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A Roman Fort on the Antonine Wall

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Chapter 13

PLANT REMAINS

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13.1 INTRODUCTION

In 1973 JHD visited the excavation and saw the section of the east annexe ditch and in particular the lower layers dark in colour. Obviously organic and waterlogged, these deposits seemed very promising of important results and so it quickly proved with the recognition of cereal bran, fig pips and mosses in the laboratory. More than sixty years before, H F Tagg's work (1911) on Roman fort at Newstead, Borders, produced a lengthy appendix on 'vegetable remains'. It concerned only larger plant remains because this was before anyone had carried out any kind of detailed pollen analysis in Britain (not till the 1920s were pollen diagrams produced). Carried out by A Raistrick in 1939, the first pollen analysis from a Scottish Roman site was from an 'earth sample' taken from the fort at Fendoch, Perthshire (Raistrick 1939). In 1944 Danes Knut Jessen and Hans Helbaek published on carbonised cereals from some Roman sites in Scotland. This investigation at Bearsden is by no means the first deliberate botanical study of Roman deposits in Scotland. However, involving both numerous pollen and macroscopic fossil analyses, it is by far the most thorough, highly detailed and informative concerning the military diet and the environment of Scotland in Roman times. Identification was by reference to modern pollen, fruits, seeds, leaves, wood, charcoal and other plant structures. The nomenclature follows, for flowering plants, Clapham et al (1981) and, for mosses, Smith (1978).

13.2 OUTER EAST ANNEXE DITCH

13.2.1 Macroscopic plant remains

A column 1.8m × 100mm × 100mm square was taken through the organic deposits from near the butt-end of the outer of the two ditches. The stratigraphy is as follows:

0–150mm grey-brown clayey silt with decayed wood

150mm–390mm woody detritus brown clay-mud, the top 0.12m disturbed

390mm–500mm laminated dark brown clay-mud

500mm–600mm transition to brown clayey silt

600mm–1.8m brown organic clayey silt with wood and charcoal fragments and occasional vivianite becoming less organic towards the base

1.80m–downwards light brown silty clay

Material above 280mm was considered too disturbed to analyse. Samples 20mm thick were taken from six levels for the detailed examination of plant remains (table 13.1). The samples were broken up in dilute sodium hydroxide and sieved. The sieved plant debris was examined using a low-power stereo-microscope and over a hundred taxa represented as fruits, seeds, moss leaves and other remains were identified.

The ditch samples, except for the uppermost sample, 0.48m–0.5m, all produced similar plant remains dominated by fragments of *Triticum/Secale* (wheat/rye) bran (the uncarbonised grain wall). The bran forms about half of the organic part of the ditch infilling. Such bran has now been recognised from a number of archaeological sites (Hall et al 1983). The bran fragments, mainly 2 or 3mm in diameter, are similar in general appearance to those produced when grain is pounded in a mortar or ground in a rotary quern, but with the outer bran layers and the proteinaceous (aleurone) and starch cells decayed away. It is notable that Helbaek (1958) found bran fragments of wheat and barley in the stomach contents of two Iron Age bog corpses. An explanation of the origin of the bran fragments was given when the excretory product of meals containing bran was sieved and compared with the sieved ditch samples; the bran fragments were basically similar in both contexts.

Subsequent biochemical tests revealed the presence of cholesterol and other sterols present in the bran-bearing material but not in the succeeding levels. These sterols are characteristic of food which has passed through the mammalian gut. The biochemical work also hints at a mainly vegetarian diet (Knights et al 1983: 150). See Addendum A.

Further corroborative evidence comes from internal parasite eggs of *Ascaris* and *Trichuris* investigated by Jones and Maytom (section 18). These three lines of evidence led to the conclusion that the ditch contained sewage. Later excavation revealed the bath-house latrine, with a drain leading towards the east annexe ditches, as the probable source of the sewage. The diet represented, as described in the following pages, confirms the likelihood of the human origin of the sewage component of the ditch infill.

Table 13.1
East annexe ditch, macroscopic plant remains

			Depth from top of column in cm					
			Roman sewage					*post-Roman*
			168–70	*148–50*	*118–20*	*98–100*	*68–70*	*48–50*
Imported culinary and medicinal plants								
Anethum graveolens (Dill)	Fruit	F			1		2	
Apium graveolens (Wild Celery)	Fruit			2	3	4	3	
Coriandrum sativum (Coriander)	Fruit	F	3	2	3	4	1	
Ficus carica (Fig)	Seed			6	3	11	2	
Papaver somniferum (Opium Poppy)	Seed	**F**		**1**			**1**	
Cultivated plants and weeds								
Agrostemma githago (Corncockle)	Seed	F	3	14	32	25	13	
Avena sp (Wild/Cultivated Oat)	Testa	F		r			r	
Brassica rapa ssp *sylvestris* (Wild Turnip)	Seed	F		1		1		
Bromus hordeaceus agg (Lop-grass)	Pericarp	F	f	f	f	f	f	
Cerastium fontanum (Common Mouse-ear Chickweed)	Seed			3	3		5	
Chenopodium album (Fat Hen)	Seed			2	1			
Chrysanthemum segetum (Corn Marigold)	Achene			1				
Fallopia convolvulus (Black Bindweed)	Nut	F		1				
Hordeum sp (Barley)	pericarp	F	r	r	o	o	r	
Cf *Lens culinaris* (Lentil)	Seed	F			r		r	
Linum usitatissimum (Flax, Linseed)	Seed	F		1			1	
Malva sylvestris (Common Mallow)	Pollen cluster						r	
Polygonum aviculare agg (Knotgrass)	Nut						1	
P. lapathifolium (Pale Persicaria)	Nut	F		1			1	
Cf *Raphanus* sp (Wild Cultivated Radish)	Seed	F				1	3	
Secale cereale (Rye)	Pericarp	F	r	r	r	r	r	
Sonchus asper (Spiny Sow-thistle)	Achene		1	1			1	1
Stellaria media (Chickweed)	Seed		5		1	1		
Triticum cf *dicoccum* (Emmer Wheat)	Pericarp	F	r	r	r	r	r	
T. aestivum/spelta (Bread/Spelt Wheat)	Pericarp	F		r	r	r		
T. dicoccum/spelta (Emmer/Spelt Wheat)	Glume base				61	80	1	
Triticum/Secale (Wheat/Rye)	Testa	F	a	a	a	a	a	
Umbelliferae (Umbellifer Family)	Fruit	F			2	1		

Table 13.1 (continued)

		Depth from top of column in cm						
		Roman sewage						*post-Roman*
			168–70	*148–50*	*118–20*	*98–100*	*68–70*	*48–50*
Cf *Vicia faba* (Horse Bean)	Seed	F			r	r	r	
Cf *Vicia* sp (Vetch, Tare)	Seed	F			r	r	r	
Heathland and bog								
Aulacomnium palustre (Moss)	Leafy stem				r	r		
Calluna vulgaris (Heather)	Leafy stem		*6	*29	*88	*50	*40	
Danthonia decumbens (Heathgrass)	Grain		1	5				
Erica tetralix (Cross-leaved Heath)	Leaf			5	9	9	4	
Erica tetralix (Cross-leaved Heath)	Seed						1	
Eriophorum vaginatum (Cotton-grass)	Leaf spindle			6	14	4	9	
Eriophorum sp (Cotton-grass)	Nut						1	
Juncus squarrosus (Heath Rush)	Seed		1	3			2	
Potentilla erecta (Common Tormentil)	Achene			4	1	1	3	
Pteridium aquilinum (Bracken)	Frond	F	r	o	f	o	o	
Pteridium aquilinum (Bracken)	Rhizome	F		r		r		
Sphagnum imbricatum (Bog moss)	leaf		r					
S. cf *palustre* (Bog Moss)	Leaf		r		r			
Sphagnum undiff (Bog Moss)	Leaf		o				r	
Vaccinium myrtillus (Bilberry)	seed				1		1	
Woodland, grassland and wet pasture								
Agrostis sp or spp (Bent-grass)	Grain		1	3	17	3		
Alnus glutinosa (Alder)	Fruit			1			1	
Betula pubescens (Birch)	Fruit			1			1	
Betula pubescens (Birch)	Catkin scale					1		
B. pubescens/pendula (Birch/Silver Birch)	Fruit						1	1
Cardamine flexuosa/hirsuta (Wood/Hairy Bitter-cress)	Seed						2	13
Calliergon cordifolium (Moss)	Leafy stem				r			
C. cuspidatum (Moss)	Leafy stem			r	r			
Ceratodon purpureus (Moss)	Leafy stem		o		r			
Cf *Conopodium majus* (Pignut)	Fruit					1		
Corylus avellana (Hazel)	Nut	F			1	1		
Deschampsia caespitosa (Tufted Hair-grass)	Grain			1	1	3	1	1

Table 13.1 (continued)

		Depth from top of column in cm						
		Roman sewage						*post-Roman*
			168–70	*148–50*	*118–20*	*98–100*	*68–70*	*48–50*
Eurhynchium praelongum (Moss)	Leafy stem		o	o	o	f		a
Fragaria vesca (Wild Strawberry)	Achene						19	1
Gnaphalium sylvaticum/uliginosum (Wood/ Marsh Cudweed)	Achene						6	
Gramineae (Grass)	grain		4	4	4	1	7	3
Holcus lanatus (Yorkshire-fog)	Grain		1					
Hylocomium splendens (Moss)	Leafy stem		o	o	r	f	o	o
Hypnum cupressiforme (Moss)	Leafy stem		o	o	r	f	r	o
Hypochaeris radicata (Cat's-ear)	Achene				1			
Isothecium myosuroides (Moss)	Leafy stem				r	r		
Juncus acutiflorus/articulatus (Sharp-flowered/ Jointed Rush)	Seed				2			
J. bufonius (Toad Rush)	Seed				2	1	5	
J. conglomeratus/effusus (Soft Rush)	seed		1		15	1	41	
Juncus sp (Rush)	stem/leaf	F			*r			
Labiatae (Mint Family)	nut				2	2		
Lathyrus pratensis (Meadow Vetchling)	leaf, stipule	F	1	4	9	2	2	
Linum catharticum (Purging Flax)	seed, capsule				1			
Luzula sp (Woodrush)	seed			1	1	2	3	
Neckera complanata (Moss)	leafy stem					r		
Phleum cf *pratense* (Timothy Grass)	grain						4	
Plagiomnium undulatum (Moss)	leafy stem				r			
Poa annua (Annual Meadow-grass)	grain						1	
P. cf *pratensis* (Smooth-stalked Meadow-grass)	grain						4	
P. cf *trivialis* (Rough-stalked Meadow-grass)	grain					1	6	4
Pohlia cf *nutans* (Moss)	leafy stem				r		r	
Polytrichum commune (Hair Moss)	leaf		r		r	o	r	r
Prunella vulgaris (Self-heal)	nut			3	3	2	2	
Pseudoscleropodium purum (Moss)	leafy stem		r		r	r		
Ranunculus sect *Ranunculus* (Buttercup)	achene			3				
Rhinanthus sp (Yellow-rattle)	seed			1				
Rhytidiadelphus squarrosus (Moss)	leafy stem		r	r	r	0		

Table 13.1 (continued)

		Depth from top of column in cm						
		Roman sewage						*Post-Roman*
			168–70	*148–50*	*118–20*	*98–100*	*68–70*	*48–50*
Rubus fruticosus agg (Blackberry)	fruit-stone				2			
R. idaeus (Raspberry)	fruit-stone		1	2	1		2	
Salix sp (Willow)	bud scale			1		1		
Stellaria graminea (Lesser Stitchwort)	seed						1	
Thuidium tamariscinum (Moss)	leafy stem						r	
Cf *Trifolium repens* (White Clover)	petal	F	4	6	7	6	5	
Urtica dioica (Stinging Nettle)	nut					1		2
Aquatic, marsh and fen								
Alopecurus cf *geniculatus* (Marsh Foxtail)	grain						1	
Bidens cernua (Nodding Bur-Marigold)	achene				2			
Callitriche stagnalis (Starwort)	fruit							>75
Carex cf *paniculata* (Panicled Sedge)	nut							>150
Carex sp or spp (Sedge)	nut		2	15	12	7	12	
Epilobium palustre (Marsh Willow-herb)	seed						1	1
Filipendula ulmaria (Meadow-sweet)	fruit			1				
Glyceria fluitans (Flote-grass)	grain			2				
Isolepis setacea (Bristle Scirpus)	nut				1			
Lemna cf *minor* (Duckweed)	seed							24
Lychnis flos-cuculi (Ragged Robin)	seed			1				7
Lycopus europaeus (Gypsy-wort)	nut			1			1	
Phalaris arundinacea (Reed-grass)	grain							1
Ranunculus sub g *Batrachium* (Water Crowfoot)	achene							24
R. flammula (Lesser Spearwort)	achene			1				
R. sceleratus (Celery-leaved Crowfoot)	achene							35
Rorippa palustris (Marsh Yellow-cress)	seed		1		1		3	
Viola palustris (Marsh Violet)	seed					1		
Miscellaneous								
Acrocarp undiff (Moss)	leafy stem				r			
Bryum sp (Moss)	leafy stem				r	r		
Cerastium sp (Chickweed)	seed					1		
Cirsium sp (Thistle)	achene		1	1				12
Galium sp (Bedstraw)	fruit				1			1

Table 13.1 (continued)

		Depth from top of column in cm						
		Roman sewage						*post-Roman*
			168–70	*148–50*	*118–20*	*98–100*	*68–70*	*48–50*
Rumex sp (Dock/Sorrel)	nut, perianth			1	1	3	2	7
Senecio sp (Groundsel/Ragwort)	achene						7	
Umbelli ferae (Umbellifer Family)	fruit			1		1	2	
Viola sp (Violet/Pansy)	seed						1	
Unidentified	seed		1		4			9

Four samples from the ditch were examined initially but when the deposit was found to be basically of sewage two further samples were processed, from 680mm to 700mm and from 1.18m to 1.2m; *c* 1% sodium hydroxide was used to disaggregate these two samples to avoid damage to the delicate food fragments. As already stated, in addition to the corn many other plant remains were identified; the native plans are grouped accordingly to their ecological preferences but they are not necessarily exclusive to those categories.

Crop plants: cereals and associated weeds

The cereal fragments consist of probably two species of wheat with barley, rye and oats. All were identified on small fragments only and criteria and photographs are provided elsewhere in this report and in Dickson, C (1987a).

Triticum cf *dicoccum* (emmer wheat) pericarp fragments are very tentatively identified from each level and the glume bases with more certainty. Emmer has been identified from three Roman sites of the Antonine period (Rough Castle, Castlecary and Lyne; and Jessen & Helbaek 1944). According to Percival (1921: 188) emmer has little frost resistance and it is notable that the only native Iron Age place in Scotland where it has been found in quantity is a west coastal site on the River Clyde (Dickson, forthcoming). Emmer is present at Roman sites in southern Britain but generally in smaller proportion than spelt wheat (Green, F J 1981: 133) where it continued in cultivation in the early Saxon period (Green, F J 1981: 136, fig 7.3) and in the early Christian period in Scotland (Jessen & Helbaek 1944).

Triticum spelta/aestivum sl (spelt/bread or club wheat) is tentatively identified as rare grain fragments from three levels. Spelt glume bases are also probably present.

Spelt wheat has been identified from three Antonine sites (Rough Castle, Castlecary and Lyne) but apparently not from native sites in Scotland. In southern Britain spelt is the commonest wheat found at sites of Iron Age and Roman date (Green, F J 1981: 136, fig 7.3). See Addendum B.

Grains of bread or club wheat have been recovered in small proportion at two Antonine Wall sites (Rough Castle and Castlecary; and Jessen & Helbaek 1944). Occasional grains have been found in native sites in Scotland from the Bronze Age onwards. In England club wheat has been recorded in some quantity from Verulamium (Helbaek 1953) from a second century context; it seems to have been more widely grown in the later Roman period.

Triticum/Secale (wheat/rye). These are ground-up bran fragments, which in fact make up the vast bulk of the cereal fragments, but they are so degraded that only the testa (similar in both wheat and rye) is left. However, as discussed below, associated glume fragments suggest that the bran is predominantly of hulled wheat; its identification and the form in which the wheat was eaten are later discussed.

Triticum dicoccum/spelta (emmer/pelt wheat). Glume bases from hulled wheats, probably from both emmer and spelt wheats were recovered in quantity from two samples. 98–100 yielded 80 and 118mm–20mm, 61 glume bases (it is probable that they were overlooked in other samples). It seems likely that these glumes, which do not thresh free easily as in modern wheats, were retained during processing of the grain; their fragmentary appearance also suggests that they were cooked and consumed with the wheat.

Hordeum sp (barley). The barley grain fragments are of two distinct types. Some are brown and appear to have been ground-up with the wheat but probably only represent a few grains in each sample; since the wheat fragments must represent some hundreds or even thousands of grains in each sample, these fragments represent only a small proportion and could well be residual barley from a previous crop or impurity in the seed corn. There are also a very few transparent fragments of barley grains which appear to have been processed differently to the wheat but in a similar way to pearl barley and are later described and discussed. Barley has been recorded from other forms on the Antonine Wall and from Birrens, Dumfriesshire (Jessen & Helbaek 1944). Tagg (1911: 356) found 'husks' of wheat and barley at Roman Newstead.

Secale cereale (rye). The rare fragments of rye from each sample suggest that it status was that of a weed in the wheat crop. Carbonised grains of rye have been recorded from several Roman sites, these include a considerable quantity from *Isca*/Caerleon,

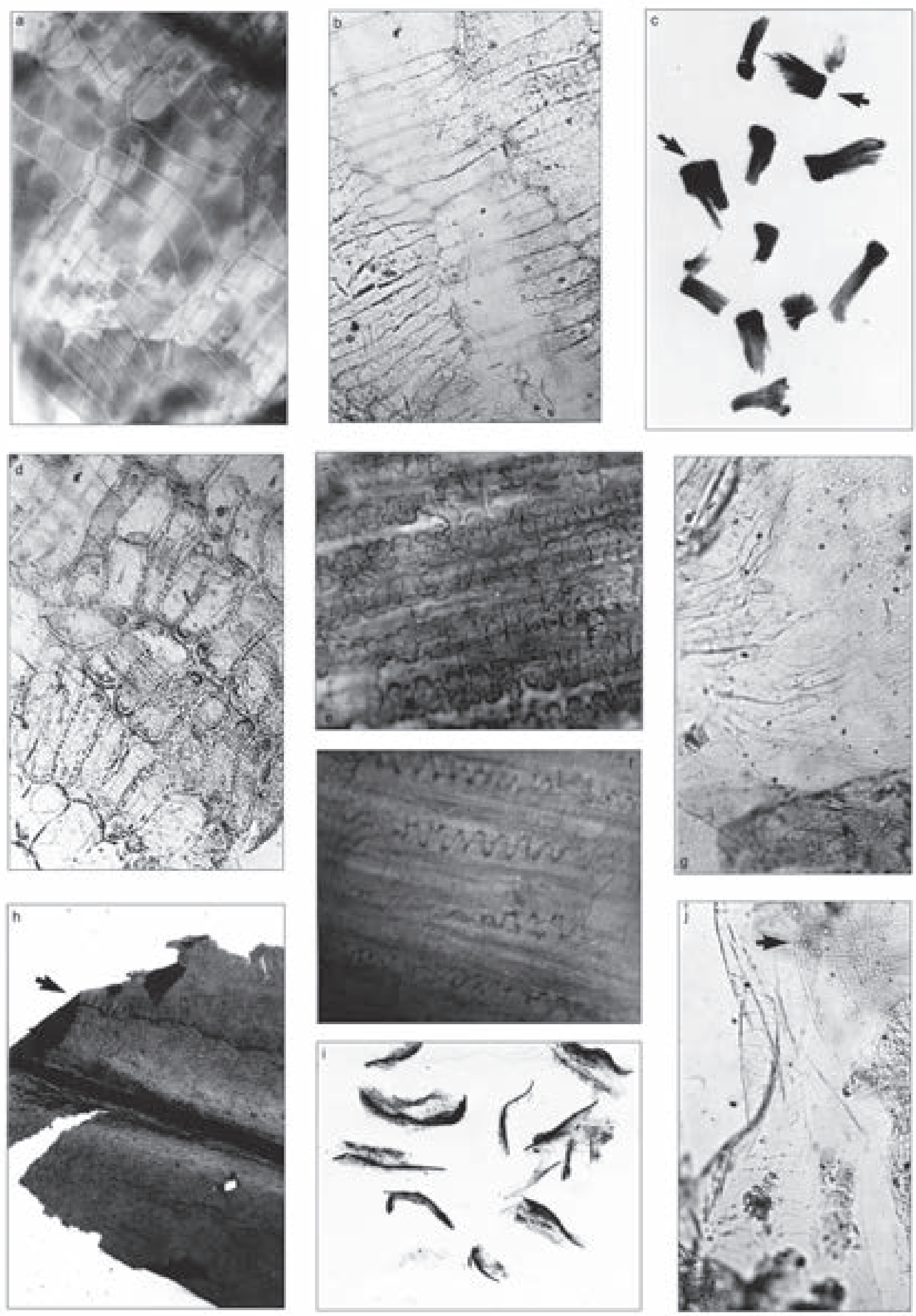

Illustration 13.1
Cereal bran.
Key: (a) *Triticum/Secale*, 2 testa layers, ×200; (b) *T. spelta/T. aestivum* sl, transverse cells, walls partly replaced with fungal hyphae, ×200; (c) *T.* cf *dicoccum*, glume bases and rachis segments (arrowed), ×3.5; (d) *Secale cereal*, transverse cells, ×200; (e) *T.* cf *dicoccum*, glume epidermal cell pattern, ×400; (f) *T.* cf *spelta*, glume epidermal cell pattern, ×400; (g) *Avena*, tube cells (the testa cells have disappeared), ×200; (h) *Hordeum*, testa with glume imprints (arrowed) each side of the hilum, ×20; (i) *Hordeum*, hilums with degraded testa, ×3; (j) *Hordeum*, perisperm and transverse cells (arrowed), ×200.

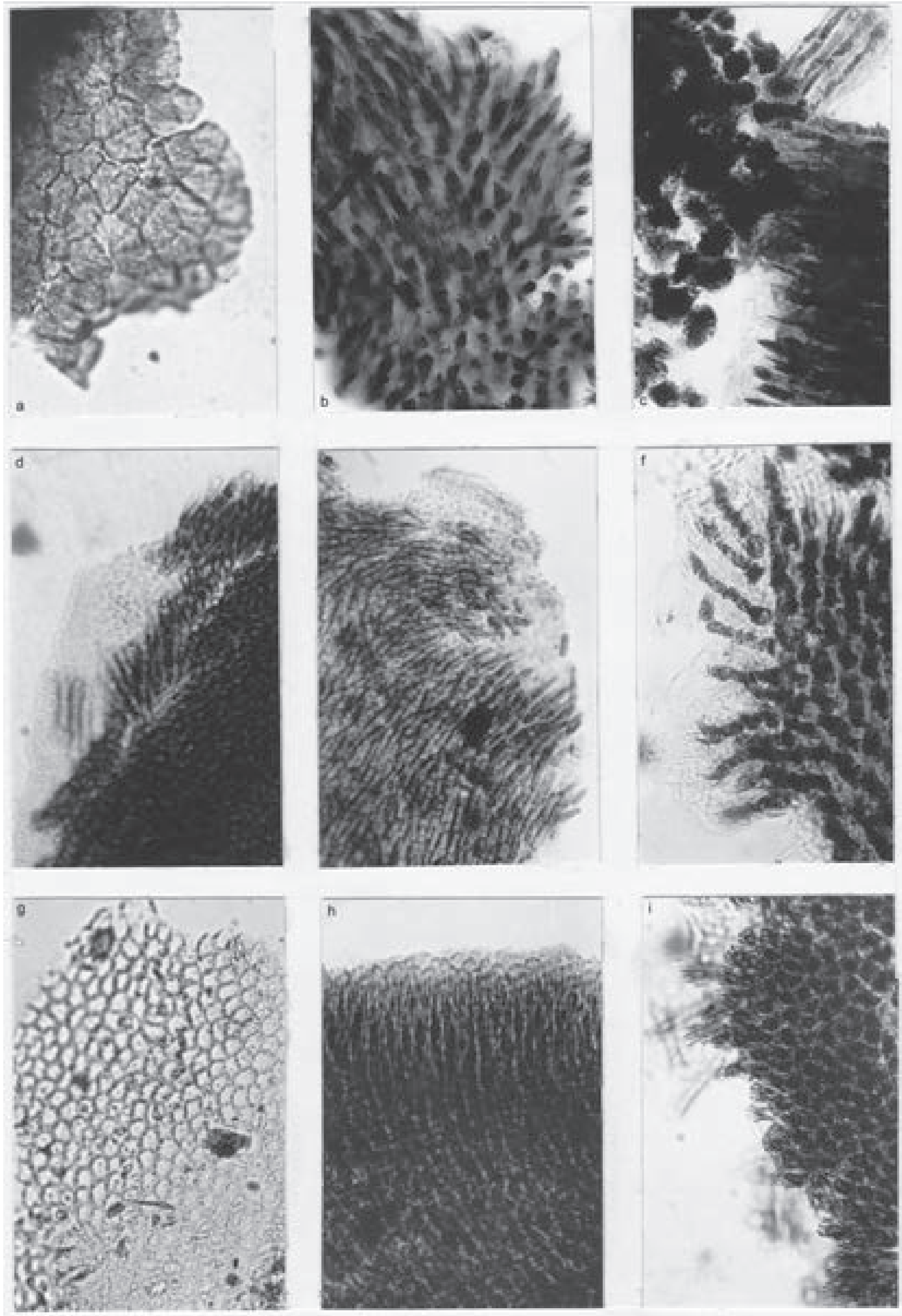

Illustration 13.2
Leguminosae, testa fragments.
Key: (a) Cf *Vicia faba*, cuticle, ×400; (b) Cf *V. faba*, palisade cells TS and oblique LS, ×200; (c) Cf *V. faba*, palisade cells LS and hypoderm cells, ×200; (d) Cf *Lens culinaris*, palisade cells and cuticle, ×400; (e) CF *L. culinaris*, palisade cells LS, ×400; (f) *V. faba*, reference testa, heated in water, showing dark brown lumina, ×200; (g) Cf *Vicia*, cuticle, ×400; (h) Cf *Vicia*, cuticle and palisade cells LS, ×400; (i) Cf *Vicia*, top of palisade cells, ×400.

