping thistle (*Circium arvense*) (det. H. Hjelmqvist) was found in square A in the western trench together with a lot of carbonized caryopses of *Hordeum vulgare* and *Triticum dicoccum* and further together with non-carbonized seeds of *Ranunculus sceleratus* and one non-carbonized seed of *Trifolium medium* (see group 7). Creeping thistle today is a "common pest on fields, roadsides and waste places" (McClintock and Fitter 1978:184). Linnaeus in his *Flora Svecica* writes: "It grows everywhere in fields and cultivated places, everywhere pursued. One of our most serious field weeds" (Linné 1755, translated into Swedish 1986). It thus seems as if *Circium arvense* grew in the newly cleared fields in the coppice woods during Alvastra time. If permanent fields existed near the pile dwelling, creeping thistle could have grown there (see below).

Fumitory [*Fumaria (Fallopa) officinalis*]
Fruits of fumitory [*Fumaria* (*Fallopa*) *officinalis*] belong solely to the peat overlying the occupation layer (fig. 45). The archaeologists demonstrated that the old plough layer which passes the excavation area in the north *never* reached the occupation layer. The fruits of the bare-soil species fumitory thus confirm the archaeologists' observation. Fruits of fumitory are thus an indicator species of the peat which has been disturbed by cultivation in

subrecent time (see also *Stellaria media*). Large hemp nettle (*Galeopsis speciosa*) and corn mint (*Mentha arvensis*) also belong to the disturbed peat overlying the culture layer. Only a total of two seeds of the latter two species have been found.

Darnel (cf. *Lolium temelentum*)
A carbonized caryopsis of a probable darnel (*Lolium temulentum*) was found in sample B2 in the western trench. The caryopsis was studied in January 1994 by H. Hjelmqvist, who then made drawings of it (fig. 42). Hjelmqvist states that the determination to species level is probable. The caryopses occurred together with *Hordeum vulgare*, *Triticum dicoccum, Chenopodium album* and about half a thousand seeds of *Ranunculus sceleratus*. In former days darnel was a weed in barley fields.

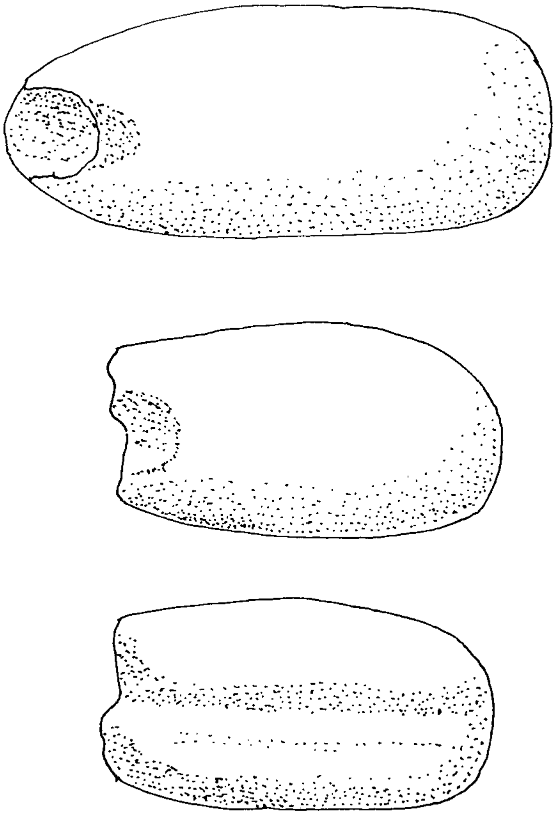


Fig. 42. Darnel (*Lolium temulentum*). Top, a recent caryopsis in dorsal view. Centre, dorsal view of a carbonized caryopsis from sample WB2, 98.46. Bottom, the same caryopsis in ventral view. Drawing: H. Hjelmqvist, 1994.

In Swedish darnel is named "dårrepe" ("fool's grass"). Linnaeus writes in his *Flora Svecica* that beer made of barley which contains kernels of darnel makes those who drink it "dizzy and for some hours blind; less harmful in bread" (Linné 1755).

Black bindweed (*Polygonum convolvulus*)
A great many carbonized nuts of black bindweed (*Polygonum convolvulus*) have been found in the middle and the western trenches. The carbonized nuts of black bindweed always occur together with caryopses of *Hordeum vulgare* or together with *Hordeum vulgare* + *Triticum dicoccum.* It thus seems very probable that black bindweed grew as a weed on the cleared, slightly burnt and hoed coppice wood fields, thus in the wandering arable fields. However, it cannot be ruled out that manured fields may have existed in the vicinity of the pile dwelling (see further on).

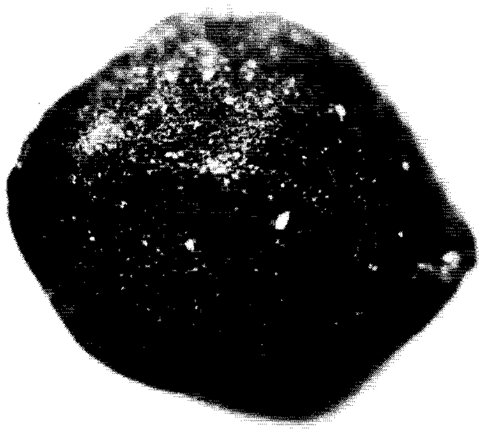


Fig. 43. Carbonized black bindweed (*Polygonum convolvulus*) from sample WL3, 98.57–54.

Table 10. Dimensions in mm for *Polygonum convolvulus* (carbonized) from Alvastra pile dwelling (N=20).

	min.	aver.	max.
length	2.07	2.50	3.20
breadth	1.58	1.92	2.31

Black bindweed is a winter annual species. As at least the four-row barley (and not unlikely also the emmer wheat – see below), may have been a summer annual, it may seem contradictory that black bindweed grew among this corn. Perhaps it need not be a contradiction.

Because of their large content of starch the seeds of black bindweed were used as supplementary food during prehistoric time (see, for instance, Helbæk 1955:682, 691). If large amounts of seeds of weeds – such as black bindweed – are found in the samples of cereals then this is evidence of the weed seeds having been intentionally added to the corn (Helbæk 1955).

Berggren found no less than a total of about 600 carbonized nuts of *Polygonum convolvulus* in 57 of the 75 samples which she investigated (Berggren 1956:107). It is thus perhaps not too risky to assume that the nuts of *Polygonum convolvulus* were deliberately collected by the Middle Neolithic forest farmer who could gather great amounts of these nutritious seeds on fallows in the coppice woods in the autumn.

A few non-carbonized nuts of *Polygonum convolvulus* have also been found in the peat overlying the occupation layer. These non-carbonized nuts are a reflection of recent cultivation and recent manuring (cf. above).

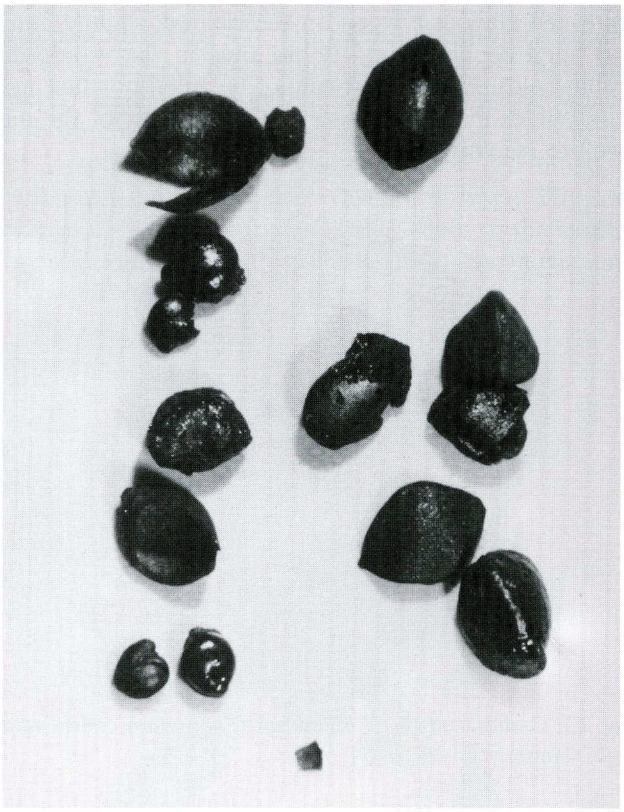


Fig. 44. Carbonized black bindweed (*Polygonum convolvulus*) and carbonized fat hen (*Chenopodium album*) from the same sample as in fig. 43.

As *Polygonum convolvulus* may have grown on newly cleared coppice wood areas which were slightly burnt, *Polygonum convolvulus* could just as well have been placed in group 4 (cf. *Artemisia vulgaris*). As described further on, permanent arable fields may have existed in the immediate vicinity of the Alvastra spring mire at the same time as wandering arable fields were found in coppice woods at some distance. If this suggestion is more than a pure guess, then *Polygonum convolvulus* may (also) have grown on manured fields.

One carbonized and one non-carbonized nut of *Polygonum lapathifolium* was found in the occupation layer – all other non-carbonized nuts of this species belong to the cultivated peat overlying the culture layer. All nuts of *Polygonum persicaria* were found in the peat above the occupation layer.

Common chickweed (*Stellaria media*)

Huge amounts of seeds of common chickweed (*Stellaria media*) have been recorded from the peat overlying the occupation layer. Only seven non-carbonized seeds of *Stellaria media* were found in the occupation layer proper. *Stellaria media* may be said to be an indicator species for the peat which is younger than the occupation layer. Thus *Stellaria media* is opposite to *Ranunculus sceleratus* which is an indicator species for the occupation layer.

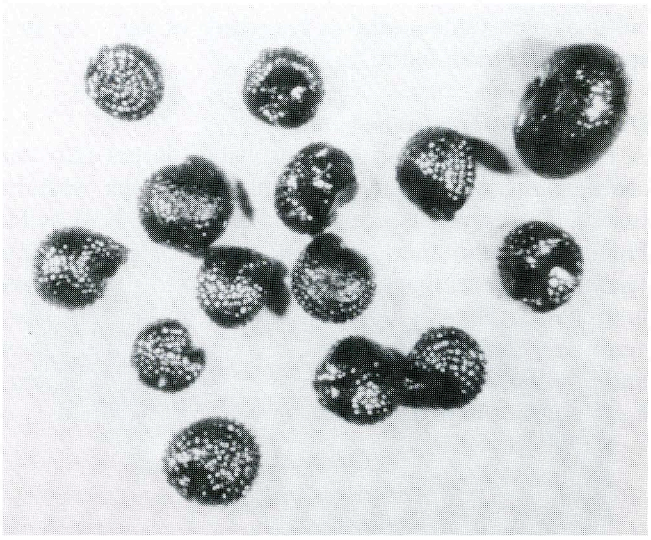


Fig. 45. Non-carbonized seeds of common chickweed (*Stellaria media*) and one fruit of fumitory [*Fumaria* (*Fallopa*) *officinalis*]. Common chickweed and fumitory are found in the peat which overlies the occupation layer. A few seeds of common chickweed, however, belong to the occupation layer proper (see text). Sample SD1 99.06–98.98 (the uppermost peat layer).

Ivy speedwell (*Veronica hederifolia*)

In a sample containing more than 150 caryopses of *Hordeum vulgare*, some carbonized nutshells, carbonized slices of apples and two carbonized seeds of *Artemisia vulgaris*, a most beautiful carbonized seed of *Veronica hederifolia* was picked out (fig. 46). Ivy speedwell prefers soils which are disturbed and rich in carbon. It is very tempting to suggest that this species grew on the newly cleared coppice wood areas, that is, on wandering arable fields. It may, however, also have grown on manured, permanent fields in the immediate vicinity of the pile dwelling (cf. above). *Veronica hederiofolia* which is summer-annual, may have followed the harvested crop to the pile dwelling.

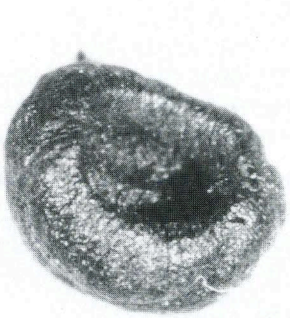


Fig. 46. Carbonized seed of ivy speedwell (*Veronica hederifolia*) from sample MN2, 98.66.

Earlier finds of species belonging to group 2.
Berggren has reported one find of a non-carbonized nut of creeping buttercup (*Ranunculus repens*) from one of the samples from the Alvastra pile dwelling.

3. Ruderal soils

Fool's parsley (*Aethusa cynapium*)
One non-carbonized seed of fool's parsley (*Aethusa cynapium*) was found in the occupation layer in sample M2 in the middle trench. It occurred together with among others, *Filipendula ulmaria* and one of the few *Stellaria media* which belongs to the occupation layer. Charcoal and small twigs were also found in this sample.

Fool's parsley today is a widespread garden and arable weed. It is many-formed with at least three subspecies in Sweden. It should be added that *Aethusa cynapium* is a very poisonous plant. It flowers in late summer or early autumn.

Fig. 47. In sample WE2, 98.46 a concentration of more than 1300 nuts of fat hen (*Chenopodium album*) was found. Diameter of nuts 1.23–1.43 mm.

Fat hen (*Chenopodium album*)
A great many nuts of *Chenopodium album* have been recorded. In sample WE2, for instance, more than 1300 nuts, constituting an almost clean collection, were found on a piece of bark. In most cases *Chenopodium album* is found together with *Hordem vulgare* or *Hordeum vulgare* + *Triticum dicoccum* or together with other species of group 1. It is difficult to decide whether the nuts are carbonized, but it seems as if only a small portion is carbonized.

Linkola found *Chenopodium album* on rocks which were situated in the vicinity of slash-and-burn areas in south-eastern Finland (Linkola 1916:186). Thus we may assume that *Chenopodium album* may have grown on the newly cleared and slightly burnt coppice wood fields. Naturally, however, this nitrophilous species also grew around the pile dwelling, on litter and dung. *Chenopodium album* could just as well have been placed in group 1 as in group 2 or group 3. If permanent manured arable fields existed in the vicinity of the pile dwelling then these fields were ideal habitats for fat hen.

Nuts of *Chenopodium album* are also found in the peat overlying the occupation layer reflecting subrecent cultivation. As has been stressed earlier, this late cultivation never disturbed the occupation layer. The seeds in the upper disturbed layer have nothing to do with the seeds in the occupation layer. Also the pollen diagram demonstrates that Chenopodiaceae dominate in the occupation layer proper (fig. 73).

Berggren found "considerable amounts" of *Chenopodium album* in 64 of the 75 samples investigated (Berggren 1956:107). In four samples the amounts of nuts were so great that Berggren suggested – as many other palaeoethnobotanists have done – that the seeds of this species were collected. Very likely both the green plants and the seeds of fat hen were collected by the Middle Neolithic forest farmer.

Knotgrass (*Polygonum aviculare*)
Only one nut (non-carbonized) of knotgrass (*Polygonum aviculare*) belongs to the occupation layer proper. It was found in peat – in the occupation layer – below a stone in sample K2 in the eastern trench. In the same sample there were 92 seeds of *Chenopodium album,* one pip of *Malus sylvestris,* two nuts of *Rumex longifolius* (see below) and one seed of *Ranunculus sceleratus. Polygonum aviculare* was a very common weed on our pre-industrial roads which were tramped by horses and cows. It was also found on fallows. All other nuts of *Polygonum aviculare* recorded belong to the peat overlying the occupation layer.

Butter dock (*Rumex longifolius*)
Two non-carbonized nuts of butter dock (*Rumex longifolius*) were found in the eastern trench together with *Chenopodium album, Malus sylvestris* and the abovementioned nut of *Polygonum aviculare.* All these seeds were found – as mentioned above – below a stone in the occupation layer. The determination was performed by H. Hjelmqvist.

Berggren (1956) found six carbonized nuts of curled dock (*Rumex crispus*).

Rumex longifolius and *Rumex crispus* thrive in the same habitats – cultivated soil, yards, gravelled roads, and also on lake shores. These two species not infrequently interbreed. They are favoured by the cattle's tramping and they are not grazed.

Bittersweet (*Solanum dulcamara*)
Six seeds of bittersweet (*Solanum dulcamara*) were found in the occupation layer in different squares in the eastern and western trenches. The seeds occurred together with species from group 1 and 2. Berggren has recorded three non-carbonized seeds of bittersweet from the occupation layer (Berggren 1956:119). Two seeds of bittersweet were found in the peat overlying the culture layer – together with *Fumaria officinalis* and other subrecent seeds. Bittersweet prefers ruderal soils but is also found on lake shores.

Stinging nettle (*Urtica dioica*)
One nut of stinging nettle (*Urtica dioica*) was found in the peat overlying the occupation layer. Berggren listed 38 non-carbonized nuts of stinging nettle and one non-carbonized nut of small nettle (*Urtica urens*) in the material from the occupation layer (Berggren 1956:107).

4. Grasslands

Cow parsley (*Anthriscus sylvestris*)
Two non-carbonized fruits of cow parsley (*Anthriscus sylvestris*) were picked out from the occupation layer – directly in the field – by the archaeologists. The fruits occurred together with *Hordeum vulgare* and *Triticum dicoccum*. The other three cow parsley fruits listed by me belong to the peat overlying the occupation layer. Cow parsley is today common in meadows, on cultivated land and along roadsides.

Black medick (*Medicago lupulina*)
One carbonized seed of black medick (*Medicago lupulina*) was found in sample ME3, 98.64 below bark in a split in a floor log. It was found together with a lot of carbonized species from groups 1 and 2. One non-carbonized seed of black medick was found in sample D1 in the western trench, also together with many carbonized seeds from group 1 and 2. Berggren recorded one non-carbonized seed and one non-carbonized fruit of *Medicago lupulina* during her investigations of the material from the Alvastra pile dwelling (Berggren 1956:108).

Today *Medicago lupulina* is very common on the grazed steppe meadows in the Isberga area, 2 km to the east of the pile dwelling – it is, on the whole, common today in bare and grazed areas with rich soils. The dandelion (*Taraxacum vulgare*) seed recorded (from the middle trench) belongs to the upper part of the peat overlying the occupation layer. It is thus of subrecent age.

Narrow-leaved vetch (cf. *Vicia angustifolia*)
One non-carbonized "pea" was picked out from the occupation layer during the fieldwork by one of the archaeologists. It was sent to me in a matchbox and I gave it to H. Hjelmqvist. He made a drawing of the "pea" and suggested that it might originate from narrow-leaved vetch (*Vicia angustifolia*) (fig. 48). This seed is one of the few which has gone astray in my voluminous seed collection from the Alvastra pile dwelling. Narrow-leaved vetch thrives on dry, lime rich grassy areas. It is probably favoured by burning.

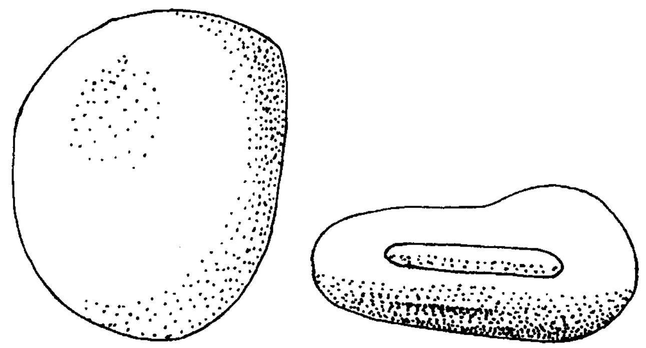


Fig. 48. Probable narrow-leaved vetch (cf. *Vicia angustifoila*), non-carbonized from MN2, 98.66. Lateral and ventral views. Length of hilum ca. 3 mm. Drawing: H. Hjelmqvist 1977.

Earlier finds of species belonging to group 4
Berggren has reported three non-carbonized fruits of agrimony (*Agrimonia eupatoria*) and one non-carbonized, rather well-preserved fruit of ox-eye daisy (*Chrysanthemum leucanthemum*). She further found 34 carbonized caryopses of meadow fescue (*Festuca pratensis*) in 11 samples and about 70 carbonized caryopses of timothy (*Phleum pratense*) in 20 of the samples investigated. *Festuca pratensis* today is one of our best forage grasses which grows on dry ground but also on shores and in damp meadows. According to Weimarck, meadow fescue "almost exclusively grows on culture ground" (Weimarck 1963:101). Timothy (*Phleum pratense*) is today one of the commonest meadow-grasses in Europe and it is one of our most important forage grasses. I find it very remarkable that these two grass species grew not far from the Alvastra pile dwelling during the Early Middle Neolithic – on the steppe meadows, for instance. Thus *Festuca pratensis* grows in the Isberga Nature Reserve, which is regularly grazed in our days. *Phleum pratense* was found in every area investigated for the new flora of Östergötland (Genberg 1977).

Berggren also has recorded one non-carbonized seed of hairy St John's wort (*Hypericum hirsutum*) and two non-carbonized seeds of common St John's wort (*Hypericum perforatum*). Of these *H. perforatum* is common on dry, grassy areas while *H. hirsutum* belongs to group 7. Also three fruits of marjoram (*Origanum vulgare*) were recorded by her. She further found one carbonized calyx of basil thyme (*Satureja acinos* = *Acinos arvensis*) and one non-carbonized fruit of wild basil

(*S. vulgaris* = *Clinopodium vulgare*), both of which I tentatively place in group 4.

5. Wetlands and Wet Meadows

In the central areas of the Alvastra spring mire, that is, in the area where the pile dwelling is situated, the layer sequence is, in the main, as follows (see Göransson 1987:24).

Layer No.	*Description*
4	Fen peat (probably *Carex* peat), black, highly humified, disturbed
3	Magnocaricetum peat (radicell peat), dark brown
2	*Cladium-Phragmites* peat blackish brown, higly humified
1	Lake marl, greyish white (with fragmented rootlets)

The occupation layer is mostly found within the *Cladium-Phragmites* peat. In the test trench it is also found in the lake marl. During the ca. 4450 C14-years which have passed since the pile dwelling was in use the Alvastra spring mire has been built up by species belonging to a wet environment.

White sedge (*Carex canescens*), great willow herb (*Epilobium hirsutum*) and hemp agrimony (*Eupatorium cannabinum*)

Fruits (achenes) of white sedge (*Carex canescens*) are found almost throughout layers 4 to 2 in the rigid system. They are sometimes missing in the uppermost peat sequence, very likely because of secondary destruction. The achenes are more rare in the lower part of the *Cladium-Phragmites* peat. They are not infrequently absent in the samples taken in the flexible system. These samples were often rather small and were further "intentionally" taken. *Carex canescens* may have been grazed in early summer. Also *Carex* species with 3-sided achenes have been recorded. They are found in the column "miscellaneous".

Great willow herb (*Epilobium hirsutum*) and/or marsh willow-herb (*Epilobium palustre*) have both grown on the spring mire or else only one of these species has grown there, the seeds being very similiar. As the latter species prefers acid soils this speaks in favour of the great willow herb having grown on the spring mire in suitable places during prehistoric time.

The grandiose hemp agrimony (*Eupatorium cannabinum*) grew in the vicinity of the Alvastra pile dwelling during the Middle Neolithic and flowered there in late summer and early autumn. It prefers a shadowy environment, probably growing in the vicinity of the alder and birches in the peripheral parts of the mire.

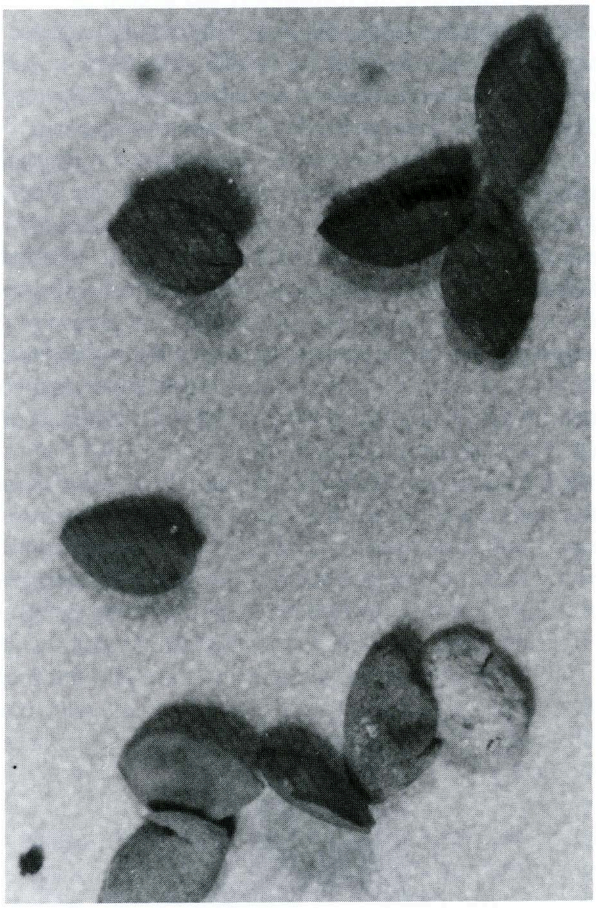


Fig. 49. Fruits (achenes) of *Carex canescens* from sample WK2, 98.57–49. Length of fruits: 1.11–1.18 mm.

Meadowsweet (*Filipendula ulmaria*)

Meadowsweet (*Filipendula ulmaria*) grew on the Alvastra spring mire during the Early Middle Neolithic (as it does today). On the steppe meadows in the Isberga area dropwort (*Filipendula vulgaris*) grows today in great amounts – as it very likely did during the Middle Neolithic (fig. 77). Dropwort is a species characteristic of the steppe meadows in Götaland. Thus meadowsweet and dropwort are two opposites.

Fig. 50. Seeds (nuts) of meadowsweet (*Filipendula ulmaria*) from sample WK2, 98.57–49.

It is not possible to distinguish the pollen of *Filipendula ulmaria* from the pollen of *Filipendula vulgaris*. T. Persson and I worked a whole day – in 1979 – at the electron microscope with material containg *Filipendula* pollen from the Isberga kettle hole without success.

In my pollen diagrams from the Alvastra spring mire which I published in 1987 I consequently placed *Filipendula* in the column "plants preferring moist habitats". In the pollen diagram from the kettle hole at Isberga – which is a little peep-hole in an area of calcareous sandy soils – I suggested that *Filipendula* could be placed in the group "grasses and pasture plants". The *Filipendula* pollen in that steppe-meadow area *might* have been produced by dropwort also during prehistoric time, according to my working hypothesis.

Three seeds of probable ragged robin (cf. *Lychnis flos-cuculi*) were found in sample D1 in the test trench. Ragged robin is often found in the same habitats as meadowsweet. Unfortunately, the sample containing these three seeds belongs both to the peat overlying the occupation layer and to the occupation layer proper. Thus these seeds *may* be younger than the pile dwelling.

One seed of gipsywort (*Lycopus europæus*) was found in the middle trench in the uppermost part of the subrecent peat.

Narrow-leaved meadow grass or wood meadow-grass (*Poa palustris* or *P. nemoralis*)

A non-carbonized glume of *Poa palustris* or *P. nemoralis* (det. M. Klee) was found in the occupation layer in sample WB1, 98.48–44 (together with more than one thousand carbonized barley caryopses, some emmer caryopses, carbonized apple pips etc.). It is not possible to distinguish between these two species by studying their glumes (M. Klee, pers. comm.).

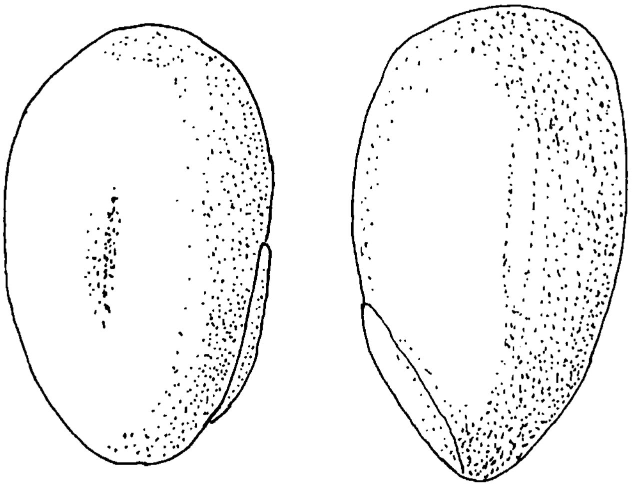


Fig. 51. Left: carbonized caryopsis of probable reed-grass (cf. *Phalaris arundinacea*). Right: caryopsis of recent reed-grass. Drawing: H. Hjelmqvist 1994.

Reed-grass (cf. *Phalaris arundinacea*)

One carbonized caryopsis of a probable reed-grass (cf. *Phalaris arundinacea*) was found in the middle trench in square M. I passed on the seed to H. Hjelmqvist, who studied it in detail and made a drawing of it in January 1994 (fig. 51). Reed-grass has been a rather important forage grass. In former days it was also used as thatching material (Linné 1775).

Marsh cinquefoil (*Potentilla palustris*)

A total of five non-carbonized seeds (nuts) of marsh cinquefoil (*Potentilla palustris*) were found in the occupation layer in both the test trench and the eastern trench. The determination was confirmed by H. H. Birks. Marsh cinquefoil is a widespread fen species.

Celery-leaved buttercup (*Ranunculus sceleratus*)

Celery-leaved buttercup (*Ranunculus sceleratus*) is remarkable in that way that it is, as far as can be seen, totally bound to the occupation layer. No carbonized seeds have been found. This buttercup species prefers wet places which are overfertilized – it is highly favoured by the presence of liquid manure (Viklund 1986:190).

Very many seeds of *Ranunculus sceleratus* have been recorded by me. Berggren also found great amounts of nuts of celery-leaved buttercup in 55 of the 75 samples investigated by her (Berggren 1956:107).

Evidently *Ranunculus sceleratus* was favoured in the pile dwelling proper – on the floor and between the trunks – and in the immediate surroundings of the platform. From presumed winter-stabled goats, sheep and cows the pile dwelling and its nearest surroundings may have been manured. (The slaughter of animals may also have had a manuring effect.) *Ranunculus sceleratus* is an indicator species of the pile dwelling proper, while *Stellaria media* is an indicator species of the peat layers which are found above the occupation layer.

Marsh woundwort (*Stachys palustris*)

One non-carbonized fruit of marsh woundwort (*Stachys palustris*) was found in the eastern trench below a stone together with *Chenopodium album,* one nut of *Polygonum aviculare,* one apple pip and two nuts of *Rumex longifolius* (cf. above). Marsh woundwort is today common by fresh water, especially in ditches, and also as an arable weed. It could thus just as well have been placed in group 2.

6. Wells and spring mires

Stonewort (*Chara* undiff.)

"Nuts" ("fruits") or "spores" (Nilsson 1952, I:31) of the cryptogam *Chara* undiff. are richly found in the lake marl underlying the *Cladium* peat in which the pile dwelling was built. During the time when the pile dwelling was built and in use, open wells existed outside the pile dwelling. As a result of the assimilation processes by *Chara* and other so-called "lime collectors", lime was deposited in these wells as lake marl. *Chara* species were thus characteristic of the wells in the spring mire during the Early Middle Neolithic. Very likely these wells were of great importance for the people who periodically utilized the pile dwelling. The accessibility of water was necessary during the livestock's foddering periods in the pile dwelling.

Sedge (*Cladium mariscus*) and greyish bulrush (*Scirpus Tabernæmontani*)

The Early Middle Neolithic wells on the spring mire were surrounded by sedge (*Cladium mariscus*) and greyish bulrush (*Scirpus Tabernæmontani*) which are both tall. Otherwise sedge and greyish bulrush grew richly in the areas where the water was copiously flowing over the spring mire (cf. Göransson 1987). Quite a few nuts of these two species have been found in the occupation layer – and below the occupation layer. A few carbonized nuts of *Cladium mariscus* have also been found.