Wales (Helbaek 1964) but as rare grain only from two Antonine Wall forts (Jessen & Helbaek 1944).

Avena sp (wild or cultivated oat) is probably under-represented since grain fragments often become transparent (microfiche). These rare fragments probably represent accidental inclusion of wild oats gathered with the wheat.

It seems probable then that the digested grain is mainly of emmer and spelt wheats, with a little barley. Bread wheat may be present but rye and oats are more likely to represent weeds. These rather tentative conclusions are strengthened by comparison with carbonised grain from other Antonine wall forts later in this report.

Almost all the fruits and seeds of cornfield weeds are damaged or in fragments as would be expected if they had been accidentally ground with the wheat. They include the grain of a wild grass, *Bromus hordeaceus* agg (lop-grass) which is still a moderately common cereal field contaminant.

Agrostemma githago (corn cockle), until recently a common cornfield weed, has seeds which can cause a susceptibility to leprosy (Godwin 1975: 146), and which deleteriously affect the physical properties of wheat flour (Clapham et al 1962: 288). Tagg (1911: 356) in a report on the Newstead plant remains found 'husks of wheat and barley in many of the pits mixed with corn cockle seeds'. *Bromus* and *Agrostemma* are present in some quantity and confined to the samples containing cereal remains.

Crop plants: pulses and linseed

The very small fragments of seeds of cf *lens culinaris* (lentil), cf *Vicia faba* (horse bean) and cf *Vicia* sp (vetch) are of particular interest: the taxa are tentatively identified because all are represented by fragments of only 1mm to 3mm diameter (microfiche). Legume seeds are uncommon in British archaeological sites and are generally carbonised.

Lentils are not native to Britain and the climate is not suited to their cultivation. They are widely cultivated in central, southern and eastern Europe but have been recorded from Roman London (Willcox 1977: 279) and *Isca*/Caerleon (Helbaek 1964). There is also a 19th-century record from a Roman villa at North Leigh, Oxfordshire which is quoted by Morrison (1959: 13–14); 'the floor is of plaster, and was covered in many places with wheat and lentils, black as if burnt; the form of the grain is, however, distinctly preserved'.

Vicia faba is perhaps best known in the form of the large pale-coloured broad bean of culinary use; these tiny fragments probably represent one of the smaller brown forms which are known as field, horse, tick or celtic beans. The species is not known in the wild and is sometimes grown for fodder. *V. faba* has been found at Early Iron Age and Roman sites (Godwin 1975: 181).

The seed fragments of cf *Vicia* sp most resemble those of *V. sativa* (common vetch), a well-known fodder plant with seeds that have been eaten in times of famine (Sturtevant. 1972). Some vetches are of course cornfield weeds and it is possible that they have been accidentally ground with the corn. *Vicia sativa* is one of eight species of *Vicia* and *Lathyrus* found in a burnt Roman grain store together with *V. faba* and *Lens culinaris* (Helbaek 1964).

The reason for the very small fragments of the pulses may be found in the preparation as described by Pliny; he states that lentils were first roasted then mixed with bran and lightly pounded (Pliny 18, 23). He also notes that bean meal (*Vicia faba*) was used to increase the weight of loaves of bread and also gives medicinal uses for bean meal (Pliny 18, 31; 22, 69). Beans and lentils were the most common vegetables of the Roman military diet (Davies 1971: 132), according to documentary evidence.

Seed fragments of *Linum usitatissimum* (flax, linseed) occurred at two levels of the sewage. Although present from Neolithic times onwards found on Roman sites (Godwin 1975: 167), it is usually unclear whether the crop was grown for fibre, food or both. However a seed fragment from a human coprolite from an Orkney broch (Dickson, C A, unpublished) shows that linseed was eaten by the Iron Age people in Scotland: there is also a single seed from a Caithness broch (Dickson, J H 1979a). The seeds have emollient, demulcent and pectoral properties and Pliny notes their use internally, and externally as a poultice (Pliny 20, 92). Helbaek states (1950) that the laxative powers can be removed by boiling the seeds and that they are a useful food containing 30 to 35% oil. Seed fragments were found in the stomach contents of three Iron Age bog corpses in Denmark (Helbaek 1950; Helbaek 1958) and were among the principal components in two of them.

Imported culinary and medicinal plants

The plant remains from the ditch are remarkable for the presence of fruits and seeds of species which are not part of the native flora of Britain. *Ficus carica* (fig), *Anethum graveolens* (dill), *Coriandrum sativum* (coriander) and *Papaver somniferum* (opium poppy) were all used by the early Mediterranean civilisations. Opium poppy is recorded from an Iron Age site at Fifield Bavant, Wilts (Helbaek 1952: 222) and all are known from Roman sites in England and, excepting the fig, from Wales also; these are listed in Godwin (1975: 247, 227, 223 and 129).

It is possible to grow figs in western Scotland but they only ripen on south facing walls in sheltered localities. A tree would take ten or more years to become established and produce a good crop, since Bearsden was only occupied for 16 years at most it seems highly improbable that the figs were locally grown. Coriander, dill, and opium poppy can all produce fruit in a single season even in western Scotland; if the initial seed were imported it is not inconceivable that subsequent crops could be grown in carefully tended patches and seeds would ripen in favourable seasons. See Addendum C.

Dried figs consist of over 50% sugar and presumably Pliny was considering them as an energy source when he recommended figs for increasing the strength of youth and for improving health and reducing wrinkles for the aged (Pliny 23, 63). Figs had many medicinal uses; they were used as a diuretic as well as a laxative, and also for difficult breathing being also beneficial to the throat and larynx. Figs were also applied with other substances externally to wounds and abscesses (Pliny 23, 63). Opium poppy seeds were sprinkled on Roman bread according to Pliny (Pliny 19, 53) and were also taken, lightly roasted; they were thought to induce sleep (Pliny 20, 76) although the ripe seeds do not contain opium. Coriander fruits are usually pounded to release the volatile oil from the resinous canals inside and it is of interest that only fragments of the fruit wall were found. The Romans used the fruit for flavouring but in addition pounded fruits had many medicinal uses for various skin conditions, wounds and internal parasites (Pliny 20, 82). In Britain coriander was once more commonly used medicinally than nowadays and has carminative and expectorant qualities as well as its use as a spice. Dill was used in the kitchen and as a medicinal herb by the Romans, and Pliny noted its carminative properties (Pliny 20,74). The fruits may be used as stimulant and stomachic, and dill water is still widely used to disperse wind in infants. The fruit tastes similar to that of caraway and is also used for flavouring.

Several other plants of the Umbellifer family (of which coriander and dill are members) with possible culinary uses were first found in Britain in Roman contexts (Godwin 1975: 222). Among them is included *Apium graveolens* (wild celery) fruits of which were present in the ditch. This plant, with a past Scottish distribution mainly restricted to a few damp coastal habitats in central Scotland, has suffered a reduction in its range in historic time and the Mull of Kintyre, its only present station in Scotland, is now the most northerly British locality (Perring & Walters 1976: 158). Its fossil distribution in Britain is confined to coastal peats and Roman sites (Godwin 1975: 223–4). In view of the fact that the plant is at the limit of its range in Scotland and is unlikely to have ever been commonly available it is considered that the fruits were imported. Leaves, leaf stalks and fruits can be used for flavouring in a similar way to those of *var dolce*, the cultivated celery. However its past uses have been mainly medical; the fruits are carminative, the roots and leaves were also used as a diuretic (the fruits are still so used), stimulant, tonic and for promoting restfulness and sleep. Marsh celery, referred to by Pliny among plants for the kitchen garden, may be wild celery. Celery seed is included in a recipe to alleviate headaches by Galen, the leading Roman authority on medicine (Davies 1970: 103).

The records for undetermined Umbelliferae are mainly for resinous canals, all that is left of the fruit; they include cumin (*Cuminum cyminum* L), another Mediterranean plant of former medicinal use. It is of interest that the Romans were aware of the properties of powered coriander and cumin to keep meat fresh during summer (Pliny 20, 82).

Native plants with culinary and medicinal uses

The two incomplete seeds of *Brassica rapa* ssp *sylvestris* (wild turnip) 1.0mm and 1.3mm in diameter, and four seeds of cf *Raphanus* sp (wild or cultivated radish) are of particular interest. Although both taxa could be present as cornfield weeds, it is noteworthy that no pod fragments were found; the tough pod segments of *Raphanus* spp are not usually separated by winnowing and sieving. Seed of wild turnip is mentioned by Gerard (1633) as a substitute for mustard seed though it is more bitter, and wild radish seed is considered an excellent substitute for mustard seed (Johnson 1862). Another name for wild turnip is bargeman's cabbage, still occasionally eaten as a green vegetable in early spring and leaves of wild radish are also edible. The cultivated turnip, B. *rapa* ssp *rapa*, has larger seeds, the Romans certainly knew it but it is not clear whether they introduced it into Britain. Roman soldiers often used radish seed as a substitute for olive oil (Davies 1971: 125) and the cultivated radish had many medical uses (Pliny 20, 13). *B. Rapa* is recorded from the Late Bronze Age site at Itford Hill, Sussex (Helbaek 1952: 137), the Bu broch in Orkney (Dickson, C 1987b: 137), the Roman site at Pevensey, Sussex (Salzman 1908: 135) and tentatively from the Roman sewer at york (Greig 1976: 25). It is the only species of *Brassica* represented from medieval layers in three Scottish towns (Fraser 1981; Fraser & Dickson 1982). *R. raphanistrum* (wild radish) has several Roman (Godwin 1975: 131) and medieval records (Fraser 1981; Fraser & Dickson 1982).

Two pollen clusters of *Malva sylvestris* (common mallow) were recovered from 680mm to 70mm, similar clusters were found in the pollen sievings from 700mm to 760mm. The exceptionally large spiky dimorphic grains (these are all of 180µm) of this insect pollinated plant must either have been growing on the ditch side or, as seems more likely since no fruits were found, to be part of the sewage. The passage of pollen through the gut is well attested through work on coprolites (eg Callen 1969). Pliny (20, 84) gives numerous medicinal uses for mallows especially for 'sylvestris' and 'Althaea', presumably *M. sylvestris* and *Althaea officinalis* (Marsh mallow). Pliny also states that any person taking daily half a cyathus (20 cc) of any of the mallows will be immune to all diseases. The Romans ate the nutlets and boiled the leaves; herbals still recommend the emollient properties of this mucilaginous plant. It is possible that the common mallow, a perennial plant of waste places, was deliberately cultivated at Bearsden. Both forms of the dimorphic pollen were found in other levels of the Roman sewage and a single grain in the Roman level of the middle W ditch but none in the post-Roman deposits. It is notable that previous archaeological records of Malvaceae are all from Roman sites (Godwin 1975: 200). In Germany, in a Roman cellar of second century date, Dr J Baas found an earthenware vessel filled with 30,000 fruits of *Malva sylvestris*. Dr Baas (in Körber-Grohne 1979) pointed out the great respect that both the Roman and Greek civilisations had for the medicinal virtues of the mallow. *M. sylvestris* is fairly common in the east of Scotland but rare and mainly coastal in the west of Scotland though perhaps formerly more common (Hennedy 1878: 28).

Heathland and bog

Plants of heaths and bogs, though present in small fragments, are represented by several species. *Eriophorum vaginatum* (cotton-grass) is confined to damp peaty places, often on deep peat, and must have been brought to the site as is the case with *Sphagnum imbricatum* (bog moss); remains of peat were found in the hypocaust system. The other plants are common on peaty soils though less exclusive in their requirements. Since none was found above the sewage layer it seems probable that all were brought to the fort. Some of the *Calluna* (heather) shoots are burnt which suggests the use of heather, possibly as thatch. *Pteridium* (bracken), here represented by frond fragments, is often associated with human use (Rymer 1976: 155), and has been found in quantity at Vindolanda where Seaward (1976) suggests it may have been used for animal bedding. The other species could well have been gathered with the heather, although the two seeds

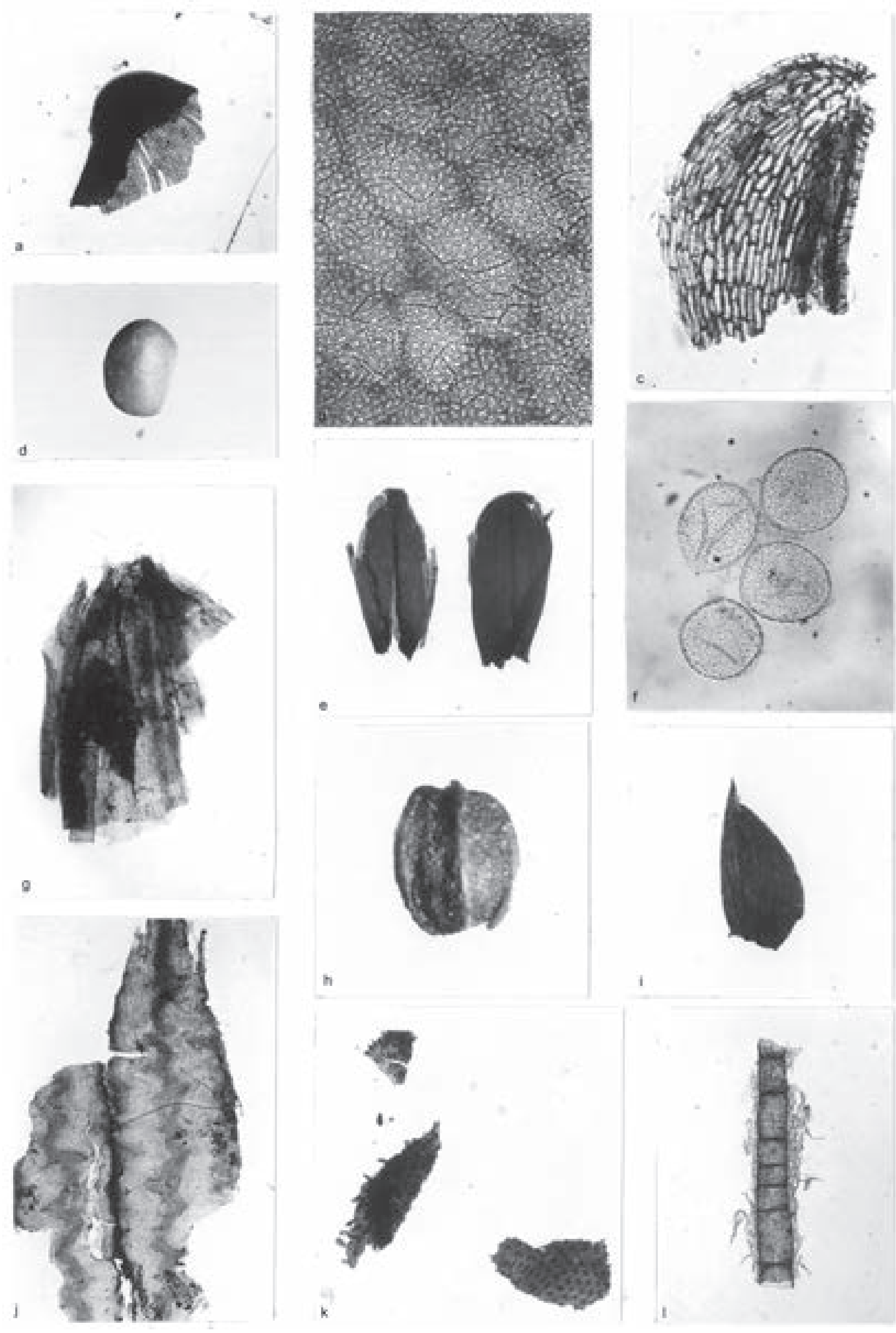

Illustration 13.3
Miscellaneous plan remains.
Key: (a) *Linum usitatissimum*, top of seed, ×20; (b) Cf *Raphanus* sp, top of testa palisade, ×200; (c) *Vaccinium myrtillus*, see, ×40; (d) *Ficus carica*, seed, ×10; (e) *Bromus hordeaceus* agg, 2 fruit, ×4.5; (f) *Malva sylvestris*, pollen, ×75; (g) *Anethum graveolens*, part of fruit with vittae, ×20; (h) *Apium graveolens*, fruit, ×20; (i) *Lathyrus pratensis*, stipule, ×4; (j) *Coriandrum sativum*, part of fruit, ×20; (k) *Agrostemma githago*, seed fragments, ×10; (l) Umbelliferae, *Cuminum* type, vitta, ×20.

of *Vaccinium myrtilus* (bilberry) are more likely to have come from fruit deliberately collected and eaten.

Woodland, grassland and wet pasture

Woodland plants are represented only in very small numbers. The very light wind-borne fruits of *Betula pubescens* (birch) could have come from nearby woodland; *Alnus* (alder) was also found. Nuts of *Corylus* (hazel), represented by small fragments and fruit of *Fragaria vesca* (wild strawberry), *Rubus fruticosus* agg (blackberry) and *R. idaeus* (raspberry) may have been gathered for food. *Linum catharticum* (purging flax, represented by two seeds, one with attached capsule valve, is a plant of dry grassland and heaths, perhaps its purgative properties were recognised by the Romans.

The number of grass grains found is surprisingly not very large; *Agrostis* spp (bent grass), *Deschampsia caespitosa* (tufted hair-grass), *Holcus lanatus* (yorkshire fog), *Poa* cf *pratensis* and *P.* cf *trivialis* (meadow grasses) are characteristic of low lying meadows and pastures sometimes cut for hay (Hubbard 1968, 28) although most of these species are not exclusive to this type of habitat. Fragments of leaves and leaf-like stipules of *Lathyrus pratensis* (meadow vetchling) and petals of cf *Trifolium repens* (white clover) are present in all samples, they may represent deliberate collection and are discussed on p 239.

Seeds of *Juncus* spp (rushes) are commonly found in persistent seeds banks; Salisbury (1961: 229) records about twenty seeds of *Juncus effusus* (soft rush) in each cubic inch of pasture soil. Other fruits and seeds found in the sewage levels and which remain dormant in soils include those of *Cirsium* and *Sonchus* sp (thistles) and *Rumex* spp (docks and sorrels) (Ødum 1978; Thompson & Grime 1979). It is possible that some of these plants may have grown around the ditch although this seems unlikely during the occupation.

Mosses which form large wefts are commonly represented; for example *Eurhynchium praelongum*, *Hylocomium spendens*, *Hypnum cupressiforme* and *Rhytidiadelphus squarrosus* are all common species which grow in damp woodland and grassland and are easily gathered in quantity. Large quantities of these and similar weft forming mosses have been found in medieval latrines; for example from Viking Dublin (Dickson, J H 1973: 233) and Bergen, Norway (Krzywinski 1979). From medieval Aberdeen eggs of the roundworm parasite *Trichuris* sp were found on leaves of *RhytidiadeIphus loreus*, another weft forming moss, by Miss M Fraser who concluded that this and other robust hypnoid mosses may have been used as toilet paper (Fraser 1981). No traces of the sponges usually associated with Roman latrines were found; sponge spicules of one or more species of marine sponges occurred in quantity in the Roman sewer at york (Buckland 1976a: 14): it seems plausible that these mosses which could be readily collected from the vicinity of the fort, should have been used instead. See Addendum D.

Aquatic, marsh and fen

Poorly preserved sedge nutlets, possibly referable to *Carex paniculata* (panicled sedge) were found in all samples. Other plants represented such as *Alopecurus* cf *geniculatus* (marsh foxtail), *Bidens cernua* (nodding bur-marigold), *Lycopus europaeus* (gypsy-wort), *Ranunculus flammula* (lesser spearwort) and *Rorippa palustris* (marsh yellow-cress) could have colonised the ditch sides during the occupation but this is unlikely because of the heavily polluted water. It is more probable that all these sparse remains represent plants which grew in the poorly drained marshy soils before the ditch was dug and their buried dormant seeds were washed in with clayey silt from the ditch sides.

Above the sewage levels, sample 480mm–500mm

No remains of cultivated plants and their associated weeds were found at this level, and plants of heath and bog are also strikingly absent.

Woodland, grassland and wet pasture

The only dry land plant commonly represented is the moss, *Eurhynchium praelongus*, a plant of shady places especially woodland, other mosses include *Hylocomium splendens* and *Hypnum cupressiforme* which could grow in grass and woodland. Occasional Gramineae (grass) fruits and a few seeds of *Cardamine flexuosa/hirsuta* (wood/hairy bittter-cress) were also found. The presence of *Sonchus asper* and *Cirsium* sp (thistles), rumex, sp (dock) and *Urtica dioica* (stinging nettle) suggests a weedy ditchside.

Aquatic, marsh and fen

Fruits and seeds of *Callitriche stagnalis* (starwort), *Lemna* cf *minor* (duckwood), batrachian *Ranunculus* (water crowfoot) and *R. sceleratus* (celery-leaved crowfoot), all plants which grow in shallow water or damp mud, are found in quantity. *Carex* cf *paniculata* (panicled sedge), represented by numerous nutlets, is usually a plant of base-rich soils; presumably the rich organic silty mud of the ditch formed a suitable habitat for it together with *Lychnis flos-cuculi* (ragged robin).

Closer sampling for pollen analysis (illus 13.1) reveals that the sewage layer extends upwards to 580mm. From 390mm to 500mm the more organic clay mud appears layered, showing that the ditch was undisturbed thus allowing the first stages of colonisation by aquatic and fen plants of the ditch bottom and sides. As described elsewhere, table 13.2 also shows that the process continued with trees and shrubs growing in and around the ditch.

13.2.2 Macroscopic plant remains from pollen samples

A pollen bearing sequence of deposits from all the ditches of a Roman occupation site is not usually available, therefore samples were examined for pollen wherever it seemed likely that pollen would be preserved. However the interpretation of such samples is problematical; pollen from the local ditch vegetation will be over-represented and therefore the regional pollen rain under-represented. At Bearsden this is likely to be further complicated by the pollen and spores adhering to plant remains deposited in the ditch by human activity, and those present in the sewage of the outer east annexe ditch.

To gain further knowledge of the local component of the ditches and the depression south of building 7, the sieved residues from the samples prepared for pollen analysis (each representing *c* 1cc of deposit) were examined. About 1cc was also taken from other levels where knowledge of the development of the local vegetation was needed for the interpretation of the pollen spectra. The results are set out in tables 13.1 and 13.2.

Outer East Annexe Ditch

ROMAN SEWAGE 580mm–1.80m

The small samples taken throughout the ditch confirm the homogeneity of the sewage layer. The large quantity of *Triticum/Secale* (wheat/rye) grain fragments consistently comprises about half of the organic fraction between 670mm and 1.67m. Leaves of *Calluna vulgaris* (heather), mostly burnt, are found in every sample from 550mm downwards. Also common throughout are very small fragments of charcoal, still sparsely present between 400mm and 590mm. *Erica cinerea* (bell-heather) is the only heathland plant not represented in the bulk samples. Present as small fragments in several samples are *Eriophorum vaginatum* (cotton-grass), *Pteridium aquilinum* (bracken) and *Sphagnum* spp (bog moss). Fern tracheids, which seem to be a particularly resistant part of the rachis and rhizone, are probably also those of bracken. Four non-aquatic grasses were identified; *Poa annua* (annual meadow-grass) is always associated with man-made habitats and well known for its resistance to trampling. *Bromus* sp (lop-grass or brome) is found only as grain fragments, together with *Agrostemma githago* (corn cockle) a cornfield weed and in this ditch found only where wheat/rye grain fragments are present. *Juncus* (rush) though present in nearly every sample as occasional seeds, as noted previously, may have been washed in with the silt.

Below about 590mm there is no certain evidence of plants actually growing in the ditch. This is to be expected due to the sewage polluting the water. The small size of the fragments of bracken, cotton-grass, heather, mosses and charcoal etc suggests that these are wind-borne fragments blown in from domestic use in the fort.

PLANT COLONISATION 280mm–580mm

From 550mm to 580mm rare seeds of *Cardamine pratensis* (lady's smock) and *Rorippa palustris* (marsh yellow-cress), both of which grow beside water, are found. Single grains of *Glyceria fluitans* (flote-grass) occur at 520mm, 530mm and 580mm and numerous grains of *Catabrosa aquatica* (water whorl-grass), now a rather rare species, were identified from 530mm and 550mm, both are plants of shallow water. The abundance of seeds of *Juncus conglomeratus/effusus* (soft rush) from 520mm upwards is most likely to represent the rushes growing on the muddy bottom of the ditch. Fruits of *Callitriche stagnalis* (starwort) from 530mm and *Ranunculus* subg *Batrachium* (water crowfoot) and *R. sceleratus* (celery-leaved crowfoot) from 500mm together with other ditch species from 480mm to 500mm listed in table 13.1 show the development of a varied flora in the shallow water and mud.

Rushes and a species of *Carex*, most probably *C. paniculata* (panicled sedge) were well established by 460mm. The tufted habit of *C. paniculata* would provide a habitat above the water level enabling an invasion of ferns, here represented by sporangia, to become established.

At the depth of 280mm to 340mm *Betula* cf *pubescens* (birch), *Corylus* (hazel) and *Salix* (willow) have invaded the ditch or its environs. It seems clear that after sewage from the annexe ceased to be deposited and the fort was abandoned the shallow water and mud were colonised by natural vegetation which soon led to the overgrowth of the ditch.

13.2.3 Outer east annexe ditch: pollen analyses

The interpretation of the larger plant remains shows that the Roman occupation is represented by the sewage and other infilling from about 580mm to 1.80m, the bottom of the ditch. It has also been shown that the deposits which overlie the sewage layer reflect the natural infilling of the ditch. Therefore a pollen series through this ditch should indicate the plant cover in the vicinity of the fort during and immediately after the occupation.

The striking feature of the six pollen analyses from 790mm to 1.8m of the sewage layer (illus 13.14) is their similarity. *Alnus* (alder) contributes *c* 25% of the total land pollen with Coryloid (mostly *Corylus* – hazel) under 20%; *Betula* (birch) ranges from 7 to 10%, *Quercus* (oak) 1–4%; *Pinus* (pine), *Ulmus* (elm), and *Salix* (willow) are also present. The presence in the ditch of charcoal and other remains of birch (fruit and catkin scale), and hazel (anther and nut fragments) show that the pollen represents local woodland as do alder (charcoal only) and willow (budscales) which would probably grow in damper areas such as around the Manse burn.

Gramineae (grasses), 26 to 31%, dominate the herbaceous pollen with about 8% *Calluna* (heather) pollen. *Plantago lanceolata* (ribwort plantain) 1–4%, is well known for its presence wherever man and animals modify the vegetation. There is a variety of other herbaceous pollen types, in small quantity, all suggesting open ground. There is very little pollen of annual weeds which would indicate arable fields. Rare cereal pollen of cf *Triticum* (wheat) was found in the sewage (microfiche) but this does not necessarily mean that cereals were grown nearby; the grains may well have been adhering to cereal grain pericarp or glume bases, as demonstrated by Robinson & Hubbard (1977: 198), which had passed through the gut. The occurrence of grains of *Malva sylvestris* (common mallow), present throughout the sewage and probably also digested has been discussed on p 232.

Some insect pollinated plants, with very local pollen dispersal, are limited to the sewage layer. They are *Lotus uliginosus* (pedunculatus) (large birdsfoot-trefoil) type. The small size of the pollen excludes *L. corniculatus* (microfiche), and on ecological grounds *L. uliginosus* is the most likely. *Trifolium repens* (white clover), flower petals were tentatively identified and they probably represent meadow hay, a possibility which is discussed on p 239.

Fern spores are present throughout the ditch and include those of *Pteridium* (bracken), frond fragments were also found in several samples. Spores of *Sphagnum* (bog moss) are similarly present in most samples and the leaves also occur sparsely throughout (table 13.1). Spores of Carboniferous age, derived

Table 13.2
East annexe ditch, macroscopic plant remains

			Depth from top of column in era Plant remains mainly from domestic use/plant growth in ditch																					
			Roman sewage														*Aquatic, marsh*						*Trees*	
			180	*167*	*147*	*120*	*96*	*89*	*79*	*76*	*73*	*70*	*67*	*64*	*61*	*58*	*55*	*53*	*52*	*50*	*46*	*40*	*34*	*28*
Cultivated plants and weeds																								
Agrostemma githago (Corn Cockle)	seed	F			+	+				+														
Bromus sp (Lop-grass or Brome)	pericarp	F		+	+	+				+	+		+											
Hordeum sp (Barley)	pericarp	F			+																			
Malva sylvestris (Common Mallow)	pollen cluster									+		+												
Triticum dicoccum/spelta (Emmer/Spelt Wheat)	glume base																							
Triticum/Secale (Wheat/Rye)	testa	F	+	++	++	++	++	++	++	++	++	++	++	+	+	+								
Heath land and bog																								
Calluna vulgaris (Heather)	leaf		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+					
Erica cinerea (Bell-heather)	seed												+											
E. tetralix (Cross-leaved Heath)	leaf									+														
Eriophorum vaginatum (Cotton-grass)	leaf/stem		+	+			+	+																
Pteridium aquilinum (Bracken)	frond	F		+	+					+	+	+				+								
Sphagnum cf *palustre* (Bog Moss)	leaf									+				+		+								
S. papillosum (Bog Moss)	leaf												+											
S. subg *Litophloea* (Bog Moss)	leaf						+	+	+															
Woodland, grassland and wet pasture																								
Cf *Agrostis* sp (Bent-grass)	grain															+								
Betula cf *pubescens* (Birch)	fruit, leaf	F																				+	+	+
B. pubescens/pendula (Birch/Silver Birch)	anther																						+	
Cardamine flexuosa/hirsuta (Wood/ Hairy Bitter-cress)	seed														+	+				+				
C. pratensis (Lady's Smock)	seed															+								
Corylus avellana (Hazel)	nut																							+
Eurhynchium praelongum (Moss)	leafy stem									+			+	+										
Filicales (Fern)	sporangium																						+	+
Cf Filicales (Fern)	tracheid		+	+			+									+								

Table 13.2 (continued)

			Depth from top of column in era *Plant remains mainly from domestic use/plant growth in ditch*																					
			Roman sewage														*aquatic, marsh*						*trees*	
			180	*167*	*147*	*120*	*96*	*89*	*79*	*76*	*73*	*70*	*67*	*64*	*61*	*58*	*55*	*53*	*52*	*50*	*46*	*40*	*34*	*28*
Cultivated plants and weeds																								
Galium sp (Bedstraw)	fruit																			+				
Gramineae (Grass)	grain			+							+			+	+	+								
Hylocomium splendens (Moss)	leafy stem												+			+								
Juncus bufonius (Toad Rush)	seed							+																
J. effusus/conglomeratus (Soft Rush)	seed		+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	++	++	+	++	++	+
Phleum cf *pratense* (Timothy Grass)	grain														+									
Poa annua (Annual Meadow-grass)	grain				+										+									
Polytrichum commune (Hair Moss)	leaf															+								
Potentilla sp (Cinquefoil/Tormentil)	achene												+											
Ranunculus sect *Ranunculus* (Buttercup)	achene						+																	
Rhytidiadelphus squarrosus (Moss)	leaf									+						+								
Rumex sp (Dock or Sorrel)	nut, perianth															+								
Salix sp (Willow)	wood																						+	+
cf *Trifolium repens* (White Clover)	petal	F			+																			
Aquatic, marsh and fen																								
Callitriche stagnalis (Starwort)	fruit																	+	+	+				
Carex sp (Sedge)	nut																		+		+	++	+	
Catabrosa aquatica (Water Whorl-grass)	grain																++	+						
Glyceria fluitans (Flote-grass)	grain							+								+		+	+					
Lychnis flos-cuculi (Ragged Robin)	seed																					+	+	
Ranunculus subg *Batrachium* (Water Crowfoot)	achene																				+			
R. sceleratus (Celery-leaved Crowfoot)	achene																			+		+		
Rorippa palustris (Marsh Yellow-cress)	seed															+	+							
Miscellaneous																								
Unidentified	seed											+												
Unidentified	charcoal <3mm		++	++	++	++	++	++	++	++	++	+	+	+	++	+	+		+	+				

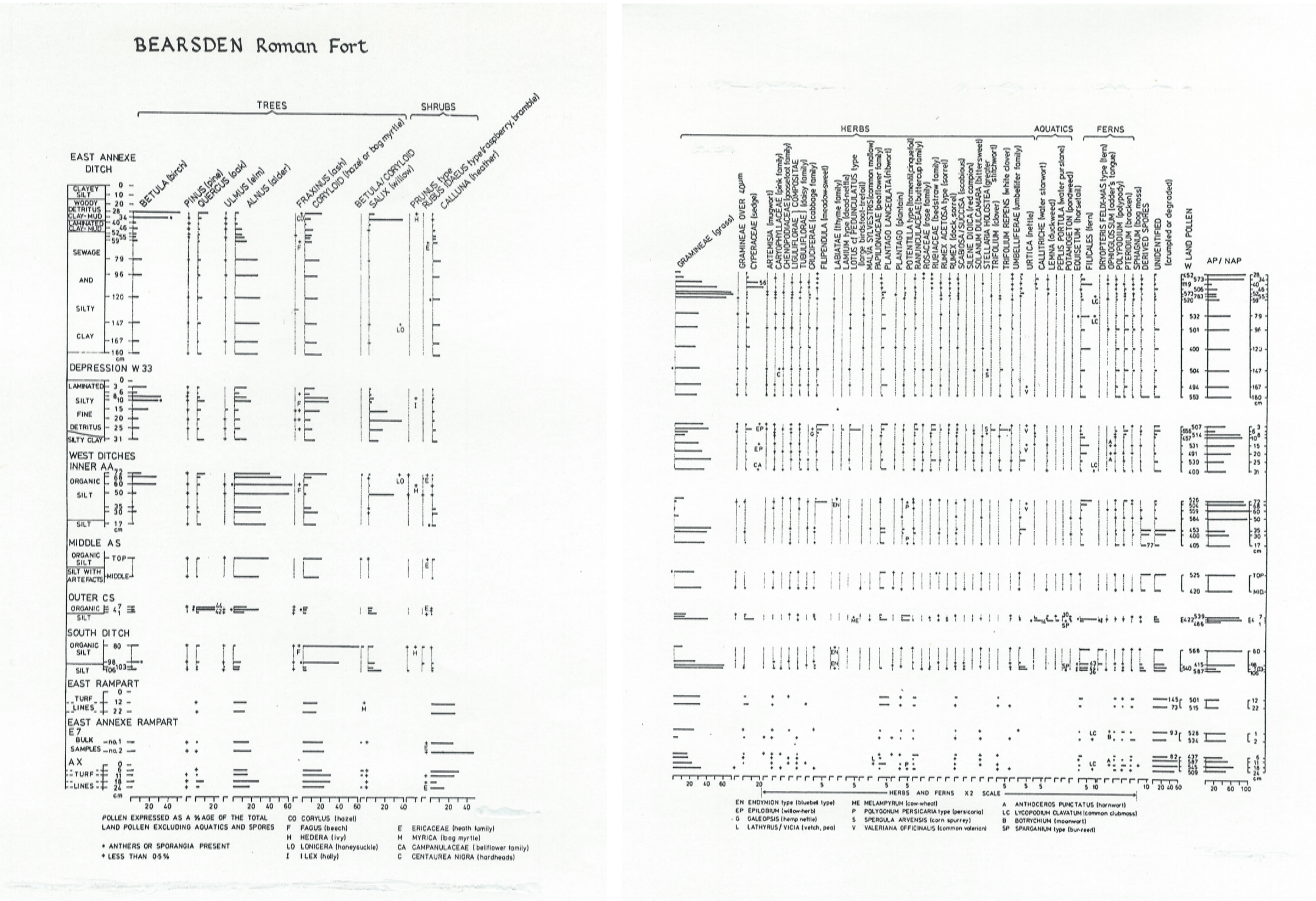

Illustration 13.4
Pollen diagram.

from the clay, appear throughout the ditch and are, appropriately, most common at 1.8m where the sample is largely of clay.

The samples from 590mm upwards, that is at the top of the sewage layer, reflect the development of the local vegetation, the nature of which has been reconstructed from the macroscopic remains listed in tables 13.1 and 13.2.

The spectacular increase in grass pollen from 400mm to 590mm coincides from 530mm to 590mm with the presence of aquatic grasses in the ditch (table 13.1) and fruit of non-aquatic grasses are also found in the sample from 480mm to 500mm (table 13.2).

Aquatic vegetation, probably in shallow water or mud, is shown by the pollen and seeds of *Lemna* (duckweed) and pollen and fruits of *Callitriche* (starwort) from 530mm to 380mm. A steep rise in Cyperaceae pollen between 400mm and 460mm coincides with abundant nutlets of *Carex* cf *paniculata* (panicled sedge). A rise of fern spores at 400mm suggests that the surface is drying out. Increases of herbaceous pollen between 460mm and 590mm, such as Caryophyllaceae, Compositae, Cruciferae, Ranunculaceae, Rubiaceae, *Rumex* spp and *Urtica* may all reflect plants growing in and around the ditch since fruits and seeds referable to these genera and families have been found at these levels.

Samples from the woody detritus mud at 280mm and 340mm show a rise in birch and willow pollen, their probable local over-representation, is attested by their larger plant remains; at 280mm the arboreal pollen rises to over 80% of the total land pollen. This has probably depressed the true values of the other pollen such as grasses and herbs and may only represent local tree growth over the deserted fort.

13.2.4 Origin of cultivated plants and the evidence for hay

The cereal fragments preserved in the outer east annexe ditch are those of the bran component of the grain, that is the indigestible grain wall. As already shown from the description of the plant remains from the outer east annexe ditch, the ditch infilling originates from a number of different sources. Although the overwhelmingly large contribution of the ground up fragments of wheat/rye grains shows the sewage to be of human origin, we must also consider possible evidence of horse droppings finding their way into the open sewer. The contents of four horse turds from a late second-century Roman well at Lancaster, England have been examined by Wilson (Wilson, D G 1979) together with 1500ml of possible stable litter found with them. Over a hundred plant species are represented from the five samples including large fragments of and whole uncarbonised cereal grains. These are predominantly of *Hordeum vulgare* (barley), 23 grains and many probable fragments, with *Avena sativa* (oats), five grains, *Secale cereals* (rye), three grains, *Triticum* sp, one grain and *T.* cf *spelta* (spelt), and nine glume bases. Leguminous plants are represented by petals, calyces, pods, bracts/stipules, tendrils and immature seeds. *Trifolium pratense* (red clover) and *Vicia* cf *sepium* (bush vetch) have been identified among the several taxa represented. Included in the species-rich stable litter are two fruits of *Apium graveolens* (wild celery), five fruits of *Coriandrum sativum* (coriander) and one achene of *Ficus carica* (fig). Many plants from arable fields, grassland, fens and heath are also represented in the litter. Some species from all these ecological groups are also present in the turds and all samples contain abundant monocotyledon leaf and stem fragments. Wilson (ibid) suggests that the horses ate plants from mature pastureland and were fed forage from a mixed unripe leguminous crop either as fresh or dried fodder; she also notes that 'Pollux (1, 183), in the second century, said that horses were fed on barley, spelt, oats, grass and hay', all of which are present in the Lancaster samples. We may assume then that the cereal and hay remains from Lancaster are probably typical of the food given to horses in the Roman cavalry.

Many of the plants listed are also present at Bearsden; could dispersed turds and stable litter be contributing to the plant remains from the annexe ditch? If turds are present in the sewage whole or partly chewed cereal grains would be present, but no whole grains and very few half grains of wheat, barley or oats have been found. Furthermore barley and oat grain fragments are only present in very small numbers; the vast majority of the cereal remains are of small fragments of ground wheat/rye grains. Similarly flowers, pods and immature seeds of legumes should be preserved but we have only occasional incomplete petals of cf *Trifolium repens* (white clover), broken leaves/stipules of *Lathyrus pratensis* (meadow vetchling) and pollen of *Lotus uliginosus* (*pedunculatus*) type (large birdsfoot-trefoil) representing leguminous plants, apart from the rare tiny cf *Vicia* spp (field beam, vetch) seed fragments which are considered to be digested remains. Although these plants could represent fodder from turds, the fragmentary nature of the remains suggests that they are wind blown fragments of meadow hay, presumably from hay used in the fort. If turds are absent or very rarely present then an abundance of stable litter would be equally unlikely. It is worthy of note that straw and plants used for animal bedding were particularly searched for; monocotyledon stems and bracken were present but only as small fragments.

It is appropriate now to consider the positive evidence for animal fodder. As already mentioned petals of white clover have been tentatively, and the pollen more certainly, identified. Petals were found in small quantity throughout the sewage layer and also in the Roman levels of the depression within the fort, south of building 7, and in two of the west ditches, notably confined to the occupational parts of the deposits. White clover is one of the most nutritious of pasture plants. *Lotus uliginosus* (large birdsfoot-trefoil) type pollen is present in the sewage levels and in the depression; *L. uliginosus* is grown for fodder in the USA. Because of insect pollination, little or no Leguminosae pollen is dispersed aerially and therefore the discovery of *Lotus* pollen in several samples indicates either immediately local growth or derivation from hay. When well grown, often in damp areas of meadow or pasture, they could be gathered in quantity together with grasses, represented in the ditches by pollen and occasional fruit and other plants such as *Filipendula* (meadowsweet), also insect pollinated, with pollen present in the ditch. Legumes and grasses would provide adequate food for grazing animals even if cereals were not available. Meadow or bog hay was, of course, one of the traditional sources of fodder before hay fields were deliberately seeded and managed.

The sewage from the outer east annexe ditch represents only the indigestible, mainly cellulose, part of the soldiers' diet. It is unlikely that either cheese and bacon, the staple foods together with corn, of the Roman military diet (Davies 1971: 125), or roots and green vegetables would leave visible traces in the sewage. However from studies of coprolites in America (Callen 1969) and preliminary studies in Scotland by the authors, it could be expected that from a predominantly meat diet, hair and bone fragments and from fish, scales and vertebrae would be preserved. Very small rare bone fragments only, some burnt, were recovered from 1.48m to 1.5m and unpublished levels and also between 200mm and 230mm (Roman levels) in the inner west ditch. The lack of animal remains together with positive biochemical evidence (Knights et al 1983) suggest that plant food may have formed the main part of the soldiers' meals. Although it seems highly likely that some of the food used for flavouring and possible medicinal use was imported from the Mediterranean region, the source of the wheat is less clear. Wheat is only rarely reported from native sources in Scotland during this period. As already stated emmer has only been found in quantity from one pre-Roman Iron Age site, on the Clyde estuary some 10km to the west of Bearsden, bread wheat finds are rare and spelt is so far unrecorded from Iron Age sites in Scotland. Wheat, including emmer and spelt, and other cereals have been grown experimentally at Bearsden for some years (Dr A M M Berrie, pers comm). All need artificial drainage of the predominantly heavy soils of the area. *Hordeum vulgare* (six-row barley) is by far the commonest crop grown throughout Scotland during the Iron Age. There is evidence of barley processing at a broch some 23km to the north of Bearsden (Boyd 1983) occupied during the first and second centuries.

If the grain was not all grown in western Scotland there are various possible sources. The south-west of Scotland has a milder climate and the drainage problems could be overcome by cultivating fertile and freely draining coastal land. The drier east side is also possible or the traditional cornlands of England.

However, as pointed out by Manning (1975a), the Romans preferred, when at all possible, to use local supplies of grain. Long journeys overland would be particularly consuming in time and manpower, and, as also stated by Manning, the grain would need to be distributed between the harvest and the winter. Part of the supplies to the northern forts, notably figs and spices, must have come by ship from the Mediterranean.

Harbours would presumably exist beyond Old Kilpatrick on the River Clyde to the west and at or near Bo'ness on the Forth to the east end of the Wall. It is probable that grain also came by ship. Mallow, possibly a prophylactic, and represented only by pollen, could have been brought and grown in the environs of the fort. Certainly mallow seems unlikely to have grown in quantity naturally and disappeared coincidentally with the end of the occupation as is suggested by the pollen evidence.

The question of the legume seeds is intriguing; although there are no records in Scotland of horse beans being grown by the native population, it is not so improbable since there is evidence of their use in England at this period (they are grown in Scotland for fodder at the present time). There are records of eleven amphorae of beans transported for the Roman troops in Europe. If the very tentative identification is correct and lentils are present they must have been imported and possibly the seed of the common vetch, equally tentatively identified, also. Many different legumes are grown in the Mediterranean region at the present time, though now mainly for fodder.

Fruit which was certainly gathered locally includes blackberry, raspberry, bilberry and wild strawberry, all of which still grow within a few kilometres of the fort.

13.2.5 Processing the crops

From comparison with other military sites we may conclude that emmer and spelt wheats and hulled barley were the cereals most commonly used by the Roman military, and these have been tentatively identified from Bearsden. These cereals would be turned into bread, porridge and soup (Davies 1971: 125) to provide the staple army foods. This knowledge raises the question of how and where the grain was processed and were the three cereals used for different purposes. By attempting archaic processing and then cooking the wheat and barley some answers to these questions may be tentatively given.

Wheat processing and cooking

How much of the processing would be carried out at the fort? Hillman (1981: 142) in his reconstruction of crop husbandry practices, states that 'in wet areas consumer settlements usually buy in glume wheat grain in the form of spikelets' as the grain of glume wheats is less likely to sprout if stored as spikelets rather than naked grain. The wheat spikelets would need to be parched to make them brittle enough to separate the grain from the persistent glumes, and spikelets have been found in Roman ovens (Hillman 1981: 154). It is notable that a kiln was found at the end of a granary at Balmuildy (Miller 1922: 27), the neighbouring fort to the east of Bearsden.

Once parched the grain is usually pounded or ground before cooking. Emmer and spelt are both hard grained wheats, but emmer grains are especially hard and flinty or semi-flinty and therefore more suitable for groats than for meal or flour. The bran layers of emmer are thinner than those of most other wheats producing smoother texture semi-liquid foods such as porridge.

The first century Romans made groats (allicia) from emmer (far) using wooden mortars (Pliny 18, 29). In Italy these groats were used to make porridge (*puls*), the staple food before bread wheat became widely available. Archaic methods of crop processing are still practised in eastern Turkey (Hillman 1981: 155; Hillman 1984: 135–40) where emmer wheat is preferred to macaroni wheat (*Triticum durum*) for bulgar (groats) because of its superior flavour and texture. Wooden mortars and mallets are favoured; to break up the spikelets a strongly curved narrow parabolic inside surface is more effective (Hillman 1984: 140) and a deep mortar prevents the spikelets escaping. However, an adjustable rotary quern, with the upper stone set high to give a clearance of two to three mm, is sometimes used to break up the spikelets and break the kernels into fragments.

By the second century hand querns had become part of the Roman army's equipment; quern stones found at the Antonine Wall forts are of the adjustable type with a perforated lower stone. The adjustable mechanism is described by Fenton (1978: 392–3) and Moritz (1958: 118–19).

Using emmer and spelt wheats grown in the south of England in 1985/86 both types of traditional processing were followed so far as was practical with small quantities of grain; this is summarised in illus 13.5. The grain was first parched at *c* 90°C (high temperatures could impair the leavening action). A wooden pestle and mortar were used. Traditionally, in Turkey, the spikelets are broken and the grain cracked in separate operations (Hillman 1984: 144–5) but it was easier to break up the glumes and the grain together by gentle pounding in this small scale processing. Loose querning proved impractical with the available well-worn rotary quern of garnetiferous schist and the Scottish practice (of grinding barley for meal with the husks still on) with the upper quern stone lowered was adopted (Fenton 1978: 392). It was found necessary to grind some of the corn twice in order to reduce all the grain to groats. This was also the experience of Moritz and Jones (1950) using a Romano-British quern to make flour from bread wheat. After pouring or grinding the four samples were winnowed ready for sieving.

In Turkey the sieves have a mesh of strands of scraped leather and 'the mesh dimensions are woven so that the holes are fractionally smaller than the smallest of the properly formed "prime" emmer grains' (Hillman 1984: 131). In Scotland a sheepskin stretched on a frame with holes pierced by a hot wire was traditionally used (Fenton 1978: 393); calfskin was similarly employed. Fortunately a domestic colander proved to have holes of a suitable size (3mm diameter) just to prevent the passage of whole grains of both emmer and spelt but to allow most of the groats to pass through. Arable weed seeds such as the rather large ones of corncockle (*Agrostemma*) also passed through as fragments, as appears to have been the case at Bearsden. In all four samples the resultant groats ranged from about 0.5mm to 3.0mm (4.0mm) × 0.5mm to 1.5mm (2.0mm) mm thick with a varying admixture of finer mealy particles. The four samples were passed, in turn, through a 0.5mm aperture sieve, which caught most of the groats with adherent bran, in order to estimate the finer mainly non-branny groats or meal in each sample. Gentle pounding in a mortar produced mainly groats from the emmer whereas about a tenth of the spelt was of meal-sized particles. Harder pounding would have produced more meal from each. After grinding through the quern about a sixth of the emmer was reduced to meal and a quarter of the spelt. The largely flinty groats of the ground emmer can be compared with the more mealy ones of the spelt (illus 13.5, e and f). A more efficient rotary quern would produce a more mealy product. The Roman army generally used stones of imported larva incised with radial grooves to regulate the passage of corn through the quern.

Another difference between emmer and spelt was that glume bases and rachis segments were particularly evident in the two sieved emmer samples but rather rare and generally broken and unrecognisable in those of spelt. It seems that spelt glumes are tougher as well as broader, some were found intact on top of the sieve, whereas glumes of emmer were usually broken and therefore more glume bases passed through the sieve. Similarly sieved spelt rachis segments were broken and uncommon whereas those of emmer were largely intact and plentiful.

The next step was to see if the different qualities of emmer and spelt grains led to differences in flavour and texture when cooked as porridge and bread. From the pounded groats a palatable porridge was produced after about 30 minutes simmering in water (comparable to the time needed to cook oatmeal porridge). The emmer porridge had a finer texture than that of spelt due to the thinner bran coats.

Many methods of breadmaking exist and the literature for traditional breadmaking is cited by Hillman (1985). The aim here was to discover the different baking qualities of emmer and spelt wheats not necessarily to produce a Roman type loaf. Several types of leavening were known to the Romans (Pliny 18, 12; 26), but for convenience dried yeast was used to make a leavened loaf from 100g each of the ground wheats adding salt and yeast, proving, and oven baking for 20 minutes at 220°C. The difference between the loaves can be seen on illus 13.5, i. The spelt loaf rose appreciably more than the emmer one and resembled a home baked loaf of strong wholemeal bread flour whereas the emmer bread was browner, heavier and rather sour tasting. A barley loaf, made from quern ground barley meal failed to rise at all due to the lack of gluten. Barley bread is traditionally made in Scotland as a flat thin bread (bannock) cooked on a hot griddle (girdle). Barley was normally given to soldiers as a punishment (Davies 1971: 140).

To compare the bran from the porridge and bread with that from the sewage, the starch etc was removed by heating with 5% hydrochloric or sulphuric acid for a few minutes (Dickson, C 1987a). Unfortunately it does not seem possible to distinguish visually the bran fragments obtained from the porridge from those from the bread by size or shape, both resemble the bran from the sewage. An example of ground bran of both emmer and spelt is shown for comparison with that from the sewage in illus 13.5, e, f and j. Microscopical examination of the cross cells of the bran pericarp showed considerable degradation in those of emmer and spelt following both cooking methods. Pounding or grinding, simmering or baking followed by digestion, excretion and many centuries in a water-logged deposit all take their roll until, in most cases, the diagnostic cross cells disappear and the fossil wheat bran becomes indistinguishable from that of rye. However, as the experimental processing has shown, it seems probable that emmer glume bases and rachis segments are more likely to be found with the bran than is the case with spelt. If well enough preserved they may be identifiable as is discussed on p 277.

It is of considerable interest that the fragment size of the fossil bran, up to 4mm by 3mm, is similar to that of the sieved emmer and spelt. We can assume from this that the Bearsden Romans probably sieved the broken grain only through a 3mm diameter aperture. Although the Romans were capable of drawing off various grades down to a fine white flour using a sieve of 0.2mm aperture (Moritz & Jones 1950; Moritz 1958: 180–1), this would entail several more grindings and sievings to remove the bran and such bran-free flour would leave no trace in the fossil record.