The rhizomes of *Scirpus lacustris* (which is very like *S. Tabernæmontani*) are a delicacy; they contain both starch and sugar and can be cooked like potatoes (Ingmanson 1983:230). *Cladium mariscus* is very useful as thatching material. The determination of *Scirpus Tabernæmontani* was confirmed by H. H. Birks and H. Hjelmqvist. Berggren also recorded quite a few nuts of sedge and greyish bulrush (Berggren 1956:165).

7. Forests and Forest Herbs

Birch (*Betula* undiff.), silver birch (*B. verrucosa*) and downy birch (*B. pubescens*)

The majority of the seeds (nuts) of birch (*Betula* undiff.) have been found in the peat overlying the occupation layer. A few catkin scales of *B. verrucosa* have been found in this subrecent peat.

In the flexible system in the eastern trench a dozen seeds of *Betula* undiff. have been found in the occupation layer, and one seed was identified as *B. pubescens*. In the middle trench some seeds and catkin scales of *B. verrucosa* and one catkin scale of *B. pubescens* have been recorded from the occupation layer.

In the western trench a few seeds and catkin scales of *Betula verrucosa* have been found in the occupation layer, as have a few seeds of *Betula* undiff. A few seeds of *Betula* undiff. have also been recorded in the test trench.

Betula verrucosa grew on the margins of the high ground immediately to the east of the spring mire, while *B. pubescens* grew in the alder carr near the rivulet in the western part of the spring mire.

Thus the seeds (and catkin scales) tell us almost nothing about the coppice woods which were found on high ground in the surroundings of the spring mire – and at some distance from the pile dwelling. No seeds of elm or lime have been found in any sample. On the other hand the twigs and piles investigated by Bartholin give us a living picture of the closest forest (Bartholin 1978, 1983 – see further on), as do the pollen diagrams.

Some information about the coppice wood species is given in column 1. There we find nuts of *Corylus avellana*, pips of *Malus sylvestris*, stone fruits of *Prunus padus* and seeds and fruits from bushes such as *Cornus sanguinea*, cf. *Cratægus* and *Rubus idæus*. The find of a fruit and a seed of *Viscum album* which sponges upon lime, maple, aspen etc. also gives us information about the forests of the Early Middle Neolithic – and of course about the forest farmers' foddering and/or cult activities.

Good Friday grass or heath woodrush (*Luzula campestris* or *L. multiflora*)

One carbonized seed of *Luzula campestris* or *L. multiflora* was found in sample C2 in the western trench (det. H. Hjelmqvist). It was found together with a great many caryopses of barley, some carbonized apple pips, two carbonized nuts of *Polygonum convolvulus* etc. *Luzula campestris* is common on open dry ground while *Luzula multiflora* grows in moist meadows, pastures and in forest clearings. Both species may grow in the same type of meadows – they thus overlap (Ekstam et al. 1988).

Fig. 52. A carbonized seed of *Luzula campestris* or *L. multiflora* from sample WC2, 98.49–45.

Linkola recorded *Luzula multiflora* on rocks in former burnt areas. According to him, *Luzula multiflora* (and *L. pallescens*) were favoured by burning (Linkola 1916:186). Thus we may assume that the find of *Luzula campestris/L. multiflora* may reflect the presence of cleared and (slightly) burnt coppice wood areas during the time when the Alvastra pile dwelling was in use.

Berggren found two fragmentized seeds of hairy woodrush *Luzula pilosa* in two different samples from the Alvastra pile dwelling (Berggren 1956:106). *Luzula pilosa* is today very common in our last, still existing grazed wood pastures. Outside my plot of land in Scania is a wood pasture which is still being grazed (in 1993 – when I am writing these lines). This wood-pasture is dominated by silver birch (*Betula verrucosa*). The wood pasture has never been manured (excepting the dung which is deposited by the cows here and there). *Luzula pilosa* is very common in that shadowy environment, and in my opinion *Luzula pilosa* is a perfect indicator species of coppice-wood pastures.

Wood millet (cf. *Milium effusum*)
In sample I4 in the eastern trench 13 carbonized grass caryopses were found below a hearth-stone together with a great many non-carbonized hazelnut shells and a beetle elytron (*Scolytus intricatus*) (det. G. Lemdahl). M. Klee has studied these caryopses and thinks that they *may* be caryopses of *Milium effusum.* Today this grass grows in dry, rather closed forests on rich soil – it thrives in shadow. *Milium effusum* may have grown in old coppice woods on high ground in the vicinity of the Alvastra pile dwelling.

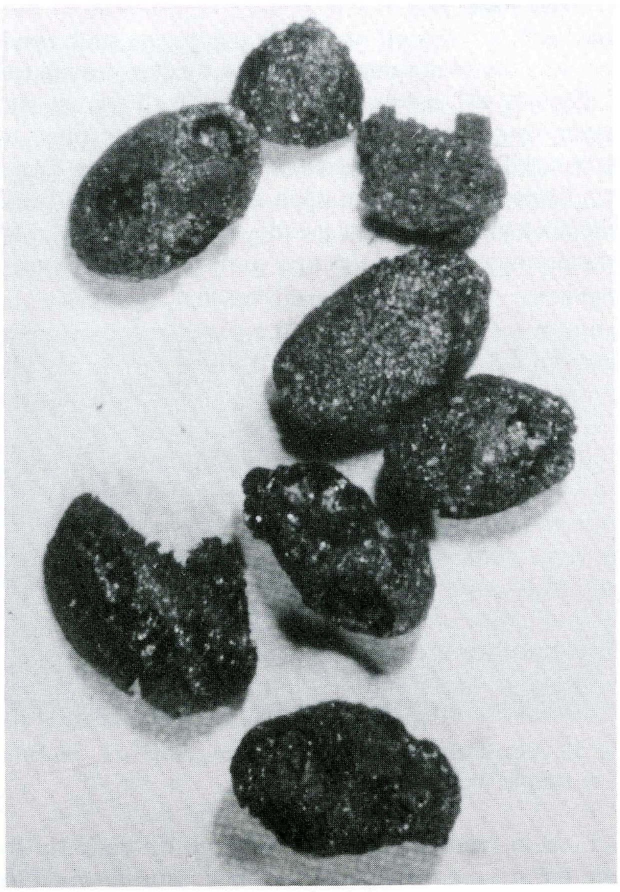


Fig. 53. Badly damaged, carbonized caryopses of probable wood millet (cf. *Milium effusum*) from sample EI, 98.63–57.

Hedge woundwort (*Stachys sylvatica*)
Two non-carbonized seeds of *Stachys sylvatica* were found in sample A3 in the western trench together with more than 150 caryopses of barley and about 150 caryopses of emmer wheat and other "culture species". In the middle trench two seeds of hedge woundwort were found in two different squares together with a lot of cultivated or collected species. In sample K1 in the eastern trench two seeds of this species were found in the occupation layer.

Today *Stachys sylvatica* grows in meadow-forests and especially on lime-rich soil.

Zigzag clover (*Trifolium medium*)
A non-carbonized seed of zigzag clover was found in sample WA1, 98.46–42 together with many carbonized and non-carbonized seeds. This clover seed is a little swollen (as it is preserved in Hantzsch's solution), but in every detail it corresponds to seeds of *Trifolium medium* which are soaked in water, according to Hjelmqvist (fig. 54).

Zigzag clower may have grown in sunny areas in the coppice woods during Middle Neolithic time, which is why I place this species in group 7.

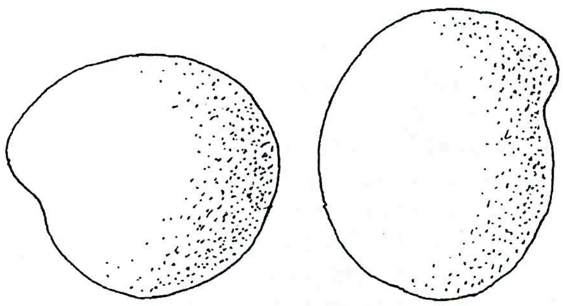


Fig. 54. Left: non-carbonized swollen seed (nut) of zigzag clover (*Trifolium medium*) (width: 1.44 mm) from sample WA1, 98.46–42. Right: recent, swollen seed of *Trifolium medium*. Drawing: H. Hjelmqvist 1994.

Earlier finds of species belonging to group 7
Berggren also found one non-carbonized fruit of *Stachys sylvatica* in the 1940s (Berggren 1956: 109). Further she records a non-carbonized seed of hairy St John's wort (*Hypericum hirsutim*) which today is a rare plant in meadow-forests. She also has noticed a carbonized seed of nipplewort (*Lapsana communis*) which, besides being a garden weed, is today found at forest edges, at the sides of forest-roads and in forest clearings. It was probably a common weed on the cleared and slightly burnt coppice wood fallows.

8. Heaths

Crowberry (*Empetrum nigrum*) and tormentil (*Potentilla erecta*)
Two non-carbonized seeds of *Empetrum nigrum* were found in the test trench (cf. p. 37), and one non-carbonized seed of *Potentilla erecta* was found in the occupation layer in the eastern trench.

Empetrum nigrum and *Potentilla erecta* reflect heathy areas (cf. Jensen 1986: 66). These heath-like areas were found not too far from the Alvastra pile dwelling. *Empetrum nigrum* also thrives on *Sphagnum* bogs, and *Potentilla erecta* has a rather great ecological amplitude and could just as well have been placed in, say, column 4.

9. Miscellaneous

The majority of the taxa listed in group 9 are of such a high rank (family, genus) that they cannot be placed in any of the 8 groups. The "Miscellaneous" taxa thus cannot give any information on their ecological demands, that is, their environment cannot be reconstructed. The genus *Viola*, for instance, contains species which grow in forests, in meadows, in grasslands, on grassy heaths, in sandy areas, in arable lands, in ruderal soils, in rich fens and other fens, and on the shores of rivers and lakes.

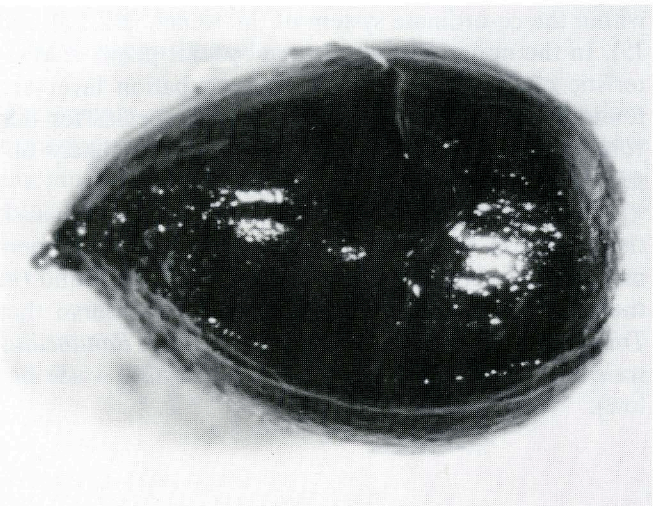


Fig. 55. *Viola* sp. from sample EN3, 98.60–58. Length: 2.22 mm.

Probably some of the two-sided and three-sided *Carex* nuts could have been determined to species. The gain, however, would not have been in any proportion to the work. It may be observed that a good deal of the miscellaneous taxa are found in the peat overlying the occupation layer.

10. Not determined

Some of the taxa belonging to group 10 are carbonized and have been found in the occupation layer proper. I have tried in vain to determine these seeds. Some important information has likely been lost for that reason.

11. Other artefacts

In the rigid system in group 11 I have listed small charcoal particles, small pottery fragments, mineral particles and small bone remains. The quantity scale goes from 1 to 3, that is, from very few fragments to quite a lot. Such fragments and particles ought to belong to the occupation layer proper.

When in a very few cases fragments/particles are found in the topmost, recent layers this does not mean that the occupation layer has been "ploughed up". The occupation layer has *never* been ploughed up, it is *hermetically sealed*. Fragments of charcoal or small amounts of mineral particles which in a few cases are found in the topmost parts of the topmost samples ought to be a residue of Frödin's earlier investigations, that is, soil which the archaeologist once upon a time happened to drop on the surface of the spring mire. Note that insect remains and molluscs have not been included in the tables.

12. Droppings of mouse and goat

In sample G1 in the eastern trench a mouse-dropping was found in the occupation layer together with, among other things, a shell fragment of hazel, one carbonized caryopsis of emmer wheat and one partly burnt apple pip. It is suggested that the mouse gnawed on hazel nuts (cf. fig. 27).

In sample EF1, 98.41 five droppings were picked out by the archaeologists directly in the field – the droppings looked like some strange berries. When I visited Skånes Djurpark ("Scania Animal Park") in December 1993 the keeper Egon Axelsson demonstrated that the droppings came from an old native breed of goat (fig. 56). The pollen spectrum from one of these goat droppings is described below. The find of these goat droppings and the pollen analysis conducted on them may be said to have given me a new view of the Alvastra pile dwelling and its function.

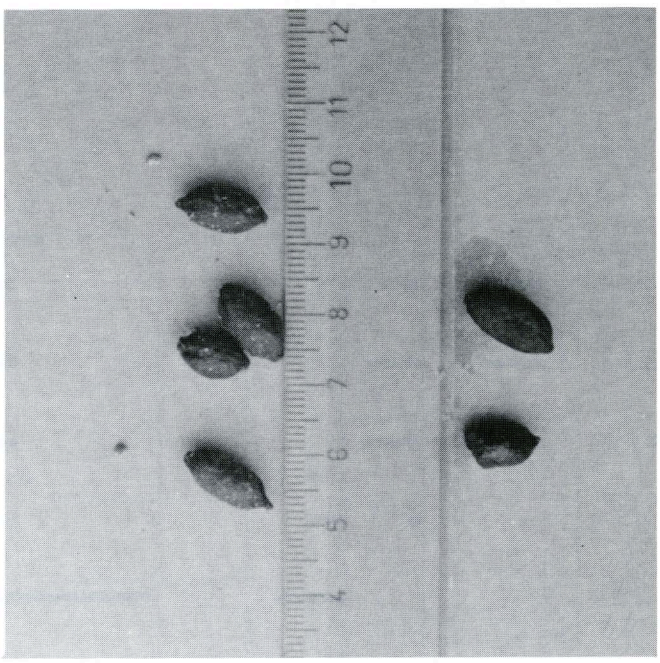


Fig. 56. One and a half droppings of goat from the Alvastra pile dwelling (sample EF1, 98.41) (right) compared with four droppings from an ancient breed of goat from Skånes Djurpark (left). The layers of manure have disappeared since they were deposited ca. 5300 calendar years ago. Only a few droppings have been preserved thanks to fortunate circumstances. In the occupation layer the almost omnipresent *Ranunculus sceleratus* can be said to constitute the "skeleton" of the former layers of manure.

The vertical distribution of the fruits and seeds in the rigid system

The vertical distribution of the different groups of taxa in the rigid system is diagrammatically reproduced in the *percentage diagrams* (figs. 57–63). Some of the diagrams not only comprise the seeds and fruits from the occupation layer but also from the layers found above – and sometimes below – the occupation layer. The diagrams are presented as bar graphs.

In the percentage diagrams *Stellaria media* is included in the group "weeds" and *Ranunculus sceleratus* in the group "wetland and wet meadows". These two species are, however, *also* placed to the right in the diagrams as "indicator species". *Stellaria media* is chosen as the indicator species for the peat overlying the occupation layer (even if a few seeds of this species do occur in the occupation layer). *Ranunculus sceleratus* constitutes the indicator species for the occupation layer proper.

The test trench

The percentage diagram for the test trench (fig. 57) is based on analyses of samples from three different points within the co-ordinate system of the trench (B2, D1 and J5). In the upper part weeds and ruderal plants characteristic of the peat overlying the occupation layer are found. The high values of the indicator species for this younger peat – *Stellaria media* – are immediately observed in the upper part of the diagram.

Somewhere at a level between 98.62 and 98.49 m a.s.l. the transition to the peat corresponding to the uppermost part of the occupation layer ought to be found (in the diagram from the flexible system we observe that *Triticum dicoccum*, *Hordeum vulgare* and *Ranunculus sceleratus* occur at the level 98.58–53 m a.s.l. – see below).

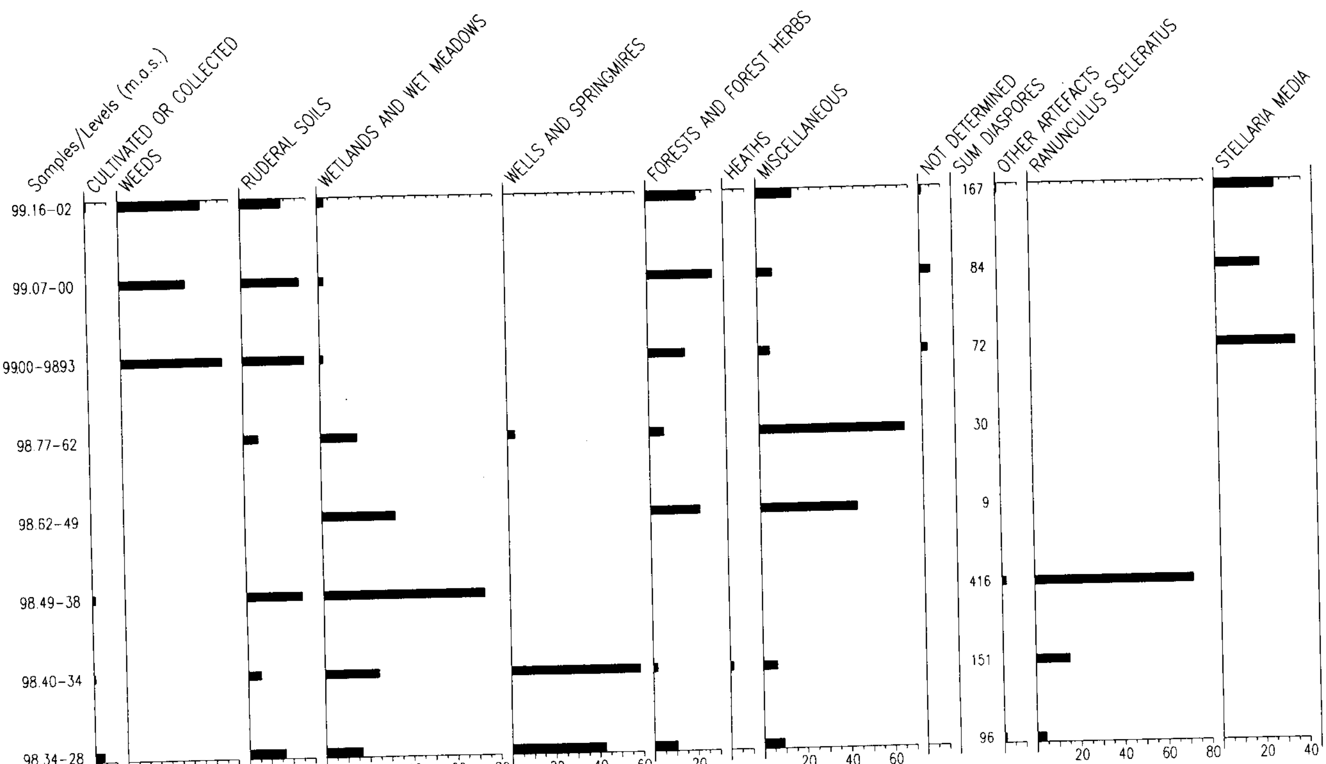


Fig. 57. The percentage diagram for the test trench.

At the level 98.34–28 m a.s.l. *Ranunculus sceleratus* occurs – as do also apple pips according to the species list. Thus the occupation layer – or rather the deposits (peat and lake marl/lime gyttja) formed during the four decades when the pile dwelling was in use – is (on average) found between ca. 98.60 and 98.30 m a.s.l. in the test trench. (It seems as if limy sediments were deposited only in the test trench area when the pile dwelling was in use – in the other trenches the pile dwelling is found in the *Cladium-Phragmites* peat immediately above the limy sediments).

The western trench

The sample at 98.57–98.49 m a.s.l. is found in the lowermost part of the occupation layer, immediately above the lime gyttja. The sample is very interesting as it contains high amounts of *Filipendula ulmaria*. Eight caryopses of *Hordeum vulgare* and three nuts of *Ranunculus sceleratus* disclose the true occupation layer character of this sample.

The middle trench

The percentage diagram for the middle trench (fig. 58), like the diagram for the test trench, is based on analyses of samples from three different points within the coordinate system (A1, B1 and M2). In the upper part fruits and seeds of weeds and ruderal plants characteristic of the peat overlying the occupation layer are found, as is the indicator species for that peat, *Stellaria media*. It is only at the bottommost level, at 98.58–52 m a.s.l., that the diagram takes on a typical "occupation level character", with *Hordeum vulgare* (= "cultivated or collected") and *Ranunculus sceleratus*. Note that the sum of seeds and fruits only amounts to eight at this level!

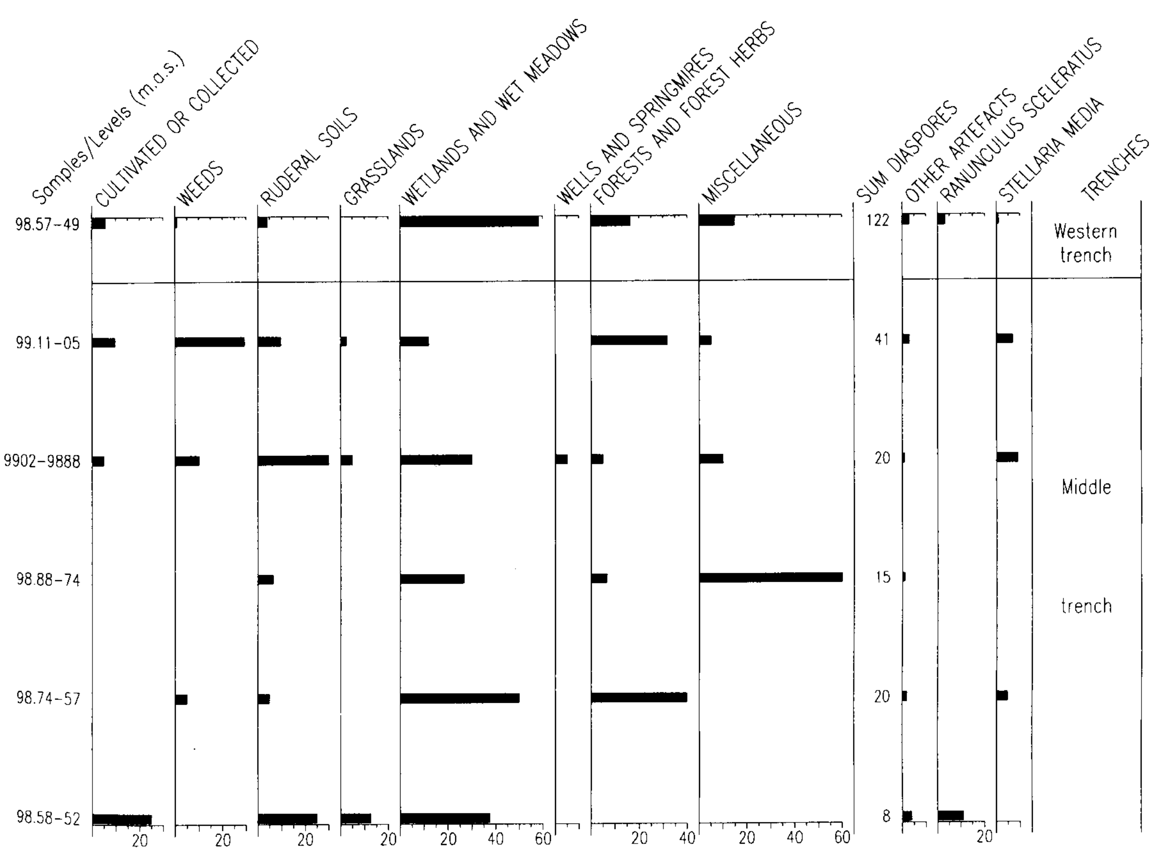


Fig. 58. The percentage diagrams for the western and middle trenches.

The eastern trench

Six percentage diagrams for the eastern trench are presented.

Diagram A1 (fig. 59). From 99.24 m a.s.l. down to 98.70–60 m a.s.l. the indicator species for the younger peat – *Stellaria media* – characterizes the diagram. Somewhere at the latter level *Stellaria media* ceases to occur – only one seed of this species has been found within the level 98.70–60 m a.s.l. (As only a total of five seeds have been registered at this level, one seed constitutes 20%!) At the same level charcoal particles and microscopic fragments of bones have been found during the analysis of the seeds. *Ranunculus sceleratus* has high values from 98.60 m a.s.l. down to 98.43 m a.s.l. Thus the occupation layer in square A1 ought to be found between ca. 98.70 and 98.43 m a.s.l. This is in total accordance with the archaeologists' observations.

Diagram K1 (fig. 60). From 99.20 m a.s.l. down to 99.79–67 m a.s.l. the indicator species for the peat overlying the occupation layer – *Stellaria media* – dominates the diagram. At 98.65–56 m a.s.l. charcoal particles and microscopic bone fragments occur – otherwise this level has extremely low frequencies of seeds and fruits. At the bottommost level 98.56–46 m a.s.l. *Ranunculus sceleratus* is recorded. The level 98.46–36 m a.s.l. was not analysed because of the low frequencies of seeds and fruits. According to the archaeologists, the occupation layer extends from 98.65 m a.s.l. down to 98.38 m a.s.l.

Diagram D4 (fig. 61). From 98.67 down to 98.55 m a.s.l. *Ranunculus sceleratus*, the indicator species for the occupation layer, has rather high values. *Hordeum vulgare* and *Polygonum convolvulus* are found in very low frequencies while *Chenopodium album* occurs in somewhat higher frequencies. Between 98.55 m a.s.l. and 98.51 m a.s.l. no culture-indicating seeds or fruits have been observed – only a few charcoal particles have been registered.

Diagram D5 (fig. 62). From 98.70–58 m a.s.l. down to 98.58–46 m a.s.l. the indicator species for the occupation layer – *Ranunculus sceleratus* – shows strongly increasing values, as do the values for hazelnut shells ("cultivated or collected"). Diagram D5 embraces almost the whole occupation layer which, according to the archaeologists, is found between 98.73 m a.s.l. and 98.49 m a.s.l. at this point.

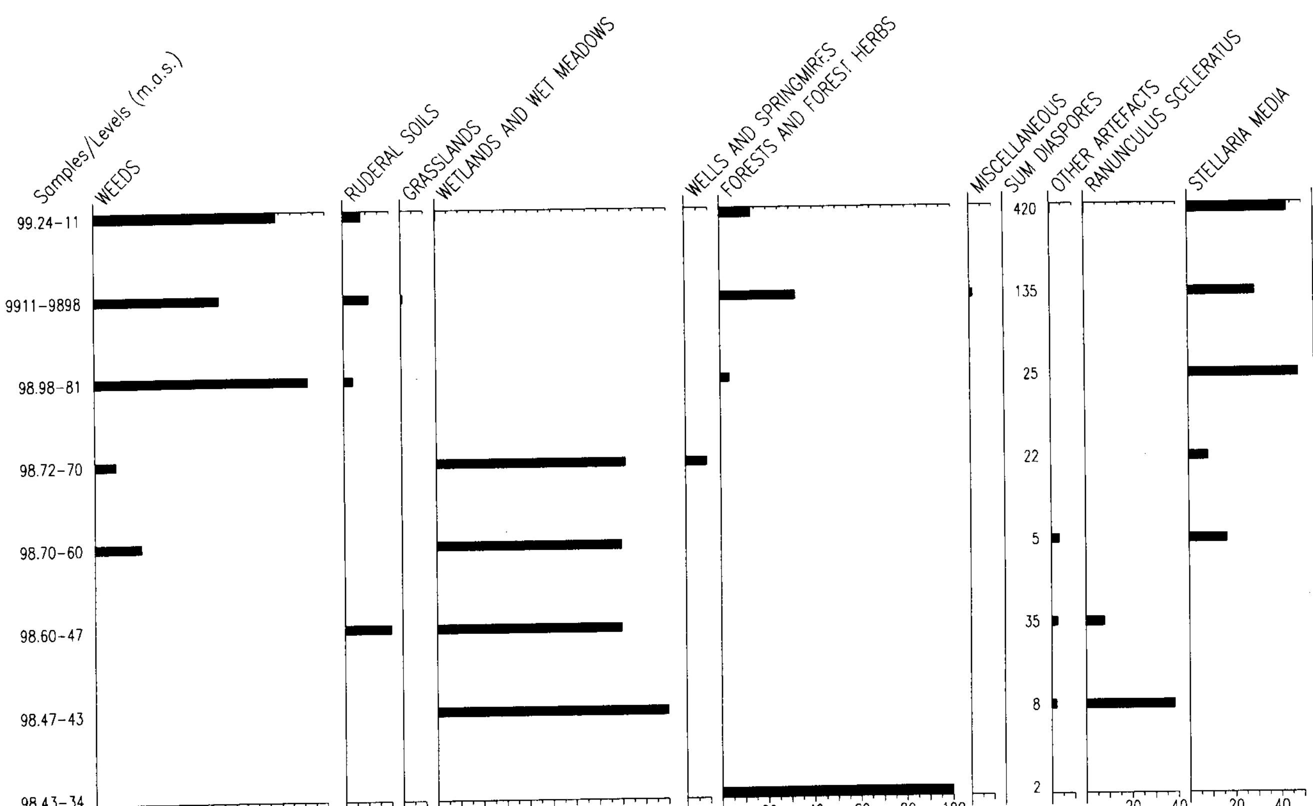


Fig. 59. The percentage diagram for A1, the eastern trench.

Diagram L4 (fig. 62). The diagram is atypical in that *Stellaria media* is present although the diagram is from the occupation layer. At the bottommost level 98.62–53 m a.s.l. one caryopsis of *Hordeum vulgare* and one stone fruit of *Cornus sanguinea* are recorded.

Diagram N3 (fig. 62). The diagram consists of only one level – 98.60–53 m a.s.l. – from the occupation layer. "Ruderal soils" consists of no less than 288 nuts of *Chenopodium album* and one seed of *Solanum dulcamara.* One non-carbonized apple pip has also been recorded.

Diagram L2 (fig. 63). At this point (222/425) in the eastern trench the surface of the spring mire is situated at 99.19 m a.s.l. Pollen analysis has been performed on the peat (and lake marl) between 99.09 m a.s.l. and 98.22 m a.s.l., and the peat samples between 98.65 m a.s.l and 98.19 m a.s.l. have been analysed for fruits and seeds (Göransson 1987: fig. 28). The pollen diagram is reproduced in the present paper as a computer-drawn diagram (fig. 73).

Some levels in diagram L2 have very low frequencies of fruits and seeds. At the level 98.57–52 m a.s.l. charcoal particles and fragments of ceramics and bones were found during the analysis for fruits and seeds. At 98.43–41 m a.s.l. one nut of *Polygonum convolvulus,* 22 nuts of *Chenopodium album* and one nut of *Ranunculus sceleratus* have been recorded. At the level 98.36–34 m a.s.l. 51 nuts of *Ranunculus sceleratus* are registered, reflecting stronger activities ("liquid manure") in the pile dwelling. Also three apple pips have been recorded at this level. At the level 98.34–28 m a.s.l. the values of *Ranunculus sceleratus* are rather high, and two caryopses of *Hordeum vulgare* and one carbonized nut of *Polygonum convolvulus* were found.

The upper surface of the lake marl underlying the occupation layer is situated at 98.26 m a.s.l. The lowermost level 98.26–19 m a.s.l. – thus consisting of lake marl – is totally void of culture-indicating fruits and seeds. *Pollen* of Cerealia is, however, found in the lake marl. This pollen was probably washed down and intermingled (by tramping?) with the lake marl. The lake marl is palaeobotanically reflected by nuts of *Cladium mariscus* ("wells and spring mires"). According to the archaeologists, the occupation layer is found between 98.69 m a.s.l. and 98.24 m a.s.l.