Although visually we cannot discern the cooking method or methods from the fossil bran (but see p 279), we may draw other conclusions from this limited small scale processing. Firstly, that emmer makes the best groats for porridge, especially if lightly pounded in a mortar, and secondly that spelt, ground in a quern, makes the better bread. This conclusion is strengthened by our rather limited knowledge of traditional grain cooking. Emmer has been the preferred wheat grain for porridge at least from ancient Rome up to the present day. Moritz (1958: 148), summarising classical sources, states that it was unusual to make bread from emmer groats. Spelt is said to be good for cakes and pastries (Percival 1921: 327) and is still used for bread making at one bakery in southern Germany and considered a delicacy (Jones, M in Hillman 1984). There is, of course, a considerable diversity in the products which can be made primarily from wheat (Hillman 1984; 1985); however few of them are made from ground or pounded hard wheats. It is not known whether emmer and spelt were always grown as single crops. Most carbonised grain from Roman military sites is found mixed. However an almost pure collection of spelt from a pit at the Roman military site of Welzheim, Germany, suggests that in some cases at least crops were grown and transported separately (there is evidence that the grain was processed but not grown there, Körber-Grohne et al 1983). See Addendum E.

Barley processing and cooking

As noted earlier in this paper the very occasional ground up barley fragments probably represent a residual weed in the wheat crop. However there are a few barley grain fragments which have an entirely different much degraded appearance as can be seen on Illus 13.5, i and j. Both types of barley remains and the probable processing which resulted in the degraded barley are described on microfiche. The degraded barley resembles pearl or pot barley which has been cooked for some three or four hours, and was probably used to thicken soup then as now. The use of pearl barley for broth and barley water was well known to both Greeks and Romans (Pliny 22, 66).

Evidence for food processing from utensils found at Antonine Wall forts

If we assume that emmer and spelt were processed separately how was this achieved? Many adjustable rotary querns exist but deep wooden mortars have so far not been recognised and deep stone ones are rare. It is quite possible that all the wheat was ground with the ubiquitous querns. The upper stones would need to be raised for emmer to produce largely meal-fee groats for porridge and lowered for spelt processing to give a more mealy product suitable for breadmaking.

‘Remnants of three great mortars’ were found at the Antonine fort at Bar Hill and are figured by Macdonald and Park (1906: 89, fig 32), presumably the same mortars described by Robertson et al (1975: 45) as ‘made of local buff sandstone external diameter 1ft 1in’ (32cm). The mortar fragments shown in the photograph strongly resemble pieces of ‘knocking stones’, traditionally used in Scotland for dehusking and pearling barley.

The high proportion of barley found at Roman forts suggests other uses besides pearl barley (which the visual evidence suggests formed only a small proportion of the cereal diet). Although at cavalry forts horses would have been fed barley and other cereals it is possible that celtic beer, the barley-based drink, was also made by the Romans. After malting the barley would be loose querned as described by Fenton (1978: 394) a process requiring an adjustable quern.

The shallow pottery mortaria, so commonly found on Roman sites, are not suitable for the pounding of grain for groats. They would be used to grind herbs and spices as is frequently instructed in the recipes of Apicius (Edwards 1984); the ground fragments of coriander from the sewage indicate such a use.

It is highly probable that perforated pottery vessels, found at two of the forts, were used as cheese presses.

13.3 DEPRESSION SOUTH OF BUILDING 7

13.3.1 Macroscopic plant remains

A seemingly natural depression within the fort, north of the Military Way, extends under the east rampart, therefore its formation must pre-date the building of the fort. The stratigraphy shows that it remained open during the Roman occupation.

A column, about 400mm long × 150mm × 100mm, was taken through the organic deposits and the underlying clay. The stratigraphy is as follows:

0–130mm	clayey silt with layers of detritus, birch bark and a little sand.
130mm–160mm	as above but not layered.
160mm–260mm	clayey silt with layers of detritus, leafy layer from 190mm to 220mm.
260mm–270mm	grey silty clay.
270mm–290mm	clayey silt with layers of leafy detritus.
290mm–400mm	grey silty clay with a layer of detritus at 310mm.
40mm–downwards	transition to pinkish clay.

Contiguous samples of approximately 1cc were examined throughout the organic silts and silty clay to detect any short lived changes in the vegetation during and after the Roman occupation. Larger samples were examined from 30mm to 80mm, 130mm to 160mm, 190mm to 220mm, 300mm to 330mm, 330mm to 350mm and 350mm to 370mm. Samples from adjacent levels containing similar remains have been grouped together (table 28). The organic sediments appear conformable with the top of the silty clay. Epidermal fragments of *Cyperaceae* (sedges) and other plants are found in the silty clay and throughout the organic layers.

Grey silty clay, 300mm–370mm

CULT IVATED PLANTS AND WEEDS

Rare bran fragments of *Triticum/Secale* (wheat/rye) and *Bromus* (lop-grass or brome) were found only in the grey silty clay beneath the organic infilling of the depression. The bran fragments are similar to those found in quantity in the outer east annexe ditch but it need not necessarily be assumed that those in the depression also result from sewage. The depression is not far from a granary and living quarters. Fragments of the hand ground corn would

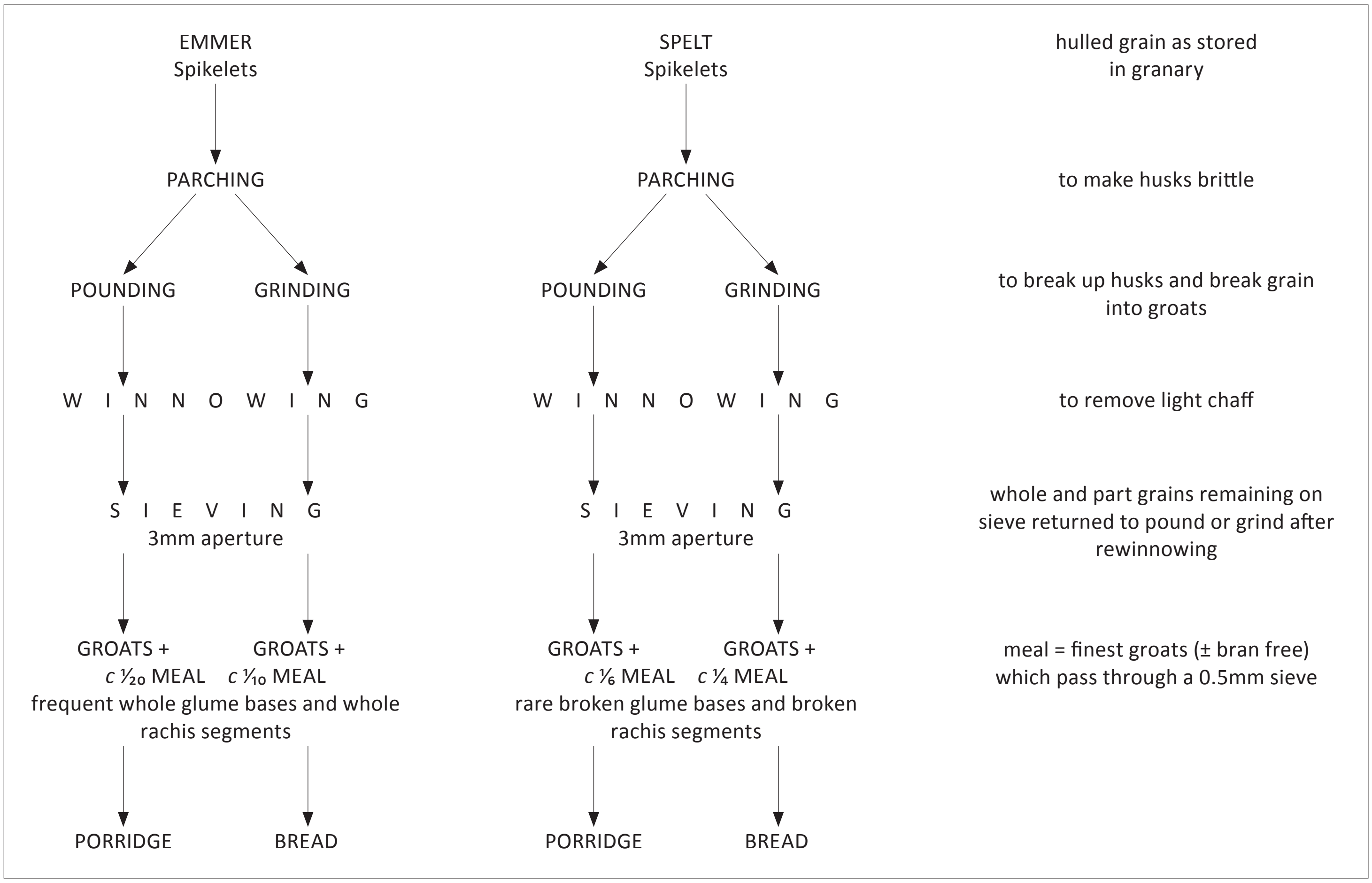

Illustration 13.5
Experimental grain processing of emmer and spelt wheats to compare with bran from Roman sewage.

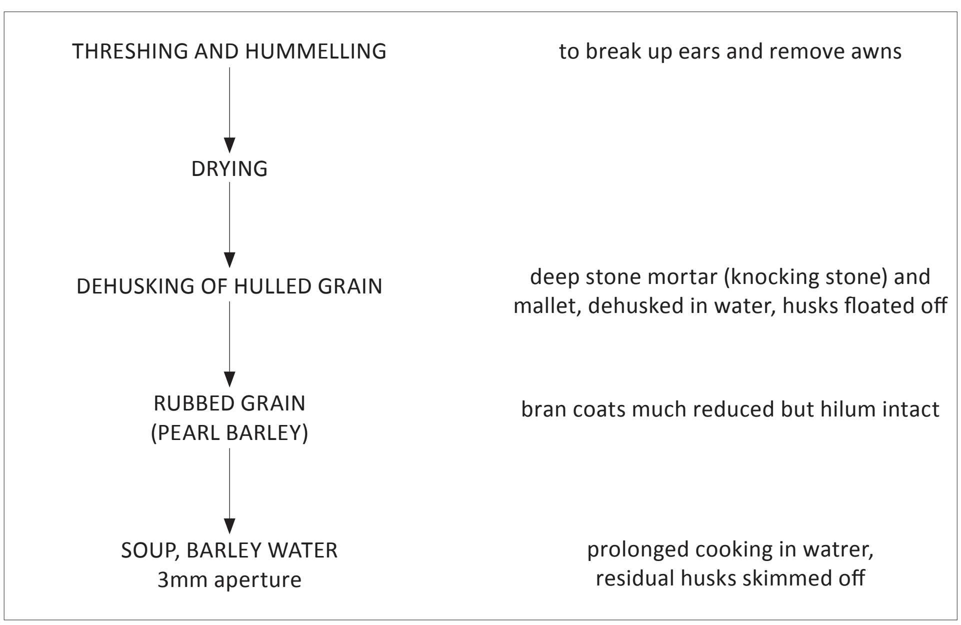

Illustration 13.6
Traditional Scottish processing of hulled six-row barley for pearl (pot) barley.

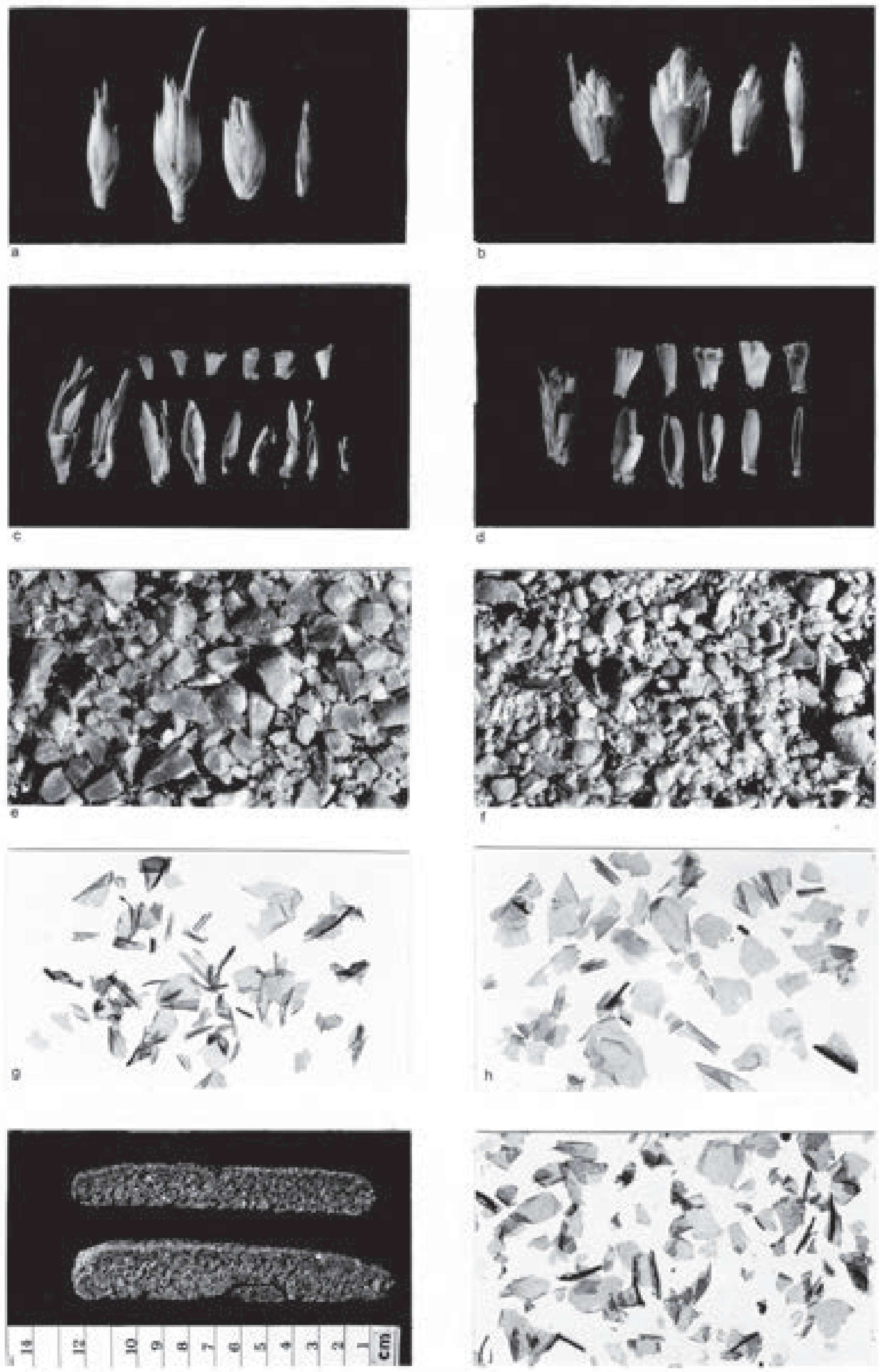

Illustration 13.7

Cereal processing.

Key: (a) *Triticum dicoccum*, spikelets, ×1.3; (b) *T. spelta*, spikelets, ×1.3; (c) *T. dicoccum*, glumes and rachis segments after grinding spikelets in rotary quern, ×1.3; (d) *T. spelta*, glumes and rachis segments after similar grinding, ×1.3; (e) *T. dicoccum*, resultant groats, passed through 3mm sieve, ×2; (f) *T. spelta*, resultant groats, passed through 3mm sieve, ×2; (g) *T. dicoccum*, bran from groats, ×2; (h) *T. spelta*, bran from groats, ×2; (i) Upper, *T, dicoccum* (emmer), bread; lower, *T. spelta* (spelt), bread; (j) Bran from sewage, ×2.

blow around the fort and become incorporated in the sediments of the depression.

HEATHLAND AND BOG

Also restricted to the silty clay are rare burnt fragments of *Calluna* (heather) and *Eriophorum vaginatum* (cotton-grass). Rare leaves of *Sphagnum* (bog moss) are also present. It seems probable that these sparse remains, also represented in the outer east annexe ditch, have blown in from use in the fort.

WOODLAND, GRASSLAND AND WET PASTURE

The sparse remains of cf *Trifolium repens* (white clover), petal fragments, and the mosses *Hylocomium splendens*, *Hypnum cupressiforme* and *Polytrichum commune* are also restricted to the clay, the possible use of similar plant fragments has also been discussed previously. Single fruits and seeds of *Epilobium* cf *obscurum* (dull-leaved willow-herb), *Rumex acetosella* (sheep's sorrel) and *Urtica dioica* (stinging nettle) are also confined to the silty clay. Perhaps these established themselves in organic mud thrown out of the depression during a cleaning operation. Their pollen in the succeeding layers suggests a continuance of suitable habitats.

The sparse remains in the silty clay include fragments of *Salix* sp (willow), and aquatic and fen plants. Well represented in the organic layers, these plants are discussed in the following paragraphs.

An intercalation of silty clay from 260mm to 270mm which had presumably slipped in from the side, also contained sparse plant debris.

Organic silt layers, 0–290mm

No remains of either cultivated plants and their associated weeds or heathland and bog plants were identified from these layers.

WOODLAND, GRASSLAND AND WET PASTURE

The base of the organic deposit from 280mm to 290mm yielded several leaf fragments of *Salix repens* (creeping willow) and two fruits of a *Salix* sp. From 190mm to 220mm a layer of leaves of *Salix repens* was also recovered and a 40mm long piece of willow wood at 140mm, most of the tiny wood fragments found throughout the profile could be those of willow. Willow bud scales and tiny epidermal fragments of *Salix* leaves were identified from 100mm to 180mm; it is possible that all these remains are of *Salix repens*, the basal cells of the hairs are similar to those of the creeping willow. It is unlikely that this quantity of willows remains had blown in from outside the fort; however if the underground creeping rhizomes were left in the ground when it was cleared for building, when conditions were favourable this low creeping willow could rapidly regenerate and recolonise the ground beside or in the depression. *S. repens*, a dwarf shrub, is characteristic of hollows and basins where drainage water collects especially on acid soils (Gimingham 1964: 266). It is notable that although *Calluna* and *Erica tetralix* can grow in similar situations their remains were not found above the silty clay.

Occasional fruits and rare leaf fragments of birch were recovered from the base of the organic deposits from 280mm to 290mm and from 100mm to 200mm, fragments of birch bark only a few mm in diameter are present in well defined layers in the top 160mm. *Rubus fruticosus* (blackberry), tentatively identified, and *Rubus idaeus* (raspberry) are present between 130mm and 220mm; they have been noted in both Roman and post-Roman contexts elsewhere in the fort.

Grains of non-aquatic grasses are only sparsely represented. Rare fragments of sedges are found throughout the organic sites. A few fragments of burnt rushes occur at 260mm and between 290mm and 350mm perhaps resulting from use in the fort. Seeds of rushes are common from 280mm upwards, which suggests that the sides of the depression or adjacent damp ground was soon colonised with vegetation.

The mosses are all shade tolerant species, and shady ditch sides, old cobble paving and nearby tree trunks could have provided suitable habitats.

AQUATIC, MARSH AND FEN

Fruits of *Calitriche stagnalis* (starwort) from 230mm to 260mm and seeds of *Lemna* cf *minor* (duckweed) from 130mm to 160mm and 230mm to 260mm indicate shallow water or damp mud as does *Glyceria fluitans* (flote-grass), some grains of the latter are eroded down to the transparent layer of the pericarp, grains of this aquatic grass were found from 10mm to 160mm. A single fruit of *Eleocharis palustris* (common spike-rush) was found between 190mm and 220mm.

MISCELLANEOUS

Charcoal, mostly fragments under 2mm diameter, is only occasionally found in the silty clay, becoming very rare from about 200mm upwards. Rare tiny fragments such as these might well have blown from fires some distance away.

The restriction of the plant fragments associated with Roman domestic use to the silty clay suggests that the depression was cleaned out during the Roman occupation. However, the succeeding organic silty infilling incorporates the remains of plants which could all have grown in and around the depression. Aquatic or semi-aquatic species persist throughout which suggests that drainage water, from the surrounding higher ground, prevented the depression drying out as plant detritus and silt accumulated. It may be that continued wetness prevented trees colonising the depression although rare birch fruits from 220mm upwards show that the tree was growing in the vicinity.

It seems reasonable to assume that the organic silts are post-occupation and the pollen should therefore reflect any changes in the vegetation around the fort after it was abandoned.

13.3.2 Pollen analysis

Pollen analyses were made throughout the organic silts which accumulated in the depression (illus 3.2.28). The analysis at 310mm is from a 10mm thick streak of organic silt within the bottom silty clay shown from the larger plant remains to contain plants used in the fort. As can be seen in the pollen diagram this single sample is very similar to those of the sewage layer of the outer east annexe ditch, apart from the *Salix* (10% of total pollen), most probably that of *S. repens* (creeping willow), represented in the larger plant remains. The presence of the insect pollinated

Table 13.3
Macroscopic plant remains in the depression within the fort

			Depth from top of column in cm										
			Roman			*post-Roman*							
			C	*C*	*C+D*	*D*	*C*	*D*	*D*	*D*	*D*	*D*	*D*
			35–7	*32–5*	*29–32*	*27–9*	*26–7*	*22–6*	*18–22*	*16–18*	*12–16*	*9–12*	*1–9*
Cultivated plants and weeds													
Bromus sp (Lop-grass or Brome)	pericarp	F	+										
Triticum/*Secale* (Wheat/Rye)	testa	F	+	+	+								
Heathland and bog													
Calluna vulgaris (Heather)	leaf		+	+	+								
Erica tetralix (Cross-leaved Heath)	leaf			+									
Eriophorum vaginatum (Cotton-grass)	leaf/stem				+								
Sphagnum subg Inophloea (Bog Moss)	leaf				+								
Sphagnum subg Litophloea (Bog Moss)	leaf		+	+	+								
Sphagnum undiff (Bog Moss)	leaf						+						
Woodland, grassland and wet pasture													
Agrostis sp (Bent-grass)	grain				+								
Amblystegium serpens (Moss)	leafy stem					+							
Antitrichia curtipendula (Moss)	leafy stem								+				
Betula pubescens (Birch)	fruit					+			+				
B. pubescens/pendula (Birch/Silver Birch)	bark								+		+	+	+
B. pubescens/pendula (Birch/Silver Birch)	fruit								+	+	+	+	
B. pubescens/pendula (Birch/Silver Birch)	leaf					+					+		
Calliergon cordifolium (Moss)	leaf					+							
C. cuspidatum (Moss)	leafy stem					+		+					
Cardamine flexuosa/hirsuta (Wood/Hairy Bitter-cress)	seed							+					
Deschampsia caespitosa (Tufted Hair-grass)	grain				+								
Dryopteris felix-mas type (Fern)	sporangium + spore			+									
Eurhynchium praelongum (Moss)	leafy stem				+	++		+	+	+			+

Table 13.3 (continued)

			Depth from top of column in cm										
			Roman			*post-Roman*							
			C	*C*	*C+D*	*D*	*C*	*D*	*D*	*D*	*D*	*D*	*D*
			35–7	*32–5*	*29–32*	*27–9*	*26–7*	*22–6*	*18–22*	*16–18*	*12–16*	*9–12*	*1–9*
Gramineae (Grass)	grain			+	+		+	+	+				
Holcus lanatus (Yorkshire-fog)	grain			+									
Homalothecium sericeum (Moss)	leafy stem				+	+			+		+		
Hylocomium splendens (Moss)	leafy stem			+									
Hypnum cupressiforme (Moss)	leafy stem		+										
Juncus acutiflorus/articulatus (Sharp-flowered/ Jointed Rush)	seed		+	+	+	+	+	++	++	+	+		+
J. bufonius (Toad Rush)	seed					+							+
J. conglomeratus/effusus (Soft Rush)	seed		+	+	+	+	+	+ +	++	++	++	+	++
Juncus sp (Rush)	leaf/stem	F		+	+								
Neckera complanata (Moss)	leafy stem		+	+		+			+				
Phleum cf *pratense* (Timothy Grass)	grain							+					
Poa pratensis (Smooth-stalked Meadow-grass)	grain							+					
Polytrichum commune (Hair Moss)	leaf			+									
Ranunculus sp (Buttercup)	achene			+									
Rubus cf *fruticosus* agg (Blackberry)	fruit-stone	F							+				
R. idaeus (Raspberry)	fruit-stone								+		+		
Rumex acetosella agg (Sheep's Sorrel)	nut			+									
Rumex sp (Dock)	nut, perianth								+				
Salix repens (Creeping Willow)	leaf					++			+ +				
Salix sp (Willow)	budscale				+				+		+	+	
Salix sp (Willow)	fruit					+							
Salix sp (Willow)	leaf e-pidermis	F			+					+	+	+	+
Salix sp (Willow)	wood										+		
Stachys sylvatica (Hedge Woundwort)	nut								+		+		

Table 13.3 (continued)

	Depth from top of column in cm												
			Roman			*post-Roman*							
			C	*C*	*C+D*	*D*	*C*	*D*	*D*	*D*	*D*	*D*	*D*
			35–7	*32–5*	*29–32*	*27–9*	*26–7*	*22–6*	*18–22*	*16–18*	*12–16*	*9–12*	*1–9*
Thuidium tamariscinum (Moss)	leafy stem			+	+	+			+				
Cf *Trifolium repens* (White Clover)	petal			+									
Urtica dioica (Stinging Nettle)	nut				+								
Viola sp (Violet)	seed												+
Aquatic, marsh and fen													
Callitriche stagnalis (Starwort)	fruit				+			+					
Carex spp (Sedges)	nut			+	+								
Cyperaceae (Sedge Family)	epidermis	F		+	+	+	+	+	+	+	+	+	+
Cyperaceae (Sedge Family)	nut, glumes		+										
Eleocharis palustris (Common Spike-rush)	nut								+				
Epilobium cf *obscurum* (Dull-leaved Willowherb)	seed			+									
Galium cf *palustre* (Lesser Marsh-bedstraw)	fruit			+				+					
Glyceria fluitans (Flote-grass)	grain										+	+	+
Lemna cf *minor* (Duckweed)	seed							+			+		
Miscellaneous													
Unidentified	bark		+	+									
Unidentified	seed							+					
Unidentified	wood		+	+	+	+		+	+		+		+
Unidentified	Charcoal < 3mm		+	+	+	+	+	+	+	+	+	+	+

Lotus uliginosus (pedunculatus) type and *Trifolium repens* (white clover) suggest that these plants were present inside the fort. *L. uliginosus*, a plant of damp grassland or marshy ground is most unlikely to have been growing on cobbled paths or in the depression. It seems more likely that they represent fodder or hay. A tentative identification of petal fragments of white clover has been made in the silty clay, 330mm–350mm. This pollen assemblage is consistent with the evidence from the larger plant remains found in the silty clay above and below the organic band, that the organic streak remained from an earlier infilling deposited within the Roman occupation before the depression was cleared out.