Erratum: At the time of going to press it has been noticed that the two ED samples in the rigid system should have the designation EB.

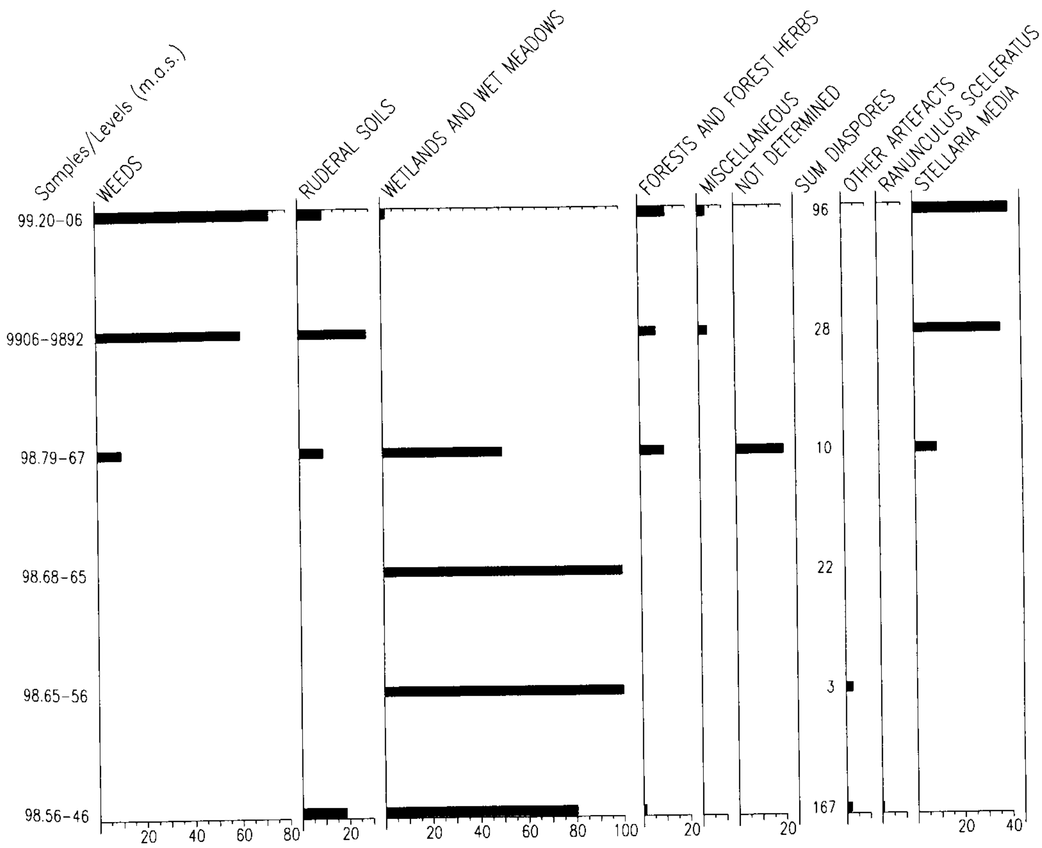


Fig. 60. The percentage diagram for K1, the eastern trench.

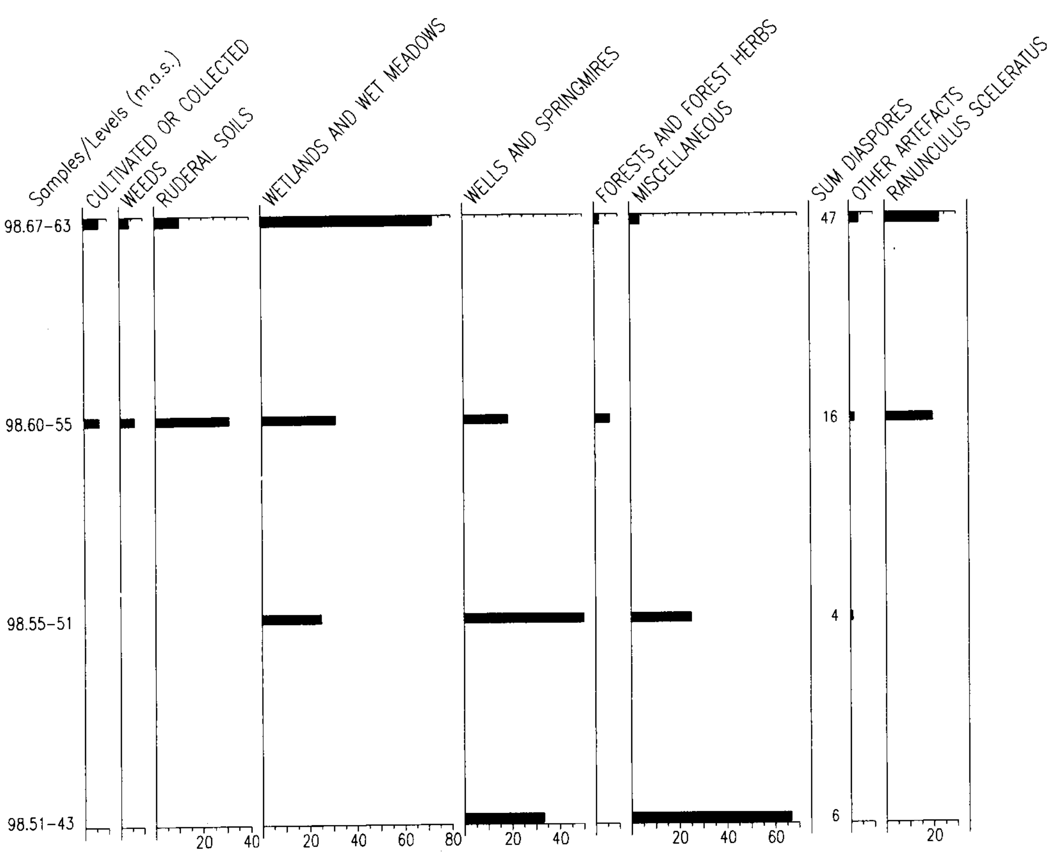


Fig. 61. The percentage diagram for D4, the eastern trench.

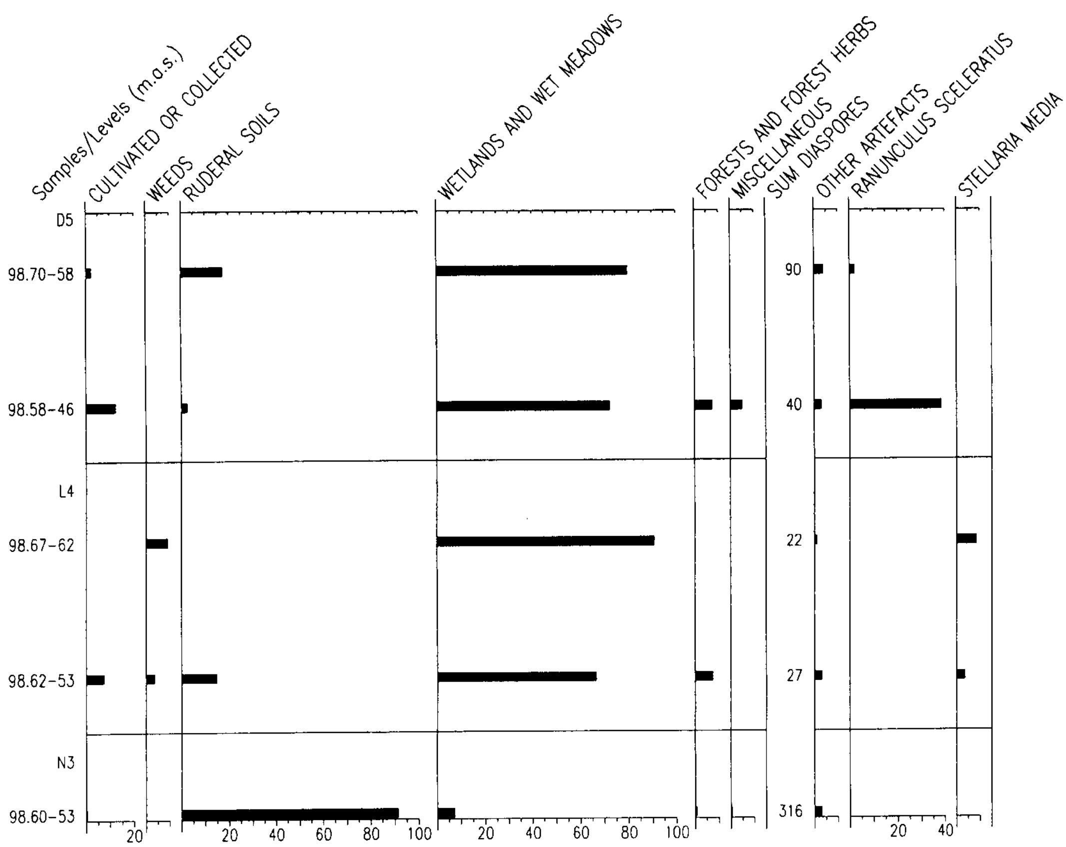


Fig. 62. The percentage diagrams for D5, L4 and N3, the eastern trench.

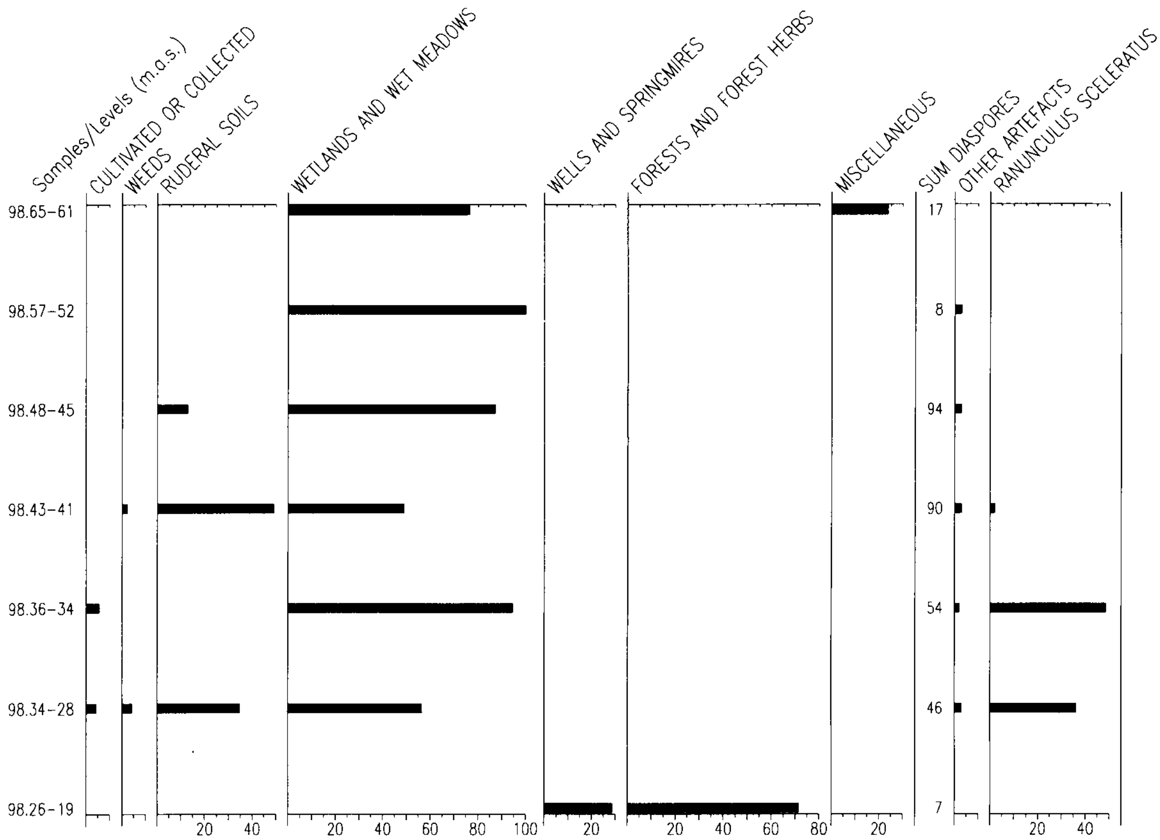


Fig. 63. The percentage diagram for L2, the eastern trench.

The vertical distribution of *Triticum dicoccum, Hordeum vulgare* and *Artemisia vulgaris* in the rigid and flexible systems

The vertical distribution of *Hordeum vulgare* (caryopses, rachis segments and ear fragments), *Triticum dicoccum* (caryopses and forks), Cerealia undiff., *Artemisia vulgaris, Polygonum convolvulus, Ranunculus sceleratus* and *Stellaria media* is reproduced in the *absolute diagrams* which, unlike the percentage diagrams, show the absolute or "real" values (amounts) of fruits and seeds.

The absolute diagrams are defined upwards to the very levels where the uppermost finds of *cereals* have been made in the two systems (that is, in the flexible system plus the rigid system) and defined downwards to the levels where the lowermost finds of *cereals* have been made in the two systems put together. In that way all seeds of *Artemisia vulgaris* are automatically included in the absolute diagrams. The absolute diagrams include *all* cereals found in the rigid and flexible systems, that is, *all* cereals collected during the analysis for fruits and seeds. Some *Polygonum convolvulus* are thus not found in the absolute diagrams as *Polygonum convolvulus* also occurs above the "cereal horizon".

No *Ranunculus sceleratus* is found above the "cereal horizon" in the absolute diagrams, which speaks in favour of this species being bound to the levels with the strongest human activities (probably the periods of leaf-foddering and twig-foddering, see below) in the pile dwelling. As can be seen in the percentage diagrams, *Ranunculus sceleratus* is sometimes found *below* the "cereal horizon".

As *Stellaria media* is tentatively used by me as an indicator species for the peat which is younger than the occupation layer, the majority of these seeds are *not* present in the absolute diagrams. Seven seeds of *Stellaria media* out of a total of 592 have been recorded in the absolute diagrams. *Note that the scale varies for the different species in the absolute diagrams!* Five *Stellaria media* take up the same space as 250 caryopses of *Hordeum vulgare* or *Triticum dicoccum*!

The test trench

At the level 98.58–53 m a.s.l. one caryopsis of *Hordeum vulgare,* one spikelet fork of *Triticum dicoccum* and one damaged undeterminable cereal caryopses have been recorded within the test trench. At the same level nine nuts of *Ranunculus sceleratus* have been listed. No *Ranunculus sceleratus* has been found above this level. On the other hand, nuts of this species occur down to 98.34–28 m a.s.l. (see the diagram for the rigid system).

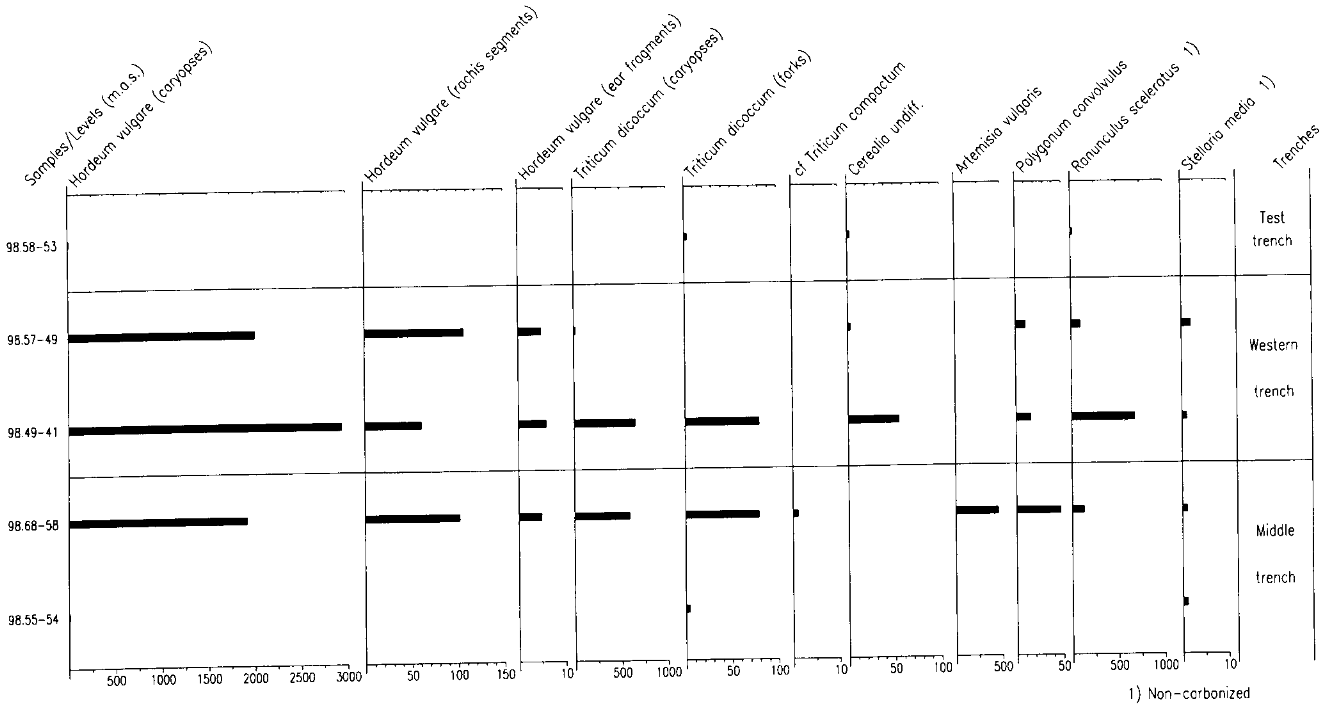


Fig. 64. The absolute diagrams for the test, western, and middle trenches.

The western trench

At the level 98.57–41 m a.s.l about 4950 caryopses and 11 ear fragments of *Hordeum vulgare* have been recorded in the rigid and in the flexible systems in the western trench. At the same level 674 caryopses and 80 spikelet forks of *Triticum dicoccum* have been recorded. All spikelet forks and 98.5% of the caryopses of *Triticum dicoccum* have been found within a very narrow zone – at 98.49–41 m a.s.l. *Hordeum vulgare* on the other hand, has almost as high values within the zone 98.57–49 m a.s.l. as within the zone 98.49–41 m a.s.l.

The only seed of *Artemisia vulgaris* recorded from the western trench is found at the level 98.44–41 m a.s.l. Eleven carbonized nuts of *Polygonum convolvulus* were found within the zone 98.57–49 m a.s.l., and 16 carbonized nuts of this species were found within the zone 98.49–41 m a.s.l.

The overwhelming majority (87.5%) of the 779 *Ranunculus sceleratus* recorded in the western trench were found at the level 98.49–41 m a.s.l. while the remainder (12.7%) were found at the level 98.57–49 m a.s.l.

Most of the cereal caryopses recorded from the western trench are found in connection with the floor or the hearths of the pile dwelling. Sample C1, 98.51–49 m a.s.l. was found at a hearth, L3, 98.57–54 m a.s.l., was found on the carbonized floor, B1, 98.48 m a.s.l. between two carbonized floor logs, G1, 98.53–52 m a.s.l. *below* the floor, B3 also below the floor and upon the lake marl, E1, 98.52–50 m a.s.l. upon a piece of bark and L4, 98.49 m a.s.l. at the side of a floor log and a carbonized apple. K2 was found immediately above the lake marl (see also tables 1 and 3).

The vertical distribution table from the rigid system in the western trench is somewhat too compressed. This is because too little material from the peat overlying the occupation layer was collected. If *all* four trenches (which thus constitute four small spot tests from the pile dwelling) are studied simultaneously we may nevertheless conclude that enough material from the rigid system has been analysed.

The middle trench

At the level 98.76–69 m a.s.l. three caryopses of *Hordeum vulgare* were found in the rigid system in the middle trench. At the level 98.68–58 m a.s.l. about 2000 caryopses (1915 whole caryopses plus a lot of crushed caryopses) have been recorded. Also found at this "cereal horizon" were 102 rachis segments and five ear fragments of *Hordeum vulgare*. At the same level 588 caryopses and 79 spikelet forks of *Triticum dicoccum* were found, as was the only probable caryopsis of *Triticum compactum.*

Of all 459 carbonized seeds of *Artemisia vulgaris* recorded from the Alvastra pile dwelling, 458 occur at the level 98.68–58 m a.s.l. in the middle trench within squares A and E (one seed of *Artemisia vulgaris* was, as mentioned above, found in the western trench, in square A). As suggested earlier, probably many more seeds of this species were from the beginning present in the soil samples. As the seeds of *Artemisia vulgaris* are very brittle and very difficult to observe, many seeds may have been lost – or not observed.

All 47 carbonized nuts of *Polygonum convolvulus* found in the middle trench occur at the level 98.68–58 m a.s.l. More than 127 nuts of *Ranunculus sceleratus* have been recorded at this horizon.

At the level 98.55–54 m a.s.l. one caryopsis of *Hordeum vulgare* and three spikelet forks of *Triticum dicoccum* have been found. No seeds of *Artemisia vulgaris* (or nuts of *Polygonum convolvulus* or *Ranunculus sceleratus*) have been recorded from this level. It can thus be concluded that almost all caryopses and glumes of cereals and all seeds of *Artemisia vulgaris* occur at the level 98.65–58 m a.s.l. in the middle trench, thus within a horizon of 7 centimetres.

The majority of the cereals and other species in the absolute diagram from the middle trench are from the floor of the pile dwelling. Thus sample A1 was collected upon and between charred logs, A2 between logs, A3 upon a charred log, C1 upon a log, E1 and E2 in a slit in a log, E3 below charred bark in a slit of a log, F1 in a hole in the floor, H1 and H3 upon twigs and bark on the floor, M1 in a hole below a hearth (in this hole – besides cereals, *Veronica hederifolia* etc. – also one seed of *Stellaria media* and one seed of *Anthriscus sylvestris* were found which confirms that seeds of these species may occur in the occupation layer proper as well), N1 in a slit in a log and O1 upon a log (for the designations A1, A2 etc. see fig. 5).

The eastern trench

In the eastern trench the vertical distribution of the caryopses of *Hordeum vulgare* extends from 98.68–63 m a.s.l. down to 98.35–28 m a.s.l., while *Triticum dicoccum* occurs from 98.68–63 m a.s.l. down to 98.39–36 m a.s.l. Both cereal species are found in very low frequencies – a total of 12 barley caryopses and four emmer caryopses have been recorded.

As mentioned earlier, *Ranunculus sceleratus* has high frequencies throughout the occupation layer – it rises strongly from 98.68–63 m a.s.l. down to 98.39 m a.s.l., after which it declines down to 98.35–28 m a.s.l. From a purely palaeoethnobotanical standpoint the following may be said: even if the frequencies of cereals are very low in the eastern trench, the "liquid manure indicator species" *Ranunculus sceleratus* discloses that the pile dwelling in the area of the eastern trench seems to have been used over a longer, more continuous period than the area of the middle and western trenches.

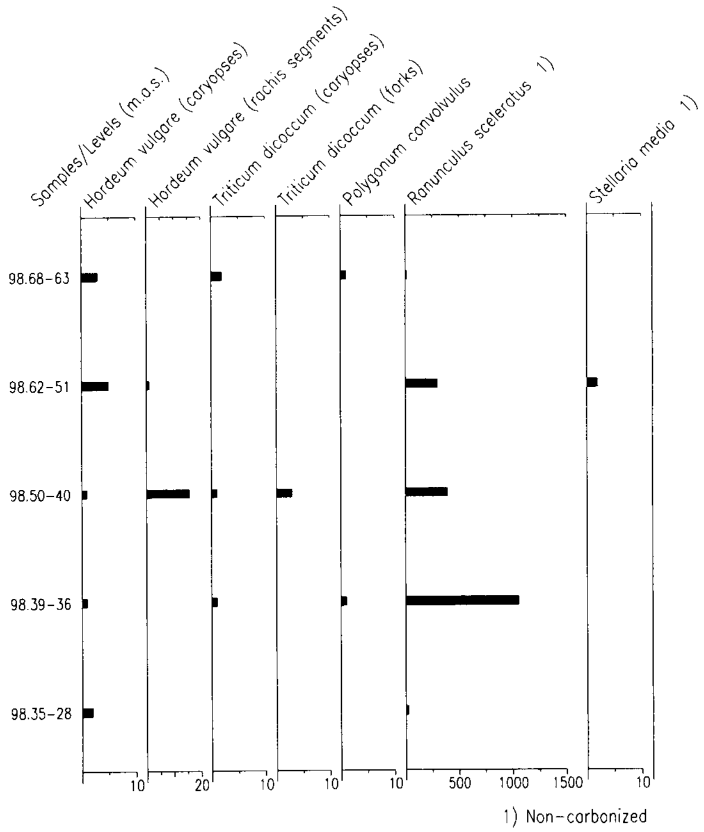


Fig. 65. The absolute diagram for the eastern trench.

Summary

From the above discussion, it can be concluded that the predominant part of the caryopses of cereals discovered during the seed-analytical work were found in the western and the middle trenches within a narrow zone in which the caryopses occur in connection with the floor and the hearths. A few caryopses are found above and below this narrow zone – thus the "total" zone is 16 cm in the western trench and 22 cm in the middle trench. In the eastern trench the very few cereal caryopses (a dozen) occur within a broader zone (ca. 40 cm). In the pollen diagram from the occupation layer of the eastern trench the "cereal pollen peak" is found in a position near the floor (fig. 73).

Ranunculus sceleratus, which in the present paper is named a "liquid manure species", is bound to the levels with the strongest human activities, that is, periods of probable leaf-foddering and twig-foddering and cultivation of cereals. It never occurs above the "cereal horizon" – in a few cases it is found below this horizon (the western trench).

Prehistoric calendars

The Alvastra pile dwelling, which is dated ca. 4430 B.P. (ca. 3340 B.C.), existed for a short time during an early part of the Middle Neolithic. It is natural that we ask how long man lived in that area before the pile dwelling was built. How did man utilize the natural environment before that time? To be able to answer these questions it is necessary to construct "prehistoric calendars" in the form of pollen diagrams with close C14-datings.

The Mabo Mosse bog

The Mabo Mosse bog lies ca. 80 km to the southeast of the Alvastra spring mire at an altitude of 118 m a.s.l. (fig. 4). It is ca. 30 hectares in area. The area around today's bog was probably deglaciated during Allerød Time and the bog basin was isolated from the Baltic Ice Lake ca. 10,800 B.P. (Göransson & Lemdahl in prep.).

The ombrotrophic stage of the bog began ca. 8700 B.P., which is unusually early. C14-dates from ombrotrophic peat are very reliable. Levels older than 8700 B.P. have been accelerator-dated. The C14-dated pollen diagram from the Mabo Mosse bog is thus an important "prehistoric calendar".

The Dags Mosse bog

The Dags Mosse bog lies immediately to the north of and adjacent to the Alvastra spring mire (figs. 2 and 3). The bog is ca. 96 m a.s.l. and it is ca. 260 hectares in area. The Dags Mosse bog and the Alvastra spring mire lie within the southern part of the Middle Swedish end-moraine zone which was deposited during the Younger Dryas (Berglund 1979:94f.). The Dags Mosse basin was isolated from the Yoldia Sea soon after 10,000 B.P. (Magnusson 1964:13, Göransson 1987: fig. 16).

The deposition of *Phragmites* peat started ca. 8700 B.P. and the deposition of *Carex* peat started about 7000 B.P. in the Dags Mosse basin (Magnusson 1964: Pl. 1, Göransson 1987: fig. 16). The ombrotrophic stage began ca. 4700 B.P. Also the underlying *Carex* fen peat has given reliable C14-dates – that is from ca. 7000 B.P. The Alvastra area is thus encircled by two well-dated pollen diagrams. We can study the vegetational history – that is, man's environment – back to Paleolithic time with the aid of the Mabo Mosse diagram and from the Middle Mesolithic with the aid of the Dags Mosse diagram.

The end of the Late Paleolithic

The highest shore line was formed by the Baltic Ice Lake in eastern Götaland. This shore line is found between 135 and 138 m a.s.l. in the Alvastra area (Svantesson 1981) and at ca. 135 m a.s.l. in the Mabo Mosse area (R. Larsson 1964).

During the end of the Late Paleolithic, from ca. 10,800 B.P. to ca. 10,100 B.P., most of the South Swedish Uplands were situated above the highest shore line. The Mabo Mosse bog is found in the north-eastern, marginal part of these uplands.

During the latest part of the Late Paleolithic the vegetation was open and light-demanding with, among others, *Artemisia* species, grasses, Chenopodiaceae, *Dryas*, sorrels, juniper, willows, dwarf birch and other taxa belonging to a tundra society. Arctic beetle species were present (Göransson and Lemdahl in prep.). At the very end of the Paleolithic, *Empetrum* heaths were formed.

Reindeer ought to have been very common on the tundra in the South Swedish Uplands during the Late Paleolithic. Many reindeer antlers have been found in bogs in Zealand and south-western Scania. Shed antlers show that reindeer lived in southern Sweden even during the winter, so human settlement must have been possible the whole year round (cf. compilation by L. Larsson 1990:273). Reindeer antler hoes have been found in gyttja layers from this time in southern Sweden (Welinder 1971). Areas which were situated above 135 m a.s.l. thus very likely were roamed through by man during the end of the Late Paleolithic.

In a recent paper Larsson suggests that South Sweden was depopulated between ca. 10,900 B.P. and ca. 10,300 B.P. The combination of a steep fall in temperature and a breakthrough of flowing water into Öresund during that epoch may have exterminated or severely reduced the reindeer population. Because of this, the ability to maintain continuous settlement in South Sweden was probably impaired or rendered impossible (L. Larsson 1994:172ff.). Not until after 10,300 B.P. were reindeer able to migrate back over the new land bridge so that South Sweden could be repopulated (ibid.).

Lemdahl, who has studied subfossil insect remains, has demonstrated that a very marked and very rapid climatic amelioration started ca. 10,100 B.P. in southern Sweden at the very end of the Paleolithic (Lemdahl 1988). Within about 50 years the climate changed from arctic to temperate conditions. This phenomenon is also observed in the Mabo Mosse bog, although this site is situated only ca. 60 km to the south of the Middle Swedish end-moraine zone (Göransson & Lemdahl in prep.).

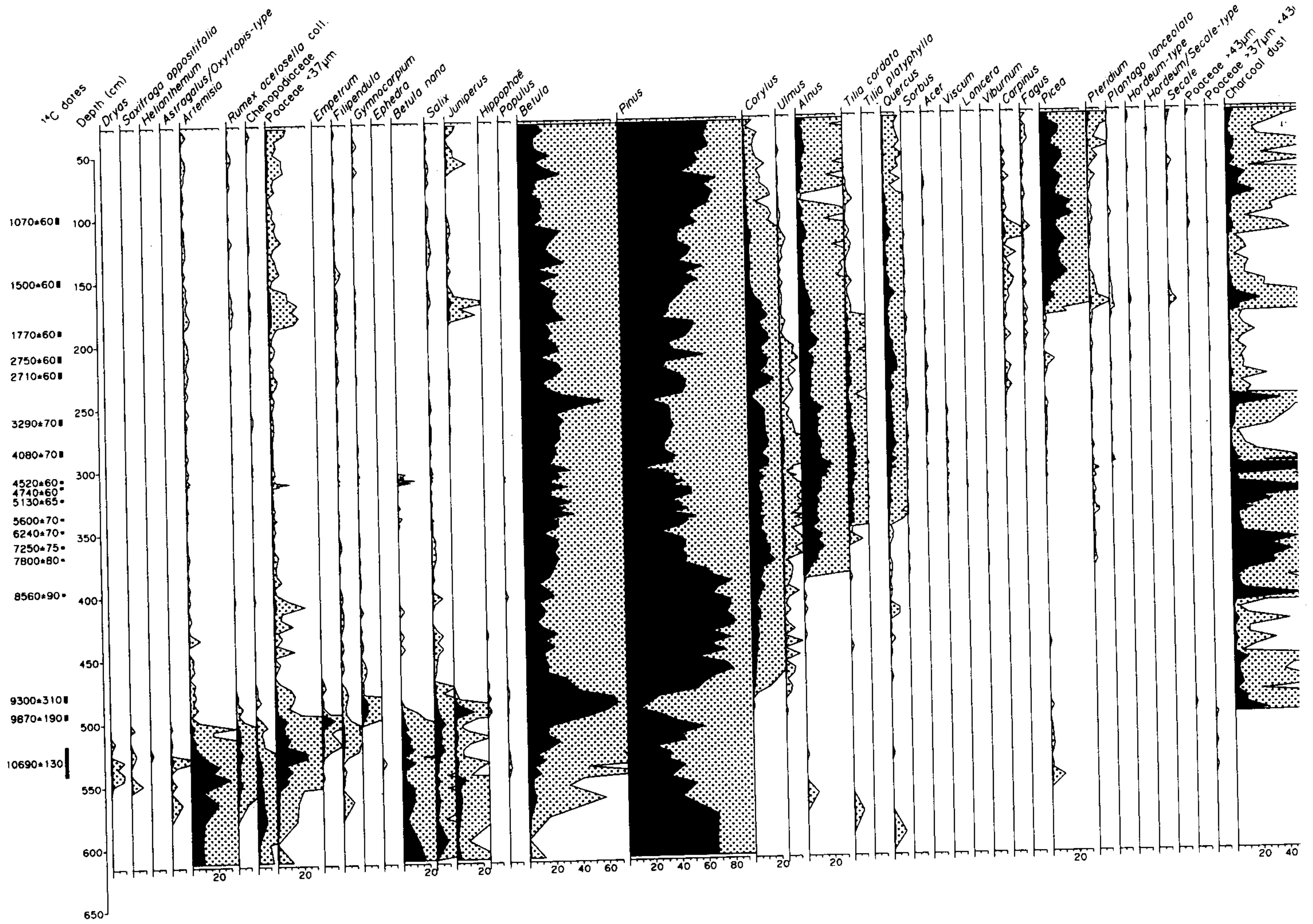


Fig. 66. The Mabo Mosse bog diagram.

The Early Mesolithic

The climatic improvement at the transition Paleolithic/Mesolithic was so rapid that the immigrating trees could not keep pace (Iversen 1960, Lemdahl 1988). The most outstanding feature of this transition is the strong rise of the *Juniperus* curve. The climatic improvement made it possible for juniper to grow tall and form rich-flowering scrub before its most effective competitors, the trees, arrived (Iversen, e.g. 1973).

For two or three hundred years the landscape was characterized by juniper scrub, sea-buckthorn (*Hippophaë*), dwarf birch (*Betula nana*), the fern *Gymnocarpium,* grasses (Poaceae) and sedges (Cyperaceae). This open scrub community ought to have been favourable for grazing animals. Aurochs had immigrated at the end of the Paleolithic (Ekström 1993), while reindeer disappeared during an early part of the Mesolithic.

The rapid spread of birch at ca. 9800 B.P. within the Mabo Mosse–Alvastra area and the formation of birch woods forced the juniper community to retreat. Sea-buckthorn was still present, and aspen (*Populus*) was rather common. At ca. 9300 B.P. pine and hazel spread in the Mabo Mosse area and at ca. 8560 B.P. alder rapidly occupied river and lake sides. The mass distribution of elm took place some hundred years after the spread of alder. It is assumed that wych elm (*Ulmus glabra*) was the dominant elm species right from the beginning.

The water level of the lakes was low during the first part of the Mesolithic (Digerfeldt, e.g. 1971, Gaillard, e.g. 1984). The fauna was rich, with aurochs and elk as big game. Red deer and wild boar ought to have been common, and the lakes and rivers were rich in fish. Thus the environment was very favourable for the Mesolithic hunter in the investigation area.

The Late Mesolithic

The border between the Early and the Late Mesolithic may be placed at 8000 B.P. – or between 8000 B.P. and 7500 B.P. The expansion of small-leaved lime (*Tilia cordata*) took place at ca. 7000 B.P. Also broad-leaved lime (*Tilia platyphyllos*) was found in the Late Mesolithic forests in the investigation area (Göransson 1977: fig. 44, 1987: fig 47 f, g). Ash (*Fraxinus*) arrived at about the same time as lime. Oak spread just before lime. It is assumed that common oak (*Quercus robur*) was the dominant species in the more fertile parts of the investigation area, as it is today.

Thus the typical "Atlantic forests" developed ca. 1000 years later in the investigation area than in southernmost Sweden (Scania). The beginning of the elm decline which marks the end of the Mesolithic is of the same age in the Dags Mosse bog (5180±60 B.P.) as in the Mabo Mosse bog (5130±60 B.P.) – and as in Scania (see below).

Forest fires and forest ground fires during the Mesolithic

In all pollen diagrams from the investigation area the curve of microscopic charcoal particles has high values during the Mesolithic. In the Mabo Mosse bog microscopic charcoal particles have been registered since about 9000 B.P.

When forest fires and forest ground fires take place the charcoal particles rise into the air, above the canopies of the trees. There the particles are caught by the winds and brought to lakes and bogs in the same way as tree pollen grains. Naturally, charcoal particles from hearth fires also are transported in the same way. Not infrequently, however, the curve of bracken (*Pteridium*) more or less coincides with that of charcoal dust. Bracken is favoured by forest fires and forest ground fires. Aspen (*Populus*) quickly occupies burnt areas and it grows tall if the environment remains unshaded. Unfortunately, *Populus* pollen is not well preserved in peat as opposed to lake sediments, where it is well preserved.

Microscopic charcoal particles, bracken spores and *Populus* pollen may thus be named "forest fire indicators" or "forest ground fire indicators". These indicators demonstrate that forest fires and/or forest ground fires occurred in the investigation area during most of the Mesolithic. Of course the Mesolithic hunter wanted to create a good environment for the grazing and browsing game and of course he wanted to favour hazel and berries of different kinds. By killing trees by girdling or by setting fire to wood piled around the bases of the trees, such an environmment was easily produced (Cronon 1984). This selective burning may have promoted a mosaic quality and "the edge effect" of the ecosystem (ibid.).

From the two "prehistoric calenders" we observe that forest fires were very intensive about 6200–6300 B.P., that is, ca. 1000 years before the elm decline. It is of great interest to observe that on the Island of Wolin (only ca. 165 km to the south of southernmost Sweden) forest fires were widespread at this time (Latałowa 1992). "It is not an exceptional case, when the vegetational changes detected by pollen analysis can be linked with the Mesolithic disturbances, although the area seems devoid of Mesolithic sites and artifacts" (Latałowa 1992:199, citing Chambers et al. 1988).

Is it really possible that the forests on high ground – especially oak and lime – could burn during the Mesolithic? By studying small kettle holes on slopes it is possible to test this hypothesis.

The kettle hole at Nässja

Twenty kilometres to the north of the Dags Mosse bog an "extremely small" kettle hole (dead-ice hole) was found at the base of an imposing glaciofluvial esker (Göransson 1991 a, b). The kettle hole is only 29 × 14

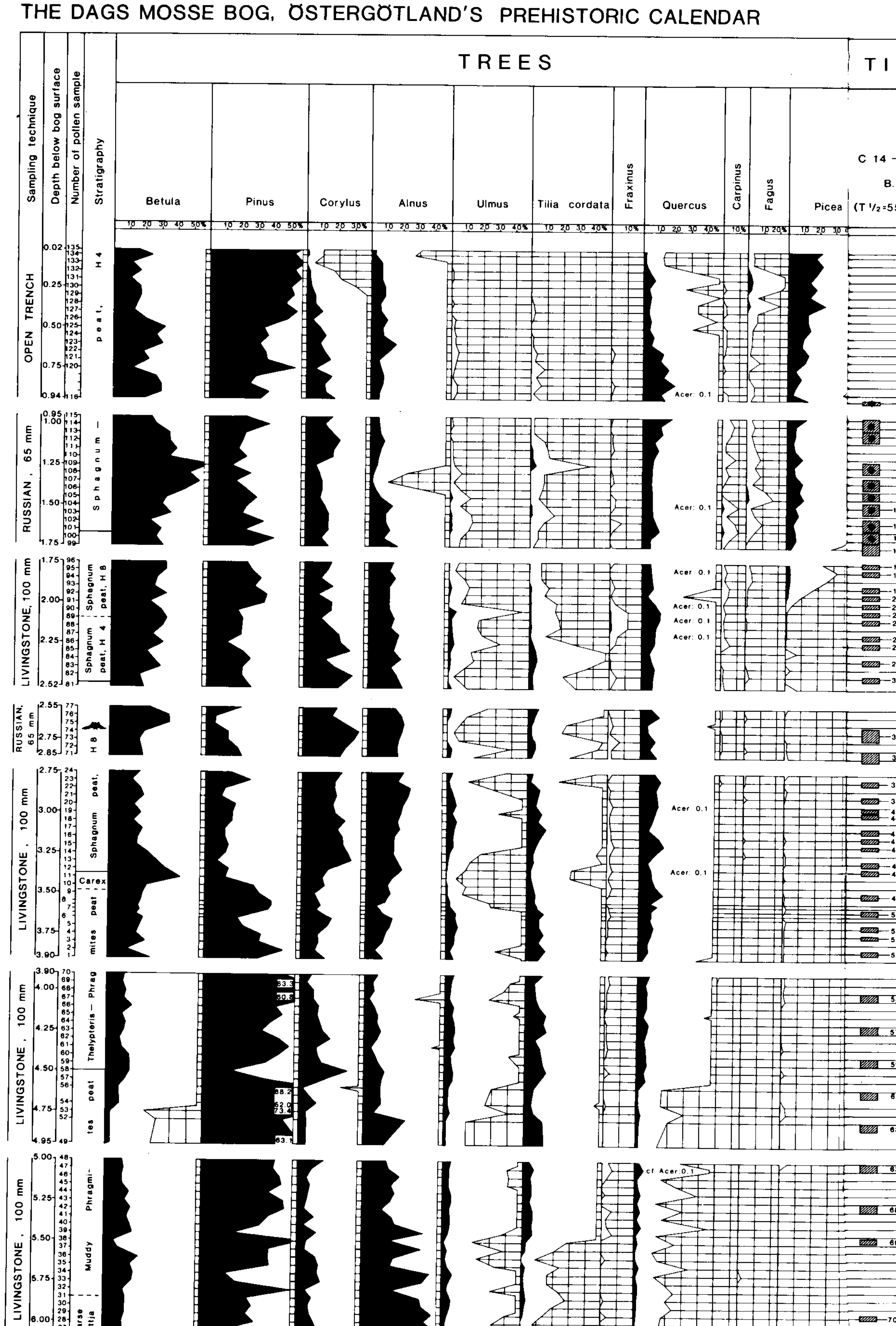
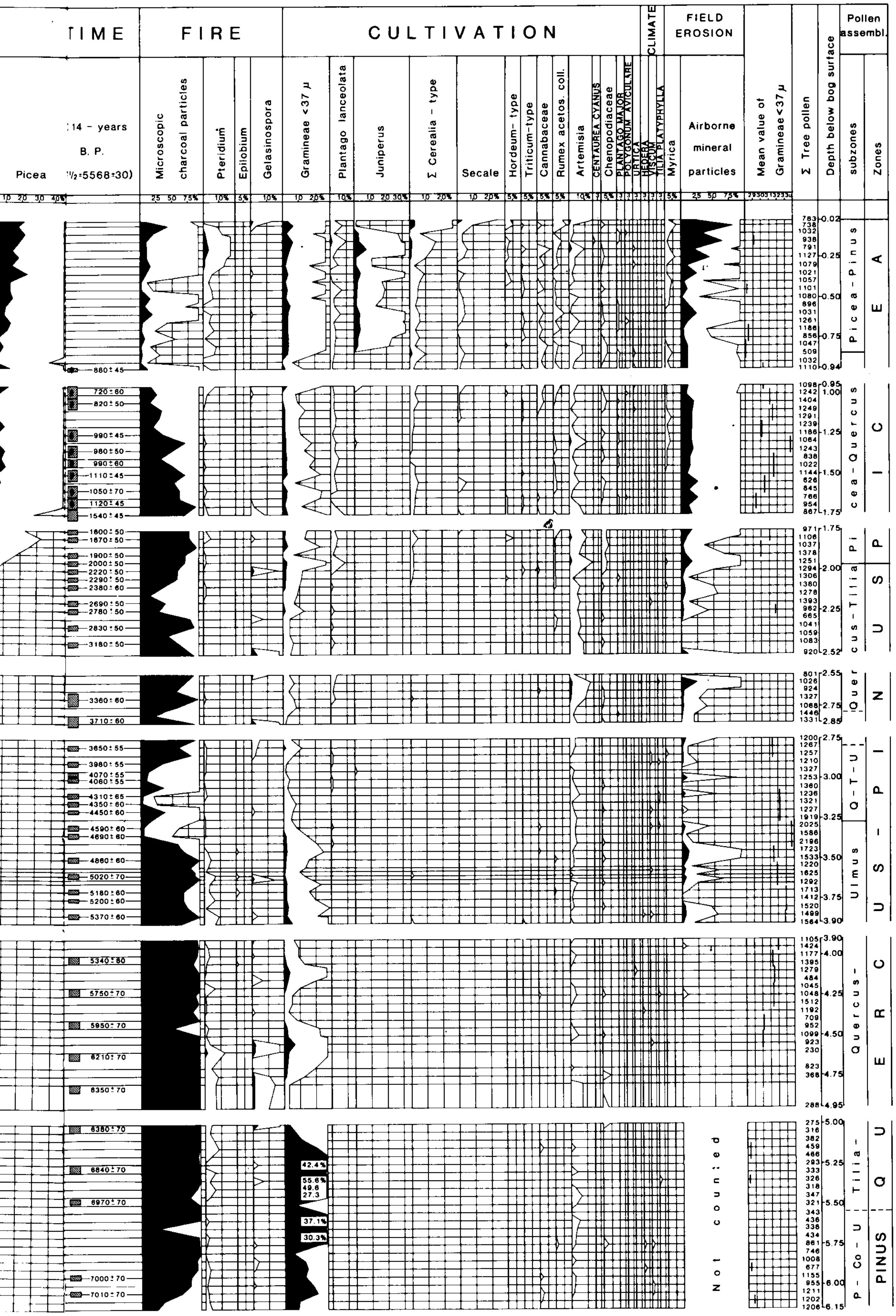


Fig. 67. The Dags Mosse bog diagram.



Analysis and Drawing : Hans Göransson 1981 - 1985 .

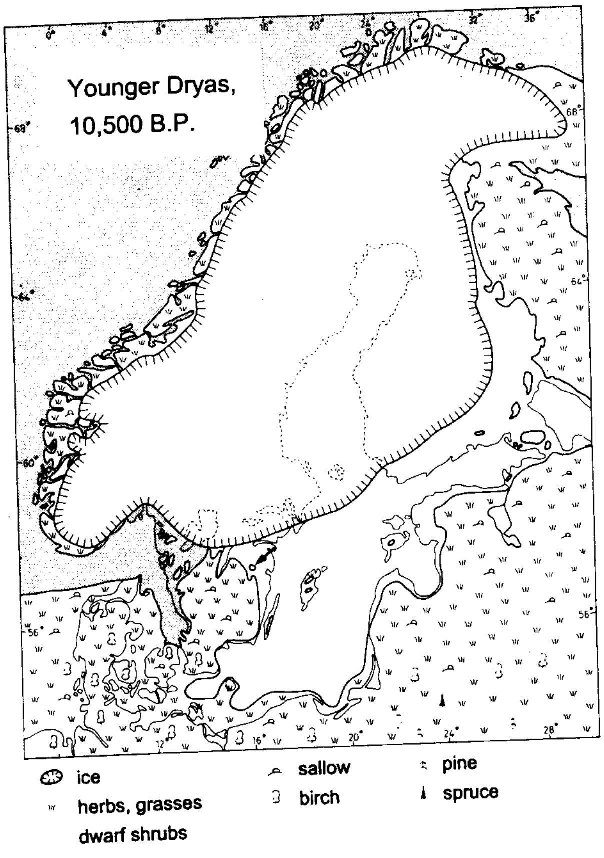


Fig. 68. Scandinavia ca. 10,500 B.P. The South Swedish Uplands form a peninsula to the south of the margin of the ice. In the southern and eastern parts of Götaland the highest shore line was formed by the Baltic Ice Lake. The Mabo Mosse bog (indicated by the arrow) was isolated from the Baltic Ice Lake at this point in time. (Recent research demonstrates that an outlet may have existed in Öresund during that epoch – see text.) After Berglund 1968.

metres. The sedimentation in the kettle hole started some time during the last third of the Mesolithic. Layer upon layer of macroscopic charcoal particles, deposited over thousands of years, were found in the sediments. No big hearth charcoals were found – only small particles (1–10 mm). The largest particles were identified by genus (by T. Bartholin). A combined pollen-charcoal diagram could thus be constructed. Some seeds are also plotted in this diagram. The beetles which have been examined by G. Lemdahl will be plotted in a future diagram (Göransson & Lemdahl in prep.).

To all appearances the macroscopic charcoal particles found in the kettle hole derive from forest fires. An accelerator dating of a macroscopic charcoal particle from a stem of *Tilia* in the undermost part of the sediment sequence (layer 10 – at ca. 1.34 m below surface) gave the C14-age of 6435±100 B.P. A macroscopic charcoal particle found in Mesolithic layers in the kettle hole at Isberga, 2 km to the east of the Alvastra spring mire, gave the C14-age of 6480±120 B.P.

A lot of charcoal particles of different broad-leaved trees were found in the Early Neolithic and Late Mesolithic layers, while no charcoal particles of *Pinus* have – up to now – been identified.

It thus seems to be confirmed that the forests of lime, oak, etc. did burn during the Mesolithic. Only dead and dry broad-leaved trees could burn. For that reason it is supposed that the Mesolithic hunter-gatherer killed big trees here and there in the way suggested above. This means that the forests between the Mabo Mosse bog in the south and up to the kettle hole at Nässja in the north were transformed by man during the Mesolithic in order to favour grazing and browsing animals and to create areas where hazel, cherry trees, crab apple trees, wild strawberries and other berries thrived. I find it self-evident to assume that Mesolithic man (in that case very likely woman!) planted some of the species mentioned. Thus it may be said that the Mesolithic hunter-gatherer was also a cultivator.

Cultivation of cereals during the latest part of the Mesolithic?

Excavations of settlements and shell middens in Jutland and bog sites in central Zealand show that the change from Mesolithic to Neolithic material culture was drastic and completed in less than 100 years between 5100 and 5000 B.P. (cf. compilation by L. Larsson 1990:294). There need not, however, as far as I understand, be any immediate connection between this "Mesolithic/ Neolithic border" and the introduction of cereals.

It is a mistake to believe that Neolithic implements were necessary to transform the forests during the Stone Age. Man's strongest and most effective tool was fire. Mesolithic know-how and Mesolithic implements were quite sufficient to kill big trees and to create the mosaic structure of the forests which has been described above. If we are able to interpret the pollen diagrams without looking at them through the lenses of convention, we will understand that the forests were transformed over very large areas during the Mesolithic.

Jennbert showed that grain and cattle, to all appearances, were introduced during the Ertebølle, before the Neolithic, as luxury goods – as "fertile gifts" (Jennbert 1984). An extensive network for exchange of prestige goods may have existed (Jennbert 1984, 1986, see also Fischer 1982, Göransson 1988). Jennbert's suggestion is supported by the fact that pollen of cereal type occurs before the elm decline at several sites in southern Sweden. Even if some – or much – of this cereal-*type* pollen may have come from some wild grasses, surely not *all* cereal pollen types came from wild grasses. When I investigated the kettle hole at Isberga in 1977 (see below), I was not aware that I was studying the Late Atlantic part of the core – because such local diagrams may be difficult to interpret before one is used to them!

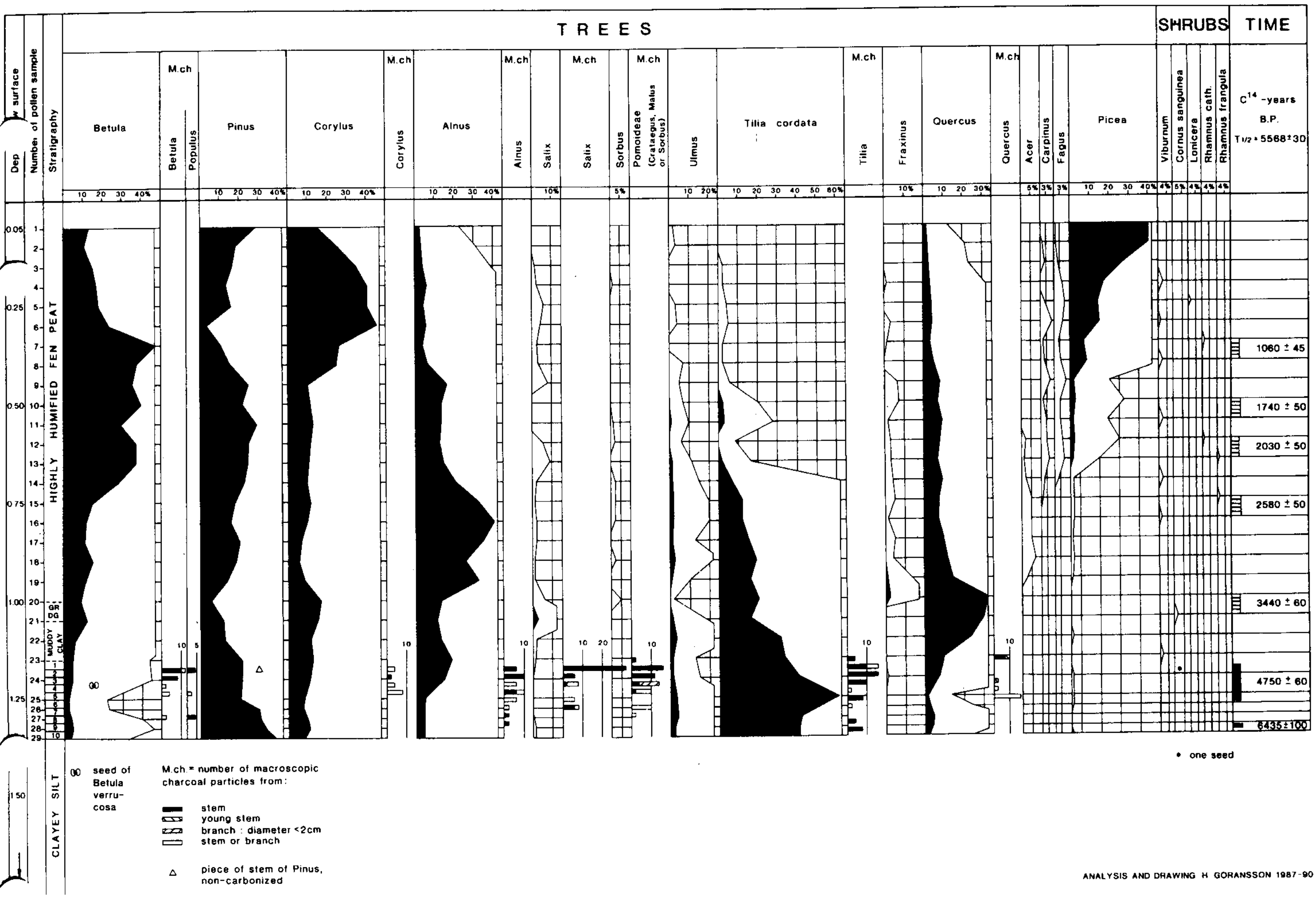


Fig. 69. The left part of the pollen-charcoal diagram from the kettle hole at Nässja ca. 20 km to the north of the Alvastra pile dwelling. The right part with herbs, graminids and beetles will be published elsewhere.

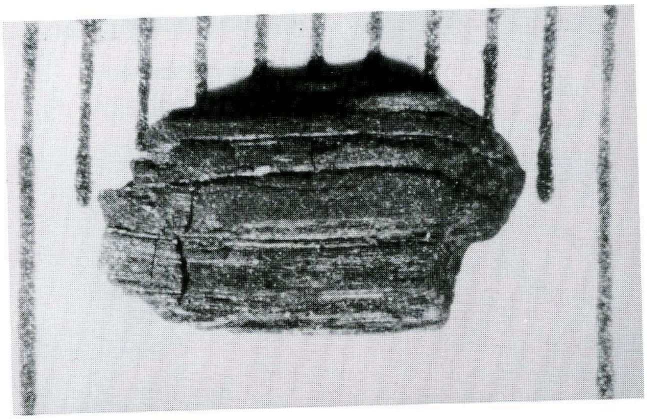


Fig. 70. Charcoal of *Quercus* from the Early Neolithic found in the kettle hole at Nässja. Scale in mm.

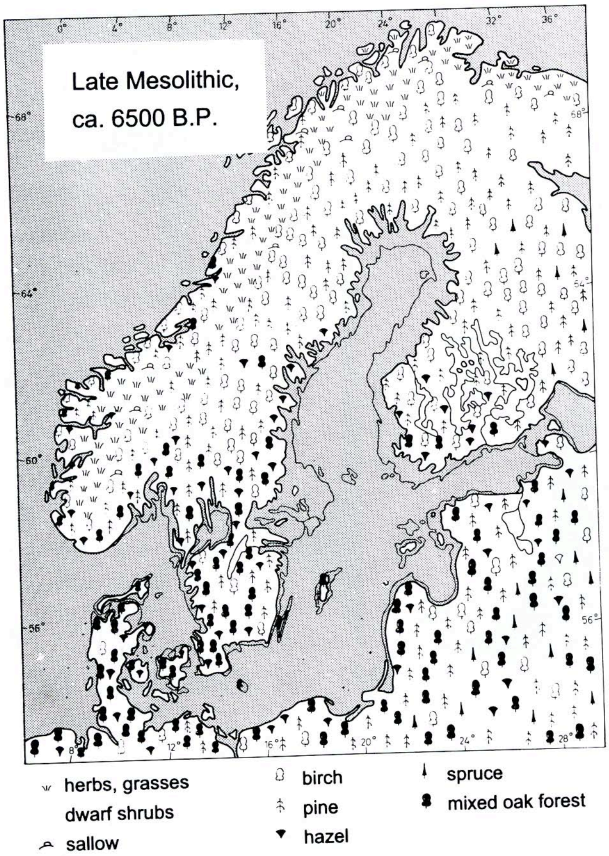


Fig. 71. Scandinavia during the Late Mesolithic (ca. 6500 B.P.). After Berglund 1968.

At the undermost level in the Isberga diagram (fig. 76) a beautiful cereal pollen (total diameter 55 μm, diameter of annulus more than 12 μm) was found. This pollen grain is of Mesolithic age. It cannot, however, be refound after so many years – at least not at the moment of writing. It should be mentioned that in the Fårarps Mosse bog in the Ystad Area Hjelmroos found *Plantago lanceolata* and cereal pollen type well before the elm decline (Berglund et al. 1991). Kolstrup also found pollen grains of cereal type and *Plantago lanceolata* well before the elm decline at Trundholm, north-western Zealand (Kolstrup 1988). In the older pollen diagram from Lake Bjärsjöholmssjön, southernmost Scania, cereal pollen and *Plantago lanceolata* were recorded before the elm decline (Nilsson 1961). *Plantago lanceolata* cannot grow in closed forests. Pre-elm-decline cereal pollen in the British Isles has been discussed by – above all – Edwards in a series of papers (e.g. 1988).

Engelmark's suggestion (1992:374f.) that "the cereal pollen grains occasionally found in south Scandinavian pollen diagrams from pre-Neolithic levels should be considered as an 'expected' influx from the continental Linear Pottery culture" seems to be a strange idea. The probability that pre-elm-decline cereal pollen which, according to Engelmark, blew in from the continent should happen to land in – above all – small kettle holes is indeed negligible. The probability is still more negligible if pollen of *Plantago lanceolata* is found in the same pre-elm-decline samples.

As I have demonstrated in a series of papers, the *Middle* Neolithic forests were not untouched forests but highly utilized forests. That the *Middle* Neolithic forests were transformed by man is difficult to observe in conventional pollen diagrams. In the same way it is difficult to observe that the *Mesolithic* forests were utilized by man by studying conventional pollen diagrams.

Mesolithic man and the forests – a summary

Let us – for the moment – ignore the discussion of cereals before the elm decline. Common sense ought to bring us to realize that Mesolithic man did utilize his inland resources – the forests – in the way described above. All over the world man has utilized the forests for thousands of years in order to favour grazing and browsing animals and in order to get better yields of wild, edible plants etc. This is self-evident. I think that the opposite view – that the Mesolithic hunter-gatherer did not utilize the inland resources – is a reflection of an old-fashioned outlook on "primitive savages", an outlook which has survived – as an unconscious current – since the 19th century. This strange outlook has, for instance, survived in the following sentences:

"The human population living here [the Ystad area] influenced the landscape and the ecosystem to a small extent by their hunting, fishing, and gathering activities. However, around their settlement local influences caused by tramping, small-scale fires, coppicing, and – during the last centuries before 3000 BC – small-scale crop tillage might have occurred. It is reasonable to estimate that human influence on the ecosystems was no greater than that of wild vertebrates" (Berglund et al. 1991:427).

I cannot share this opinion – and the pollen diagrams give us another picture. Mesolithic man's experience of how to utilize the forest resources was indeed greater than that of wild animals. Very likely it was Mesolithic man that made it possible for the vertebrates to browse and graze in the forests. Mesolithic man knew much more about how the different trees reacted to different manipulations than any man in south Sweden today – with the exception of a very few specialists, perhaps.

The period from the Early Neolithic up to the Early Middle Neolithic – comparisons between pollen diagrams from different areas in southern Sweden

In fig. 72 we shall compare two C14-dated pollen diagram sections from two different parts of southern Sweden with each other. The diagram sections – the period of time – which we shall discuss start at the elm decline level (that is, the start of the Early Neolithic) and end in the first part of the Regeneration Phase – at the very point of time when the Alvastra pile dwelling was built.

One of the diagrams is the diagram from the Dags Mosse bog, which we already know from the above discussion. The other diagram is from Lake Bjärsjöholmssjön, which is situated in southernmost Sweden, about 3 kilometres to the north of the coast of the Baltic and the town of Ystad. The distance between Lake Bjärsjöholmssjön and the Dags Mosse bog is 325 kilometres. Also the diagram from the Mabo Mosse bog is referred to in the text. This bog is, as mentioned earlier, situated 85 kilometres to the south-east of the Dags Mosse bog.

The C14-dates for the Lake Bjärsjöholmssjön diagram *outside* the brackets are correct (the C14-dates in brackets are not discussed here – for details see Göransson 1991a). The C14-dates from the Dags Mosse bog are from peat and they are correct. The "index horizons" are after Nilsson (Nilsson 1961). [There is no need for a deeper discussion of these index horizons here or the abbreviations used. The interested reader is referred to Nilsson's work. That I use these horizons here does not mean that I have abandoned the Chronozone system suggested by Mangerud et al., which some readers believe! (Ekström 1993:58)].

The C14-sample for the elm decline (U-decl.) in Lake Bjärsjöholmssjön has its heavy point 2.5 cm *above* the elm decline level. Thus the date of the elm decline level is somewhat older than 5100 B.P. – that is, of the same age as in the Dags Mosse bog (5180±60 B.P.). As mentioned earlier, the *Ulmus* decline was dated to 5130±60 B.P. in the Mabo Mosse bog. Thus the elm decline is roughly synchronous from southernmost Sweden to Östergötland – from Ystad to Alvastra.