No larger plant remains from Roman use were found above 300mm and at 250mm the relatively high Rubiaceae, probably *Galium* (bedstraw), and *Urtica* (nettle) pollen values may mark the abandonment of the fort although fruits of *Galium* cf *palustre* (lesser marsh bedstraw) and *Urtica dioica* (stinging nettle) were also present between 300mm and 330mm. The tree pollen values from 150mm downwards are depressed by a proportion of local *Salix* (willow) pollen. *Betula* (birch) also has large plant remains present throughout and its pollen may be over-represented especially towards the top where anthers were found at 100mm. Part of the grass pollen may also be very local, fruits of *Glyceria fluitans* (flote-grass) are present in the top 160mm. It is of interest that *Ulmus* (elm) present as less than 0.5% in all other samples from the fort attains 3% of total land pollen at 150mm. Small aquatic or semi-aquatic plants are present. There is *Lemna* (duckweed) in the lower part and *Callitriche* (starwort) in the upper part of the profile.Fern spores are consistently present but spores of *Sphagnum* (bog moss) are rare (150mm and 200mm) and *Sphagnum* moss leaves are notably only present in the silty clay. *Anthoceros punctatus* (hornwort), a thallose liverwort, with single spores at 150mm and 200mm, indicates patches of bare ground. The top two samples at 30mm and especially at 60mm have particularly high values of insect pollinated plants represented which have pollen not normally dispersed far from the parent plant. In fact they comprise over 30% of the total pollen at 60mm. They include *Filipendula* (meadowsweet), Labiatae including *Lamium* (dead-nettle), *Lotus uliginosus* (*pedunculatus*) type (large birdsfood-trefoil). *Silene dioica* (red campion), *Trifolium repens* (white clover) and *Trifolium* sp (clover or trefoil). These plants grow in grassland and wet places; the legumes and meadow-sweet in particular are among plants collected for meadow hay. Although such high values would seem to indicate plants growing in or near the depression it is notable that no larger plant remains were found of these taxa. The *Plantago lanceolata* (ribwort plantain), an indicator of human disturbance, pollen values are comparable to those recorded during the occupation. All these factors suggest that the two samples point to human interference with the vegetation; for instance a wisp of meadow hay blown into the depression could account for this pollen. If we accept the evidence that traces of occupation ceased above 300mm, this represents post-Roman farming. With the exception of these two samples, the pollen from the depression shows reasonable agreement with that of the sewage layer of the east annexe ditch. We do not know what period of time is represented by this depression but if the layers are annual it may be less than half a century. It seems that the surrounding woodland did not greatly alter during that period.

13.4 INNER WEST DITCH

13.4.1 Macroscopic plant remains

Large stones in the top of the grey silts prevented a complete column from being taken through the middle of the ditch infilling; instead a column 1.160m × 100mm × 100mm was taken from the side and 290mm of the basal silt was duplicated from the middle of the ditch beneath the stones. 0m is at approximately the same depth in both columns which are measured from the base upwards.

Column from side of ditch:

1.16m–850mm	khaki clayey silt becoming more organic downwards
850mm–420mm	dark grey-brown woody silty detritus with streaks of carbon from 550mm to 430mm, gradual transition downwards to the next layer
420mm–300mm	grey and khaki mottled silts with sand, stones, small charcoal, wood and silvery bark fragments
300mm–130mm	light grey to khaki clayey silt with occasional streaks of carbon and wood fragments, stone between 270mm and 180mm
130mm–0mm	dark grey streaky clayey silt with fragments of silvery bark

Duplicate of base of column from middle of ditch:

290mm–120mm	mottled yellow and grey clayey silt
120mm–70mm	blue-grey clayey silt with small stones
70mm–0mm	blue-grey clayey silt with coarse sand and stones

Samples 30mm thick, each of *c* 150cc were taken from 170mm upwards from the main column, similar samples but of *c* 27cc were taken from 0 to 170mm throughout the duplicate column unless otherwise stated. Table 29 records the main plant bearing part of the silts from the two columns. Where plant remains are very sparse or very similar the results from adjoining levels have been combined or detailed below. Wood and charcoal are shown in table 29, small unidentifiable charcoal fragments under 3mm were found throughout.

Sparse plant remains from the base of the duplicate column are as follows:

170mm–140mm	*Triticum/Secale* (wheat/rye) bran fragments and *Juncus effusus* (soft rush) seeds, occasional; *Calluna* (heather) leaves, rare; coal, occasional; charcoal, rare

140mm–110mm	*Triticum/Secale* bran fragments, rare
110mm–70mm	no plant remains seen
70mm–40mm	coal and other Carboniferous – plant fragments, rare
40mm–0mm	unidentified stems

Coal and Carboniferous megaspores are also present in the silts of the occupation levels shown in table 13.4. The presence of coal (all of fragments under 10mm) in silts with and without fort debris suggests that it is derived from the underlying Carboniferous clays rather than from use in the fort.

Middle of ditch, 17–23, 230mm–290mm, Roman occupation

A piece of a Roman leather shoe was found at approximately this level.

CULTIVATED PLANTS AND WEEDS

Some bran fragments of *Triticum/Secale* (wheat/rye) and a few glume bases of *T. dicoccum/spelta* (emmer/spelt) are present. A single carbonised wheat grain, the only one to be found at Bearsden, was recovered from 0.23 to 0.29m; it is 'puffed' and therefore not further identifiable. *Hordeum* (barley) and *Bromus* sp (lop-grass or brome) are present as occasional bran fragments. *Linum usitatissimum* (flax, linseed) is represented by part of a single seed (170mm–230mm); the cell pattern and characteristic beak are well preserved. Although the cereal and weed fragments are similar to those from the outer east annexe ditch they do not necessarily originate from sewage. Barrack-blocks and one of the fort's granaries are sited just the other side of the rampart, moreover a drain from the fort empties into the ditch. It seems more probable that these and other plant fragments from use in the fort were blown or washed into the ditch.

It is notable that four fragments of bone, one of them burnt and none larger than 2mm across, were found between 200mm and 230mm; as stated earlier fragments were also noted in the outer east annexe ditch.

HEATHLAND AND BOG

Calluna (heather) contributes leafy stems, some burnt, and *Pteridium* (bracken), frond fragments. These small fragments could have been blown or washed into the ditch from use in the fort. As has been postulated for the east annexe ditch the other plants from heath and bog habitats could have been gathered with the heather.

WOODLAND, GRASSLAND AND WET PASTURE

Wild plants which may have been gathered for food are represented by single fruitstones of *Rubus fruticosus* agg (blackberry) and *R. idaeus* (raspberry). The grass grains are all of species found in the outer east annexe ditch; together with wild legumes, represented by fragments of *Lathyrus pratensis* (meadow vetchling) and of *Trifolium repens* (white clover) they may have been gathered for fodder as is discussed on p 239. Abundant seeds of *Juncus effusus* (soft rush) may represent dormant seeds, the rare burnt fragments of rush stems/leaves in these and subsequent levels probably result from use in the fort. A clump of moss at 270mm consists mainly of *Hylocomium splendens* with other weft-forming robust hypnoid mosses easily gathered in quantity, they are mostly the same species as those found in the outer east annexe ditch.

AQUATIC, MARSH AND FEN

Fruits and seeds of sedges and other semi-aquatic plants are present in such small numbers that it is doubtful whether they were growing in the ditch during the occupation. Persistent seed banks or collection with hay from damp places could account for their presence.

Side of ditch, 20mm–300mm, Roman occupation

The lower sample from 20mm to 130mm contains seeds of *Juncus* spp especially *J. effusus* (soft rush) and grains of *Glyceria fluitans* (flote-grass). From 130mm to 300mm fruits of *Isolepis setacea* (bristle scirpus), a plant of damp places, and abundant *Juncus* seeds were noted. Many of the *Glyceria* grains and *Juncus* seeds are corroded perhaps due to fluctuating water levels in the ditch. At least 12 different mosses, many of them robust species, from woodland and both wet and dry grassland are present as small fragments. Flowering plants from similar habitats are generally not represented at this level. This diverse assemblage of mosses would seem to have been deliberately collected, perhaps the rushes were too.

300mm–400mm, Roman occupation

CULTIVATED PLANTS AND WEEDS

Rare bran fragments of *Triticum/Secale* (wheat/rye) and *Bromus* sp (lopgrass or brome) are confined to between 300mm and 400mm.

HEATHLAND AND BOG

Eriophorum vaginatum (cotton-grass), as noted previously, a plant of damp peaty places only, shows deliberate collection. Leafy stems of *Calluna* (heather), some of them burnt, and associated heath and bog plants were recognised; also a few frond fragments of *Pteridium* (bracken). All are less common than in the middle of the ditch and diminish upwards.

WOODLAND, GRASSLAND AND WET PASTUR E

Grasses of low lying meadow and pasture are present but in no great numbers; rush seeds are still abundant. A single seed of *Plantago lanceolata* (ribwort plantain) is of interest. *Urtica dioica* (stinging nettle), present in all samples, is a plant which rapidly invades habitation sites. Ten different mosses are virtually all the same species found in the lower samples and in the middle of the ditch suggesting a continued domestic use.

AQUATIC, MARSH AND FEN

Aquatic and semi-aquatic plants are present in quantity; cf *Nymphaea alba* (water-lily) and *Potamogeton natans* (broad-leaved pondweed) all need permanent standing water. *Callitriche stagnalis* (starwort), *Glyceria fluitans* (flote-grass), *Ranunculus* subg *Batrachium* (water crowfoot) and *Rorippa palustris* (marsh yellow-cress) grow in water or damp mud. *Lychnis flos-cuculi* (ragged robin) and probably *Carex* spp (sedges) would grow in marshy ground.

MISCELLANEOUS

Carduus spp (thistles) and most species of *Cirsium* are characteristic of waste places and disturbed ground; *Sonchus asper* (spiny sow-thistle) and *Rumex obtusifolius* (broad-leaved dock) can grow in similar habitats.

The evidence shown here, together with that of the charcoal, is consistent with the destruction of the fort with a few wind-blown fragments from domestic use in the fort, rapid plant growth in the ditch, and the invasion of weeds and nettles around it.

470mm–500mm, Post Roman

It is notable that neither cultivated plants nor plants of heathland and bog are present.

WOODLAND, GRASSLAND AND WET PASTURE

It is striking that very few species are represented. *Alnus* (alder) fruits and *Salix* (willow) buds are notable; alder and willow pollen dominate the pollen spectrum at this level. Seeds of *Juncus effusus* (soft rush) are still abundant.

AQUATIC, MARSH AND FEN

The aquatic plants have disappeared; *Lychnis flos-cuculi* (ragged robin) and *Potentilla palustris* (marsh cinquefoil) together with the rushes show that the overgrown ditch is still marshy.

Conclusions

The two sequences of samples suggest that during the occupation the organic infilling derived mainly from use within the fort, probably either via a drain emptying into the ditch or from wind-blown fragments. These plant remains seem to have occupied the basal silt in the middle of the ditch and a few centimetres at the side of the ditch infilling suggesting that the ditch was cleared out shortly before the fort was abandoned. The plants from domestic use are also represented in the outer east annexe ditch.

The sequence of deposits is interrupted by the large stones in the middle of the ditch, presumably from the destruction of the fort, but the sequence at the side of the ditch seems continuous. However, the silts below 400mm probably accumulated rapidly as a result of disturbance at the end of the occupation and may represent only a brief period of deposition. Rapid growth of water and marsh plants is shown by their presence in the same samples as fragments from domestic use between 300mm and 400mm; at the same time nettles and rank weeds colonised the ditch sides. The sample from 470mm to 500mm shows that subsequent overgrowth by marsh plants and trees or shrubs is marked by a striking reduction in the number of dry land plants. It is tempting to conclude that many of these, including the mosses, derive from domestic use in the fort.

13.4.2 Pollen analyses

The larger plant remains have shown that levels below about 400mm reflect the end of the Roman occupation and the beginning of aquatic plant growth. The sample from 170mm is from the duplicate column, the pollen from both it and the samples from 300mm and 350mm is very similar to that from the sewage levels of the outer east annexe ditch with *Alnus* (alder) and *Corylus* (hazel) as the main tree pollen. *Gramineae* (grass) pollen is probably attributable in part to *Glyceria fluitans* (flote-grass) fruits of which are also present. Rare cf *Triticum* (wheat) pollen is present at 250mm, presumably having adhered to wheat bran. *Calluna* (heather) and *Plantago lanceolata* (ribwort plantain) are present in small amounts. *Urtica dioica* (stinging nettle), represented by both pollen and nutlets from 300mm upwards must have grown nearby. About half the pollen is derived from trees including hazel. The high values for derived spores coincide with carboniferous megaspores and coal, the spores are also presumed to be of Carboniferous age.

The samples from 500mm upwards show initial overgrowth by *Alnus* (alder) and *Salix* (willow), their local origin is confirmed by larger plant remains with Betula (birch) replacing *Salix* (willow) from 600mm upwards and *Filipendula* (meadow-sweet) and ferns notable in the upper two samples.

13.5 MIDDLE WEST DITCH

13.5.1 Macroscopic plant remains

Due to the instability of the section it was only possible to take bulk samples from the silts as indicated. The woody detritus layer was not sampled since it is clearly post-Roman. The stratigraphy of the section is as follows:

Topsoil *c* 800mm thick
Brown soil *c* 500m thick
Clayey silt *c* 360mm thick
Woody detritus *c* 900mm thick
Grey-brown silt *c* 120mm–240mm thick, 'top silt'
Grey silt (with artefacts) *c* 440mm thick, 'middle silt'
Silt below artefacts (not sampled)

Middle silt with artefacts, Roman occupation

CULTIVATED PLANTS AND WEEDS

Triticum/Secale (wheat/rye) and *Bromus* sp (brome or lop-grass) are present in small amount and confined to the silt containing the artefacts, as shown in table 13.5.

HEATHLAND AND BOG

Rare fragments of these plants, associated with use in the fort, are also only found in this silt.

WOODLAND, GRASSLAND AND WET PASTURE

The flowering plants and mosses are all of species also recovered from the inner west ditch. Similar conclusions can be drawn as to the origin of these and the other plant remains from this silt of undoubtedly Roman age: namely that most fragments probably originate from use in the fort. The plant fragments are possibly wind-blown and/or the ditches were linked and the contents of drains from the fort flowed from the inner to the middle ditch.

Table 13.4
Inner west ditch, macroscopic plant remains

			Depth in cm from base upwards							
			Middle of ditch		*Side of ditch*					
			Roman		*Roman*					*post-Roman*
			23–17	*29–23*	*13–2*	*30–13*	*34–30*	*37–34*	*40–37*	*50–47*
Cultivated plants and weeds										
Agrostemma githago (Corn Cockle)	seed	F		1						
Bromus sp (Lop-grass or Brome)	pericarp	F	o	o			r			
Cerastium fontanum (Common Mouse-ear Chickweed)	seed		1				9	5	2	
Galeopsis tetrahit agg (Common Hemp-nettle)	nut						1	1	1	
Hordeum sp (Barley)	pericarp	F	o	o						
Linum usitatissimum (Cultivated Flax)	seed	F	1							
Polygonum aviculare agg (Knotgrass)	nut								1	
R. persicaria (Persicaria)	nut			1						
Rumex obtusifolius (Broad-leaved Dock)	nut, perianth						8			
Sonchus asper (Spiny Sow-thistle)	achene						1	3	3	
Stellaria media (Chickweed)	seed						5		5	
Triticum dicoccum/spelta (Emmer/Spelt Wheat)	glume	F	6	5			r			
Triticum/Secale (Wheat/Rye)	testa	F	f	f			r			
Triticum sp (Wheat)	gram			1*						
Heathland and bog										
Aulacomnium palustre (Moss)	leafy stem		r	f		o	r			
Calluna vulgaris (Heather)	flower		1	6			3	2		
Calluna vulgaris (Heather)	leafy stem		41*	15			13*	6*	1	
Calluna vulgaris (Heather)	seed						3	1	1	
Danthonia decumbens (Heath-grass)	grain			1						
Dicranum cf *bonjeani* (Moss)	leafy stem		r							
Erica tetralix (Cross-leaved Heath)	leaf		6				2			
Erica tetralix (Cross-leaved Heath)	seed			3			1			

Table 13.4 (continued)

			Depth in cm from base upwards							
			Middle of ditch		*Side of ditch*					
			Roman		*Roman*					*post-Roman*
			23–17	*29–3*	*13–2*	*30–13*	*34–30*	*37–34*	*40–37*	*50–47*
Eriophorum vaginatum (Cotton-grass)	leaf spindle		3	2			3	2		
Juncus squarrosus (Heath Rush)	seed		0	r	r	r	o	o	o	
Polytrichum sect *Juniperina* (Hair Moss)	leafy stem		r							
Potentilla erecta (Common Tormentil)	achene		6	1			1	1	1	
Pteridium aquilinum (Bracken)	frond	F			r	o	r			
Sphagnum sect *Acutifolia* (Bog Moss)	leaf		r							
S. subg *Litophloea* (Bog Moss)	leaf		r	r						
S. palustre (Bog Moss)	leaf						r			
Woodland, grassland and wet pasture										
Agrostis sp (Bent-grass)	grain		13	14			1	2	3	
Alnus glutinosa (Alder)	fruit									3
Calliergon cordifolium (Moss)	leafy stem					r				
C. cuspidatum (Moss)	leafy stem						r	r		
Campanula rotundifolia (Harebell)	seed		1							
Cardamine flexuosa/hirsuta (Wood/Hairy Bitter-cress)	seed						9	2	8	
Ceratodon purpureus (Moss)	leafy stem		r	r		o	r	r	o	
cf *Conopodium majus* (Pignut)	fruit									1
Deschampsia caespitosa (Tufted Hair-grass)	grain		1	2			10	3	9	
Dicranella cf *heteromalla* (Moss)	leafy stem		r				r			
Dryopteris felix-mas type (Fern)	sporangium								1	
Eurhynchium praelongum (Moss)	leafy stem		r	r		r	f	a	f	
Eurhynchium sp (Moss)	leafy stem		0	0		0	r			
Gnaphalium sylvaticum/uliginosuim (Wood/Marsh Cudweed)	fruit			2			2			
Gramineae (Grass)	grain		12	9		1	4	18	10	
Holcus lanatus (Yorkshire-fog)	grain		2	1						

Table 13.4 (continued)

			Depth in cm from base upwards							
			middle of ditch		*side of ditch*					
			Roman		*Roman*					*post-Roman*
			23–17	*29–23*	*13–2*	*30–13*	*34–30*	*37–34*	*40–37*	*50–47*
Hylocomium splendens (Moss)	leafy stem		o	a		o	o	r	r	
Hypericum cf *humifusum* (Trailing St John's Wort)	seed							1		
Hypnum cupressiforme (Moss)	leafy stem		r	o		o	o	r	r	
Juncus articulatus (Jointed Rush)	seed		1		r	a	f	f	f	
J. bufonius (Toad Rush)	seed		o	r	r	a	f	f		
J. effusus (Soft Rush)	seed		a	a	a	a	a	f	a	a
Juncus sp (Rush)	stem/leaf	F		r*			r*	r*		
Juncus sp or spp	seed		f			f	o	o	o	
Lathyrus pratensis (Meadow Vetchling)	leaf/stipule	F	6	1				1		
Luzula sp (Wood Rush)	seed		2	2		1	2	3		
Mnium hornum (Moss)	leafy stem			r		r		r	r	
Myosotis sylvatica (Wood Forget-me-not)	nut			1					1	
Neckera complanata (Moss)	leafy stem					r				
Plantago lanceolata (Ribwort Plantain)	seed						1			
Pleurozium schreberi (Moss)	leafy stem		r	r						
Poa annua (Annual Meadow-grass)	grain		1	1						
P. cf *pratensis* (Smooth-stalked Meadow-grass)	grain		2					1	1	
P. cf *trivialis* (Rough-stalked Meadow-grass)	grain		1				1			
Polygala sp (Milkwort)	seed	F		1			1	1		
Polytrichum commune (Hair Moss)	leafy stem		r	o		r	r	r	o	
Pseudoscleropodium purum (Moss)	leafy stem			o						
Ranunculus acris (Meadow Buttercup)	achene		4							
R. repens (Creeping Buttercup)	achene		1				3	2		
Rhytidiadelphus squarrosus (Moss)	leafy stem			o			r			

Table 13.4 (continued)

			Depth in cm from base upwards							
			Middle of ditch		*Side of ditch*					
			Roman		*Roman*					*post-Roman*
			23–17	*29–3*	*13–2*	*30–13*	*34–30*	*37–34*	*40–37*	*50–47*
Rubus fruticosus agg (Blackberry)	fruit-stone		1							
R. idaeus (Raspberry)	fruit-stone			1						1
Rumex acetosa (Sorrel)	nut, perianth						1	5	1	
Sagina procurabens (Procumbent Pearlwort)	seed						1	1		
Salix sp (Willow)	bud scale						3			10
Salix sp (Willow)	leaf	F					o			
Stachys palustris/sylvatica (Marsh/Hedge Woundwort)	nut				1					
Thuidium tamariscinum (Moss)	leafy stem			o						
Thuidium sp (Moss)	leafy stem					r				
cf *Trifolium repens* (White Clover)	petal	F	7	3			2			
Urtica dioica (Stinging Nettle)	nut						11	14	4	
Aquatic marsh and fen										
Callitriche stagnalis (Starwort)	fruit			2			2	1		
Caltha palustris (Marsh Marigold)	seed		1							
Carex nigra (Common Sedge)	nut, utricle			2						
C. cf *paniculata* (Panicled Sedge)	nut, utricle		4						1	
C. cf *riparia* (Great Pond Sedge)	nut						2	2		
Carex spp (Sedge)	nut		13	12			14	14	6	12
Eleocharis palustris (Common Spike-rush)	nut									1
Epilobium cf *obscurum* (Dull-leaved Willow-herb)	seed		1				3	6	3	
E. palustre (Marsh Willow-herb)	seed						2		3	
Glyceria fluitans (Flote-grass)	grain				75		21	15	4	1
Isolepis setacea (Bristle Scirpus)	nut					7				
Lychnis flos-cuculi (Ragged Robin)	seed						27	39	4	94

Table 13.4 (continued)

			Depth in cm from base upwards							
			Middle of ditch		*Side of ditch*					
			Roman		*Roman*					*post-Roman*
			23–17	*29–23*	*13–2*	*30–13*	*34–30*	*37–34*	*40–37*	*50–47*
Lythrum portula (Water Purslane)	seed		2							
Montia fontana (Blinks)	seed						5	5		
cf *Nymphaea alba* (White Water-lily)	seed	F					1			
Potamogeton natans (Broad-leaved Pondweed)	fruit-stone								131	
Potentilla palustris (Marsh Cinquefoil)	achene									11
Ranunculus subg *Batrachium* (Water Crowfoot)	achene						168	156	65	
R. flammula (Lesser Spearwort)	achene			1						1
Rorippa palustris (Marsh Yellow-cress)	seed						6	5	2	
Viola palustris (Marsh Violet)	seed						1			10
Miscellaneous										
Acrocarp undiff (Moss)	leafy stem			o		r				
Bryophyta (Moss)	capsule			r		r	r	r		
Bryophyta (Moss)	leafy stem						o			o
Bryum sp (Moss)	leafy stem					r				
Carduus sp (Thistle)	achene						1			
cf *Cirsium* sp (Thistle)	achene						2	2	7	5
Epilobium sp (Willow-herb)	seed		1				3	6	4	
Galium sp (Bedstraw)	fruit						1	1		1
Pohlia sp (Moss)	leafy stem		o	r		r				
Potentilla sp (Cinquefoil)	achene			1						4
Rumex sp (Dock/Sorrel)	nut		1				3		1	
Senecio sylvaticus/vulgaris (Wood Groundsel/Groundsel)	achene						4	3	8	
Unidentified	charcoal <3mm		r	r	r	r	r	r	r	r
Carboniferous,	megaspore			1		2	1	1		
Carboniferous	coal		r	r			r			

Top silt, post-Roman

Neither cultivated plants nor those from heathland or bog were found.

WOODLAND, GRASSLAND AND WET PASTURE

The plants represented are similar to those from the middle silt.

AQUATIC, MARSH AND FEN

The beginning of aquatic plant growth in the ditch is shown, *Potamogeton natans* (broad-leaved pondweed) indicates standing water; the same taxa are present in the inner ditch between 300mm and 400mm.

13.5.2 Pollen analysis

The larger plant fragments (table 13.5) show the middle and top of the silt to be Roman and immediately post-Roman respectively. The pollen spectra from both samples are very similar to those from the lower three samples from the inner west ditch.

Conclusions

These two samples indicate similar conditions to those of the inner ditch. The middle silt, with Roman artefacts, contains similar plant remains from use in the fort to those from 170mm to 290mm from the middle of the inner west ditch: the top silt though lacking most of these plants has elements of the aquatic flora similar to that from 300mm to 400mm from the side column of the inner ditch.

The silts in the middle ditch obviously accumulated very rapidly which may account for the smaller quantity of plant remains. The unsampled woody detritus above these silts suggests that the deposits were sealed in by later tree overgrowth in a similar way to those of the inner west ditch.

13.6 OUTER WEST DITCH

13.6.1 Macroscopic plant remains

A column 600mm × 100mm × 180mm was taken through the organic deposits. It proved impossible to sample the underlying silts due to the imminent collapse of the section. The stratigraphy of the column measured from the base upwards is as follows:

600mm–100mm	unsampled woody detritus
100mm–30mm	coarse detritus with leaves and *Salix* (willow) wood
30mm–0mm	coarse detritus consisting mainly of the moss *Fontinalis antipyretica*, slightly silty at the base.

The material is very rich in plant remains and only *c* 30cc each of samples 30mm and 30mm–60m was examined. The samples at 70mm and 100mm are from pollen washings each of *c* 1cc, the results are set out in table 31.

0–30mm, post-Roman

WOODLAND, GRASSLAND AND WET PASTURE

Local growth of *Juncus effusus* (soft rush) is evinced by capsules and abundant seeds; with shade tolerant ferns and grass, and *Myosotis sylvatica* (wood forget-me-not), a plant of damp woods.