Nilsson's index horizon AT/SB is above all characterized by an accelerated fall of the *Ulmus* curve – and most often also of a fall of the *Tilia* curve. It obviously has a C14-age of 5040±60 B.P. in Scania (for details see Göransson 1991a:17ff.). This level is easily identified also in the Dags Mosse bog, where it was dated to 5020±60 B.P. Thus AT/SB is practically synchronous from Scania to Östergötland.

Another level which is found in all "fully developed" pollen diagrams from Scania to Östergötland is index horizon SB1 g. It is, above all, characterized by the very *Ulmus* minimum after the decline and by a marked *Betula* maximum. This level was not dated in Scania. Unfortunately, SB1 g was the only C14-sample from the Dags Mosse bog which – for unknown reasons – collapsed. In the Mabo Mosse bog this index horizon was dated to 4740±60 B.P. It seems very likely that SB1 g is synchronous from Scania to Östergötland and that it has a C14-age of ca. 4750± 60 B.P.

The important index horizon SB1 f corresponds to the very level where the *Ulmus* curve begins to rise again after the elm decline. At the same time *Corylus* has a maximum while *Betula* is falling. This is the very level where the "forest regeneration" starts after the elm decline. SB1 f was dated to 4510±60 B.P. in Scania, to 4520±60 B.P. in Mabo Mosse and to 4590±60 B.P. in Dags Mosse. SB1 f thus seems to be synchronous over the whole of the eastern part of south Sweden and it coincides with the start of the Middle Neolithic.

Index horizon SB1 e is slightly, although distinctly, younger than SB1 f. It is characterized by a further rise of the *Ulmus* curve (and of *Tilia* and *Fraxinus*) and a decline of *Betula* (and a slight decline of *Corylus*). Often the *Quercus* curve has a peak at this level.

SB1 e was dated to 4450±60 B.P. in the Dags Mosse bog. The Alvastra pile dwelling was built at a time which corresponds almost exactly to this pollen-analytical horizon (the mean value of the C14-datings from the pile dwelling is slightly younger than ca. 4450 B.P.). At SB1 e the regeneration of *Ulmus*, *Tilia* etc. has thus lasted 60–140 years. The "Regeneration Phase" is under full development.

From the above discussion we have now learnt that the forest history of the Early Neolithic is reflected in our pollen diagrams from southern Sweden between the (initial) fall of the elm curve and the very level where the *Ulmus* curve begins to rise again – at SB1 f. The elm decline is, as mentioned above, dated to ca. 5150 B.P. and SB1 f is dated to ca. 4550 B.P. Between these two dated levels we find the 600 C14-year-long Early Neolithic forest history. The Early Middle Neolithic starts at SB1 f.

The use of fire during the Early Neolithic

In very many pollen diagrams from southern Sweden the curve for microscopic charcoal particles rises distinctly at – or slightly above – the elm decline level. In most of my diagrams from the investigation area there is at the same time a strong rise of the *Pteridium* curve. In Lake Striern we observe a strong rise of the *Populus* curve immediately above the elm decline (Göransson 1987: fig. 36). An extremely strong rise of the *Populus* curve was observed at Mogetorp in the province of Södermanland (Florin 1957). As mentioned earlier, *Pteridium* and

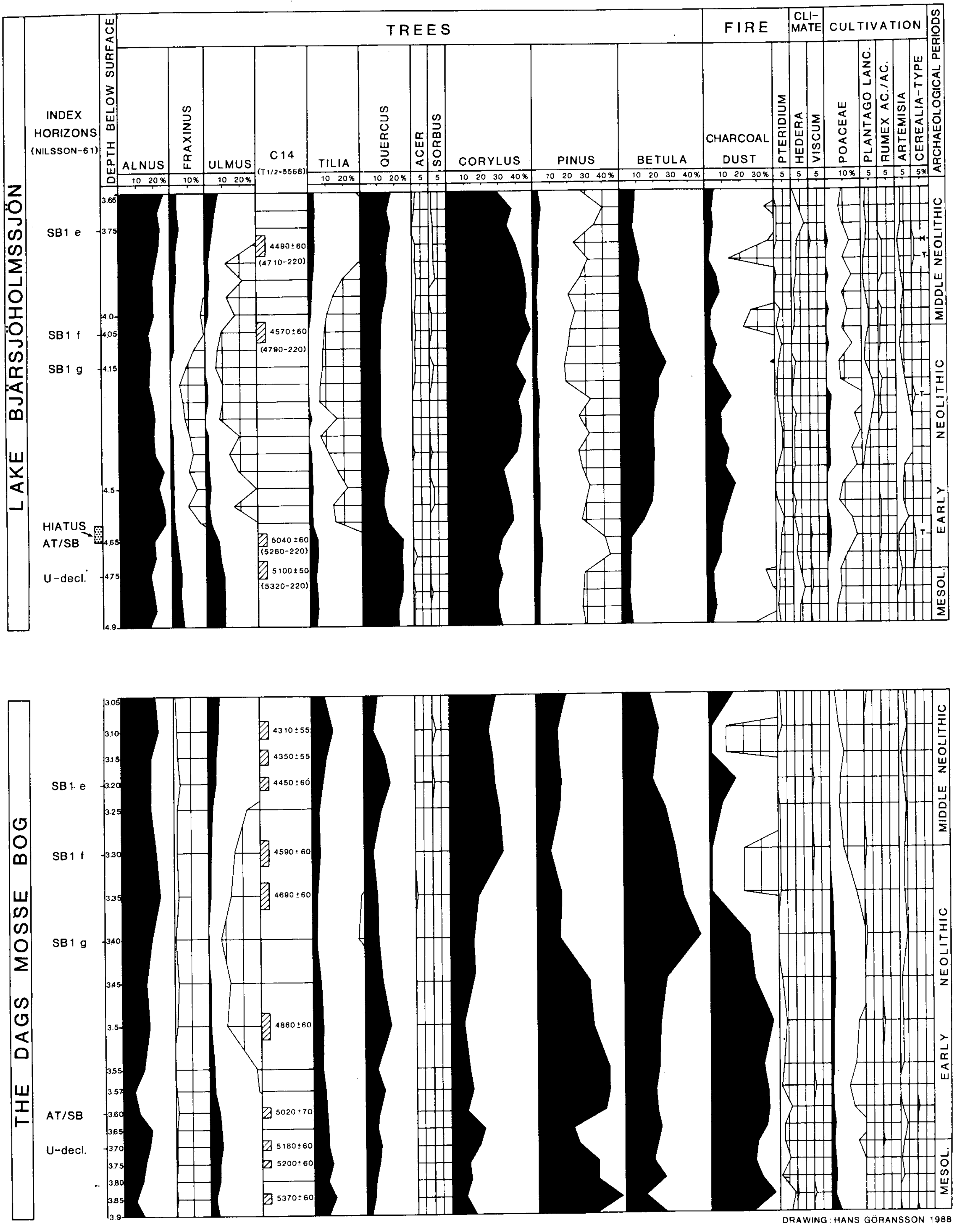


Fig. 72. Comparisons between pollen diagram sections from Lake Bjärsjöholmssjön, southern Scania and the Dags Mosse bog, western Östergötland. For details see text. After Göransson 1991a.

Populus are strongly favoured by forest fires. Pollen grains of Cerealia type, reflecting cultivation of cereals, are found during this "fire phase", as are pollen grains of the grazing indicator *Plantago lanceolata.* Soon after SB1 g (see above), that is, soon after 4750 B.P., there is a very distinct decline of the curve of microscopic charcoal particles. This phenomenon is also observed in westernmost Sweden (Thelaus 1989:36). The decline of microscopic charcoal particles, *Pteridium* and *Populus* does *not* correspond to a decline in pollen of Cerealia type or of *Plantago lanceolata* (see below).

In extremely small kettle holes microscopic charcoal particles "turn into" macroscopic charcoal particles (Göransson 1991 b,c). Thus in the kettle hole at Nässja (fig. 69) macroscopic charcoal particles from the Early Neolithic are, as mentioned earlier, found in layer upon layer. These macroscopic charcoal particles derive from stems and branches of *Tilia, Quercus, Corylus, Alnus, Salix*, Pomoideae (*Cratægus, Malus* or *Sorbus*), *Betula* and *Populus.* Because of lack of funds it has not been possible to complete the investigation at this site. A sample from the charcoal layers between 1.18 m and 1.27 m below the surface gave the C14-age of 4750±60 B.P.

The forests were very probably cleared by burning in order to create areas for cultivation of cereals. It is not necessary to assume that these clearances by burning were of the same type as historical burn-beatings. Probably already then – during the Early Neolithic – clumps of stump-sprout forests ("coppice woods") of different ages were found on the eskers near the kettle hole. Burning also created grazing areas, as during the Mesolithic. The difference is that man's livestock now grazed on the cleared areas where deer and so on had grazed and browsed during the Mesolithic.

At Munkeröd to the north of Gothenburg in westernmost Sweden G. Lindman found a variable pattern of charcoal layers alternating with thicker layers of sandy, sooty humus as well as thin layers of peat (Lindman 1993). The charoals were found in sand-filled erosion gullies which contained from 1 to 6 charcoal layers. The charcoal originated from trunks, branches and twigs of birch, oak, hazel, alder, aspen, rowan/sallow as well as other deciduous trees. The oldest charcoals were dated to 4800±70 B.P. "Some form" of slash-and-burn took place in the Munkeröd area – followed by grazing (Lindman, 1993:111). No Mesolithic charcoal particles were found in the Munkeröd area.

The Neolithic forest fires initiated by the forest farmers are thus reflected in many pollen diagrams in high values of microscopic charcoal particles, *Pteridium* and *Populus.* The study of extremely small kettle holes gives us, as we have seen, information about which genera of broad-leaved trees were burnt (Göransson 1991 b,c). Archaeological excavations of the type described by Lindman show us where these Early Neolithic forest fires occurred within a certain area and which genera were burnt (Lindman 1993).

The terminology concerning the forest fires which were initiated – on patches – by the Early Neolithic forest farmer has not yet been stabilized. The terms "slash-and-burn" or "burn-beating" must be considered provisional arrangements. It is strange that the term "clearance fires" may not be used, this term being reserved for the fires which are initiated on sites which are selected for the creation of permanent fields (the seminar on slash-and-burn and clearance fires in Norden, Stockholm 1992). "Slash-and-burn" or "burn-beating" is surely not an adequate term for the "mild" fires which took place in newly cleared coppice wood areas during the following Middle Neolithic (see below).

The expansion–regression model for the Early and Middle Neolithic

The ca. 600 C14-year long period with low values for elm, lime and ash and high values for birch reflects – according to tradition – the Early Neolithic "expansion phase" (Berglund, e.g. 1991). Then comes the Middle Neolithic "regression phase", which is characterized by a decline of birch and an increase of elm, lime and ash (starting at index horizon SB1 f). The Alvastra pile dwelling itself (built at SB1e) demolishes the regression hypothesis for the Early Middle Neolithic.

There seem to be some unknown factors lying beyond man's control, beyond man's activities (tree-felling, burning etc.) and beyond the effect of grazing on a large scale which cause the vegetational changes which are synchronous over large areas, from the elm decline level (ca. 5150 B.P.) up to index horizon SB1 f (ca. 4550 B.P.) and further upwards in time.

The pollen-analytical dating of the Alvastra pile dwelling

Pollen from *Hordeum vulgare* (in the main naked four-row barley) and *Triticum dicoccum* (emmer wheat) – the cereals which were cultivated by the population who built the pile dwelling in the Alvastra area – spread extremely small amounts of pollen during flowering time as the pollen is "trapped" within the chaffs. Only when the ears are threshed are great amounts of pollen released. (It also seems as if during harvest time pollen may be released when the straws are cut off and thus "shaken" and disturbed – see further below.)

The fact that huge amounts of cereal pollen may be found in the occupation layer of the Alvastra pile dwelling is evident from Magnusson's investigations (1964:39). In one sample he found no less than 2511 cereal pollen grains (with only 351 tree pollen grains). Of these cereal pollen grains 2087 were of *Hordeum* type, 312 of *Triticum* type, 101 of *Hordeum* or *Triticum* type, and 10 of *Elytrigia repens* type (Magnusson 1964:39). No pollen grains of *Glyceria* type were re-

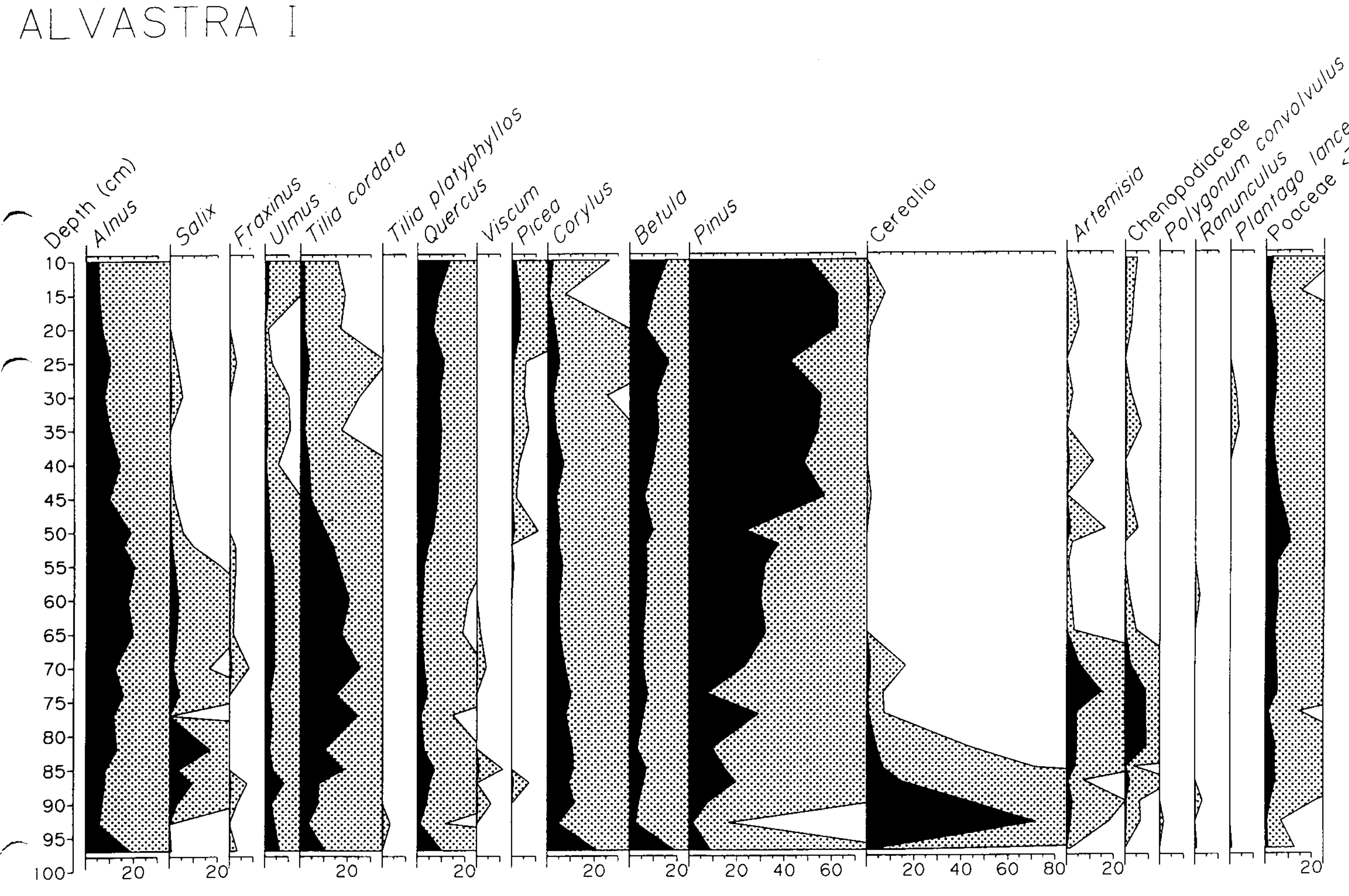


Fig. 73. The Alvastra I pollen diagram. The occupation layer is found between ca. 0.5 m and ca. 0.95 m below the surface of the spring mire (= ca. 98.69 m and 98.24 m a.s.l.). After Göransson 1987: fig. 28.

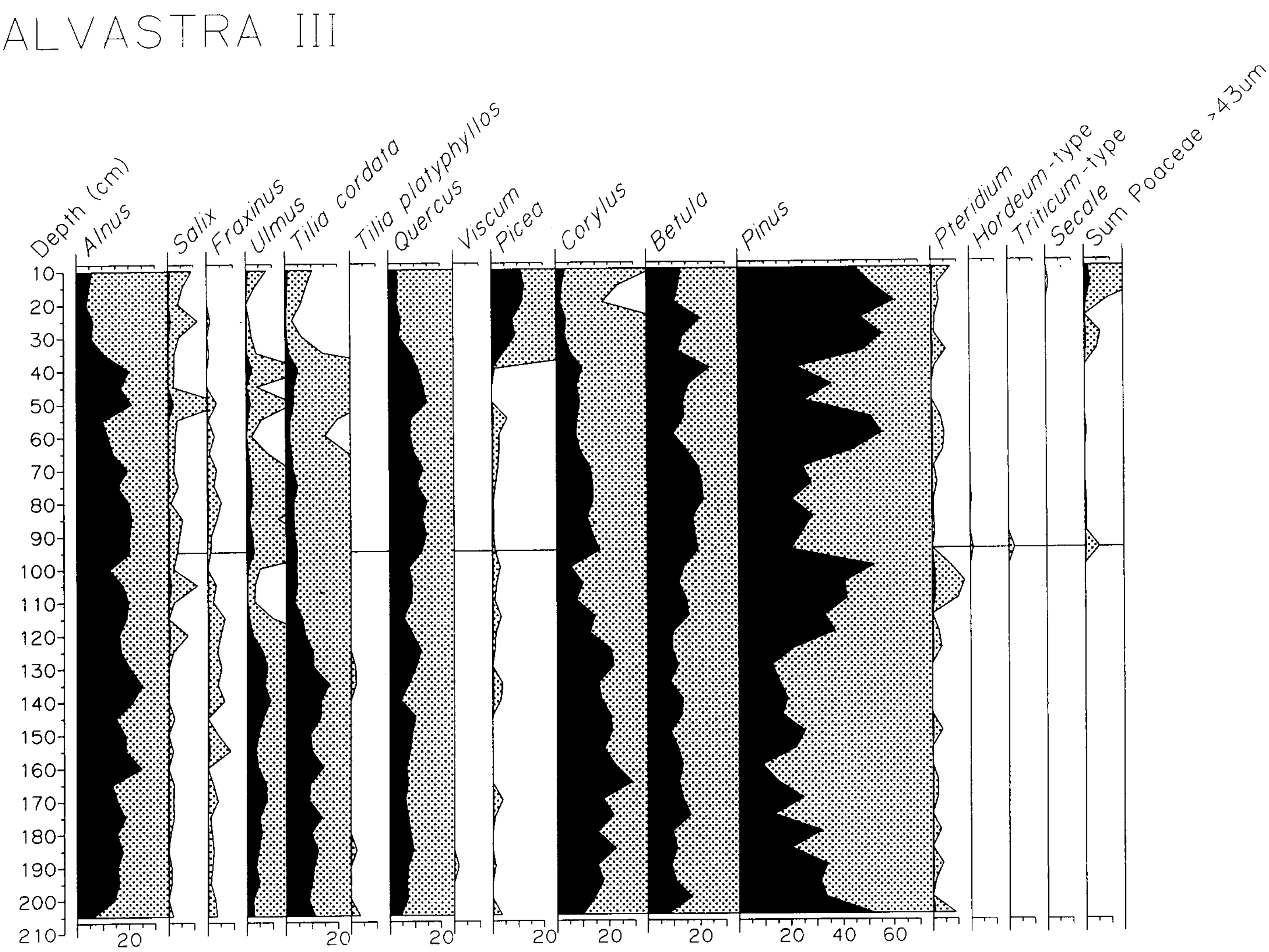


Fig. 74. The Alvastra III pollen diagram is from a core which was taken in the spring mire 32 m to the north-east of the eastern trench in 1976. At the level which is marked by a horizontal line cereal pollen suddenly makes its appearance with abnormally high values for such a large basin at such an early period. The cereal pollen grains were transported by the wind from the dwelling site to the investigation point. After Göransson 1987: fig. 31.

corded by Magnusson. I myself found 435 cereal pollen grains among 146 tree pollen grains in a sample from the lower part of the occupation layer (fig. 73).

During warming (drying) on the hearths and threshing activities on the floor of the pile dwelling, huge amounts of cereal pollen were thus released – during 10 to 15 threshing seasons. Most of this cereal pollen fell down on the floor but it also spread over the spring-mire, forming a small cereal pollen peak.

Only a few metres outside the floor of the pile dwelling the cereal pollen values are very low compared with those of the occupation layer, and tree pollen strongly dominates over cereal pollen. The percentage (or per thousand) value of cereal pollen in the spring-mire at the "Alvastra time level" is, however, much greater than we ever find during the Regeneration Phase in even the most carefully chosen "peep-hole" (see below). Thus, 32 m to the north-east of the eastern trench five cereal pollen grains were found among 874 tree pollen grains (fig. 74).

Fig. 75. The Isberga Nature Reserve ("Norrö backar"), surrounded by several square kilometres of cultivated fen soils. The Isberga area is made up of sandy-silty, calcareous glaciofluvial and other dead-ice formations which today carry a unique dry steppe meadow flora. A very common species is dropwort (*Filipendula vulgaris*). The kettle hole from which the Isberga III pollen diagram originates is distinctly seen as a dark circle in the middle of the picture. Photo: P.-A. Carlsson.

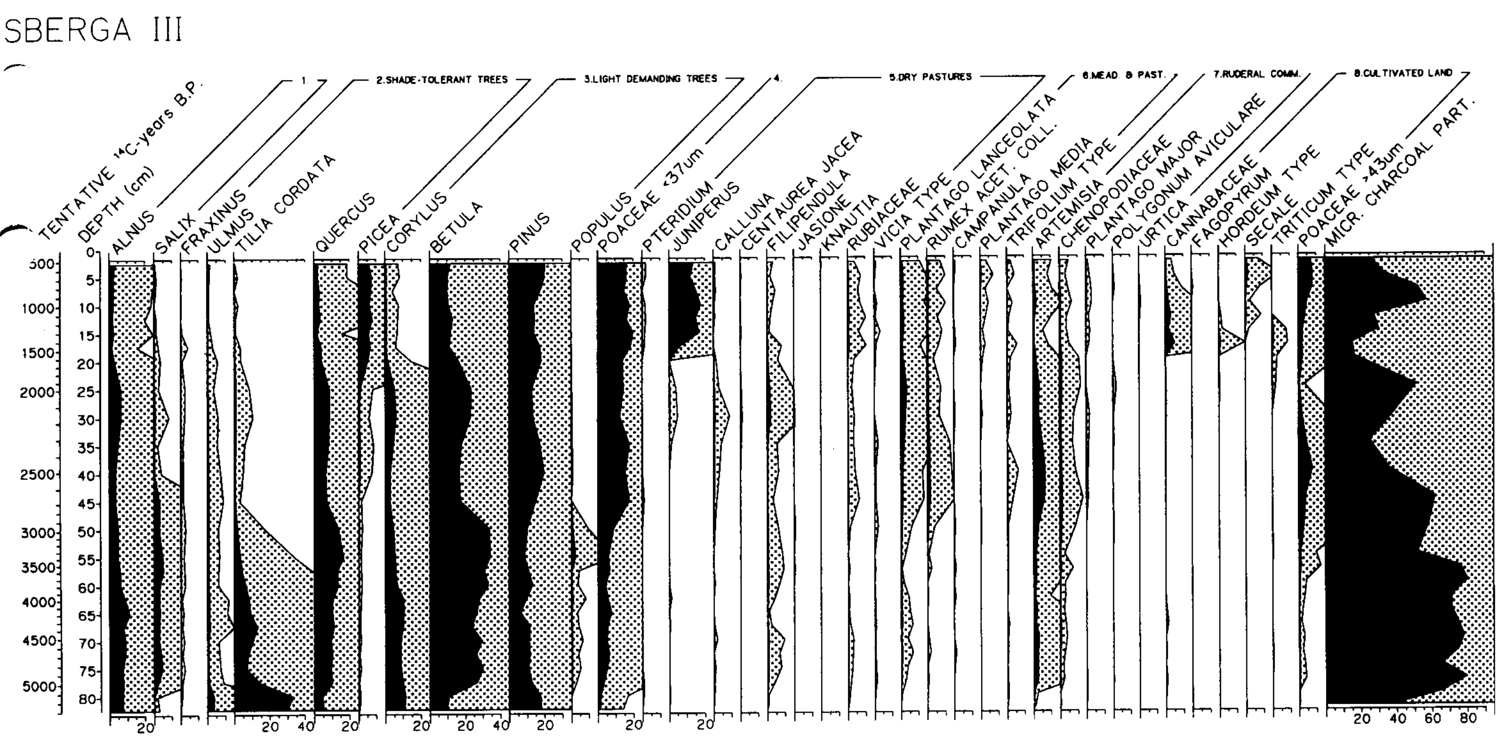


Fig. 76. The redated pollen diagram from the kettle hole at Isberga.

As the pile dwelling is dated to ca. 4430±50 B.P. it was built and used at a point of time which corresponds to index horizon SB1 e (fig. 72). As we have already learnt from the above discussion, this level corresponds to a time when the Regeneration Phase had lasted about a century. The Alvastra pile dwelling was – according to the archaeologists – a social and cult centre for a prosperous farming population, part of which lived in the vicinity of the Dags Mosse bog. (As will be discussed below, the pile dwelling may also have functioned as a byre for cattle, sheep and goats during winter.) In spite of the presence of a farming population, the pollen diagram from the Dags Mosse bog shows us a distinct regeneration of elm, lime, etc. – as we can observe in almost all other pollen diagrams from southern Sweden during that epoch. The early Middle Neolithic farming is thus *characterized* by rather high values of elm, lime, oak, ash and hazel.

Because of the filtration effect (Tauber 1965) or "curtain effect" (Göransson 1984, 1987, 1991 a) of the growing forests, only very seldom are there any finds of cereal pollen from the early Middle Neolithic in pollen diagrams from medium-sized or large basins. Furthermore, pollen from four-row barley and emmer wheat spread extremely small amounts of pollen during flowering time (see above). As we have seen, most of the pollen which is released in a near-ground level is spread very short distances.

Fig. 77. One of the predominant species today in the dry steppe meadows in western Östergötland is dropwort (*Filipendula vulgaris*) which here is seen at Ljungstorp to the south-east of the Isberga Nature Reserve. Photo: A. Tingvall/Callunabild.

Cultivation of cereals in the Alvastra area during the Early Middle Neolithic

As mentioned earlier, during harvest time pollen of the Middle Neolithic cereals may have been released when the ears were cut (or broken) off and thus "disturbed". This implies that it should be possible to trace the Early Middle Neolithic fields of corn which once bordered on very small basins, surrounded on all sides by light, lime-rich soils. Such a basin is found 2 km east of the pile dwelling at the Isberga Nature Reserve or "Norrö backar" ("the Hills of Norrö").

There is a small kettle hole in the middle of the Isberga Nature Reserve. Pollen analysis and stratigraphical investigations were performed in 1977–78 (Göransson 1987). As no datings could be obtained – the analyses were performed before the introduction of the accelerator dating method – my argument that "there are only few cereal pollen grains registered in the Early Neolithic part of the Isberga pollen diagram" (Göransson 1987:57) was quite wrong. Not only I, but also my colleagues and my reviewers, misinterpreted the pollen diagrams from Isberga. The Isberga I and Isberga II diagrams should thus be omitted and the redated Isberga III diagram should be used.

A charcoal particle found in the kettle hole at 97 cm below the surface was dated to 6435±165 B.P. The Isberga III diagram thus starts during the Late Atlantic. At 80 cm we find the *Ulmus* decline which coincides with a steep fall of the *Tilia* curve (fig. 76). Already at the beginning of the elm decline the unbroken *Plantago lanceolata* curve begins, disclosing grazing from the very first part of the Early Neolithic up to our days. Slightly above the elm decline an irrefutable *Triticum* pollen was found and photographed (fig. 78 – cf. discussion by Göransson 1994a:127).

At 70 cm we find the level which broadly corresponds to "Alvastra time". In the Isberga area the cultivation of cereals, like the grazing, has gone on without interruption since the start of the Early Neolithic. In fact, the pollen curve for Cerealia starts well before the elm decline – as mentioned above.

Stone Age trees and the dragon's head phenomenon

It is suggested that the Middle Neolithic "forest farmer" utilized the light, calcareous soils – that is, glaciofluvial deposits of different kinds – in the investigation area for cultivation of cereals. During the Stone Age these glaciofluvial deposits were covered with, above all, lime, oak and hazel.

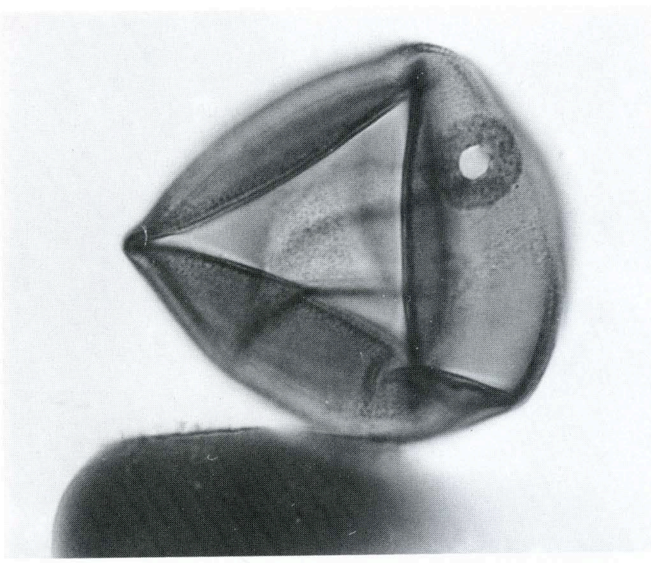


Fig. 78. A pollen grain of *Triticum* type (M+ = 52 μ) from the earliest Neolithic from the kettle hole at Isberga.

If a lime-tree, an oak or a hazel is cut down in the autumn, winter or early spring the stumps will sprout already in the following summer. These sprouts will quickly grow up to "stump-sprout trees". Many such trees will form a "stump-sprout forest" or a "coppice wood".

The growing sprouts will soon become fertile. I myself have studied stump-sprouts of oaks in my own garden. They began to flower when they were 13 years old (fig. 79d). Hazel gets catkins when the sprouts are two years old (Sjöbeck 1964). Lime-trees which have grown up from stumps will probably flower when they are 10–15 years old. Also elm, ash and alder sprout richly after having been cut down. As far as I understand, the growing sprouts of these species will also flower within 10–15 years. It must thus be very difficult to observe clearings in forests of the above-mentioned trees – the trees of the Stone Age – by studying pollen diagrams from that epoch.

When the hero of the fairy-tale cut off the dragon's head, seven new heads grew up immediately from the decapitated monster. In the same way, sprouts thus "immediately" grew up when Stone Age man cut down trees in his forest. I think the term "the dragon head's phenomenon" may be useful when we talk about man and the Stone Age forests.

Why should we then be surprised if we find that cultivation of cereals took place at the same time as lime, oak, hazel, etc. flowers richly during the Stone Age? Why should we go on saying that high values of these species show the absence of cultivation during the Middle Neolithic?