AQUATIC, MARSH AND FERN

Potamogeton berchtoldii (small pondweed) indicates standing water, marshy areas at the ditchside would provide habitats for *Eleocharis palustris* (common spike-rush), *Epilobium* cf *obscurum* and *E. palustre* (dull-leaved and marsh willow-herbs), *Lythrum* (*Peplis*) *portula* (water purslane) and *Potentilla palustris* (marsh cinquefoil). The most abundant plant remains are of a moss, *Fontinalis* antipyretica, which grows on rocks, exposed roots and tree boles submerged or subject to submergence; it often grows in moving water.

30mm–100mm, post-Roman

WOODLAND, GRASSLAND AND WET PASTURE

The shade tolerant herbaceous plants are still present and local tree growth is shown by anthers of *Corylus* (hazel) and *Quercus* Cog); with fruits of *Alnus* (alder), *Betula pubescens* (birch) and *Quercus* (oak) together with leaves of *Quercus* and *Salix* (willow). Most of the mosses such as *Antitrichia curtipendula*, *Homalothecium sericeum*, *Isothecium myosuroides* var *myosuroides*, *Thuidium tamariscinum* and *Zygodon* cf *viridissimus* grow on trees and rocks and *Ulota* spp on trees near water.

AQUATIC, MARSH AND FEN

The same plants of wet places continue to flourish, open water is still indicated by pollen of *Potamogeton* (pondweed) at 100mm.

Conclusions

Plants used in the fort are absent but the base of the column adjoining the top of the unsampled silt shown in the section is probably immediately post-Roman. The presence of *Urtica* (stinging nettle) pollen at 10mm and 40mm, a plant characteristic of abandoned habitation sites, contributes to this view. The ditch flora shows rather different conditions to those of the other two west ditches. The aquatic moss *Fontinalis*, 0–30mm, could indicate moving water from percolating drainage water from higher ground at the north end of the ditch. Open water conditions continued for at least the period while 100mm of deposit accumulated: a link with the south ditch which the Roman levels show was cut into lower ground then as now would account for the water movement and relatively slow silting up of the ditch. The coarse nature of the debris suggests that the basal 0.1m soon accumulated, perhaps 50mm in as little as 40 to 50 years, the time it would take an oak grown from seed to produce fruit, or if from a coppiced shoot only 20 to 25 years (Jones, E W 1959).

13.6.2 Pollen analysis

The obtainable samples have been shown to be post-Roman. The lowest at 10mm has a similar pollen spectrum to those from the inner and middle ditches; *Plantago lanceolata* (ribwort plantain)

Table 13.5
Middle west ditch, macroscopic plant remains

			Roman	*post-Roman*
			Middle top silts	
Cultivated plants and weeds				
Bromus sp (Brome or Lop-grass)	pericarp	F	r	
Sonchus asper (Spiny Sow-thistle)	achene			2
Stellaria media (Chickweed)	seed		2	
Triticum/*Secale* (Wheat/Rye)	testa	F	o	
Heathland and bog				
Calluna vulgaris (Heather)	leafy stem		1	
Juncus squarrosus (Heath Rush)	seed		1	
Polytrichum sect *Juniperina* (Hair Moss)	leaf		r	
Pteridium aquilinum (Bracken)	frond	F	r	
Sphagnum subg *Inophloea* (Bog Moss)	leaf		r	
Sphagnum subg *Litophloea* (Bog Moss)	leaf		r	
Woodland, grassland and wet pasture				
Agrostis sp (Bent-grass)	grain		1	2
Betula pubescens/*pendula* (Birch/Silver Birch)	fruit			1
Cardamine flexuosa/*hirsuta* (Wood/Hairy Bittercress)	seed		1	
Ceratodon purpureus (Moss)	leafy stem		o	r
Gramineae (Grass)	anther		3	1
Gramineae (Grass)	grain		3	10
Hylocomium splendens (Moss)	leafy stem		r	r
Hypnum cupressiforme (Moss)	leafy stem		o	
Juncus acutiflorus/*articulatus* (Sharp-flowered/Jointed Rush)	seed		r	r
J. *conglomeratus*/*effusus* (Soft Rush)	seed		r	
Juncus sp (Rush)	stem/leaf		r*	
Luzula sp (Woodrush)	seed			2
Mnium hornum (Moss)	leaf		r	r
Poa annua (Annual Meadow-grass)	grain		2	2
Ranunculus repens (Creeping Buttercup)	achene			1
Rumex acetosa (Sorrel)	anther, perianth			1, 2
cf *Trifolium repens* (White Clover)	petal	F	3	
Urtica dioica (Stinging Nettle)	nut		4	6

Table 13.5 (continued)

			Roman	*post-Roman*
			Middle top silts	
Aquatic, marsh and fen				
Carex spp (Sedge)	nut		4	2
Epilobium cf *obscurum* (Dull-leaved Willow Herb)	seed			2
Potamogeton natans (Broad-leaved Pondweed)	fruit-stone			5
Ranunculus subg *Batrachium* (Water Crowfoot)	achene			3
Rorippa palustris (Marsh Yellow-cress)	seed			3
Miscellaneous				
Bryum sp (Moss)	leafy stem		r	r
cf *Cirsium* sp (Thistle)	achene		9	
Pohlia sp (Moss)	leafy stem		o	
Potentilla sp (Cinquefoil or Tormentil)	achene		1	1
Rumex sp (Dock)	perianth		4	
Unidentified	seed		1	1

at about 5% of the total land pollen and a small amount of *Urtica dioica* (stinging nettle) pollen would seem to indicate the end of the occupation as is the case in the inner ditch. The moderate grass values are in part attributable to the aquatic grass *Glyceria aquatica*, and Cyperacese pollen is probably that of *Eleocharis palustris* (common spike-rush). Pollen from aquatic and marsh plants corresponds to larger plant remains; *Potentilla* is probably attributable to *P. palustris* (marsh cinquefoil), more certainly *Callitriche* (starwort), *Lemna* (duckweed) and *Lythrum* (*Peplis*) *portula* (water purslane) are present as both pollen and fruits or seeds.

At 40mm and 70mm values of over 40% of *Quercus* (oak) are shown to be of local origin from abundant larger plant fragments, anthers of *Alnus* (alder) and *Corylus* (hazel) are also present. The high values of *Quercus* in particular may mask changes in the other pollen; authors' unpublished analyses from 100mm to 150mm show the *Quercus* pollen values to have remained high. Pollen of aquatic plants is still present.

13.7 SOUTH DITCH

13.7.1 Macroscopic plant remains

A column 1.100m × 170mm × 100mm was taken through the organic deposits down to the top of the natural clay, stratigraphy is as follows:

0–1m	silty woody detritus mud with leaf fragments
1m–1.100m	clayey silt with wood fragments and *Salix* (willow) twigs
1.100m–	downwards silt and natural clay, unsampled

Bulk samples of *c* 75cc were taken from 100mm to 105mm and 1.05m to 1.1m, a further 60cc was later sampled from 1.050m to 1.100cm to search particularly for pericarp fragments but none were found; the samples were disaggregated in water before sieving. The result from these and two pollen washings each of *c* 1cc from 800mm and 980mm are listed in table 32.

1m–1.05m, 1.05–1.1m, post-Roman

WOODLAND, GRASSLAND AND WET PASTURE

There is little difference between the assemblages recovered from the two samples. There is no definite evidence of plant use from the fort though *Urtica dioica* (stinging nettle), with pollen and fruits present, once again suggests recent habitation. *Salix* (willow) remains suggest early colonisation by these shrubs or trees. The presence of edible fruits of *Fragaria vesca* (wild strawberry), *Rubus fruticosus* (blackberry), *R. idaeus* (raspberry) and *Sorbus aucuparia* (rowan) are of interest, they could represent use in the fort. *Rubus* pollen was only found at 980mm and 800mm perhaps from bushes growing from discarded fruit. The presence of ferns with spores present in all samples and sporangia, abundant from 1m to 1.05m and at 900mm, suggests shady habitats as do the seeds of *Silene dioica* (red campion).

Table 13.6
Outer west ditch, macroscopic plant remains

			Depth from base of column in cm			
			post-Roman			
			0–3	*3–6*	*7*	*10*
Woodland, grassland and wet pasture						
Alnus glutinosa (Alder)	anther			1		
Alnus glutinosa (Alder)	fruit		1	22		2
Amblystegium riparium (Moss)	leafy stem			r		
Antitrichia curtipendula (Moss)	leafy stem					r
Betula pubescens (Birch)	fruit			8		4
B. pubescens/pendula (Birch/Silver Birch)	fruit			7		
Corylus avellana (Hazel)	anther			1		
Deschampsia caespitosa (Tufted Hair-grass)	grain		3	2		
Dryopteris felix-mas type (Fern)	sporangium		1	3		
Eurhynchium praelongum (Moss)	leafy stem			r		
Eurhynchium sp (Moss)	leafy stem			r		
Filicales (Fern)	frond	F	r	r		
Filicales (Fern)	sporangium				4	4
Gramineae (Grass)	grain		2	5	1	
Homalothecium sericeum (Moss)	leafy stem			r		
Hypnum cupressiforme (Moss)	leafy stem		r	r		r
Isothecium myosuroides var *myosuroides* (Moss)	leafy stem			r	r	0
Juncus effusus (Soft Rush)	capsule, seed		f, a	r, a	r, f	0
Lathyrus pratensis (Meadow Vetchling)	leaf	F		r		
Myosotis sylvatica (Wood Forget-me-not)	nut		11	12		
Neckera complanata (Moss)	leafy stem					1
Prunella vulgaris (Self-heal)	nut			1		
Quercus sp (Oak)	acorn, cupule			3, 2		
Quercus sp (Oak)	anther			1		2
Quercus sp (Oak)	leaf	F		o		
Salix sp (Willow)	leaf	F		r		
Salix sp (Willow)	wood	F			r	
Thuidium tamariscinum (Moss)	leafy stem			o		
Ulota sp (Moss)	leafy stem			r		r
Zygodon cf *Viridissimus* (Moss)	leafy stem			r		

Table 13.6 (continued)

			Depth from base of column in cm			
			post-Roman			
			0–3	*3–6*	*7*	*10*
Aquatic, marsh and fen						
Callitriche stagnalis (Starwort)	anther		12			
Callitriche stagnalis (Starwort)	fruit		7	8		1
Cardamine cf *amara* (Large Bitter-cress)	seed			1		
Carex sp (Sedge)	nut			1	1	
Eleocharis palustris (Common Spiker-rush)	nut		16	8	1	
Epilobium cf *obscurum* (Dull-leaved Willow-herb)	seed		2			
E. palustre (Marsh Willow-herb)	seed		6	2	1	
Fontinalis antipyretica (Moss)	capsule			1		
Fontinalis antipyretica (Moss)	leafy stem		a			
Galium cf *palustre* (Lesser Marsh Bedstraw)	fruit		2	1		
Glyceria fluitans (Flote-grass)	grain		1			
Lemna cf *minor* (Duckweed)	seed		2	1		
Lythrum portula (Water Purslane)	seed		77	27	2	2
Phalaris arundinacea (Reed-grass)	grain			1		
Potamogeton berchtoldii (Small Pondweed)	fruit-stone		5			
Potentilla palustris (Marsh Cinquefoil)	achene		48	54	1	1
Sparganium cf *minimum* (Small Bur-reed)	fruit-stone			1		
Miscellaneous						
Bryum sp (Moss)	leafy stem			r		

AQUATIC, MARSH AND FEN

The presence of *Glyceria fluitans* (flote-grass) implies stagnant or slow-flowing water.

800mm, 980mm

The overgrowth of trees by 980mm is suggested by anthers of *Betula* (birch) and *Corylus* (hazel), the latter on a pollen slide. The mosses are a shade tolerant assemblage found in woodland, shady banks and tree trunks, with base-rich soil implied.

13.7.2 Pollen analysis

Samples from 1.06m and 1.03m show similar results to those from the base of the outer west ditch; local overgrowth by shrubs and small trees is suggested by pollen of *Salix* (willow) and *Prunus* type. The aquatic grass contributes to the high grass pollen count. By 800mm *Corylus* (hazel) has dominated the pollen spectrum and its local over-representation has eclipsed most of the pollen from outside the ditch.

Conclusions

The absence of cultivated plants and those of heathland and bog suggests that the ditch was cleaned out by the Romans, the basal samples may be immediately post-Roman and if so the remains of edible fruits could be refuse from deliberate collection. The pollen evidence shows that the willow scrub was soon invaded by hazel and the ditch deposits sealed in by resulting woodland overgrowth.

Table 13.7
South ditch, macroscopic plant remains

			Depth from base of column in cm			
			post-Roman			
			105–110	*100–105*	*98*	*80*
Woodland, grassland and wet pasture						
Betula pubescens/pendula (Birch/Silver Birch)	anther				1	
Cardamine flexuosa/hirsuta (Wood/Hairy Bitter-cress)	seed		1	1		
Eurhynchium striatum (Moss)	leafy stem					r
E. cf *swartzii* (Moss)	leafy stem				r	
Filicales (Fern)	sporangium		r	a	a	
Fragaria vesca (Wild Strawberry)	achene		10	1		
Galeopsis tetrahit agg (Common Hemp-nettle)	nut			2		
Gramineae (Grass)	grain		1			
Homalothecium sericeum (Moss)	leafy stem			r		r
Isothecium myosuroides (Moss)	leafy stem					r
Juncus effusus (Soft Rush)	seed		o	r		
Mnium hornum (Moss)	leaf					r
Neckera complanata (Moss)	leafy stem					r
Ranunculus sect *Ranunculus* (Buttercup)	achene		1			
R. repens (Creeping Buttercup)	achene			3		
Rubus fruticosus agg (Blackberry)	fruit-stone		2		1	
R. idaeus (Raspberry)	fruit-stone		2	1		
Salix sp (Willow)	budscale		2	1		
Salix sp (Willow)	leaf	F		r		
Salix sp (Willow)	wood		r			
Silene dioica (Red Campion)	seed		21	11		
Solanum dulcamara (Bittersweet)	seed		1			
Sorbus aucuparia (Rowan)	seed		1			
Urtica dioica (Stinging Nettle)	nut		2	2		
Aquatic, marsh and fen						
Callitriche stagnalis (Starwort)	fruit		3			1
Glyceria fluitans (Flote-grass)	grain		30	10	1	
Miscellaneous						
Unidentified	fruit		1			

13.8 RAMPART TURVES

13.8.1 East annexe rampart

A small bulk sample consists of grey clayey si1t, with sand and small stones with a thin dark turf line *c* 5mm thick. The sample (NK77EI) is penetrated by roots of cf *Corylus* (hazel) possibly from a tree colonising the slighted rampart.

Another column, 300mm × l50mm × 100mm, was taken through a section of the east annexe rampart. It consists of grey clayey silt with sand and small stones with four thin dark turf lines each *c* 5mm thick and approximately 60mm apart; occasional roots have penetrated throughout the column. The four turf lines were pollen analysed and bulk samples 100mm thick × 50mm × 100mm were taken through the turf lines, first examined untreated and then disaggregated with 2% sodium hydroxide before sieving for larger plant remains. 1cc samples were also taken from below the turf lines at 210mm and 270mm to detect any differences in the flora before the preserved turf had formed (NK78Ax).

13.8.2 East fort rampart

A small bulk sample from the rampart between the fort and the annexe to the east of building 12 and just below the present ground level consists of grey, clayey silt with sand and stones, with a thin dark turf line. The sample (NK77By) is penetrated by roots of cf *Salix* (willow), decayed wood of cf *Salix* was also found. Pollen was too sparse to count.

A column 450mm × 150mm × 100m was taken through a section of the turf rampart east of building 8, 910mm below

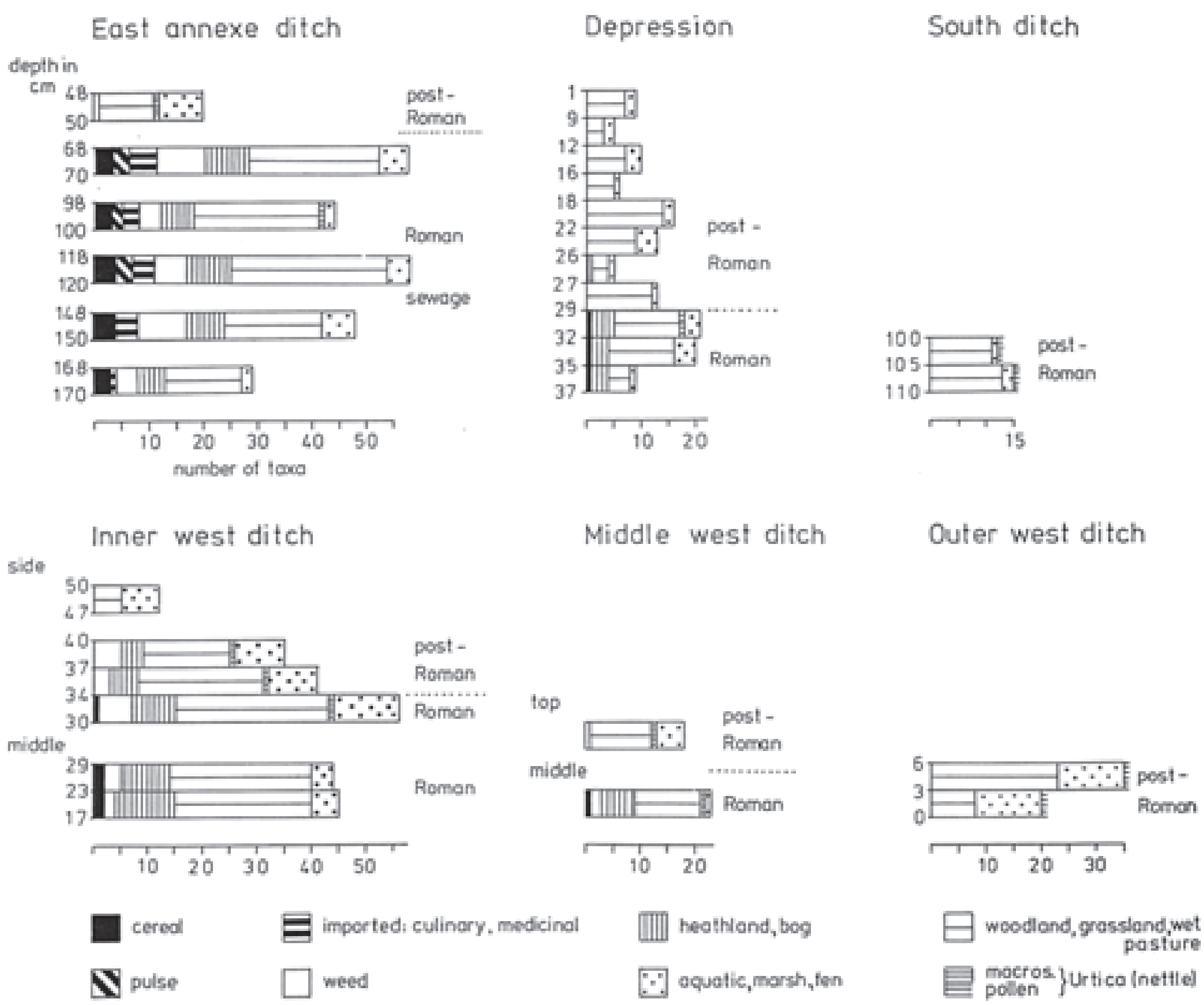

Illustration 13.8

Macroscopic plant remains: summary diagram. These bar diagrams show clearly that macroscopic plant remains of cereals, pulses and culinary or medicinal plants characterise the Roman sewage and cereals distinguish the Roman levels in other deposits. Plants of heath and bog, found throughout the occupation levels, cease at or soon after the fort's destruction which is immediately followed by a growth of nettles recorded in all deposits.

Table 13.8
Turf ramparts, macroscopic plan remains

		East rampart							*East annexe rampart*							
		NK778Y	*NK78DS*				*NK78DR*		*NK77EI*		*NK78AX*					
			T		*T*		*T*	*T*	*T*	*T*	*T*	*T*	*T*		*T*	
			12	*15*	*22*	*25*	*36*	*42*	*1*	*2*	*6*	*11*	*18*	*21*	*24*	*27*
Calluna vulgaris (Heather)	leaf								*	*						
Chenopodium cf *album* (Fat Hen)	seed								+							
Corylus (Hazel)	charcoal	*														
Erica tetralix (Cross-leaved Heath)	leaf								*	*						
Juncus bufonius (Toad Rush)	seed								+		+		+	+	+	+
J. *conglomeratus/effusus* (Soft Rush)	seed						+	+	++	+	+	+	++	++	++	++
Quercus (Oak)	charcoal	*			*				*			*	*		*	
Salix (Willow)	bud scale				+											
Bryophyta (Moss)	stem		*		*				*	*	*				*	
Unidentified herbaceous plant fragments	carbonised		*		*	*	*	*			*		*	*	*	*
Unidentified, < 3mm	charcoal	*	*	*	*	*			*	*	*				*	

Depth measured in cm from tops of columns, except NK77BY and NK77EI which are from bulk samples
T, turf line; ++, >100 seeds per cc; *, carbonised

the present ground surface. It consists of grey silt with sand and stones; only two turf lines are clearly visible at 120mm and 220mm. The sample is slightly penetrated by roots. Samples were taken as for NK78Ax with 1cc samples below the turf lines at 150mm and 250mm (NK78DS).

A duplicate column from the same location was extensively penetrated by roots, the least affected turf lines at 360mm and 420mm were examined for larger plant remains (NK78DR).

13.8.3 Macroscopic plant remains

Plant remains, shown in table 13.8, are mainly sparse in all samples. The presence of rare leaves of burnt *Calluna* (heather) and *Erica tetralix* (cross-leaved heath) in two samples suggests heathy grassland. *Chenopodium* cf *album* (fat hen), represented by a single seed, is a plant of waste places and cultivated land. *Juncus conglomeratus/effusus* (soft rush), with particularly abundant seeds in three of the turves, are both characteristic of wet pastures. *Corylus* (hazel) and *Quercus* (oak) are both represented as charcoal, none of the fragments being larger than 10mm diameter. The small samples taken from the soil beneath the turf lines, shown in table 13.8, contain less burnt material but have otherwise similar plant remains.

13.8.4 Pollen analysis

It is of particular interest to have countable pollen preserved from rampart turves since these are similar to surface pollen samples reflecting the vegetation at the time the fort was built. However, between 30% and 145% of the pollen was too crumpled or deteriorated to identify and the results are accordingly more tentative than for the other samples. Heather and alder pollen are both recognisable when poorly preserved, grass pollen is markedly less so. The pollen from the seven turf lines which were analysed is predominantly of *Alnus* (alder), *Corylus* (hazel), *Calluna* (heather) and *Gramineae* (grasses). *Plantago lanceolata* (ribwort plantain) provides up to 7% of the total pollen; this plant is resistant to trampling and grazing and is one of the most consistent components of pasture. Other herbaceous pollen such as that of *Ranunculaceae* (buttercup family) is only present in small amounts; there are virtually no plants of arable land. Boggy areas are indicated by the occurrence of *Sphagnum* (bog moss) in all samples.

The low values for herbaceous pollen suggest that the grassland was well grazed, the rushes and mosses indicate damp areas. Comparison with recent surface samples from established pasture (p 268) show a good measure of agreement with these samples. Further interpretation of the pollen in the terms of the landscape it represents is attempted on pp 268–9.

13.9 WOOD, CHARCOAL AND OTHER BURNT PLANT REMAINS

Charcoal was recovered from most of the samples, often as tiny unidentifiable fragments under 3mm in diameter. The width of the transverse face was seldom greater than 15mm but by comparing the diameter of the annual rings with templates of known diameter, the approximate minimum diameter of the original branch or trunk was estimated for some of the charcoal. This does not allow for asymmetric growth and only when most of the transverse face is preserved, as with most of the wattle, is it certain.

13.9.1 Outer east annexe ditch

The charcoal is all of small fragments of alder, birch, hazel and oak and is restricted to the Roman sewage levels (table 13.2). It is assumed, from the presence of pollen, that all the trees grew locally. The conifer is not pine but could be juniper (*Juniperus*) which used to grow locally (Hennedy 1878). The hazel wood from between 620mm and 65omm is about 30mm in diameter; it lies a few cm below the top (at *c* 580mm) of the sewage and could, with other hazel fragments a few cm lower, represent wattle from the slighted rampart. The birch and willow wood from the post-Roman levels result from ditch overgrowth.

13.9.2 Inner west ditch

The wood and charcoal is all of Roman age (table 13.4), the charcoal is of fragments of 5mm diameter or less; the only measurable wood is the willow, originally *c* 300mm including bark and the hazel, of 15mm diameter, both from between 300mm and 400mm, the end of the occupation; they may therefore have come from the slighted rampart.

13.9.3 Middle west ditch

Wood was retrieved from the same Roman silt as nails and arrowheads. Of this wood (table 13.5) four pieces of oak appear to be shaped.

13.9.4 Ramparts

The charcoal from the rampart turves is of hazel and oak, wood commonly used in the fort. From immediately outside the west rampart small fragments of oak charcoal were found. From the slighted east rampart a quantity of burnt roundwood, mainly of willow but with some alder and hazel with one piece of gean, was recovered. The roundwood is mainly 7mm–16mm in diameter, three–eleven years old and broken into fragments 20mm–143mm long; some still retains bark and is clay covered. It seems probable that it represents a timber breast-work of wattles on top of the rampart.

13.9.5 Charcoal associated with buildings in the northern part of the fort

The evidence for building materials is from post-holes, drain fills, gulleys and areas of burning between buildings as shown in illus 13.8.

Alder over 50mm diameter, together with birch roundwood, 16mm diameter and hazel roundwood, 8mm diameter, was recovered from the gulley north of building 1. Alder and sparse rush leaves/stems were found in the gulley between buildings 1 and 2. South-east of building 2, ash cut from wood originally over 80mm in diameter was found with alder, hazel, oak and willow. Alder fragments were found in two post-holes in the north-west of building 2.

South of the officer's quarters of building 3, a daub-filled gulley yielded a fragment of oak with roundwood of alder, 18 and 25mm diameter, hazel, 15 and 22mm diameter and willow, the most common, 10–15mm diameter. Some roundwood has retained its bark and adherent clay; the pieces are between 15 and 28mm long and from three to seven years old. The gulley also produced fragments of burnt rushes, partly in small bundles, in a clay matrix; it is assumed that the rushes were used to reinforce the daub instead of straw. This is the most complete evidence for wattle and daub produced in the fort. From the south end of building 3 was found a piece of ash, squarish in section, about 18mm × 22mm, which could have been part of a structure; alder, a piece of willow roundwood 12mm in diameter and daub were also recorded.