It is much more astonishing that the effect of the dragon's head phenomenon did not take place or did not function between the the elm decline level and the horizon SB1 f – that is during the ca. 600 C14-years of the whole of the Early Neolithic. Why, for instance, did all the lime-trees not grow up "immediately" when they were cut down for cultivation of cereals during the Early Neolithic?

What is the cause of the Early Neolithic "forest destruction"? It is difficult to accept that cultivation, grazing and browsing could have such an effect on the forests over hundreds of thousands of square kilometres simultaneously from Ireland in the west over the whole of North-West Europe to Östergötland and western Russia in the east. If grazing and browsing and cultivation on such a large scale were the only cause of the Early Neolithic forest destruction, then the grazing and browsing animals must have been attacked by some epizootics at the beginning of the Middle Neolithic. According to the expansion–regression model the cereals must also have been affected in some way (by some sort of plant pathology?) – or was the human population attacked by a Neolithic Black Death? Or did the Early Neolithic farmers abandon the forest farming and turn to the life of the hunter-gatherer again? Or did they settle on the coast, as the archaeologists of the regression school believe?

Fig. 79a. A two-year old coppice wood near Ljungbyhed, Scania.

Fig. 79b. The same coppice wood, now four years old.

Fig. 79c. The coppice wood is now 10 years old and the rowan is in flower.

In the present paper the regression hypothesis is not accepted. Instead I suggest that the forest regeneration ca. 600 C14-years after the elm decline, during the beginning of the Middle Neolithic, is a reflection of cultivation. My model for the forest farming during an early part of the Middle Neolithic was for the first time presented at a meeting in Oslo in 1980 and it was described in detail in my pollen-analytical work on the Alvastra pile dwelling in 1987. A short summary is given below.

The Middle Neolithic forest farming in stump-sprout forests ("coppice woods")

It has thus, as described above, been possible to place the Alvastra pile dwelling in an exact position in the forest-historical succession with the aid of the pollen diagrams from the Alvastra spring mire (figs. 73 and 74). Cereal pollen was transported by wind from the dwelling site to the points investigated in the mire. The cereal-pollen peak exactly pinpoints the pile dwelling in the forest-historical succession. It was built and in use at a point of time corresponding to index horizon SB1 e (fig. 72) when the forests of elm, lime and ash were under strong regeneration ca. 700 C14-years above the elm decline and when hazel was still of very great importance.

That cereals were cultivated at the same time that the forests of the above-mentioned trees increased so distinctly and when hazel-bushes were very common is, in my opinion, direct evidence of the presence of coppice woods. As underlined above, the coppice woods of the Middle Neolithic are not equivalent to the strict coppice woods of the Middle Ages and later on (see, for instance, Bergendorff & Emanuelsson 1982, Worsøe 1979). A better name for these early coppice woods is perhaps "stump-sprout forests". As this name is unwieldy, however, I prefer to use the term "coppice woods".

Fig. 79d. The coppice wood is 13 years old and the oaks have flowered.

Fig. 79e. A close-up picture of acorns in the 13-year-old coppice wood in September 1993.

Fig. 79f. Stem bases of oaks in the 13-year-old coppice wood.

Fig. 79g. The 13-year old coppice wood being cut down in March 1994. The oaks were ca. 5.80–6.10 m, the beeches ca. 6.20 m, the birches ca. 6.30 m, the rowans ca. 6.20 m and the alder buckthorn ca. 5.15 m.

My model for the Middle Neolithic coppice woods was thus described by me about 15 years ago and it may be summarized as follows. Certainly the forests of, for example, hazel were also coppiced during the Early Neolithic, the coppice wood tradition thus being very long. During the Late Atlantic coppice woods arose automatically when sprouts grew up from the stumps of the fallen trees which were killed by "fire-girdling" and from very young cut-off trees (Göransson 1987:46.) During the beginning of the Middle Neolithic the utilization of coppice woods was accomplished.

The coppice wood system was introduced to give a secure supply of mineral nutrients and of nitrogen so that continuous cereal growing could be maintained. We have to imagine a system of coppice wood groves of different ages on light soils. These coppice-wood groves were allowed to grow very dense so that the weeds were choked. Every year one coppice-wood grove was cut down with axes, and twigs and small stems were burnt. On the slightly burnt and cleared coppice wood areas emmer wheat and four-row naked barley (and probably small amounts of hulled six-row barley) were cultivated. The large stems were probably used as fences or for building and fire-wood. Only one harvest was taken on the cleared area. At harvesting time the stump-sprouts had already grown.

The cleared area was left alone for 20–60 years. By taking harvests with such a time interval on each small area, the light soils in the investigation area could have been utilized for cereal cultivation – theoretically – over thousands of years. A harvest interval of that kind would give us an unbroken cereal curve such as that found in the Isberga diagram – at the same time as the values for lime, hazel, etc. rise in the pollen diagram (probably hazel produced the best "manure" in the coppice woods, its decaying leaves giving very rich soil). We can observe, however, that the pollen production from the coppice woods is lower (the very local Isberga diagram) than that

Fig. 79h. The stumps sprout profusely in July 1994. The leaning sprouts are 1.20 m in length while the erect sprouts are 0.90–1.00 m in length.

from coppice woods plus "real" regenerated forests (the regional Dags Mosse diagram). (Permanent arable fields on the calcareous soils in the Isberga area cannot be ruled out.)

Recently Andersen has developed a model for cultivation in coppice woods during the Early and Middle Neolithic in Denmark which has much in common with my model suggested above (Andersen 1993).

M. Larsson has demonstrated that the habitation sites of the Early Middle Neolithic in Scania moved around according to a fixed pattern within limited areas (M. Larsson 1992:83). [It may be of interest to notice that human geographers and archaeologists have demonstrated with their methods that cultivation in coppice woods took place on wandering arable fields in the Late Bronze Age, from which time innumerable clearance cairns are found in the South Swedish uplands (Gren, e.g. 1989)].

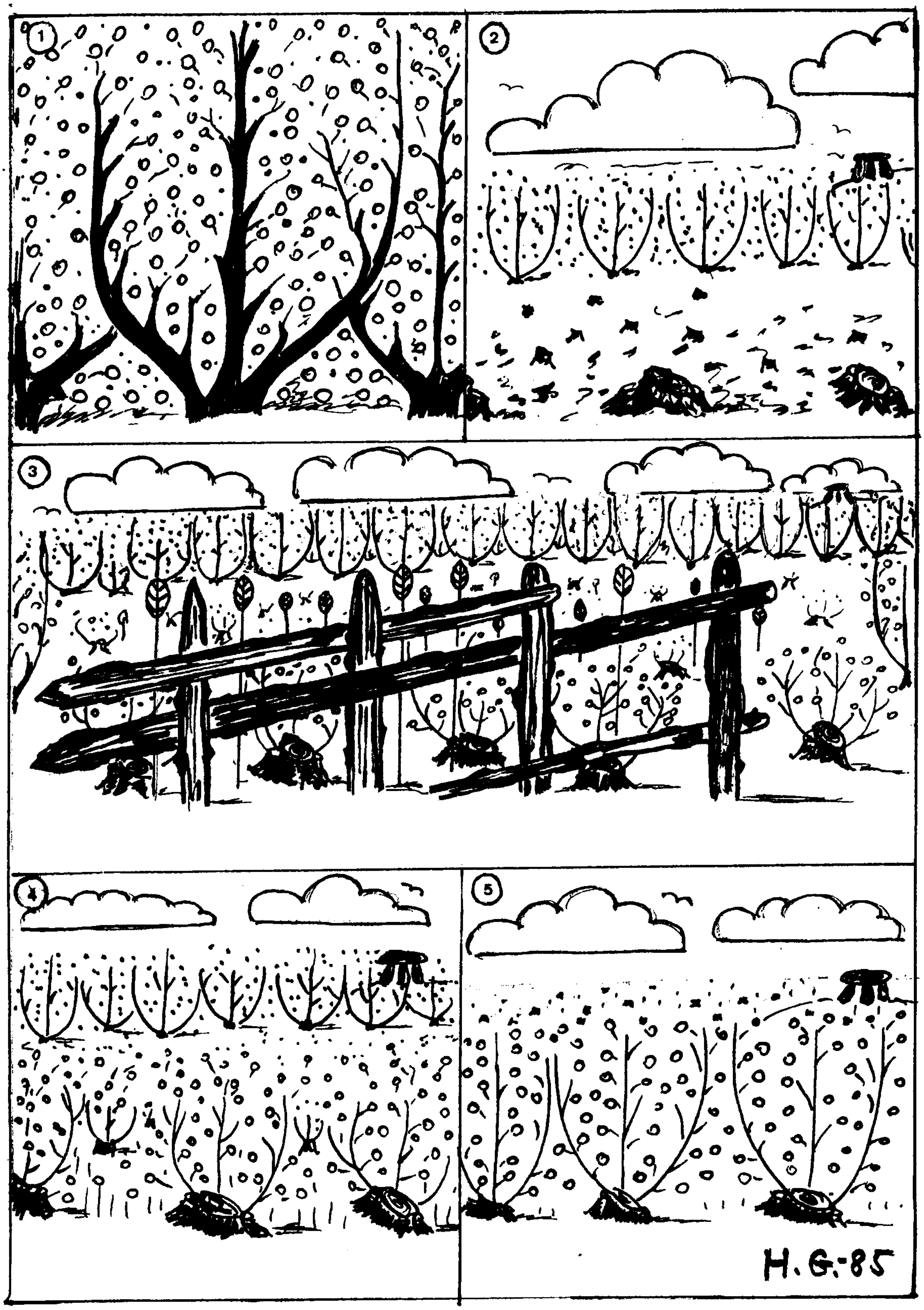


Fig. 80. Schematic drawing of coppice-wood groves of different ages during the Regeneration Phase (the Middle Neolithic). 1: 25–40-year-old grove just before felling; there are no weeds in the very dense grove. 2: The grove has been cut down and the ground has been cleared by burning. 3: One-year-old stump-sprouts and emmer wheat (in August) on the cleared area. A part of a fence, marked by coppice-wood trunks, can be seen; not only fences but also pile dwellings could be built of coppice-wood trunks. 4: A two-year-old coppice wood on the previously utilized area. 5: A four-year-old coppice wood on the same area. Soon the coppice wood will start producing pollen. The megalithic graves were plainly visible in the coppice-wood landscape. Drawing: Hans Göransson 1981, redrawn 1985. After Göransson 1987: fig. 33.

Fig. 81. Thomas Bartholin with two oak logs from the Alvastra pile dwelling. Photo: M. P. Malmer.

Dendrochronological evidences of stump-sprout forests (coppice woods) in the vicinity of the Alvastra pile dwelling

Bartholin investigated no less than 200 oak logs from the pile dwelling (Bartholin 1978, 1983). They were all cut down on high ground in the vicinity of the pile dwelling. All oaks had begun to grow at the same time, which demonstrates that they had grown up from stumps. When the cutting and building activities started, the oaks were ca. 40 years old.

The building activities ended after 42 years. The oaks which were felled at "year 42" were thus slightly more than 80 years old. Also the lime and aspen trunks had started their growth at the same time as the oaks. Hazel is the most common tree species used in the construction work. Also as "flooring material" hazel predominates (see below).

The 20 or so elm logs investigated by Bartholin also grew up from stumps, as can be seen in the form and the growth manner of the stems (Bartholin 1995). The elm logs are older than the oak logs. The forests of oak, lime, hazel, elm, aspen, etc. grew denser and denser during the 42 years the pile dwelling was in use. The pile dwelling was more or less intensively used only during the first 18 years (during that time with breaks in the building activities). At the end of this first period of activity a fire probably affected the forest. After a 22-year pause in the construction work the activities started again and went on for two years. After "year 42" these activities ended. No *regular* coppicing took place in this forest.

It was the original coppice wood (in the vicinity of the pile dwelling) which was continuously cut down by the people who built the pile dwelling. Bartholin seems to think that the cleared area – which thus continuously grew larger over four decades – was maintained as a wood-meadow-like area with, for instance, well-kept crab-apple trees (see below).

During the periods when the pile dwelling – or parts of the pile dwelling – were not in use willows grew on the abandoned floor ("platform"). These willows were cut down in summer when the activities started again and the leafy twigs were spread over the floor (Bartholin 1983:25).

There are a great many hazel rods, up to 2 cm thick, in the occupation layer of the pile dwelling and also a great many twigs of willow and crab apples. Great amounts of sprigs of mistletoe have also been found. Bartholin says that the branches and twigs may have been used as stabilizing flooring. He suggests, however, that the twigs of mistletoe may have been used as fodder (Bartholin 1983:27). The hazels grew in a "wood-meadow-like pasture" together with crab-apple trees. It seems as if the crab apples were actively favoured and taken care of. Their crowns may have been thinned out. Thus a sort of apple tree pruning may have been known already at the beginning of the Middle Neolithic. The supply of light was rich in that environment (Bartholin 1995).

The weeds in the coppice wood

As suggested by me in a series of papers (cf. compilation by Göransson 1987), mugwort (*Artemisia vulgaris*) grew as a weed on the cleared, slightly burnt coppice wood fields. Mugwort is a perennial which today grows on roadsides and in waste places. According to Linnaeus, mugwort was a severe weed in the arable fields in his time (Linné 1755, translated into Swedish 1986). That seeds of perennials were found in the Middle Neolithic fields may be explained by the fact that the scarification during that time was very different from that of our time. In late summer when the emmer wheat and the barley were harvested – by breaking off the ears, as suggested by Engelmark (Engelmark, seminar in Lund 1992) – or by cutting them off – also tops of mugwort may have followed the ears to the pile dwelling.

It cannot be totally excluded that emmer wheat was sown in the autumn. At least einkorn was sown both in the autumn and in springtime at the end of the 19th century (Bertsch 1947:30). According to Engelmark, the spelt wheats (einkorn, emmer and spelt wheat) may be sown in the autumn as well as in spring (Engelmark 1991). If sown in the autumn, the roots and the ramification will develop better (see Osvald 1959: fig. 37) and it will be more resistant to blight (Gunnar Svensson, Svalöf Weibull AB, pers. comm.). This means that autumn-sown emmer wheat will produce more stems than spring-sown emmer wheat. In this way seed for sowing is saved. Four-row naked barley was probably only sown in springtime.

Also the perennial creeping thistle (*Circium arvense*) ought to have been a typical weed of the cleared coppice wood fields. As mentioned (see the species list) Linnaeus called creeping thistle one of the most serious field weeds of his time (Linné 1755). Both *Circium arvense* and *Elytrigia repens* are perennial root-weeds with underground productive organs (Mikkelsen 1989:77).

The annual darnel (cf. *Lolium temulentum*) may have been found in the seed of barley which was sown in springtime. The winter annual black bindweed (*Polygonum convolvulus*) also grew on the wandering arable fields in the coppice woods. That seeds of winter annual species are found amongst summer annual cereals in the occupation layer is in no way astonishing. Probably seeds of black bindweed may have been collected actively on the fallows (see below). On the other hand, as discussed above, it cannot be ruled out that emmer wheat was sown in the autumn, something which might have favoured black bindweed. I myself have found black bindweed growing in great amounts among *spring*-sown barley both in Scania and in Småland.

Fig. 82. These twigs from the southern floor of the eastern trench seem to have served as flooring material while other twigs may have constituted fodder. Photo: M. P. Malmer.

The annual ivy speedwell (*Veronica hederifoila*) grows as a weed on disturbed ground. More seldom it is found in rich deciduous forests. It is suggested that ivy speedwell was favoured by the coppice wood management and that it grew on the wandering arable fields. It cannot be excluded that creeping buttercup (*Ranunculus repens*) also grew in these fields. However, it is found in moister places in woods as well.

The species which have been placed in group 3, "Ruderal soils", may partly also have grown on the wandering arable fields. Above all the summer annual fat hen (*Chenopodium album*) may have been a common weed among the four-row naked barley which thus probably was summer annual too. Very likely many of the seeds of fat hen found in the Alvastra pile dwelling were actively collected in the fields in the coppice woods. This species was also, however, directly favoured by the manure which, so to speak, impregnated the floor and the immediate surroundings of the pile dwelling (see below).

Only one nut of knotgrass (*Polygonum aviculare*) was, as we saw above, found in the occupation layer proper. It is a variable species which is abundant on cultivated and waste ground and it is also found on sea-shores. It may have grown on the wandering arable fields. "After the corn in the autumn has been gathered in, whole fields are red with this plant, which thrives on roads, where other plants are trodden into pieces by human feet" (Linné 1755).

The annual common chickweed (*Stellaria media*) flowers the whole year round – if there is no snow – and it produces several generations of seeds during one year. Even if the few seeds recorded were not transported to the pile dwelling from the cultivated fields, it was probably a common species on bare soil – that is together with emmer wheat and four-row barley. In cultivated soil it is a very aggressive weed which in wet summers may be a serious threat to the crops (Helbæk 1955:683). Also stinging nettle (*Urtica dioica*) may have been a part of the weed flora of the wandering arable fields.

Harvesting seeds of weeds on the first year's fallows

Helbæk demonstrated that during the Iron Age seeds of weeds were intentionally gathered by the farming poulation (Helbæk, for instance, 1950, 1951, 1955). Helbæk underlines that *Polygonum convolvulus* and *Chenopodium* species were of very great importance. He draws the conclusion that the place where Iron Age man (or very likely woman – my thoughts!) gathered the weed seeds would be the first year's fallow. Only on the first years' fallows could the annuals possibly develop dense formations. The prehistoric farmer would go over the fields in the early autumn and pull up all plants of the few species which he knew would add most to the agricultural output (Helbæk 1955:691f). Helbæk's statement may probably also be valid for the early Middle Neolithic coppice wood fields.

Helbæk (1955:692) cites E. Neuweiler who writes: "Den Ackerbau begleiten immer eine Menge Unkräuter, die auf dem nahrstoffreichen Kulturboden sich einfinden. In den Pfahlbauten liegen von einigen die Samen in so reichlicher Menge vor, dass sie nur infolge Verwendung durch den Menschen zu erklären ist, indem sie ihm als Nahrung dienten. Es mochten solche Pflanzen als willkommene Beigabe gesammelt worden sein" (Neuweiler 1924).

Other models for cultivation of cereals during the Middle Neolithic

Experiments in annual cropping of wheat and barley with and without manuring have been performed at Rothamsted and Woburn Experimental Stations (1969, 1970). These experiments demonstrate that harvests can be taken on the same area – on better soils in England – without manuring for more than one hundred years. Such experimental cereal cultivation without manuring has also started in Germany, on loess soils (Lüning & Meurers-Balke 1980).

Cultivation of cereals without manuring on permanent fields on the light, calcareous soils in western Östergötland during the Early Neolithic and the Middle Neolithic cannot be ruled out. The pollen-charcoal diagram from the kettle hole at Nässja, however, discloses that the forests were actively burnt during most of the Early Neolithic. Thus some sort of a "slash-and-burn-like culture" existed at least on some soils during that time (see Lindman 1993). The fire was also used for the creation of grazing areas. As mentioned, I have suggested that the use of fire on the newly cut coppice wood fields on light soils was of less intensity during the Middle Neolithic, although fire was used during that time (among the stumps). Also during the Middle Neolithic fire was used in order to create grazing areas – and these fires could possibly be stronger than those on the wandering arable fields.

The terminology concerning the forest fires which were initiated – on patches – by the Early Neolithic forest farmer is not yet stabilized. The terms "slash-and-burn" or "burn-beating" must be considered provisional arrangements. I have not yet found any good term for the "mild" fires which took place on newly cleared coppice-wood areas during the subsequent Middle Neolithic.

Thirty years ago Troels-Smith put forward the hypothesis that small, manured plots were cultivated permanently with wheat and barley at the very beginning of the Early Neoltihic both in Denmark and Switzerland (Troels-Smith, e.g. 1955, 1988). He suggested that cattle and sheep had been kept in byres or pens and foddered with twigs and leaves. From the foddering places the manure was brought to the fields.

Unfortunately Troels-Smith was very tied to his elm-decline hypothesis, which almost every pollen analyst knows. His epoch-making work on leaf-foddering during the Neolithic in Switzerland is not known by so many pollen analysts.

At Weier, Switzerland, Guyan and Troels-Smith found concentrations of twigs of different kinds of deciduous trees which had been collected in special barns (Troels-Smith 1984). In the immediate vicinity of the barns probable cow-houses and in addition a probable pen for goats were found. In the pen pupae of housefly (*Musca domestica*) occurred. Houseflies do not place their eggs in cowpats of grazing cows but only in layers of manure (they may also place their eggs in kitchen refuse etc.). In the Alvastra pile dwelling some pupae of housefly have been found (see below and Lemdahl in the appendix).

Troels-Smith was able to demonstrate that the manure had been carried out from the byres at Weier to a permanent arable field in the vicinity. Besides a great number of annual weeds, pupae of the housefly were also found in the fossil field. This demonstrates, according to Troels-Smith, that the fields were manured. He means that a symbiosis of cattle-breeding and cereal-growing existed at the very beginning of the Early Neolithic.

Troels-Smith's work has been continued by P. Rasmussen and many interesting results have been provided by these new investigations (see below). As the Alvastra pile dwelling seems to have been saturated with dung during its existence the problem of leaf-foddering and manure will be discussed in greater detail below.

Grazing during the Middle Neolithic

Several of my pollen diagrams from north-eastern Götaland reflect forest grazing during the beginning of the Middle Neolithic. The best indicator species for grazing is ribwort plantain (*Plantago lanceolata*) which has rather high values during the Middle Neolithic in the Isberga III diagram (fig. 76). At that site *Plantago lanceolata* is found throughout the Middle Neolithic.

The main profile from the Mabo Mosse bog (fig. 66) is situated ca. 360 m to the west of imposing glaciofluvial deposits which were already grazed at the very beginning of the Middle Neolithic. In the pollen diagram from that profile the *Plantago lanceolata* curve is only continuous at the beginning of the Middle Neolithic. The "special" profile is found only 36 m to the west of the eskers, that is "ten times nearer" the former grazed areas.

In the pollen diagram from the special profile (which will be published elsewhere) the *Plantago lanceolata* curve is almost continuous (broken only twice!) from the beginning of the Middle Neolithic up to the Roman Iron Age. Thus, the nearer we come to the former grazed areas, the stronger the manifestation of grazing indicators in our pollen diagrams! This observation invalidates the theory of "long-distance transport" of grazing indicators during the Middle Neolithic. Indirectly, the theory of long-distance transport of cereal pollen during the Late Atlantic (and the Middle Neolithic) is also eliminated by this study in the Mabo Mosse bog.

Grazing is also reflected by the rising *Juniperus* curve during the Middle Neolithic, as is distinctly seen in the diagrams from the lakes in southern Östergötland (Göransson 1987: figs. 35–37). It is not possible to go on saying that the grazing activities during the Middle Neolithic everywhere reflect "transhumance". We cannot have transhumance everywhere and settlements at only a few sites during the Middle Neolithic. The settlements were not situated too far from these summer grazing areas. Probably, however, a sort of transhumance from the coast of the Baltic to the interior of north-eastern Götaland took place during the Middle Neolithic, as suggested by me (Göransson 1991:27ff. – see also L. Larsson 1992:150ff.).

The following seeds found in the occupation layer may reflect grazing. Cow parsley (*Anthriscus sylvestris*) was favoured by the effect of the clearance manuring and may have grown on wandering arable fields which had turned into coppice pasture. The leguminous black medick (*Medicago lupulina*) probably also grew in the grassy areas in the coppice woods. The leguminous narrow-leaved vetch (*Vicia angustifolia*) was probably common in the coppice-pastures but also in the wandering arable fields. The species may have been favoured by the "mild" burning on the cut-down coppice wood areas. Leguminous plants are able to bind the free nitrogen of the air, and plants of the family Fabaceae (= Leguminosae) may have been important in the Middle Neolithic wandering arable system.

The carbonized seed of Good Friday grass or heath woodrush (*Luzula campestris* or *L. multiflora*) probably reflects burning for the creation of grazing areas in the coppice woods. Zig-zag clover (*Trifolium pratense*), hedge woundwort (*Stachys sylvatica*) and nipple wort (*Lapsana communis*) were also characteristic of openings in the coppice woods.

Butter dock (*Rumex longifolius*) and curled dock (*Rumex crispus*) are favoured by the cattle's tramping and they are left on the grazed areas (that is, they are not grazed). They may thus be said indirectly to reflect grazing activities. Berggren's find of oxe-eye daisy (*Chrysanthemum leucanthemum*) is very interesting. It was a common species in the former forest hay-meadows. Ox-eye daisy was probably favoured by the presence of wandering arable fields which had turned into grassy areas.

Most remarkable are Berggren's finds of quite a few carbonized caryopses of meadow fescue (*Festuca pratensis*) and timothy (*Phleum pratense*). Both these grasses were in earlier days found in former manured arable lands which had turned into grassy areas (Swedish "lindor") (Ekstam et al. 1988). These grasses were probably highly favoured by the presence of wandering arable fields which hade turned into grassy areas. Common St John's wort (*Hypericum perforatum*) today grows in hedge-banks and scrub and dry meadows. This species may thus have thrived in coppice-pastures.

I suggest that the very large fens which surrounded the Alvastra pile dwelling were grazed in early summer. Even today the remaining *Carex elata* communities are grazed in early summer in the Alvastra area (fig. 86). During the high summer the coppice woods – outside the areas where cereals were cultivated – were grazed. It is not unlikely that the hill of Omberg was grazed during the high summer and the early autumn.

No *Plantago lanceolata* seeds have been found in the occupation layer of the pile dwelling. This means that the cows, the sheep and the goats were not taken in from the fields and put up for the night in the pile dwelling in the summer or autumn. In winter and early spring the livestock, to all appearances, was fed on twigs and leaves. During these seasons the pile dwelling may have constituted such a winter-foddering site: the sanctuary could have been turned into a byre during winter and early spring (see below).

Branch and twig foddering during the Early Middle Neolithic

As mentioned above, there are a great many hazel rods, up to 2 cm thick, strewn over the floor of the pile dwelling. They are found together with branches of crab apple, twigs of willow and great amounts of mistletoe sprigs. The pollen diagrams from the occupation layer give, as we have seen, abnormally high values for *Viscum* – and also for *Tilia* and *Ulmus*.

Most of the hazel logs and hazel rods were cut down in winter (Bartholin 1995 and pers. comm.). "Winter-felling" takes place before cell-division starts. Future studies may perhaps demonstrate that anther-bearing twigs were collected a little later in spring. On 8 February 1995 I received Thomas Bartholin's final version of his "Den neolitiska hasselskov", in which he writes (my translation from the Danish): "As is the case with the oak, the wood-anatomical analyses show that the hazel was cut down in winter, early spring and summer." (As far as I understand, this observation concerns, in the main, the hazel logs.) This means that some of the hazel rods could have been cut down at a time when the ground was covered with flowering blue anemones (*Hepatica nobilis*) (see below). Another explanation for the presence of pollen of *Anemone*-type is given below.

Studies in Switzerland

For a decade P. Rasmussen has performed pollen and plant macrofossil analyses of faeces of domesticated animals from the Swiss Neolithic (Rasmussen, e.g. 1993). At the settlement site of Egolzwil 3, which is the oldest Neolithic settlement in Switzerland, goats and/or sheep were the most common livestock. Pollen, plant macrofossil and lignin test analyses were carried out on goat/sheep droppings.

The pollen content of the ovicaprid faeces is totally dominated by *Corylus, Alnus* and *Betula,* which all flower prior to leaf emergence in the early spring. Furthermore, the faeces were found in association with large numbers of twigs, mostly of *Corylus* and *Alnus.* Analyses of the development of the annual rings in the twigs show that a large proportion was gathered in early spring before leaf emergence. The analyses demonstrate that the Neolithic farmers at Egolzwil 3 harvested leafless branches and twigs with anthers in the early spring and brought them to the habitation site for foddering the livestock (Rasmussen 1993:479).

Pollen diagrams from Neolithic occupation layers in Switzerland and southern Germany often show sudden and extreme maxima for various trees and herbs (cf. compilation by Rasmussen 1993:497). These maxima reflect intentional collection of the species in question. In some deposits there are unusually high percentages of *Tilia,* while in other deposits there are unusually high percentages of *Ulmus*, *Quercus*, *Corylus*, *Acer* or *Betula*.

Of the species mentioned, *Tilia*, *Acer* and *Quercus* flower after leaf emergence, so branches of these species must have been collected in a leafy state. *Betula*, *Corylus*, *Salix* and *Ulmus* were collected in a leafless state (Rasmussen 1993:498).

Branch and twig foddering of goats – and probably sheep and cows – during an early part of the Middle Neolithic on the floor of the Alvastra pile dwelling

During the excavation in the Alvastra pile dwelling 1976–80 the archaeologists collected some strange "fruits" which puzzled me. It is amusing to read about Oswald Heer being faced with the same puzzle 130 years ago. He was helped – by chance – by a farmer who immediately examined the "fruits" which turned out to be droppings of goats and sheep (Rasmussen 1993:480, citing Messikommer 1913:96).

Only when I visited Skånes Djurpark in December 1993 and met the zoo-keeper Egon Axelsson was my problem solved. He demonstrated some goats for me which were of a very ancient native breed (the Jämtland goat). These goats, according to Egon Axelsson, prefer twigs of deciduous trees, not least willow twigs and willow bark which they were consuming at my visit. The droppings of this ancient breed corresponded exactly to the droppings from the Alvastra pile dwelling, in both form and size (fig. 56). Thus the droppings found in the occupation layer of the Alvastra pile dwelling derive from an ancient breed of goat. One could argue that the droppings could derive from a goat which had been taken in from the forest in early spring and slaughtered in the pile dwelling. This hypothesis seems rather unlikely, however, when considering, for instance, the rich twig material found on the floor. In all probability the goat had been kept and foddered in the pile dwelling – see below.

Pollen analysis of one of these goat droppings gave the following pollen spectrum:

Taxon	Pollen/spore sum	Percentage
Corylus	1014	75.3
Ulmus	160	11.9
Betula	77	5.7
Alnus	15	1.1
Tilia	15	1.1
Quercus	1	0.1
Pinus	2	0.1
Viburnum	1	0.1
Anemone type	53	3.9
Filipendula	4	0.3
Artemisia	1	0.1
Polypodiacae	4	0.3

Fig. 83. Goats of ancient native breed browsing on sallow twigs in Skånes Djurpark, April 1994.

This pollen spectrum agrees very well with those from Egolzwil (Rasmussen 1993). Much of the tree pollen very likely came from twigs with anthers (hazel, birch, alder) or flowers (elm) (the *Ulmus* pollen seems not to be "fully ripe"). Pollen is developed already in the non-flowering anthers and the flowers of the trees mentioned. Thus the twigs with anthers (and flowers) had been collected and consumed in a leafless state, in early spring.

Blue anemone (*Hepatica nobilis*) may have flowered when some of the branches and twigs were trailed over the ground to the pile dwelling. Pollen of *Anemone* type occurs richly in the goat dropping analysed (*Anemone* – type may derive from blue anemone). It is indeed amazing that also in Switzerland high values of *Anemone* are found in the goat droppings (Rasmussen 1993:497). It cannot at all be excluded that the green leaves and the violet buds of the "wintergreen" blue anemone was gathered by the farmers in February–March and used as fodder for the goats. As regards the Jämtland goat, it consumes almost everything – even cigars and cigarette-ends.

So, why could the green leaves and the buds of blue anemone not have been appropriate emergency fodder for at least the goats at the end of the winter? The flower of blue anemone is fully developed – with all its details – within the bud the year before it appears (Linné 1755, 1986:166). As far as I understand, this means that the pollen of blue anemone is almost fully ripe within the buds already in February. *Addendum:* At the very moment when my manuscript was being set, I tested my blue anemone hypothesis. On 2 February 1995 I picked a handful of green leaves of *Hepatica nobilis* and gave them to a female goat with a kid. The goat eagerly snatched the leaves from my hand, chewed them, swallowed them and frenetically searched for more in my hands.