Charcoal, thought to be from a barrack wall, included two fragments of oak planks or boards, both were sawn tangentially. One piece has two flat, smooth, parallel sides and is now 65mm wide, 19mm thick and 50mm long; the third straight side has been accurately cut at right angles to the parallel sides. The second piece, also 19mm thick with parallel sides is now 149mm wide and 65mm long. A small piece of possibly worked alder, a piece of ash resembling an irregularly angled peg and a fragment of hazel roundwood, of 10mm diameter were also recovered.

From a gulley west of building 3 alder of 50mm diameter was identified. The area between the building 3 and north granary yielded birch fragments. Outside the east wall of the granary a gulley contained alder charcoal, and the tumble of the north wall produced alder and birch charcoal. In the gulley outside the granary a layer of burnt rushes up to 12mm thick was identified; these rushes originated either from the granary or the adjacent barrack-block to the north. The rushes are of *Juncus effusus* (soft rush), identified on occasional fruiting heads. Four nutlets of *Carex ovalis* (oval sedge) and one of *C. pulicaris* (flea-sedge) were found among the rushes and were presumably gathered with them. There is no clay admixture and it seems probable that this represents rush thatch.

From the worked wood charcoal associated directly with buildings 1 to 4, alder, oak and ash seem to have been used as structural timber and oak planks or boards were associated with one of the barracks. Alder, birch, hazel and willow occur as roundwood and range from 8 to 22mm diameter; presumably they were used as wattle. Clay daub was commonly found around the fort, but the only good evidence to suggest that it was reinforced with rushes is from building 3. Rushes may have provided roofing for the granary or barracks. It is the most likely roofing material to have been used at Bearsden since the presence of seeds in both ditch and turf samples shows that suitable rushes grew nearby. There is no evidence to suggest cereal growing in the vicinity and so straw may not have been readily available.

13.9.6 Charcoal associated with buildings in the southern part of the fort

The charcoal in the south area is less clearly linked to particular buildings and is mainly from features and pits together with burnt deposits overlying them as shown in illus 13.8.

From the west side of the south granary charcoal of alder and oak from mature wood was recovered together with a fragment of burnt hazel nut shell and an uncarbonised seed fragment of *Euphorbia helioscopia* (sun spurge).

The contents of three post-holes were examined; one of these, F49, contained charcoal of alder, hazel, including roundwood, and birch. It seems likely that this includes wattle from the fort's destruction. From F55 a shaped piece of alder and from Fl a fragment of alder were identified.

In the area of building 16 a scoop, F4l, produced alder including a shaped piece. In a pit, F36, was found a roughly squared piece of ash, 35mm × 35mm, which must originally have been split into quarters, the radius of the wood was originally at least 38mm. Willow roundwood, 10mm in diameter, was also present. Charcoal from within and overlying other pits was of alder including roundwood of 12mm–6mm diameter, hazel, mainly roundwood of 7mm–20mm diameter and willow roundwood 6mm–14mm diameter. Burnt daub was present in most samples. It seems probable that these represent one or more structures built of ash and alder timbers with wattle of alder, hazel and willow roundwood covered with daub. Charcoal fragments from other pits, features and drain fills in this area add little to the overall picture with the exception of charcoal of silver fir.

Abies Alba (Silver Fir)

Fragments of silver fir charcoal were found in the fill of the drain running east–west immediately south of the south wall of the forehall to the headquarters building. They are probably all from one piece now 53mm long, 22mm wide along the tangential axis and 8mm deep along the radial axis. The growth rings are more or less straight indicating, assuming regular growth, wood of at least 200mm minimum diameter. Smaller fragments were found in a small patch of burnt clay (daub?) overlying the cobbles beside the drain; all the wood is slightly degraded.

This find is of considerable interest as silver fir is not native to Britain. At Silchester, Reid (1901, 253) reported Roman wells lined with barrel staves which he interpreted as the re-use of casks used for transporting wine from the Pyrenees. Williams (1978: 48–50) identified silver fir wood from a staved bucket found in a fourth century Roman well in york. He suggested that the bucket or its constituent staves were purposely brought from the continent. Barrels made of fir wood have been found in Roman sites in northern Germany brought from Bavaria or the Danube basin. Fir wood was chosen because the wood lacks resin canals. However, silver fir wood was also used for writing tablets and has been recorded, thus used, from Roman Carlisle (Donaldson & Rackham 1984). The Romans appear to have made writing tablets from rather thin slices of wood, up to 3mm thick, at Vindolanda, so perhaps these rather thicker fragments are more likely to have derived from a container.

13.9.7 Bath-house

The bath-house and hypocaust system contained charcoal and other burnt material. Post-hole 1 in the changing room contained small fragments of birch, hazel, oak and willow, these probably include charcoal which fell in during demolition. From the north-west corner small fragments of alder charcoal were identified. In the cold room a post-hole in the north wall contained alder and birch derived from wood of about 60mm and over 140mm diameter respectively. A post-hole in the west wall had alder, birch and willow fragments and a drain contained fragments of alder and oak. The hazel and willow fragments could be from roundwood, the oak and birch are from mature wood.

Picea (Spruce)

A fragment of spruce wood was found in the cold room in the bath-house. It is roughly oblong and measures 75mm long × 83mm wide and a maximum of 9mm thick. The two sides are roughly parallel becoming thinner at the edges, the opposite ends have been roughly broken. The wood has been cut along the radii and is irregular in thickness; one of the faces is slightly convex. Much of the surface is covered in hard silt which cannot be readily brushed away. All exposed surfaces are dark brown, the inside is very pale arid fresh looking. The surface was viewed with oblique light; no scratches such as would be made by a stylus were seen. Two stylus tablets of spruce or larch (*Larix*) wood were found at Vindolanda but their centres were hollowed out to hold wax (Bowman & Thomas 1983: 29–31). Spruce is not native to Britain and presumably the wood once formed part of an imported artefact.

A drain in the warm room contained alder with a fragment of a non-British conifer, possibly of silver fir. Fragments of alder, hazel and oak charcoal were also found in drains running from the bath-house. These are the only contexts which derive certainly from structures; on this slight evidence it appears that alder may have been the main building timber.

The charcoal found in the hot room flue and stoke-hole, the hot dry room stoke-hole, the stoke-pit and between the stoke-pit drain and rampart was of alder, birch, oak and cf rowan (one fragment). Alder from the hot room flue was from wood originally between 40mm and 200mm in diameter and oak from wood of between 80mm and 200mm diameter; unburnt willow roundwood of 7mm diameter was also present. The drain running south from the stoke-hole yielded rare fragments of heather and occasional burrs from bark. A small amount of burnt peat was also found in the hot room flue, also unidentified bark with burrs. Burnt turf was present in the stoke-pit. Seemingly a variety of fuels was used in the hypocaust system, at least for the last fires.

In the hot dry room, sieved from 100cc of light brown clay from the drain-fill, unburnt hazel nut fragments were found; they consisted of over 80 fragments representing perhaps half a dozen hazel nuts. The only other plant material was a single rush seed.

The upper 80mm of a column of stony silty clay from the warm room yielded three achenes of *Fragaria vesca* (strawberry), one of *Potentilla palustris* (marsh cinquefoil) and a seed of *Sagina* sp (pearlwort), all unburnt. These could represent part of the original flora washed in with the clay but the *Fragaria* and *Potentilla* are unlikely to have grown together. It is tempting to interpret these finds as evidence of the Romans enjoying local fruit and nuts while relaxing in the hot dry and warm rooms of the bath-house.

13.9.8 Latrine

Ten samples from the rubble fill, flagged floor, sponge channel and drain inside the latrine, together with four from outside it, contained burnt plant remains. Charcoal is present in most samples, one fragment is from wood 50mm in diameter, another from wood originally of 240mm or more in diameter and these presumably represent structural timbers. Roundwood composed of alder, 6mm, 7mm and 30mm diameter, hazel, of 4mm–14mm diameter and willow 4mm–12mm diameter, are probably the remains of wattle. There is also a piece of hazel roundwood of 25mm diameter and 35mm long which appears to have been cut vertically. Fragments of birch, hazel and oak were also found. Small fragments of mainly clay-covered burnt rushes, of 2mm to 3mm across and up to 5mm in length could represent rush-tempered daub.

Samples from a 200mm depth of sandy, clayey silt from the drain running diagonally under the paving of the latrine were examined for possible signs of sewage; they contained numerous rush seeds. It is just possible that the seed derived from rush thatch, although rush seeds were also common in the clay subsoils of the fort. A similar sample from the lower fill of a drain beneath the floor yielded a few burnt heather stems with two fragments of burrs from bark, similar to material from the drain running south from the stoke-hole.

13.9.9 Conclusion

The finds of wood, charcoal and associated burnt plant remains from all contexts are summarised in table 13.9. Alder, hazel, oak and willow were commonly used, ash and birch less so and single finds of gean and rowan are tentatively identified. Alder in particular with some oak and ash were used as structural timbers; oak planks or boards were used in one of the barracks. Although no post-hole had been disturbed by the removal of its content, the evidence for posts is equivocal. Of seven post-holes containing charcoal, four have more than one type the others are of alder. The wattles of the timber buildings were mainly of hazel and willow with some alder. Rushes seem to have been used to temper clay daub and probably for roofing thatch although evidence for this only remains for either the north granary or one of the barracks. Fuel used in the hypocaust was mainly of timbers with a little evidence for the use of peat and turf.

At Falkirk, on the eastern part of the Wall, a hypocausted Antonine building produced large charred timbers (Dickson, C 1981: 258). Shaped pieces of ash were found with timber of alder and birch also indicated; oak timber seems to have been less commonly used.

Alder, ash, birch and elm have been used as structural timbers at other forts in Britain (Hanson 1978: 299, table 2) although oak was the preferred timber because of its durability.

Pollen evidence from Bearsden and turf analyses from other forts on the Antonine Wall suggests that alder and hazel were relatively plentiful but oak and birch sparse; ash and willow pollen are probably under-represented. It seems most probable that local wood was used in the forts along the Antonine Wall and the shortage of oak timber resulted in the extensive use of alder and to a lesser extent ash timber. Alder, ash, birch and willow are not durable timbers and would only last a few years in contact with the damp ground. The two exotic woods, silver fir and spruce are believed to have derived from artefacts.

13.10 INTERPRETATION OF POLLEN ANALYSES

The interpretation of the pollen analyses in terms of the vegetation they represent is complicated by several factors:

1. differential preservation, especially in silts and aerated samples such as rampart turves;
2. different pollen sources:
   (a) rampart turves: pollen is local and regional in origin;
   (b) ditches during the occupation: pollen is local and regional, assuming the ditches are regularly cleared of plant growth or conditions preclude plant colonisation;
   (c) ditches after the occupation: over-representation of local pollen, eg aquatic grasses, marsh plants, tree and shrub overgrowth.

Differential preservation of pollen and spores is well known and the literature is summarised by Birks and Birks (1980: 187–8) with a table showing the order of susceptibility to corrosion. Perhaps the experimental work by Havinga (1971) into pollen preservation in river clay soils is the most relevant here. Spores such as *Polypodium* (polypody) and pollen of Compositae of the dandelion type are highly resistant to corrosion, other relevant pollen types in descending order of resistance are *Quercus* (oak), *Betula* (birch), *Salix* (willow), *Ulmus* (elm), *Alnus* (alder), *Corylus* (hazel) and *Myrica* (bog myrtle). At Bearsden the unidentified pollen, particularly abundant in the rampart turves is probably mainly of Graminese, Coryloid and *Betula*, these being particularly difficult to identify when crumpled and deteriorated.

The interpretation of the tree pollen component is further complicated by the nature of the woodland; for instance one tree in an open position may disperse more pollen into the surrounding area than a dense stand of trees. Willow is insect pollinated therefore its pollen dispersal is not as effective as that of wind pollinated trees. The many factors affecting pollen dispersal and deposition are summarised by Birks and Birks (1980: 179–83). The distance of the woodland from the sampled area is important; Tinsley and Smith (1974) have shown a very rapid decline in arboreal pollen within 100m of a woodland edge bounding onto heather moorland.

Caseldine (1981) has taken surface pollen samples at 10m intervals along transects across a small raised bog and through birch woodland into pasture and similarly through the woodland into tall grass. In the birch woodland the pollen is predominantly of birch, 50 to 90% of the total pollen, but in a distance of 50m into pasture birch has dropped to only 5 to 15% of total pollen. There is an interesting distinction between samples in tall grassland and those in pasture. There is less difference than might be expected between the range of variation of grass pollen; about 30 to 76% in pasture and 40 to 66% in tall grassland. However, the contribution of *Corylus* (hazel) pollen ranges from 3 to 20% in pasture but is less than 5% in tall grassland and even lower in the other plant communities. Other values which are higher in pasture are *Alnus* (alder), 2 to 14%, *Calluna* (heather), + to 12%, the tree and shrub pollen range from 15 to 50% of the total pollen. Caseldine states that hazel and alder pollen are derived from hedgerow and regional sources. It would appear that the regional pollen rain is more widely represented in the pasture where local pollen is less abundant due to grazing.

The pollen spectra from the Roman deposits of the outer east annexe ditch and those from the rampart turves are rather similar to these twelve pasture samples in relative values of alder, hazel, heather and grass pollen and in the proportion of tree and shrub to that of herb pollen. The similarity between the high proportion of birch pollen in the top two samples from the outer east annexe ditch and that from the birch woodland is also noteworthy. In addition to the variable contribution of local pollen the variation between the different proportions of pollen in Caseldine's (1981) surface samples is shown to be closely related to the distance from the main source of pollen. One of the differences between the rampart turf analyses and those from the outer east annexe ditch lies in the higher proportion of Coryloid pollen in the turves and the generally lower values of alder. This could represent a difference in exploitation of the woodland before and during the life of the fort or merely different distances from the pollen sources.

Can we then deduce the plant cover of the cleared area represented? We may assume the pollen in the turves and occupation levels of the ditches is coming from a wide area around the fort with a limited local component. The turf analyses with grass values from 6 to 33% and heather from 7 to 47% suggest irregularly grazed areas with local patches of heather. Established pasture with wet areas is indicated from the macroscopic plants and the other pollen evidence. Well-cleared established grassland would be essential to cut the large quantities of turves needed for the rampart walls. By analogy to the recent surface samples already discussed the tree and shrub proportion varying between 27 and 64% of the identifiable land pollen of the turves suggests that there is considerable clearance of local woodland. However individual trees, copses or even large areas of woodland probably remained around the fort. Similar conditions seem to have existed during the life of the fort as the samples from the outer east annexe ditch and inner and middle west ditches show. The post-occupation ditch overgrowth is so clearly dominated by local trees and shrubs, from evidence of anthers and larger plant remains, that subsequent changes in the tree cover outside the fort would not be apparent.

13.11 THE WOODLAND AROUND BEARSDEN

Although there is a lack of well radiocarbon dated, pollen-analysed cores for central Scotland, covering the period when natural undisturbed woodland was gradually cleared by prehistoric man, nevertheless we can deduce with some confidence the composition of the original 'wild wood' in the area. From data collected by Birks (1977) in central Scotland and pollen analyses from the Loch Lomond basin (Dickson, J H et al 1978), it seems that the forest was predominantly of oak with birch, alder and willows on wetter soils and ash and elm on richer soils; pine is thought to have been very local, not forming, extensive forests.

At Mugdock, 5km to the north of the Bearsden fort, on similar glacial drift, there is a managed remnant of semi-natural woodland. This once coppiced wood supports oak, alder, ash, birch, bird-cherry, blackthorn and gean, with hazel at the margins. The removal of such woodland for pasture would, with light grazing pressure, give rise to heather and bracken; heavier grazing combined with burning would result in grassland. Uncleared wet areas would retain alder and willow carr and accompanying marsh and fen plants. Depending on the intensity of grazing and burning, seedlings of birch and willow, oak and hazel would, from fossil pollen evidence, soon be established (nowadays animals prevent hazel becoming established from seed). Hazel can also regenerate from underground stools each producing 20 or more poles. The deliberate removal of trees at or just above ground level, known as coppicing, is one of the bases for managing woodland; hazel is one of the fastest growing coppice trees, cropping of poles can continue indefinitely and hazel can even flower and fruit on a five-year coppicing cycle (Rackham 1980: 208). Most other deciduous trees will also coppice; some, but not hazel, can also be pollarded (Rackham 1976: 34), an advantage if animals such as cattle and deer, which browse on tender young coppice shoots, are present. Both coppiced and pollarded poles grow faster and straighter than most seedlings. Some fast growing willows grow up to six feet in a season. Traditionally coppice has been cut principally for hurdles, fencing and wattle.

It must be stated that we have little direct evidence of coppicing or other form of woodmanship in Scotland before slight evidence from the medieval period (see Addendum F). We know little of Roman woodland management in Britain. The art of coppicing was certainly known to the Romans and Rackham (1976: 51) considers that a permanent coppice system would be needed to maintain all the Roman industry and the building of forts and villas. Hazel coppicing is suggested from pollen evidence from about 250 BC onwards in Shropshire, England (Turner 1965: 351).

Is there any evidence of woodland management from the pollen, wood and charcoal from Bearsden? Certainly substantial clearing and thinning of the woodland before the fort was built is implied from the pollen evidence with oak no longer the dominant tree. Hazel values are relatively high, especially in the turf analyses. High alder values are as would be expected; alder-willow carr is still found in undrained areas to the north of the fort; willows do not distribute pollen over a wide area so their small pollen contribution is unremarkable.

Most of the wood and charcoal from Bearsden is of alder, hazel and willow; oak is less frequently present and birch even less common. It is not possible to say whether any grew from coppiced shoots, no long straight lengths have been preserved. However much of the wood is of small diameter (illus 13.8) and was probably used as wattle, it therefore would of necessity be in straightish lengths and could be the product of woodland management.

13.12 THE PLANT COMMUNITIES

From knowledge of present day plant communities it is possible to reconstruct some of the main types of vegetation which existed in the vicinity of Bearsden during and immediately after the occupation. It can be assumed that those species which grew just after the fort was abandoned did so from dormant seed or from seed dispersed from nearby.

Some 180 taxa of flowering plants, ferns and mosses are represented as pollen, spores, seeds and other vegetative remains. Many of these plants have specific requirements and have been grouped in the communities in which they are most commonly found in the area at the present time but they are not necessarily exclusive to these groups.

Weeds of cultivated and waste ground

Those plants which are represented as seed fragments thought to have been brought in with the wheat are excluded.

Chenopodium album (fat hen), *Poa annua* (annual meadow-grass), *Polygonum aviculare* agg (Knotgrass), *Rumex obtusifolius* (broad-leaved dock), *Sonchus asper* (spiny sow-thistle), *Spergula arvensis* (corn spurrey), *Stellaria media* (chickweed) and *Urtica dioica* (stinging nettle).

Heath and mire plants

Calluna vulgaris (heather), *Danthonia decumbens* (heath grass), *Erica cinerea* (bell heather), *E. tetralix* (cross-leaved heath), *Eriophorum vaginatum* (cotton-grass), *Juncus squarrosus* (heath rush), *Potentilla erecta* (common tormentil), *Salix repens* (creeping willow), *Vaccinium myrtillus* (bilberry) and the mosses *Hylocomium splendens* and *Polytrichum* sect *Juniperifolia*. Wet areas, often peat forming: *Aulacomnium palustre* (moss), *Sphagnum imbricatum*, S. *papillosum* (bog mosses).

Deciduous woodland

Trees and shrubs: *Betula pubescens* (birch), *Corylus avellana* (hazel), *Fraxinus excelsior* (ash), *Prunus* cf *avium* (gean), *Quercus* sp (oak), *Sorbus aucuparia* (rowan), *Ilex aquifolium* (holly). Climbing plants: *Hedera helix* (ivy), *Lonicera periclymenum* (honeysuckle). In open woodland: cf *Conopodium majus* (pig nut), *Fragaria vesca* (wild strawberry), *Hyacinthoides* (*Endymion*) *non-scriptus* (type) (bluebell), *Rubus fruticosus* agg (blackberry), *R. ideaus* (raspberry), *Silene dioica* (red campion), *Solanum dulcamara* (bittersweet), *Stellaria holostea* (greater stitchwort); ferns: *Dryopteris* felix-mas (type), *Pteridium aquilinum* (bracken); mosses: *Eurhynchium striatum*, *Mnium hornum*, *Thuidium tamariscinum*, other mosses and a fern commonly found in shady places include *Eurhynchium praelongum*, *Homalothecium* *sericeum*, *Isothecium myosuroides*, *Neckera complanata* and *Polypodium vulgare* agg (polypody).

Wet woodland

Trees and shrubs: *Alnus glutinosa* (alder), *Salix* spp (willows), sallows, which are not readily distinguishable on pollen or wood anatomy from willows, are included, herbs: *Myosotis sylvatica* (wood forget-me-not), and many of the fen and marsh plants listed subsequently, mosses: *Calliergon cordifolium*, *C. cuspidatum*, *Sphagnum palustre* and the epiphytic *Ulota* sp which grows in humid places.

Grassland

Agrostis app (bent-grasses), *Campanula rotundifolia* (harebell), *Holcus lanatus* (yorkshire fog), *Hypochaeris radicata* (cat's ear), *Lathyrus pratensis* (meadow vetchling), *Linum catharticum* (purging flax), *Plantago lanceolata* (ribwort plantain), *Poa* (cf) *pratensis* (smooth-stalked meadow-grass), *P.* cf *trivialis* (roughstalked meadow-grass), *Prunella vulgaris* (self-heal), *Ranunculus acris* (meadow buttercup), *R. repens* (creeping buttercup), *Rumex acetosa* (sorrel), *Stellaria graminea* (lesser stitchwort), *Trifolium repens* (white clover) and the mosses *Rhytidiadelphus squarrosus*, *Pseudoscleropodium purum*. Two other mosses, *Ceratodon purpureus* and *Hypnum cupressiforme*, perhaps occurred in such a habitat. Wet places in grassland and open woods; *Jincus acutiflorus*/*articulatus* (sharp flowered/ jointed rush), wet pasture and damp wood. *Juncus effusus*/ *conglomeratus* (soft rush).

Fen and marsh

Where the summer water table is usually below the surface but liable to winter flooding: *Caltha palustris* (marsh marigold), *Carex nigra* (common sedge), *C.* cf *paniculata* (panicled sedge), *Deschampsia caespitosa* (tufted hair-grass), *Eleocharis palustris* (common spike-rush), *Epilobium* cf *obscurum* (dull-leaved willow-herb). *E. palustre* (marsh willow-herb), *Filipendula ulmaria* (meadow-sweet), *Glyceria fluitans* (flote-grass), *Lotus uliginosus* (*pedunculatus*) (type) (large birdsfoot-trefoil), *Lychnis floscuculi* (ragged robin), *Lycopus europaeus* (gypsywort), *Phalaris arundinacea* (reed-grass), *Potentilla palustris* (marsh cinquefoil), *Ranunculus flammula* (lesser spearwort), *Valeriana officinalis* (common valerian), *Viola palustris* (marsh violet).

Semi-aquatic

Exposed mud with water standing in winter such as the muddy margins of ditches: *Alopecurus* cf *geniculatus* (marsh fox-tail), *Bidens cernuus* (nodding bur-marigold), *Catabrosa aquatica* (water whorl-grass), *Isolepis setacea* (bristle sedge), *Juncus bufonius* (toad rush), *Lythrum* (*Peplis*) *portula* (water purslane), *Ranunculus sceleratus* (celery-leaved crowfoot), *Rorippa palustris* (marsh yellow-cress).

Aquatic

Floating leaved and submerged vegetation often grading into reedswamp: *Lemna* cf *minor* (duckweed), *Nymphaea alba* (white water-lily), *Potamogeton berchtoldii* (small pondweed), *P. natans* (broad-leaved pondweed), *Sparganium* cf *minimum* (small bur-reed). Shallow water or damp mud: *Callitriche stagnalis* (starwort), *Ranunculus* subg *Batrachium* (water crowfoot).

The picture of the landscape we can derive from these plant communities is one of mixed woodland, at least partly cleared or thinned with shrubs, herbaceous plants and mosses in light shade. Low lying areas supported wet woodland and fen and marsh plants. Grassland developed on heavily grazed and burnt areas with bracken and heath where the pressure from man and animals was less, and rushes in damper grassland. Weeds grew in waste ground around habitations. Pools and streams supported floating water plants fringed with aquatic grasses, reeds and rushes; muddy margins had low-growing vegetation. Bog mosses and cotton grass must have derived from peat bogs. This diversity of habitats can be matched in areas a few kilometres to the north of Bearsden at the present time; most of the plants represented still grow in the county, a few have reduced their ranges due to drainage and cultivation but still grow in the west of Scotland.

The local environment envisaged at Bearsden would provide most, if not all, of the building materials needed for the fort in the form of wood and rushes for building, wood and peat for fires, bracken and heather for bedding and marsh hay for fodder. Local fruit in season would supplement cereals and pulses, together with herbs and fruit for medicine and flavouring, all possibly imported although medicinal plants such as mallows may have been cultivated at Bearsden.

13.13 COMPARISON WITH OTHER SITES

13.13.1 Pollen analyses

Pollen analyses of sites in the north-east of England, mainly from south of Hadrian's Wall, have shown substantial clearances both before and during the Roman occupation (Turner 1979). Most of the sites have been radiocarbon dated and Turner says 'that the native British populations of the two centuries before and early first century after Christ cleared woodland, maintained pasture and grew crops on a totally different scale from that of their predecessors in both the uplands and lowlands, and that the cleared land remained in use throughout the Roman occupation'.

At Vindolanda on Hadrian's Wall, from the civilian settlement dated from 100 to 125, the base of a marshy hollow produced small amounts of tree pollen and evidence of pasture and arable farming (Davies & Turner 1979). Fellend Moss, sampled less than 0.2km south of the Wall, is 9.3km west of Vindolanda; the pollen profile through the bog shows that much of the forest was cleared and the land used partly for growing crops at or just before the time of the Roman occupation (Davies & Turner 1979). However, in the north-west of England extensive clearance dates from after the Roman withdrawal and starts about 400 (Turner 1965: 353).