It seems as if leafy twigs of *Tilia* may have been collected in summer, as the percentage value for *Tilia* is very high in the pollen diagram from the occupation layer of the Alvastra pile dwelling. Further, 1.5% of the pollen content of the goat dropping consisted of *Tilia*. Thus the goat may also have consumed dry, leafy twigs of *Tilia* which had been stored in a "barn" on the platform.

As some of the trees which were used as logs in the pile dwelling were cut down in summer (Bartholin 1983:23) also many leafy twigs were probably collected in summertime. The willows which grew up in the abandoned parts of the pile dwelling were, as mentioned above, cut down in summer and the leafy twigs were spread over the floor.

Perhaps future studies of the pile dwelling may disclose the presence of barns for leaf-fodder. This is, for the moment, a pure guess. Then also the grasses meadow fescue and timothy (see above) could have been used as hay, which indeed would be a sensation (which at our present level of knowledge seems unbelievable.) Hay has not been observed anywhere in botanical material from the European Stone Age, as far as

I know. The presence of carbonized caryopses of these grasses is indeed puzzling (see above) and Berggreen's grass caryopsis material should, in my opinion, be reanalysed.

The evergreen *Viscum,* which has abnormally high values both in my pollen diagram from the occupation layer and in that produced by Magnusson (Magnusson 1964), was probably also collected in early spring. This semi-parasite flowers early in spring when its host trees are still leafless. Pliny mentions that the Gauls fed their cattle on mistletoe in order to make them fertile and in order to protect them against disease (cf. compilation by Troels-Smith 1960:17).

It thus seems very likely that at least the goats were foddered in the pile dwelling during winter and early spring. Whether or not the cows and sheep were also foddered in the pile dwelling during wintertime can only be disclosed by future excavations. Bones of slaughtered cattle and sheep are numerous in the occupation layer (During 1986).

Almost every sample from the occupation layer contains seeds of celery-leaved buttercup (*Ranunculus sceleratus*). This buttercup grows on wet, nutritious sites. It is distinctly seen in the seed diagrams that this species was, for some reason, bound to the occupation layer proper (and probably its nearest surroundings). Celery-leaved buttercup is, as we saw earlier, greatly favoured by liquid manure. Large amounts of seeds of fat hen (*Chenopodium album*) are also found in the occupation layer. Even if many of these seeds may have been collected on the fallows in late summer, fat hen probably grew on the "platform" and its immediate surroundings. It thus seems as if the pile dwelling was more or less impregnated with manure.

Fig. 84a. The Alvastra pile dwelling may have constituted a good shelter – a pen for goats and sheep and, not unlikely, a cow-house – during winter and early spring. The leaf-fodder was also protected – in barns behind the close piles and the twig fences – against the roaming cervids. This is only a tentative suggestion. Photo: ATA.

Some pupae of housefly (*Musca domestica*) were found in EF4,98.44–40 (see Lemdahl, appendix 1). This implies that the probability of the presence of manure and of "indoor warmth" during wintertime in the pile dwelling has increased strongly. As mentioned above, Troels-Smith and his colleagues suggested that the pupae of housefly (*Musca domestica*) which they found at Weier revealed the presence of manure. Three insect species living in the dung have been recorded (Lemdahl, appendix 1).

Especially in winter it must have been difficult to protect freely roaming livestock from the attacks of wolves and lynx. During that time the pile dwelling ought to have been a safe site for the livestock which could not escape from it (fig. 84) and which was guarded throughout the winter by armed shepherds.

When *Carex elata* and other species began to grow green in early summer in the fens the livestock were probably turned out to grass on the fens and – after a short period of time – on the grassy areas in the coppice woods. In almost every "room" described by Browall there are huge amounts of twigs. Frödin recorded "twig beds" which were found here and there on the floor of the pile dwelling (Frödin 1910:37). During summer and autumn, the suggested pens (after the manure had been removed!) may have turned into "rooms" for the population of the resource area. This means that Browall's model (described below) may be applicable.

Fig. 84b. The close piles are, in the main, found at the points where the bridge meets the platform in the southeast and in the west (Malmer & Bartholin 1983:19, Browall 1986: fig. 30), that is, where the pile dwelling was most easily reached by roaming cervids and also by predators. At the northern and southwestern parts of the pile dwelling, simpler twig fences may have been sufficient as shelter. Crooked twigs of crab apple trees have been found on the floor (Bartholin 1983:27). These twigs could not have been used as "flooring material" and they were not used as fodder (Kardell 1995). They were most likely used as fences. The picture shows a reconstruction of a twig fence (Danish *grenegærde* or *brudgærde*) built by Eiler Worsøe. Photo: Eiler Worsøe.

Fig. 85. Modern shelter in Skånes Djurpark. The photo was taken in April 1994.

Fig. 86. In early summer the cows may have grazed on the very large fens in the Alvastra area. Even today the calves graze on the tufted sedge (*Carex elata*) near the pile dwelling in the Isberga Nature Reserve. This picture is from the early summer of 1977.

Fig. 87. In summer and autumn the cows may have grazed in coppice woods outside the areas which were used for cultivation of cereals. Here cows are grazing in a coppice wood in the vicinity of Ljungbyhed, Scania, in late summer in the 1980s.

The resource area *sensu* Browall

Browall calculates the pile-dwelling community to about 17 househoulds comprising ca. 130 individuals with a total resource area of ca. 70 km² (Browall 1986). He presents three different models with different fallow periods. The most probable model is described here. Browall suggests that Middle Neolithic farming took place in the same areas and on the same soils as farming in the 17th century. Some 3600 hectares of such soils were potentially usable for cultivation of cereals, coppice-pasture and leaf-fodder gathering. A prerequisite for the validity of Browall's models is that my coppice-wood model is practicable.

The light, well-drained soils in Browall's resource area comprise ca. 1400 hectares. If 32 hectares constituted the arable fields ("wandering arable lands") which were used each year, then the coppice wood fallow periods could last 44 years. Grazing and leaf-foddering took place on ca. 2220 hectares on other soils on high ground.

Fig. 88. Probably more than one megalithic tomb was originally built at the southern end of the hill of Omberg. At the same time the Alvastra pile dwelling (2 km to the ENE of the tomb) was in use. The arrow shows where the megalithic tomb excavated by G. O. Janzon is situated. Photo: P.-A. Carlsson.

(As mentioned earlier the fens constituted very large areas around the pile dwelling. Probably the fens were grazed in early summer.)

According to Browall (his model C), the agriculturally produced foods ought to have constituted ca. 75% of the population's annual food consumption. The remaining 25% thus consisted of meat and fish. This suggestion has been confirmed by Sælebakke and Welinder who performed measurements of the C13-content and the strontium/calcium (Sr/Ca) ratio in human bone tissue of three individuals from the Alvastra pile dwelling.

Browall suggests that the calculated, relatively large, annually utilized areas (cultivation of cereals, herding, leaf-fodder gathering) make it likely that the pile dwelling community consisted of several settlement sites, that is, individual farms which were scattered over a rather large area. Such a scattered form of settlement may have caused the need for a joint meeting-place, a community centre *sensu* Malmer (Malmer, e.g. 1984 and in press).

Fig. 89. The Alvastra spring mire with the hidden and partly excavated pile dwelling (x). In the background the Dags Mosse bog with the sampling point (xx). To the left the forest on the hill of Omberg. Lake Tåkern is dimly seen behind the Dags Mosse bog. Photo: P.-A. Carlsson.

About 40 years after its foundation the pile dwelling turned into a burial-place, a village for the dead (Malmer 1984). Also the megalithic tomb which is found two kilometres to the west of the pile dwelling consi-tuted such a social and cult centre (Janzon 1984, Malmer 1984:375). This megalithic tomb was built at the same time as the pile dwelling (Janzon 1984, During 1984).

It is evident that production of axes, firestones and small implements took place in the pile dwelling. Browall underlines – as I have done (see above and below) – that it is important to note that there need not be any contradiction between practical work (the production of objects, food preparation, etc.) and symbolic actions (ceremonies). Such human actions can merge into one ideological goal (Browall 1986:158).

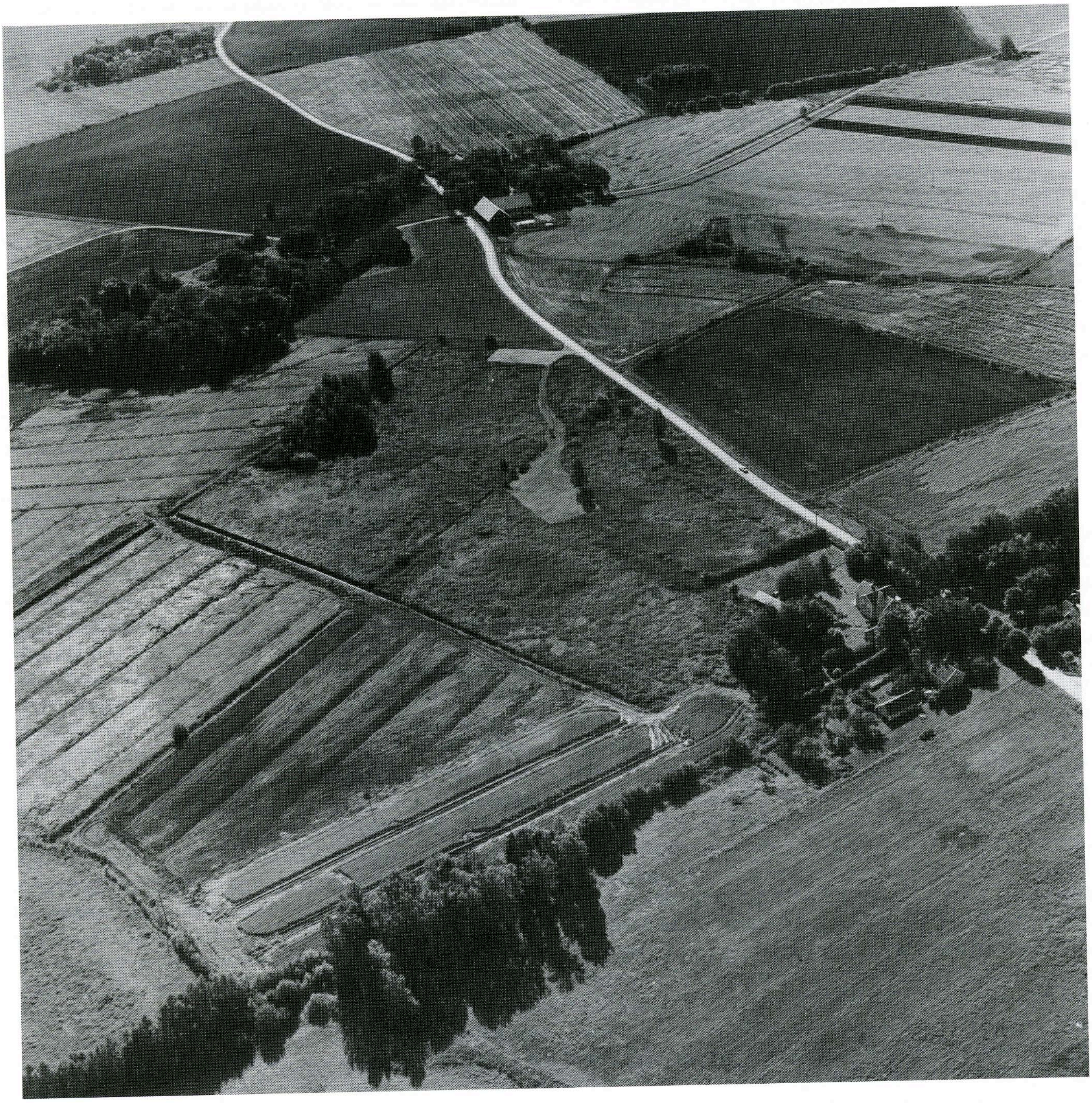


Fig. 90. The Alvastra spring mire and the pile dwelling area seen from a position above the hill of Omberg. The farmyard of Broby is situated to the left of the road – in the upper part of the picture – in the shadow of the trees. Immediately behind the square car park the spring-mire meets the high ground. Manured fields *may* have existed there during an early part of the Middle Neolithic. If this suggestion is more than a pure guess then the manure was brought from the pile dwelling in early spring to the supposed fields. In other areas there were wandering arable fields in coppice woods. Photo: P.-A. Carlsson.

On the function of the Alvastra pile dwelling

Cult ceremonies may have been strongly associated with the forest farmer's daily life during the Early Middle Neolithic. Thus it is no contradiction that the pile dwelling had both rational and irrational functions. In fact, it was "rational" during that time to see nature as animated. Everything in nature – stones, clouds, the sun, the moon, the stars, trees, herbs, wild animals as well as livestock – had the same spiritual power as man himself. The many practical (rational) activities which took place in the pile dwelling – in the middle of a very rich environment – had their (irrational) superstructures.

During wintertime the pile dwelling may thus have functioned as a byre – at least for the goats. Parts of the pile dwelling, as we have seen, may have been barns for leaf-fodder. In spring the dung could have been carried away from the pile dwelling over the bridge to the high ground to the west of today's Broby farmyard. Permanent arable fields *may* have existed there – at the same time as wandering arable fields were found at some distance from the pile dwelling. Borings in the spring-mire in the area where the bridge meets the high ground could perhaps show us whether this assumption is more than a pure guess.

The harvests of emmer wheat and four-row barley were brought to the pile dwelling in order to be dried over the hearths. Probably most of the carbonized cereal caryopses found in the occupation layer derive from such activitites which had failed, that is, the grains were sometimes overheated. The drying of the cereal grains by warming has several advantages (Guyan 1955, see also the compilation by Browall 1986). The subsequent threshing is facilitated and the warming "conserves" the grains; it makes them crispy so that they can more easily be transformed into meal and the starch partly transformed into dextrine. The cereals which were destined for burnt offerings must have been totally annihilated by the heat. Recent research at Weier demonstrates that the animals were being fed on grain or grain-rich chaff, probably as a supplement to their winter fodder (Robinson 1988:481, Rasmussen in print).

Crab apples were brought to the pile dwelling from the "fruit gardens". The apples were, as we saw earlier, sliced and then dried on the warm hearth stones. Also rose hips may have been dried on the warm hearths. Together with the dried crab apples the dried rose hips constituted an important vitamin resource during wintertime. From the actively favoured hazel bushes huge amounts of hazelnuts were harvested before the bushes were invaded by squirrels and nut-collecting birds. The thus not fully ripe hazelnuts were also probably dried on the hearth-stones.

The solution to the enigma of the pile dwelling lies in its not yet published, enormously rich material of twigs and charcoal. I suggest that when the leaves, catkins, and small twigs were consumed by the livestock, many of the thicker twigs they left were used as firewood in the hearths.

When the rich twig and charcoal material is published in the future, then – *perhaps!* – we will be able to say the following: the Middle Neolithic forest farmer collected branches and twigs not only in winter but also in summer. The branches and twigs which were collected in summer may have been stored as leaf-fodder for use in wintertime. The anther-bearing twigs were collected for the livestock's immediate wants in late winter and early spring.

All the practical activities mentioned – together with slaughter and smoke-drying of the meat and other activities – ought to have been interrupted at certain times for the offering activities suggested by Malmer (1981, 1983, 1984 and in print). As the pile dwelling was centrally situated in rich countryside where ample harvests of emmer wheat and four-row barley, crab apples, hazelnuts and rose hips, etc. were taken every autumn, it was natural that the population cooperated and met at certain times. In that way the pile dwelling also became a community centre and a cult site, as suggested by Malmer (see above) and Browall (1986).

During winter an armed guard (armed herdsmen) probably lived among the goats, sheep and cattle in the pile dwelling. "Guarded byres" like the Alvastra pile dwelling were probably found at other sites in Götaland at that time.

The activities which took place in the Alvastra pile dwelling and which are palaeobotanically reflected by pollen, carbonized and non-carbonized seeds and fruits and also by a great many twigs and charcoal – and by insect remains – very likely reflect activities which were carried on at other sites in southern Sweden during an early part of the Middle Neolithic. It should at least be *permissible* for a palaeoethnobotanist to express this opinion. If such sites – where domestic animals were winter-foddered behind fences – were situated on high ground, almost nothing would be preserved for today's palaeoethnobotanist or archaeologist. Such suggested sites ought to have been built in the immediate vicinity of wells (which do not freeze in winter-time), as the Alvastra pile dwelling was. Only in the Alvastra pile dwelling has the palaeoethnobotanical material been preserved, thanks to a series of lucky circumstances.

Summary

The Alvastra pile dwelling, discovered in 1908, is the only pile dwelling found to the north of the Alps. It is situated in the Alvastra spring mire in the westernmost part of the province of Östergötland (fig. 4:1). In 1976 Prof. Mats P. Malmer organized the research project "Alvastra pålbyggnad" ("Alvastra pile dwelling"). The excavations ended in the autumn of 1980.

The Alvastra pile dwelling was built ca. 4430±50 B.P. (T½=5568, 0-year=A.D. 1950) and it was in use for only ca. 42 years. The pile dwelling was built when the forests of broad-leaved trees had begun to regenerate ca. 700 C14-years above the start of the elm decline.

I began my work by producing several pollen diagrams and by describing the forest environment around the pile dwelling (Göransson 1987). At the same time soil samples for fruit and seed analyses were taken by the archaeologists. The artefact and ecofact material is found in a 15–40 cm thick layer of *Cladium-Phragmites* peat which underlies a 25 cm thick layer of *Carex* peat and which is underlain by lake marl and lime gyttja.

During the excavation the sampling for fruit and seed analyses was undertaken in two ways. In the *rigid* system peat samples were taken at randomly chosen points. In the *flexible* system the sampling was performed by fruits and seeds being collected directly in the field when they were observed. The fruits and seeds identified and counted in the samples from the rigid system are listed in table 1 and those identified and counted in the flexible system are listed in the tables 2–5. (The quite correct term should be "seeds and other diaspores" – see Jensen 1979. I content myself with the well-established term "fruits and seeds".)

Thousands of carbonized caryopses of barley have been recorded. The barley seems to be of the naked, four-row type. About a quarter of a thousand carbonized rachis segments and some ear fragments of this type of barley have been identified. More than 1200 caryopses and ca. 150 spikelet forks of emmer wheat have been counted.

It is suggested that the harvested cereals were dried on the warm hearth-stones on the floor of the pile dwelling. Crab apples were collected, sliced and then dried in this way, as were very likely *Glyceria* species, hazelnuts and rose hips. Other species which were collected for consumption include bird cherry, raspberry and dogwood.

Already in 1980 I suggested that the barley and the emmer wheat were cultivated in wandering arable fields in stump-sprout forests ("coppice woods"). A grove was cut down and the ground was cleared between the stumps with the aid of "mild" fires. The weeds in the fields were, among others, mugwort (*Artemisia vulgaris*) and black bindweed (*Polygonum convolvulus*), of which many hundreds of carbonized seeds have been recorded. Other field weeds were fat hen (*Chenopodium album*), creeping thistle (*Circium arvense*), ivy speedwell (*Veronica hederifolia*) etc.

Black bindweed, for instance, is a characteristic weed among winter-sown cereals. The naked four-row barley was, to all appearances, sown in springtime while the emmer wheat was sown either in winter or in spring. The seeds of black bindweed (which are rich in nutrients) were very likely collected on the fallows, before these were choked by the growing stump-sprouts.

The find of almost half a thousand carbonized seeds of mugwort is, indeed, remarkable. It confirms my earlier suggestion that mugwort grew as a weed in the wandering arable fields (Göransson 1987:65). My supposition has later on been adopted by Andersen (1993).

We should admit that we do not yet know enough to construct an absolutely certain model for the Middle Neolithic arable system. New finds may change the model that has been built up over decades.

Pollen analysis of a goat dropping found in the occupation layer may shed new light on the function of the pile dwelling and on Middle Neolithic agriculture. The pollen spectrum of this goat dropping agrees very well with those from Egolzwil, Switzerland (Rasmussen, e.g. 1993). It seems as if twigs with anthers (hazel, birch, alder) and with not "fully ripe" flowers of elm were collected in a leafless state, in early spring as fodder for the goats.

The pollen spectra from the occupation layer proper show abnormally high values for elm, lime and mistletoe. Twigs of lime and other broad-leaved trees may thus have been collected in a leafy stage (lime flowers in July when the twigs are leafy). Elm and mistletoe flower on naked twigs – they were thus collected in early spring (see above). Thus the pile dwelling – besides other functions – may have served as a barn for leaf-fodder and as a goat-, sheep- and cow-house during wintertime.

According to earlier investigators, a great many carbonized caryopses of meadow fescue (*Festuca pratensis*) and of timothy (*Phleum pratense*) have been found in the occupation layer (Berggren 1956). If the determinations are correct these grasses could have been used as hay, which at our present level of knowledge seems to be (but need not be) unlikely.

Almost every sample from the occupation layer contains seeds of celery-leaved buttercup (*Ranunculus scel-*

eratus), a species which is highly favoured by liquid manure. The large amounts of fat hen (*Chenopodium album*) found in the occupation layer may partly have grown in the immediate vicinity of the platform. Fat hen is also favoured by manure. Some pupae of housefly (*Musca domestica*) have also been recorded (Lemdahl, appendix 1).

The suggested layers of manure may have been brought from the pile dwelling to high ground – over the bridge – in springtime. Thus permanent, manured arable fields *may* have existed in the vicinity of the pile dwelling. Also non-manured, permanent arable fields *may* have existed on calcareous soils – in the Isberga area for instance.

We may thus assume – at the moment when I am writing these lines – that wandering arable fields in coppice woods, manured fields in the vicinity of the sites where the livestock was guarded in wintertime (the pile dwelling!) and non-manured fields (on very lime-rich soils) may have existed at the same time during an early part of the Middle Neolithic.

The Alvastra pile dwelling is the site of the great possibilities. The present palaeoethnobotanical study may thus be said to be a guide for the coming generation who will continue the excavations in the Alvastra spring mire. In the year A.D. 2008 the pile dwelling will have been subjected to investigations for 100 years! Let us hope that at this date the archaeologists and palaeoethnobotanists have come a little closer to solving the enigma of the function of the pile dwelling.

References

Andersen, S. T. 1993. Early and middle Neolithic agriculture in Denmark: pollen spectra from soils in burial mounds of the Funnel Beaker culture. – Journal of European Archaeology 1993:1:151–180.

Bartholin, T. S. 1978. Alvastra pile dwelling: Tree studies. The dating and the landscape. – Fornvännen 73:213–219. Stockholm.

Bartholin, T. S. 1983. Træet i Alvastra. - Skalk 1984:4:22–27. Aarhus.

Bartholin, T. S. 1995. Den neolitiske hasselskov. - Skrifter i skogs- och lantbrukshistoria 7. Lövfoderkultur och skottskogsbruk (eds. Ljunggren, L., Göransson, H. & Slotte, H.) Kungl. Skogs- och Lantbruksakademien. Stockholm.

Behre, K.-E. (ed.). 1986. Anthropogenic Indicators in Pollen Diagrams. – Rotterdam-Boston.

Behre, K.-E. 1990. Kulturpflanzen und Unkräuter der vorrömischen Eisenzeit aus der Siedlung Rullstorf, Ldkr. Lüneburg. - Nachrichten aus Niedersachsens Urgeschichte 59:141–165. Hildesheim.

Beijerinck, W. 1976. Zadenatlas der Nederlandsche Flora. Amsterdam.

Bergendorff, C. & Emanuelsson, U. 1982. Skottskogen - en försummad del av vårt kulturlandskap. - Svensk Botanisk Tidskrift 76:2:91–100. Stockholm.

Berggren, G. 1956. Växtmaterial från träskboplatsen i Dagsmosse. – Svensk Botanisk Tidskrift 50:1:97–112. Uppsala.

Berglund, B. E. 1968. Vegetationsutvecklingen i Norden efter istiden. – Sveriges Natur Årsbok 1968:31–52. Stockholm.

Berglund, B. E. 1979. The deglaciation of southern Sweden 13.500 -10.000 B.P. – Boreas 8:2:89–117. Oslo.

Berglund, B. E. et al. 1991. Cultural landscape periods - patterns and processes. – In Berglund, B. E. (ed.). The cultural landscape during 6000 years in southern Sweden – the Ystad Project. – Ecological Bulletin. Copenhagen. 41:427.

Berglund, B. E., Hjelmroos, M. & Kolstrup, E. 1991. The Köpinge area. Vegetation and landscape through time. – In Berglund, B. E. (ed.). The cultural landscape during 6000 years in southern Sweden – the Ystad Project. – Ecological Bulletin. Copenhagen. 41:109 -112.

Bertsch, K. & Bertsch, F. 1947. Geschichte unserer Kulturpflanzen. Stuttgart.

Browall, H. 1986. Alvastra pålbyggnad – social och ekonomisk bas. – Theses and Papers in North-European Archaeology 15. Stockholm.

Chambers, F. M. et al. 1988. Development of the Late-Prehistoric Cultural Landscape in Upland Ardudwy, North-West Wales. – In Birks et al. (eds.). The Cultural Landscape – Past, Present and Future: 333–348. Cambridge University Press.

Cronon, W. 1984. Changes in the Land. Indians, Colonists, and the Ecology of New England. – New York.

Dahl, C.G. 1945. Nyare fynd av torkade äpplen på stenåldersboplatsen vid Alvastra. – Lustgården. Föreningens för Dendrologi och Parkvård Årsskrift 1944–45:25–26:253–262. Stockholm.

Digerfeldt, G. 1975. Post-Glacial water-level changes in Lake Växjösjön, central southern Sweden. – Geologiska Föreningen i Stockholm Förhandlingar. 97:2:167–173. Stockholm.

Dimbleby, G. W. 1985. The Palynology of Archaeological Sites. – Academic Press, Inc. USA.

During, E. 1983. Stenålder eller medeltid i Alvastra? Inlägg i en 60-årig diskussion. – Fornvännen 78:176–188. Stockholm.

During, E. 1986. The Fauna of Alvastra. An Osteological Analysis of Animal Bones from a Neolithic Pile Dwelling. – Stockholm Studies in Archaeology 6 (Offprint from OSSA 12:1 1986). Stockholm.

Edwards, K. J. 1988. The Hunter-Gatherer/Agricultural Transition and the Pollen Record in the British Isles. – In Birks et al. (eds.). The Cultural Landscape – Past, Present and Future: 255–266. Cambridge University Press.

Engelmark, R. A review of the farming economy in South Scania based on botanical evidence. – In The Archaeology of the Cultural Landscape. Field Work and Research in a South Swedish Rural Region (eds. Larsson, L., Callmer, J. & Stjernquist, B.) – Acta Archaeologica Lundensia. Series in 4°:19:369–375. Stockholm.

Ekstam et al. 1988. Ängar. Om naturliga slåttermarker i odlingslandskapet. – Skötsel av naturtyper. Stockholm.

Ekström, J. 1993. The Late Quaternary History of the Urus (*Bos primigenius* Bojanus 1827) in Sweden. – LUNDQUA Theses 29. Lund.

Fischer, A. 1982. Trade in Danubian shaft-hole axes and the introduction of Neolithic economy in Denmark. – Journal of Danish Archaeology 1:7–12.

Florin, M. B. 1957. Pollen-Analytical Evidence of Prehistoric Agriculture at Mogetorp Neolithic Settlement, Sweden. – In Vråkulturen. Stenåldersboplatserna vid Mogetorp, Östra Vrå och Brokvarn (ed. Florin, S.): 1–25. Stockholm.

Fredskild, B. 1978. Seeds and Fruits From the Neolithic Settlement Weier, Switzerland. – Botanisk Tidsskrift 72:189–201. Copenhagen.

Frödin, O. 1910a. En svensk pålbyggnad från stenåldern. – Fornvännen 5:29–77. Stockholm.

Frödin, O. 1910b. Ein schwedischer Pfahlbau aus der Steinzeit. – Mannus. Würzburg.

Gaillard, M. J. 1984. A Palaeohydrological Study of Krageholmssjön (Scania, South Sweden). Regional Vegetation History and Water-Level Changes. – LUNDQUA Report 25. Lund.

Genberg, E. 1977. Östergötlands Flora. Lund.

Göransson, H. 1984. Pollen analytical investigations in the Sligo Area. In Burenhult, G. (ed.). The Archaeology of Carrowmore. Environmental Archaeology and the Megalithic Tradition at Carrowmore, Co. Sligo, Ireland. Theses and Papers in North-European Archaeology 14:154–193. Stockholm.

Göransson, H. 1987. Neolithic Man and The Forest Environment around Alvastra Pile Dwelling. – Theses and Papers in North-European Archaelogy 20. Stockholm. Lund University Press, Chartwell-Bratt Ltd.

Göransson, H. 1988a. Comments on Remodelling the Neolithic in Southern Norway. On Pollen Analytical Myths. – Norwegian Archaeological Review 21:1:33–37. Oslo.
Göransson, H. 1988b. Can Exchange During Mesolithic Time be Evidenced by Pollen Ansalysis? – In Hårdh, B. et al. (eds.) Trade and Exchange in Prehistory. Studies in Honour of Berta Stjernquist. Acta Archaeologica Lundensia. Series in 8°:16:33–40. Lund.
Göransson, H. 1989. Dags Mosse – Östergötlands förhistoriska kalender. – Svensk Botanisk Tidskrift. 83:370–407. Lund.
Göransson, H. 1991a. Vegetation and man around Lake Bjärsjöholmssjön during prehistoric time. – LUNDQUA Report 31.
Göransson, H. 1991b. How the Forests are Reflected in Pollen Diagrams from Different Regions and from Basins of Different Size in South Sweden. – Regions and Reflections. In Honour of Märta Strömberg. Acta Archaeologica Lundensia. Series in 8°:20:5–14. Lund.
Göransson, H. 1993. Elm, Lime and Middle Neolithic Cultivation – an Interesting Problem. – Current Swedish Archaeology 1:117–118. Stockholm.
Göransson, H. 1994a. Elm, Lime and Middle Neolithic Cultivation – a Solvable Problem. – Current Swedish Archaeology 2:123–139. Stockholm.
Göransson, H. 1994b. Forntida skogsbränder och förhistoriska kalendrar. – Skrifter om skogs- och lantbrukshistoria 6. – Svedjebruk och röjningsbränning (ed. Larsson, B.). Nordiska museet och Kungl. Skogs- och Lantbruksakademien.
Göransson, H. 1995. Om stubbskottskogsbruk under mellanneolitisk tid och om skogsutnyttjandet under mesolitisk tid. – Skrifter om skogs- och lantbrukshistoria 7. – Lövfoderkultur och skottskogsbruk (eds. Ljunggren, L., Göransson, H. & Slotte, H.) Kungl. Skogs- och Lantbruksakademien. Stockholm.
Göransson, H. & Lemdahl, G. The Mabo Mosse bog (in prep.).
Göransson, H. & Lemdahl, G. The Kettle Hole at Nässja, western Östergötland (in prep.).
Gren, L. 1989. Det småländska höglandets röjningsröseområden. – Arkeologi i Sverige 1986. RAÄ Rapport 1988:2:73–95. Stockholm.
Guyan, W. U. 1955. Das jungsteinzeitliche Moordorf von Thayngen-Weier. – In Guyan, W. U. (ed.). Das Pfahlbauproblem. Monographien zur Ur- und Frühgeschichte der Schweiz. 11:221–272.
Haas, J. N. & Rasmussen, P. 1993. Zur Geschichte der Schneitel- und Laubfutterwirtschaft in der Schweiz – eine alte Landwirtschaftspraxis kurz vor dem Aussterben. – Festschrift Zoller. Dissertationes Botanicae 196:469–489. Berlin-Stuttgart.
Heer, O. 1865. Die Pflanzen der Pfahlbauten. Neujahrsblatt der Naturforschenden Gesellschaft aus dem Jahr 1866 (An die Zürcherische Jugend auf das Jahr 1866). Zürich.
Hegi, G. 1926. Illustrierte Flora von Mittel-Europa V:2. München.
Helbæk, H. 1952. Early Crops in Southern England. – Proceedings of the Prehistoric Society XVIII:194–233. London.
Helbæk, H. 1955. The Botany of the Vallhagar Iron Age Field. – In Stenberger, M.: Vallhagar, a Migration Period site on Gotland, Sweden: 653–699. Stockholm.
Helbæk,H. 1958. Grauballemandens Sidste Måltid. – Kuml 1958:83–116. Århus.
Hjelmqvist, H. 1955. Die älteste Geschichte der Kulturpflanzen in Schweden. (English Summary.) – Opera Botanica 1:3. Stockholm.
Hjelmqvist, H. 1979. Beiträge zur Kenntnis der prähistorischen Nutzpflanzen in Schweden. – Opera Botanica 47: 1–58. June 1979. Stockholm.
Hjelmqvist, H. 1992. Some economic plants from the Prehistoric and Medieval Periods in Southern Sweden. In The Archaeology of the Cultural Landscape. Field Work and Research in a South Swedish Rural Region (eds. Larsson, L., Callmer, J. & Stjernquist, B.) – Acta Archaeologica Lundensia. Series in 4°:19:359–367. Stockholm.
Hunter, H. 1951. The Barley Crop. London.
Ingmanson, I. 1983. Kan man äta sånt? – Rabén & Sjögren. Stockholm.
Iversen, J. 1960. Problems of the early Post-Glacial forest development in Denmark. – Danmarks Geologiske Undersøgelse IV:3. Copenhagen.
Iversen, J. 1973. The Development of Danmark's Nature since the Last Glacial. – Danmarks Geologiske Undersøgelse V: 7-C. Copenhagen.
Jacomet, S. 1987. Prähistorische Getreidefunde. Eine Anleitung zur Bestimmung prähistorischer Gersten- und Weizen-Funde. – Botanisches Institut der Universität Basel.
Jankuhn, H. 1969. Vor- und Frühgeschichte vom Neolithikum bis zur Völkerwanderungszeit. – Deutsche Agrargeschichte I. Stuttgart (Ludwigsburg).
Janzon, G. 1984. A Megalithic Grave at Alvastra in Östergötland, Sweden. – In Burenhult, G. (ed.). The Archaeology of Carrowmore. Environmental Archaeology and the Megalithic Tradition at Carrowmore, Co. Sligo, Ireland. – Theses and Papers in North-European Archaeology 14: 361–366. Stockholm.
Jennbert, K. 1984. Den produktiva gåvan. Tradition och innovation i Sydskandinavien för omkring 5300 år sedan. (English Summary.) – Acta Archaeologica Lundensia. Series in 4°:16. Bonn-Lund.
Jennbert, K. 1986. Neolithisation – a Scanian perspective. – Journal of Danish Archaeology 4:196–197.
Jensen, H. A. 1979. Seeds and other diaspores in medieval layers from Svendborg (The Archaeology of Svendborg 2): 1–102. – Odense University Press. Odense.
Jensen, H. A. 1986. Seeds and other Diaspores in Soil Samples from Danish Town and Monastery Excavations, dated 700 – 1536 AD. – Biologiske Skrifter 26. Copenhagen.
Jensen, H. A. 1987. Macrofossils and their Contribution to the History of the Spermatophyte Flora in Southern Scandinavia from 13000 BP to 1536 AD. – Biologiske Skrifter 29. Copenhagen.
Jessen, K. 1939. Bundsø, en yngre stenalders boplads paa Als. III. Kornfynd. – Aarbøger for nordisk Oldkyndighed og Historie. Copenhagen.
Jørgensen, G. 1976. Et Kornfund fra Sarup. Bidrag til Belysning af Tragtbægerkulturens Agerbrug. – Kuml 1976:47–64. Århus.
Jørgensen, G. 1977. Acorns as a Food-Source in the Later Stone Age. – Acta Archaeologica 48:233 –238. Copenhagen.
Jørgensen, G. 1981. Korn fra Sarup. Med nogle bemærkninger om agerbruget i yngre stenalder i Danmark. Kuml 1981:221–231. Århus.
Kardell, L. 1995. Lövbrott, lövtäkt, lövgöring. – Skrifter om skogs- och lantbrukshistoria 7. Lövfoderkultur och skottskogsbruk (eds. Ljunggren, L., Göransson, H. & Slotte, H.) Kungl. Skogs- och Lantbruksakademien. Stockholm.
Keller, F. 1854. 1. Pfahlbaubericht. – Mitteilungen der Antiquarischen Gesellschaft in Zürich. 9:3. Zürich.
Kolstrup, E. 1987. Tidligt Landbrug. – Skalk 5:9–12. Århus.

Kolstrup, E. 1988. Late Atlantic and Early Subboreal Vegetational Development at Trundholm, Denmark. – Journal of Archaeological Science 15:503–513.
Larsson, L. 1990. The Mesolithic of Southern Scandinavia. – Journal of World Prehistory 4:3:257–309.
Larsson, L. 1992. Settlement and environment during the Middle Neolithic and Late Neolithic. – In The Archaeology of the Cultural Landscape. Field Work and Research in a South Swedish Rural Region (eds. Larsson, L., Callmer, J. & Stjernquist, B.) – Acta Archaeologica Lundensia. Series in 4°:19:369–375. Stockholm.
Larsson, L. 1994. The Earliest Settlement in Southern Sweden. – Current Swedish Archaeology 2:159–177. Stockholm.
Larsson, M. 1992. The Early and Middle Neolithic Funnel Beaker Culture in the Ystad area (Southern Scania). Economic and social change 3100–2300 BC. – In The Archaeology of the Cultural Landscape. Field Work and Research in a South Swedish Rural Region (eds. Larsson, L., Callmer, J. & Stjernquist, B.) – Acta Archaeologica Lundensia. Series in 4°:19:369–375. Lund.
Larsson, R. 1964. Kvartärgeologisk områdesöversikt NW Gamleby i Kalmar län. – Typewritten manuscript. Department of Quaternary Geology University of Lund.
Latałowa M. 1992. Man and Vegetation in the Pollen Diagrams from Wolin Island (NW Poland). – Acta Palaeobotanica 32:1:123–249. Gdańsk.
Lemdahl, G. 1988. Palaeoclimatic and Palaeoecological Studies based on Subfossil Insects from Late Weichselian Sediments in Southern Sweden. – LUNDQUA Thesis 22. Lund.
Lindman, G. 1993. Svedjebruket i Munkeröd. Ett exempel på periodiskt svedjebruk från yngre stenålder till medeltid i södra Bohusläns kustland. – Riksantikvarieämbetet Arkeologiska undersökningar – Skrifter: 3. Göteborg.
Linkola, K. 1916. Studien über den Einfluss der Kultur auf die Flora in den Gegenden nördlich vom Ladogasee. – Acta societatis fauna & flora fennica 45:1.
Linné, C. von 1755. Flora Svecica. Stockholm. – Swedish translation ("Svensk flora") 1986. Stockholm.
Lüning, J. & Meurers-Balke, J. 1980. Experimenteller Getreideanbau im Hambacher Forst, Gemeinde Elsdorf, Kr. Bergheim/Rheinland. – Bonner Jahrbücher 180. Bonn.
Magnusson, E. 1964. Pollen-analytical investigations at Tåkern, Dags Mosse and the Neolithic Settlement at Alvastra, Sweden. – Sveriges Geologiska Undersökning. Serie C:597. Årsbok 58:3:1–47. Stockholm.
Malmer, M. P. 1977. Alvastra pålbyggnad. – Kungliga Vitterhets Historie och Antikvitets Akademiens Årsbok 1977:204–212. Stockholm.
Malmer, M. P. 1978. Forskningsprojektet Alvastra pålbyggnad. – Fornvännen 73. Stockholm.
Malmer, M. P. 1981. The Explanation of a Pile Dwelling. – In Königsson, L. K. & Paabo, K. (eds.) Florilegium Florinis Dedicatum. STRIAE 14:26–28.
Malmer, M. P. 1983a. Alvastra pælebygning. – Skalk 4:18–22. Aarhus.
Malmer, M. P. 1983b. Alvastra pålbyggnads konstruktion och användning. – In Olafsson, G. (ed.). Hus, gård och bebyggelse. Föredrag från det XVI nordiska arkeologmötet, Island 1982. Reykjavik.
Malmer, M. P. 1984. On the Social Function of Pile Dwellings and Megaliths. – In Burenhult, G. (ed.). The Archaeology of Carrowmore. Environmental Archaeology and the Megalithic Tradition at Carrowmore, Co. Sligo, Ireland. – Theses and Papers in North-European Archaeology 14:371–375. Stockholm.
Mangerud et al. 1974. Quaternary stratigraphy of Norden, a proposal for terminology and classification. – Boreas 3:109–126. Universitetsforlaget. Oslo.
McClintock, D & Fitter, R. S. R. 1956. The Pocket Guide to Wild Flowers. – 11th impression 1978. London and Glasgow.
Messikommer, H. 1913. Die Pfahlbauten von Robenhausen. L'époque Robenhausienne. Zürich.
Mikkelsen, V. M. 1989. Cultivated Fields. – Opera Botanica 96. Lund.
Neuweiler, E. 1924. Die Pflanzenwelt in der jüngeren Stein- und Bronzezeit der Schweiz. – Mitteilungen der Antiquarischen Gesellschaft in Zürich.
Nilsson, T. 1952. Kvartärpaleontologi I & II. – Lund.
Nilsson, T. 1961. Ein neues Standardpollendiagramm aus Bjärsjöholmssjön in Schonen. – Lunds Universitets Årsskrift, N.F.2:56. Lund.
Nilsson, T. 1964. Standard Pollendiagramme und C14-Datierungen aus dem Ageröds Mosse im Mittleren Schonen. – Lunds Universitets Årsskrift, N.F. 2:59. Lund.
Osvald, H. 1959. Åkerns nyttoväxter. – Stockholm.
Piening, U. 1981. Die verkohlten Kulturpflanzenreste aus den Proben der Cortaillod- und Horgener-Kultur. – Die neolithischen Ufersiedlungen von Twann 14:69–88. Bern.
Rasmussen, P. 1990. Leaf Foddering in the Earliest Neolithic Agriculture. Evidence from Switzerland and Denmark. – Acta Archaeologica Vol. 60:989:71–84. Copenhagen.
Rasmussen, P. 1993. Analysis of Goat/Sheep Faeces from Egolzwil 3, Switzerland: Evidence for Branch and Twig Foddering of Livestock in the Neolithic. – Journal of Archaeological Science 20:479–502.
Renfrew, J. 1973. Palaeoethnobotany. The prehistoric food plants of the Near East and Europe. – London & New York.
Robinson, D. E. 1988. Neolithic Cultivation at Weier, Switzerland – Some New Evidence. – In Birks et al. (eds.). The Cultural Landscape – Past, Present and Future. Cambridge University Press.
Rothamsted Experimental Station 1970: Details of the Classical and Long-Term Experiments up to 1967. Harpenden, Herts.
Sælebakke, I. & Welinder, S. 1988. The Alvastra diet from bone chemistry. – Fornvännen 83.
Schnittger, B. 1908. Mossfynd från stenåldern vid Alvastra. – Meddelanden från Östergötlands Fornminnes- och Museiförening 1908. Linköping.
Sjöbeck, M. 1964. Skottskog och grässvål. – Sveriges Natur Årsbok: 27–52. Stockholm.
Svantesson, S. I. 1981. Jordartsgeologiska kartbladet Hjo SO med beskrivning. – Sveriges Geologiska Undersökning Serie Ae 44. Stockholm.
Thelaus, M. 1989. Late Quaternary vegetation history and palaeohydrology of the Sandsjön-Årshult area, southwestern Sweden. – LUNDQUA Thesis 26. Lund.
Troels-Smith, J. 1955. Pollenanalytische Untersuchungen zu einigen schweizerischen Pfahlbauproblemen. – Das Pfahlbauproblem: 11–64. Schaffhausen 1954. (Also published by the author as a dissertation, Copenhagen 1955.)
Troels-Smith, J. 1960. Ivy, Mistletoe and Elm. Climate Indicators – Fodder Plants. – Danmarks Geologiske Undersøgelse IV Række: 4:4. København.
Troels-Smith, J. 1984. Stall-Feeding and Field-Manuring in Switzerland about 6000 Years ago. – Tools & Tillage V:1:13–25. Copenhagen.

Viklund, L. 1986. A Mediaeval Lane in the *Kransen* Block, Uppsala. Palaeoecolocigal Studies of Environmental Changes over 300 Years. – In Königsson, L. K. (ed.) STRIAE 24:187–191. Uppsala.

Villaret-von Rochow, M. 1967. Frucht- und Samenreste aus der neolitischen Station Seeberg-Burgäschisee-Süd. – Acta Bernensia II:21–64. Bern.

Villaret-von Rochow, M. 1969. Fruit size variability of Swiss prehistoric *Malus sylvestris*. – In Ucko, P. & Dimbleby, G. W. (eds.): The Domestication and Exploitation of Plants and Animals. London.

Wasylikowa, K. 1989. Palaeoecological Characteristics of the Settlement Periods of the Linear Pottery and Lengyel Cultures at Cracow-Nowa Huta (on the Basis of Plant Material). – Przegląd Archeologiczny 36:57–87.

Weimarck, H. 1963. Skånes Flora. – Lund.

Welinder, S. 1971. Tidigpostglacialt mesoliticum i Skåne. – Acta Archaelogica Lundensia. Series in 8°. Lund.

Worsøe, E. 1979. Stævningsskovene. – Danmarks Naturfredningsforenings Forlag. Diaprint A/S.

Zeist, W. van 1968 (reprinted 1970). Prehistoric and Early Historic Food Plants in the Netherlands. – Palaeohistoria XIV:41–173. Groningen.

Appendix 1: Insect remains from the Alvastra pile dwelling by Geoffrey Lemdahl

Description of the insect record

A total of 27 taxa were identified from 47 analysed samples (table 11). This must be regarded as a relatively poor insect record. Many of the remains were rather corroded, probably mainly due to oxidation. The preservation of insect remains in peat may sometimes vary because of changes in dampness. During drier years oxidation of the insects may occur in layers just under the soil surface.

Coleoptera (beetles) dominate the record with 24 taxa. Besides the remains of Diptera (true flies), some Acaria (mites) were also found. The identified arthropods can be characterized on the basis of the species' modern biology and geographical distribution derived from the literature (Fitter & Manuel 1986, Hansen 1987, Harde 1984, Lindroth 1985, 1986, Mourier & Winding 1986, Palm 1948, Rognes 1991). The analysed samples orginate from either the occupation layer or the peat immediately above it.

Finds in the occupation layer

A number of ground beetles (Carabidae) were recorded. *Calosoma inquisitor* lives in open deciduous forests, particularly formed by oak trees, where it preys on larvae of the moths Geometridae and Tortricidae. It is at present a fairly rare species in the southern half of Fennoscandia.

Elaphrus uliginosus lives on open moist soil with moss and moderately dense vegetation on the margins of lakes, ponds and marshes. It prefers rich fens with *Carex*, *Eriophorum* and moss. It is a rare species today in Fennoscandia, with a northern distribution limit at about 67°N.

Clivina species burrows in damp soils.

Trechus secalis is found on moist, rather shaded sites, preferably under leaf litter and other debris both in woodland and open country, e.g. rich meadows and arable land.

T. quadristriatus is predominantly found on open, rather dry ground with short vegetation of grasses etc., on sandy or gravelly, often clay-mixed soil. It is frequently encountered on arable land, especially with root crops. Both the recorded species of *Trechus* today have a pronounced southern distribution in Fennoscandia.

Bembidion gilvipes lives on clayey moist soil, predominantly in marshes and on shores of fresh water, usually occurring in shady sites among leaf litter under *Salix* and *Alnus* or in *Phragmites* vegetation. It is also found in deciduous forest swamps. It is fairly common today in the south of Fennoscandia.

Pterostichus nigrita is confined to wet habitats, usually on shores of ponds, lakes and rivers, preferably on clayey, humus-rich soil with dense vegetation. It is a common species in all Fennoscandia and throughout Europe.

Agonum livens is found in marshy deciduous forests, particularly in stands of alder and birch, where it lives among litter and moss. It is distributed in the southern half of Scandinavia, south to northern Spain, central Italy and Serbia.

Amara apricaria lives in open country on almost every kind of moderately dry soil. It is favoured by human activity, usually occurring in weedy vegetation in fields, gardens and ruderal sites. It is a very common species all over Fennoscandia today.

Three species of water scavenger beetles (Hydrophilidae) were found. *Cercyon tristis* and *C. sternalis* are found at the edges of fresh, mainly stagnant, and usually rather eutrophic waters, where they live in wet mud, among wet moss or under decomposing plant debris. *C. tristis* is a common species all over Fennoscandia except the northernmost part, while *C. sternalis* is more frequent only in southernmost Scandinavia.

C. analis lives in all kinds of decaying organic matter, especially decomposing plant debris. It is today common to very common all over Fennoscandia.

The rove beetle (Staphylinidae) genera of *Quedius* and *Lathrobium* contain a large number of species with a variety of habitat preferences. However, the majority of *Quedius* species live in ground litter and moss, mostly in wet places. *Lathrobium* species are also found in damp spots, at water margins, in woods under moss and leaves.

Pill beetles (Byrrhidae) of the genus *Cytilus* live on moss and are found in wet mossy meadows and in marshes.

Beetles of the family Cisidae mainly live on tree fungi.

Adults of sap-beetles (Nitidulidae) of the genera *Meligetes* and *Epuraea* are often found in flowers where they feed on pollen.

The weevil (Curculionidae) *Brachysomus echinatus* lives under leaves and in moss, often on dry hillsides with short grass.

The bark beetle (Scolytidae) *Scolytus intricatus* is found under the bark of particularly oak, but also of beech and hazel.

The pupae of many flies (Diptera) are very resistant and are often well preserved as subfossils. Some of the finds have been identified as the housefly *Musca domestica*. The housefly larvae live in manure, but they can also develop in kitchen waste and similar refuse. However, they need relatively high temperatures for their development, which is a limiting factor. It has been suggested that this fly originally came from Africa and was spread all around the world due to human impact. In northern Europe it may have become established when man began to keep domestic animals indoors during the winter.

The blowfly *Phormia terrae-novae* is occasionally known as a sheep myasis fly in the Old World, but no such record has hitherto been reported from Fennoscandia and Denmark. Normally blowflies lay their eggs on carcases, decomposing organic matter and faeces. However, in some cases larvae may infest the bodies of living vertebrate animals and feed, at least for a certain period, on the host's living tissue, liquid body substances, or ingested food. This phenomenon is called myasis.

The majority of the fly pupae possibly belong to shore-flies (Ephydridae). Most of these flies live in damp soil. This is also a habitat for *Botanophila* spp.

Most orbatei mites (Acaria) are terrestrial and live in litter and soil, while a few occur in fresh water on water plants.

Finds just above the occupation layer

Some insect remains were also found in the peat just above the occupation layer.

Dyschirius globosus is a very common species that inhabits almost every kind of moderately humid soil with sparse vegetation. It occurs on the borders of lakes and rivers, but also far from water on e.g. heaths and arable lands.

Trichocellus placidus occurs in moderately shaded and moist sites, among moss and leaf litter under deciduous trees and bushes in open woods, forest edges, thickets or fens. It is a common species in southern Fennoscandia.

The click beetle *Agriotes obscurus* was found just above the occupation layer. It occurs in meadows and gardens, where its larvae can do severe damage to crops such as barley. It is a very common, widespread species.

Larvae of *Apion* species attack various parts of flowering plants, particularly leguminous plants.

Some remains of Nitidulidae (sap-beetles) and Ephydridae (shore-flies) were also recorded in the peat layer.

Implications of the insect assemblages

The insect assemblages indicate a varity of habitats. Insects preferring moist places dominate the record (12 taxa), but also drier habitats are indicated (4 taxa). Species living in fens (4 taxa) may represent the local fauna that could have inhabited the Alvastra pile dwelling, a fen dominated by *Cladium* and *Phragmites* vegetation. Moreover, two species suggest that a forest swamp with alder or birch may have surrounded the fen.

Three ground beetles present in the record live in open deciduous forests. According to the pollen analysis, oak and hazel seem to have been the dominant tree species. The recorded bark beetle, which prefers oak, may originate from the timber brought to the pile dwelling.

Treeless open ground is also suggested. These areas may, at least partly, have been occupied by pastures and arable land, where four of the beetle species recorded could have lived. Beetles usually found in fields with root crops and cereals were found in two samples.

Three taxa living in dung may either orginate from the surrounding pasture lands or from dung on the pile dwelling construction. The pupae of *Musca domestica* that were recorded in one sample are very interesting finds. The larvae of the housefly develop mainly in manure. In northern Europe it survives the cold winters by hibernating indoors. Even if the winters may have been less severe during the Neolithic in southern Sweden, it is not likely that it could hibernate outdoors during this period. This could suggest that domestic animals were kept in stables on the Alvastra pile dwelling during the cold season of the year. In addition, the record of the blowfly *Phormia terrae-novae* may also indicate the presence of livestock. This is also supported by indications from the plant macrofossil analysis.

No exotic species, as regards their geographical distribution, are present in the insect record. All the animals may be found in the region of Alvastra today. Some of the species recorded may be regarded as rather stenothermic and thus helpful for a climatic reconstruction. Information from these species suggests a climate similar to the present or slightly warmer during the period of the Alvastra pile dwelling.

Acknowledgements

I am most grateful to Peter Skidmore, who helped to identify some of the Diptera remains. During the identification procedure I used the collections at the Entomological Museum in Lund, where the curator Roy Danielsson helped me with various problems; I am very thankful to him. I also thank Hans Göransson for providing the insect material and Alan Crozier for correcting my English.

References

Fitter, R. and Manuel, R. 1986. Field guide to the freshwater life of Britain and North-West Europe. 382 pp. Collins, London.

Hansen, M. 1987. The Hydrophiloidea (Coleoptera) of Fennoscandia and Denmark. Fauna Entomologia Scandinavica 18, 1–254. E. J. Brill, Leiden.

Harde, K. W. 1984. A field guide in colour to beetles. Octopus Books, London, 334 pp.
Lindroth, C. H. 1985. The Carabidae (Coleoptera) of Fennoscandia and Denmark. Fauna Entomologia Scandinavica 15(1), 1–232. E. J. Brill, Leiden.
Lindroth, C. H. 1986. The Carabidae (Coleoptera) of Fennoscandia and Denmark. Fauna Entomologia Scandinavica 15(2), 233–497. E. J. Brill, Leiden.
Mourier, H. and Winding, O. 1986. Collins guide to wild life in house and home. 224 pp. Collins, London.
Palm, T. 1948. Skalbaggar. Coleoptera. Kortvingar, Fam. Staphylinidae – Underfam. Micropeplinae, Phloeocharinae, Olisthaerinae, Proteininae, Omaliinae. Svensk Insektfauna 9, 1–133.
Rognes, K. 1991. Blowflies (Diptera, Calliphoridae) of Fennoscandia and Denmark. Fauna Entomologia Scandinavica 24, 1–272. E. J. Brill, Leiden.

Table 11. Arthropods recorded in samples from the Alvastra pile dwelling.

TAXON	SAMPLES
COLEOPTERA	
Carabidae	
Calosoma cf. *inquisitor* (L.)	MM2, 98.77–72
Elaphrus uliginosus Fabr.	ED7, 98.57–53
Clivina sp.	MM2, 98.73–69
Dyschirius globosus (Herbst)	SJ5, 99.16–02
Trechus secalis (Payk.)	EN, 98.62–55
T. cf. *quadristriatus* (Schrank)	M2, 08.65–56
Bembidion gilvipes Sturm	MM2, 98.63–56
Pterostichus nigrita (Payk.)	MM2, 98.77–72
Agonum livens (Gyllh.)	SI1, 98.44
Amara cf. *apricaria* (Payk.)	SD1, 98.77–62
Trichocellus cf. *placidus* (Gyllh.)	SJ5, 99.16–02
Gen. indet.	WA3, 98.465–440
Hydrophilidae	
Cercyon tristis (Ill.)	EM2, 98.39–36
C. sternalis (Sharp)	SD1, 98.49–38
C. analis (Payk.)	EG1, 98.41–40
Staphylinidae	
Quedius sp.	ED4, 98.67–63
Lathrobium sp.	EM2, 98.39–36
Byrrhidae	
Cytilus sp.	WA3, 98.465–440
Cisidae	
Gen. indet.	EL1, 98.48–38
Elateridae	
Agriotes obscurus (L.)	MM2, 98.82–77
Nitidulidae	
Meligetes/Epuraea sp.	SJ5, 99.16–02; EG1, 98.41–40
Apionidae	
Apion sp.	SJ5, 99.16–02
Curculionidae	
Brachysomus echinatus (Bons.)	MH2, 98.67–64
Scolytidae	
Scolytus intricatus Ratz.	EI4, 98.63–57
DIPTERA	
Muscidae	
Musca domestica L.	EF4, 98.44–40
Anthomyiidae	
Botanophila sp.	ED2, 98.47–50
Calliphoridae	
Phormia terraee-novase R.-Desv.	SH1, 98.41–35
Cyclorapha indet. (?Ephydridae)	MM2, 98.63–50; SJ5, 99.16–02; EK4, 98.44-40; ED6, 98.45–40; ED2, 98.50–43; EH3, 98.45–37; SH1, 98.41–35
ACARIA	
Oribatei	WA5, MN1

Appendix 2: Sub-fossil molluscs from the Alvastra pile dwelling area by Birgitta M. Johansson

Description of the material

Sub-fossil shells of gastropods and mussels from the occupation layer and from the peat overlying and underlying the occupation layer have been studied. Most of the shells are very fragile and difficult to identify to species level. The nomenclature for terrestrial species follows Waldén (1984) and that for limnic species follows Hubendick (1949).

Seven samples from the occupation layer:

SB2. 98.40-34: 1 freshwater mollusc: 1 *Planorbis* sp. MNI = 1

SH1. 98.41-35: 2 land molluscs: 2 *Succinea* sp. MNI = 2

ED7. 98.55-53: 2 land molluscs: 1 *Vertigo pygmæa*, 1 Zonitidæ. MNI = 2

EI3. 98.62-57. 1 land mollusc: 1 *Nesovitrea* sp. MNI =1

EM4. 98.33: 1 land mollusc: 1 *Cochlicopa lubricella* MNI = 1

EO2. 98.42: 1 land mollusc: 1 *Succinea* sp. MNI = 1

EO3. 98.41: 1 land mollusc: 1 *Succinea* sp. MNI = 1.

One sample comprising the undermost part of the occupation layer and the uppermost part of the underlying lake marl:

SB1. 98.40-32: 14 land + 6 freshwater molluscs: 1 *Bithynia* sp., 1 *Planorbis* sp.?, 2 *Spermodea lamellata*, 4 *Sphærium* sp., 12 *Succinea* sp., 2 undetermined fragments. MNI = 20.

Forty-seven land molluscs and two freshwater molluscs were found above the occupation layer within the squares SB2, SD1, SJ 5 MM2 and EA1:

2 *Carychium tridentatum*, 1 *Cochlicopa lubricella*, 4 *Cochlicopa* sp., 1 *Nesovitrea* sp., 2 *Planorbis* sp.?, 2 *Spermodea lamellata*, 1 *Succinea* sp., 9 *Tricha hispida*, 1 *Tricha hispida*?, 2 *Vallonia excentrica*, 1 *Vallonia pulchella*, 3 *Vallonia* sp., 1 *Vertigo pygmæa*, 1 *Vertigo* sp., 18 Zonitidæ. MNI = 49.

The following land, freshwater, marsh and ditch molluscs were found below the occupation layer within squares SB2, SH1, EA1 and EL2:2 *Cochlicopa lubricella*, 1 *Nesovitrea sp.*, 2 *Planorbis* sp.?, 1 *Pupilla muscorum*, 7 *Spermodea lamellata*, 2 *Sphærium* sp., 14 *Succinea* sp., 3 *Vallonia pulchella*, 3 *Vertigo genesii*, 2 *Vertigo pygmæa*, 7 *Vertigo substriata*, 1 *Vertigo sp.*, 2 undetermined fragments, 4 Zonitidæ. MNI = 47.

Interpretation of the material

In all, five genera and ten species were identified from the samples above, below and from the occupation layer proper. The larger land molluscs include amber snail (*Succinea* sp.), rayed glass snail (*Nesovitrea* sp.) and hairy snail (*Tricha hispida* Müller). The smaller species include slippery moss snail (*Cochlicopa lubricella* Porro), whorl snails (*Vertigo pygmæa* Daraparnaud, *V. substriata* Jeffreys, *V. genesii* Gredler), moss snail (*Pupilla muscorum* Linnæus), smooth grass snail (*Vallonia pulchella* Müller), *Vallonia excentrica* (Sterki), *Carychyium tridentatum* (Risso) and *Spermodea lamellata* (Jeffreys). The freshwater molluscs include ramshorn snail (*Planorbis* sp.), orb mussels or "pea cockles" (*Sphærium* sp.) and *Bithynia* sp.

The species found (excluding *Sphærium*) can be classified in the following ecological groups:

1. Woodland species: *Carychium tridentatum, Spermodea lamellata*.
2. Catholic species: land = *Cochlicopa lubricella, Nesovitrea sp.*; water = *Bithynia* sp.
3. Open country species: *Vallonia* spp., *Pupilla muscorum, Vertigo* spp, *Tricha hispida*
4. Marsh species: *Succinea* sp.
5. Ditch species: *Planorbis* sp.

Most of the identified species from the Alvastra spring mire have been recorded and discussed by Odhner (1910) in his study of the sub-fossil mollusc fauna from the province. When he studied the recent mollusc fauna in and around Lake Tåkern in 1929, fifty-five species were observed. In 1949 Lohmander gave only a brief account of the land mollusc fauna in Östergötland. *Tricha hispida*, however, has not been mentioned before in any study. This species is connected to a man-made, agricultural landscape, similiar to today's landscape in the Alvastra area, which has been discussed by Göransson (1987).

References

Fries, C. and Curry-Lindahl, K. (eds.) 1949. *Natur i Östergötland*. – Svensk Natur. Göteborg.

Göransson, H. 1987. *Neolithic Man and the Forest Environment around Alvastra Pile Dwelling*. – Theses and Papers in North-European Archaelogy 20. Stockholm. Lund University Press, Chartwell-Bratt Ltd.

Hubendick, B. 1949. *Våra snäckor. Illustrerad handbok*. – Stockholm.

Kerney, M. P. and Cameron, R. A. D. 1979. *A Field Guide to the Land Snails of Britain and North-West Europe.* – London.

Lohmander, H. 1949. Småkryp i Östergötland. In: Fries, C. and Curry-Lindahl, K. (eds.) 1949. *Natur i Östergötland*: 89–96. – Svensk Natur. Göteborg.

Odhner, N. 1910. Beiträge zur Kenntnis der fossilen Molluskenfauna Schwedens. Mollusken aus Kalktuffen von Östergötland. – Arkiv f. Kemi, Min. o. Geol. (K. Sv. Vet. Akad.) 3:33.

Odhner, N. H. 1929. Die Molluskenfauna des Tåkerns. No. 8. – In: *Sjön Tåkerns fauna och flora.* – K. Sv. Vet. Akad. Uppsala:1–129.

Waldén, H. W.1984. Sveriges landmollusker – en artlista med kommentarer. – *Fauna och Flora* No. 1. Årg. 79:29–43. Stockholm.