Unfortunately there are very few radiocarbon dated pollen analysed sites of Iron Age or Roman date in central Scotland. At

Bloak Moss, Ayrshire, 32km south-west of Bearsden, extensive clearance does not begin until about 450, although there are small temporary clearances of Bronze Age date (Turner 1965: 348–9; Turner 1975). At Flanders Moss, Stirlingshire, 26km north-east of Bearsden, extensive clearance began at about AD 200 (Turner 1965: 352). From the southern basin of Loch Lomond, 22km north-west of Bearsden, high grass and ribwort plantain values begin at about the same time (Dickson, J H et al 1978). These three areas, however, are considerable distances from the Antonine Wall and would not reflect local clearances along the Wall. See Addendum G.

There are turf analyses from Roman forts in Scotland and north-east England; unfortunately for none of the following turf analyses are numbers of pollen grains given. From Northumberland, at Benwell on Hadrian's Wall (Simpson & Richmond 1941) mainly hazel and alder with small amounts of herbaceous pollen were recorded. To the north of the Wall at Risingham and High Rochester (Richmond 1936: 196), birch was common with small amounts of hazel and alder and abundant grass pollen; Chew Green (Richmond 1937: 149) produced abundant heaths, a little grass and scarce hazel pollen. These forts therefore indicate extensive pre-Roman forest clearance both on and to the north of the Wall with varying amounts of light woodland, heath and grassland.

In Scotland at Fendoch, Perthshire, rampart turf produced 'a very small percentage of pollen about equally grass-spores and hazel-alder pollen' (Raistrick 1939: 154). This evidence from Roman forts has been summarised by Hanson and Macinnes (1980: 96–102). At Birrens, Dumfriesshire, an analysis by Beck in Wilson (1975) from the early Antonine well shows evidence for woodland and high values for grass and heather, the latter especially may be associated with abundant larger plant remains, there are no definite indications of agricultural activity.

Pollen analyses by Boyd (1984), however, have added substantially to our knowledge of the local vegetation from before the Roman presence up to the time of the construction of the Antonine Wall. Boyd analysed four turves from the Antonine fort at Bar Hill and one from the Agricolan fort (about 80–90) at Mollins, both 15km to the east of Bearsden. All the turves contained abundant well-preserved pollen and up to ten samples were analysed through each turf showing striking changes in the proportions of various pollen types during the time taken for about a 100mm thickness of turf to accumulate. The main changes are interpreted by Boyd as representing initially pre-Roman open woodland, regenerating from earlier probable, but unrecorded, forest clearance. By 80–90 a period of increased pastoral activity was accompanied by possible deliberate clearance of *Quercus* in the vicinity of Mollins. By about 142, when the Bar Hill turves were cut, there was an open landscape with a mosaic of *Calluna* – and grass – dominated rough grazing. The pollen profiles from the uppermost parts of the Bar Hill turves show steadily decreasing values for *Alnus* and *Coryloid* pollen, constantly low values for *Betula* and *Quercus* and rising values for *Calluna* and *Gramineae*. These proportions are essentially similar to these from the Bearsden turves. There are also other indications of an open pastoral landscape in the western part of the Antonine Wall from Wilderness West, 5km east of Bearsden (Newell 1983: 243) and from Croy Hill about 18km to the east (Robinson forthcoming). There is very little evidence of arable farming at any of these sites.

From the turf evidence then, it seems that in the Bar Hill area at least closed woodland was largely removed by native peoples and pasture established well before the Agricolan campaign. This clearance continued up to the establishment of the Antonine forts as is recorded between Bearsden and Croy Hill and there was little change in this open pastoral landscape during the early period of occupation as evinced from Bearsden.

13.13.2 Macroscopic plant remains

As shown in table 35 of selected Roman military sites, those in Britain and Welzheim in Germany have produced much useful information on the soldiers' diet. It is notable that only at sites which have remained waterlogged have the full range of cereals, pulses, culinary/medicinal plants and fruits and nuts been preserved. Useful plants from thirty two deposits from Roman military and non-military sites from Germany have been tabulated by Körber-Grohne et al (1983: table 7), together with a supplement of seeds from green vegetables and other less commonly found plants.

Avena spp (oats) contribute only a small proportion of cereal grains. Species have only occasionally been listed; one such is from an Antonine Wall site where Jessen and Helback (1944) identified *A. sativa* (common oats) and *A. strigosa* gp (black oats) which comprised about half a small sample of grain. *Hordeum vulgare* (six-row barley) forms a varying proportion of the grain. It is rarely possible to determine whether this was used as food, beer or animal feed. From the Lancaster evidence it appears that a variety of grain was fed to horses. *Secale* (rye) is absent or present in only small amounts in Scotland whereas in one sample from york, and probably also from Caerleon, it forms a substantial proportion of the grain. *Triticum aestivum* sl. (bread or club wheat) is sometimes present but only in small amounts. The glume wheats seem to have been the most important grains consumed and *T. spelta* (spelt) appears to be more common than *T. dicoccum* (emmer). Most of the indeterminate wheat from Scotland is probably of these two glume wheats.

Pulses rarely feature in the fossil record and *Lens* esculenta (lentil) and *Vicia faba* (horse bean) have only rarely been found in the British military sites. However, together with *Pisum sativum* (pea), they occur in thousands at the German military hospital at Neuss (Knorzer 1970; Körber-Grohne et al 1983).

Plants of culinary/medicinal use are *Anethum graveolens* (dill), *Apium graveolens* (celery) and *Coriandrum sativum* (coriander), these are the most commonly found spice plants in Britain and Germany. *Linum usitatissimum* (Linseed, flax) and *Papaver somniferum* (opium poppy), sometimes categorised as oil plants, have been less frequently preserved.

In Britain and Germany *Ficus carica* (fig) is the most commonly imported fruit but *Vitis vinifera* (grape) is present in northern Britain, presumably as dried fruit, for instance at york 2 (not tabulated). Remains of wild fruit are often found in some abundance, in particular those of *Fragaria vesca* (strawberry), *Rubus fruticosus* agg (blackberry) and *R. idaeus* (raspberry). Sloes and cherries have been recorded from Britain (Davies 1971: 132) and the range of fruit is greater in the more southerly German sites (Korber-Grohne et al 1983).

Nuts of *Corylus avellana* (hazel) have been found and *Juglans regia* (walnut) has been recorded from another Antonine Wall fort (Macdonald & Park 1906: 129), the latter presumably not grown locally; walnuts have also been found in Germany.

Although we have as yet only a little evidence from Britain, the similarity in food plants between forts in Scotland, north-east and north-west England, south Wales and Germany is clear, embracing the furthest north-west corner of the Roman empire to the south-east of Germany in this limited survey. Overall the implication is that many of these plant foods were standard supplies and it can be no coincidence that, with the exception of seasonal fruit, all can be kept for many months with little or no deterioration.

It must not be forgotten that animal products were readily eaten when available. The presence of bones of both domestic and wild animals and wild fowl together with molluscan shells from forts in Britain and Germany is tabulated by Davies (1971: 127–30). Davies also reviews the evidence from archaeological and literary sources for plant foods and alcoholic beverages and considers 'the basic diet, then, in peace-time will have consisted of corn, bacon, cheese, and probably vegetables to eat and sour wine to drink' (Davis 1971: 125). Although bacon and cheese would leave no discernible record, perforated vessels thought to have been used for cheese making have been found at various military sites; one from the Antonine Wall is illustrated by Robertson et al (1975: 161, fig 54, 21).

At the present time it seems unlikely that any of these plant foods were provided by the native populations in Scotland, excepting perhaps some of the cereals. However in Scotland we lack in general native water-logged sites where such evidence might have survived.

Work in progress shows that imported plant foods were certainly eaten in colonia in northern England, for instance in Carlisle (Donaldson & Rackham 1984) and york (Hall et al 1980: 143–4). Towns in southern England were, of course, importing a wide range of foods even before the conquest.

13.14 SUMMARY OF THE PLANT REMAINS

The outer east annexe ditch filled with sewage during the occupation of the fort and was sealed in by subsequent plant growth. The study of plant remains from the sewage has revealed that wheat formed a major part of the soldiers' diet. Two species of primitive wheat were ground, sieved and cooked. Experimental processing and cooking, supported by literary evidence, indicate that emmer wheat could have been used for porridge, whereas spelt wheat was probably made into bread. Barley appears to have been used, in small quantity only, as pearl barley probably for thickening broth. Figs, and the spices coriander, celery and dill, with the oily seeds of linseed and opium poppy together with pulses were consumed. Some or all were imported from the Mediterranean region. The flowering parts of common mallow appear to have been eaten, possibly as a prophylactic. Local fruit and nuts formed part of the diet. Mosses were used, perhaps for toilet purposes.

Comparisons with other military sites in Britain and one in south-east Germany indicate that the Roman military diet was remarkably uniform and that cereals, pulses, figs, spices and oil seeds must have been standard supplies.

A depression within the fort remained open during the occupation, probably for drainage. There is slight evidence for hay in this and two of the ditches although all except the outer east annexe ditch appear to have been regularly cleaned out.

The pollen analyses from the rampart turves indicate that there was established pasture before the fort was built and ditch analyses show little change in the open vegetation during the occupation. All the excavated ditches give evidence of the vegetation that developed after the fort was abandoned resulting in its eventual overgrowth by trees.

A variety of local woods were used for timber and wattle buildings, some at least were thatched with rushes. A wattle breastwork topped the ramparts. Rare finds of silver fir and spruce woods suggest their importation as artefacts.

From the identification of the pollen and other plant remains it has been possible to reconstruct the types of vegetation in the vicinity of the fort. Woodland was light and mainly secondary having been exploited before and during the Roman presence; it was possibly restricted to copses and streamsides. Turf was cut from well-grazed pasture with damp rushy areas and drier heathy ones. Bracken and heather were gathered and peat bogs exploited for fuel. Grassland, marshes and fen would have provided meadow hay. Standing water in winter and permanent open water would have been common on the poorly drained predominantly clay soils. Apart from staple plant foods the local countryside provided much of the Bearsden garrison's needs.

13.15 FUTURE WORK

Now that a variety of Roman sites has been examined for evidence of the Roman diet and impact on the vegetation it is perhaps appropriate to consider future lines of research. Although there are undoubtedly defensive waterlogged ditches which have not been excavated at other Roman sites, it seems, from the evidence at Bearsden, that these are more likely to record only small amounts of wind borne plant material from the Roman fort and perhaps evidence of destruction debris, along with the local vegetation. Sewage is potentially the most valuable source of dietary evidence; however digested seed fragments seem to be present in very small numbers apart from cereal grain fragments. Infillings of pits and wells may give evidence of food and also of agricultural practices along with rubbish from other sources. Interpretation of pollen from rampart turves may be hampered by poor preservation, but pollen and larger plant remains will give the local vegetation in some detail. However in order to assess the impact of the Romans and indeed the native settlers on the vegetation, what is needed are highly detailed, closely sampled and well radiocarbon dated pollen analyses. The sites should be sources of regionally derived pollen rain,

Table 13.9
Selected useful plants from other Roman military sites in Britain and Germany

	SCOTLAND				*WALES*	*ENGLAND*			*GERMANY*
	Bearsden	*Castlecary*	*Lyne*	*Rough Castle*	*Caerleon*	*Lancaster*	*York 1*	*York 2*	*Welzheim*
Cereals	Numbers as a percentage of cereals								
Avena (wild/cultivated oats)	+	8	0.6	0.2	+	+	3.6– 5.6		0.2
Hordeum vulgare (six-row barley)	+	7.3	91.2	54.1	+	+	23.2– 25.0	1	1
Secale (rye)	+	–	–	–	? ++	+	9.4– 17.8		(+)
Triticum aestivum s.l. (bread/club wheat)	?	1.1	–	2.1	? +			1	(+)
T. dicoccum (emmer)	cf+	6.6	3.2	3.5		cf +	–		17
T. spelta (spelt)	cf+	10.8	2.6	5.6	++	cf +	54.8–61.0		78
Triticum spp (indeterminate wheat)	+	66	3.2	34.3		+	–		
Pulses	Non cereals as absolute numbers								
Lens esculenta (lentil)	cf+				C.40				?1/2
Vicia faba (horse bean)	cf+				3				1
Culinary/medicinal									
Anethum graveolens (dill)	3								7
Apium graveolens (wild celery)	12					4		cf 1	16
Coriandrum sativum (coriander)	5					5			23
Linum usitatissimum (flax)	2								56
Papaver somniferum (opium poppy)	2							cf 28	18
Fruit									
Ficus carica (fig)	22					1	3		55
Fragaria vesca (strawberry)	20							146	>268
Rubus fruticosus agg (blackberry)	2							147+ }	>2755
R. idaeus (raspberry)	6							>82 }	
Nut									
Corylus avellana (hazel)	2								57

* Cereals includes *Panicum miliaceum* (millet) 4% and *Triticum monococcum* (einkorn) 1%; (+) present in second-century pit.
x; variation between differenct counts, total 2,500 grains. +; present; ++; many.

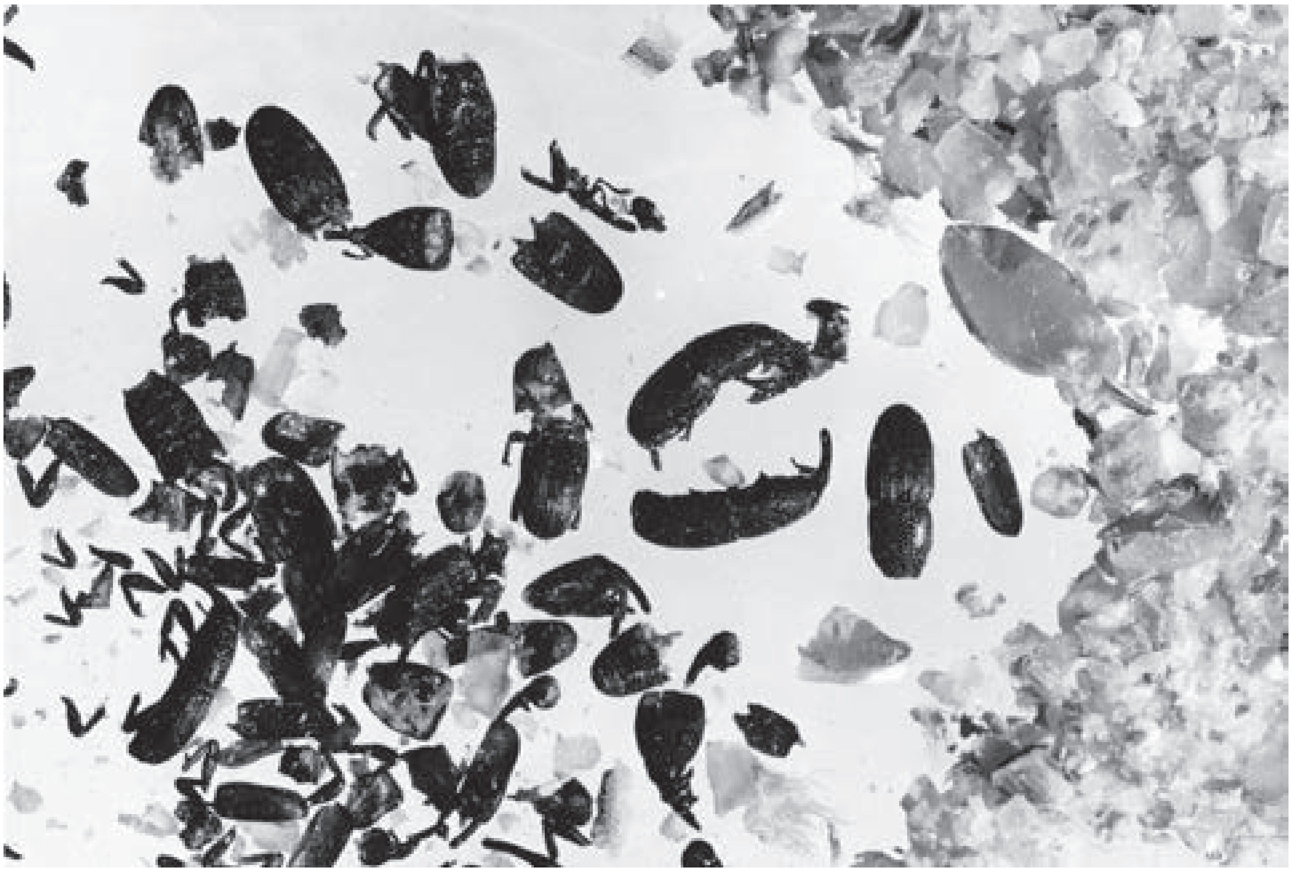

Illustration 13.9
Sitophilus granarius and emmer wheat groats after grinding in a rotary quern (see p 241). Photo: T N Tait.

preferably from lake basins close to Roman remains. It would then be possible to gauge farming practices and woodland management before, during and after the Roman occupation. See Addendum G.

APPENDIX 1: NOTES ON THE IDENTIFICATIONS

Pollen identification

Standard conventions are used. The name followed by type indicates that one fossil type is present, three or more taxa are possible but further identification does not seem possible. The name is of the genus or species most likely to occur on ecological or phytogeographical grounds.

Gramineae and Cerealia

The presence of grass pollen of at least 32µm diameter with pore annulus 8µm or more was noted using the method of Andersen (1979) taking the mean of the largest diameter and also that at right angles to it. Many of the larger and less well-preserved grains are folded and could not be measured, therefore it was not attempted to estimate frequencies.

According to Andersen (1979) large grains with a mean pollen size larger than 40µm together with a pore annulus diameter larger than 10µm are confined to species of *Avena* (oats including wild oats) and *Triticum* (wheat). The large grains of *Secale* (rye) are distinguished from those of other cereals by their asymmetrically placed pores and oblong shape. Andersen (table 3) gives means of eight collections of *Secale* as 40.1µm, annulus 8.9µm. None of the fossil grains is of the *Secale* shape and dimensions.

Large cereal grains (mean diameter 50.5µm, mean annulus 13.3µm) were found in the sewage levels of the east annexe ditch from 790mm downwards and from 550mm, just above the top of the sewage. Grains of *Avena* (oats) have a mean pollen size up to 44µm, mean annulus to 12µm; the means for *Triticum* spp (excluding *T. monococcum*) range from 42 to 50µm, annulus 11 to 14µm (Andersen 1979: table 3). It seems probable that most, if not all, these grains are of *Triticum*. Most of the grains are more or less folded and their surfaces are poorly preserved; if, as seems likely, they were adhering to the cereal pericarp and glumes and have been cooked and consumed their rather poor preservation is not surprising! From the inner west ditch grains have a mean diameter of 41.8µm, mean annulus 10.8µm; these are notably smaller grains, within the size range of *Avena* and *Triticum*, but are probably the latter since they are accompanied by wheat/rye grain fragments. Their smaller size suggests they have not been cooked and eaten.

Andersen defined a second group of grass pollen, mean pollen size 32–45µm, mean annulus diameter 8–10µm (Andersen 1979: 82). The measurements given below are from his figs 6 and 7 and table 3. Those species unlikely on phytogeographical grounds to be present at Bearsden have been excluded. Occasional grains, referable to the above group, were found in many of the samples from both occupation and post-occupation levels. Two size ranges appear to be present. Those with diameters 34–40µm, annulus 9–12µm resemble grains of *Elymus* (*Agropyron*) *repens* (couch grass); 30–45µm, means 37.3– 38.3, annulus 7.2–12.0µm, means 8.6–9.1µm, three collections measured. Couch grass is a common weed of cultivated ground and waste places and its presence in both Roman and post-Roman levels would be unexceptional. The second group, diameters 31–36µm, annulus 7–10µm can be matched within the size range of *Glyceria fluitans* (flote-grass); 28–41µm, means 31.6–35.9µm, annulus 7.2–12.0µm, means 8.9–10.6µm, six collections measured (pollen of *G. plicata* (sweet grass) falls within the same size range). Six of the 15 levels from which pollen samples were taken also contain fruit of flote-grass. Pollen of *Hordeum vulgare* (six-row barley), 32–43µm, means 36.3–39.1µm, annulus 6.0–10.8µm, means 8.0–8.6µm, three collections measured, is not thought to be represented. The annulus is generally smaller than that of the grains resembling *Elymus repens*, and the grain diameter generally larger than those of the *Glyceria* type. Due to the overlapping ranges in grain and annulus diameters with the species described here it does not seem possible to make definitive determinations especially on the small number of measureable grains. However, this data does suggest the presence of two wild grasses and absence of barley pollen.

Leguminosae

Lotus of *uliginosus* (*pedunculatus*) type pollen is distinguished from that of *L. corniculatus* on size. Birks gives size-frequency distribution curves for *Lotus* spp, the mean for *L. corniculatus* is about 19µm, that for *L. uliginosus* is 13µm, grains from Bearsden measured between 10 and 14µm (Birks 1973: 232).

Table 13.10
Measurements of cereal and large grass pollen

	Depth in mm				
	Roman	*Post-Roman*	*Number*	*Grain diam (µm)*	*Annulus diam*
Cf *Triticum* (wheat)					
East annexe ditch	790mm downwards	550	(12)	43–55 (50.5)	11–16 (13.3)
Inner west ditch	250		(8)	40–46 (41.8)	10–11 (10.8)
Cf *Agropyron repens* (couch grass)					
East annexe ditch	590, 610, 960, 1200	520,550	(15)	35–41 (37.2)	9–12 (10.0)
Depression		60, 80, 100	(10)	35–42 (38.0)	9–12 (10.5)
Outer west ditch		10, 40, 70	(13)	36–40 (38.6)	10–12 (10.5)
South ditch		980, 1060	(6)	34–40 (36.6)	9–11 (10.1)
East annexe rampart	180		(1)	38 (38.0)	9 (9.0)
Cf *Glyceria*					
East annexe ditch	610	550G	(5)	33–36 (34.2)	7–10 (8.4)
Depression		60G, 100G, 150G, 200, 250			
			(14)	31–36 (33.3)	7–9 (8.3)
Inner west ditch		500G	(3)	33–35 (34.0)	7–10 (8.3)
Middle west ditch	mid-silt		(2)	32 (32.0)	8 (8.0)
Outer west ditch		10G, 40, 70	(3)	31–34 (33.0)	8–10 (8.8)
South ditch		800, 980, 1060	(10)	32–36 (35.0)	8–9 (8.6)

G = *Glyceria fluitans* fruit present.

Fruits and seeds

Cruciferae

Brassica rapa ssp *sylvestris*, syn *B. campestris* ssp *campestris* (wild turnip, wild navew).

This species is represented by two black seeds which, though incomplete, appear to have been spherical, they are 1.1 and 1.3mm diam, each with a clear reticular pattern. The seeds are distinguished from those of *B. oleracea* (wild and cultivated cabbages) and *B. napus* (swede) by their spherical shape, clear reticulation and smaller size. Seeds of *B. nigra* (black mustard) are small (1.0mm–1.5mm) but the surface reticulations are thick and cord-like. Seeds of *B.rapa* spp *rapa* (cultivated turnip), a plant known to the Romans, are larger. M Fraser has studied seeds of *Brassica* spp and concluded that seeds of the wild subspecies are generally smaller than those of spp *rapa* although the diameter ranges overlap (Fraser 1981). Her measurements, with those from a number of published sources, give diameters of over 1.4mm for seeds of *B. oleracea*, *B. napus* and *B. rapa* spp *rapa*. The combination of small size and well-defined reticulation suggest that these seeds are referable to the wild spp *sylvestris*. Carbonised seeds, 1.1–1.5mm, of this type of Iron Age date have been found at Bu Broch, Orkney (Dickson, C 1987b).

Cf Raphanus sp (wild or cultivated radish) (illus 13.3, b)

Two reddish testa fragments, the larger 1.3mm × 1.2mm, were recovered from the sewage. Both have small angular polygonal cells mainly 7µm–18µm diameter, each with a small rounded lumen. One fragment also has an outer layer of palisade cells of unequal height forming a larger overlying network (illus 13.3, b). The other fragment lacks this network but has occasional large cells of *c* 25µm. Seeds of wild and cultivated *Raphanus* spp exhibit both cell types. The fragments are distinguished from those of *Brassica* spp mainly by the smaller size of the inner palisade cells; the testa cells of *Sinapis arvensis* (charlock) lack a large network and are uniformly small.

Graminae (grasses)

Grass grains were identified by reference to the keys and photographs in Körber-Grohne (1964). The identifications are based on the shape and size of the grain and hilum together with the cell pattern as seen after treatment with dilute sulphuric acid as described for cereal grains. Unidentified grains are mainly poorly preserved; a few are of genera not represented in Körber-Grohne's work which describes about half the genera present in the British flora.

Cereal bran and wheat glume bases

In order to identify the cereal grain fragments it was found necessary to prepare reference cereal grains to simulate the fossil state. As described by Dickson, C (1987a) grains are first treated to remove the starch andaleurone and to degrade chemically the cells to resemble those found fossil. To simulate very degraded bran fragments it may be necessary to pound, grind or rub grain and cook it as porridge or bread as described in the crop processing section and, for barley, in subsequent notes. The cooked bran fragments may then be retrieved from the matrix and heated in small quantities with 5% hydrochloric or sulphuric acid for a few minutes or until the desired degree of degradation is reached. For wheat or rye this may leave only the two testa layers (illus 13.1, a) or some bran fragments as is frequently found fossil. Other fragments will retain some of the diagnostic transverse cells of the pericarp, often heavily degraded, and comparable with those of the better preserved fossil bran. The grain fragments are rinsed and any remaining starch and aleurone brushed away before mounting the bran in a water soluble medium such as Gurr's Aquamount.

Rare attached glume fragments, longitudinal and transverse cells of the pericarp, testa and aleurone cells (of wheat and rye) were all found in the Bearsden sewage and all vary greatly in their preservation. The transverse cells, essential for distinguishing between wheat and rye, are particularly poorly represented. A 5ml sample from each investigated level in the sewage was examined particularly for transverse cells and 25ml from a particularly well-preserved level. 1% sodium hydroxide was used for a few hours only to disaggregate the silt and minimise further damage to the delicate fragments. The best preserved bran fragments were mounted in Gurr's Aquamount and examined at ×100 and ×400. About 10% of these showed fragments of transverse cells still adhering to the testa. A quantative assessment was not possible as even from the 25ml sample only about twenty fragments proved identifiable. Detailed, illustrated descriptions of the bran layers of *Avena*, *Hordeum*, *Secale* and *Triticum* most commonly found in fossil are given in Dickson, C (1987a). Winton (1916) and, in more detail, Winton and Winton (1932) give comprehensive illustrated accounts.

Triticum/Secale (wheat/rye) (illus 13.1, a)

The vast majority of the cereal grain fragments are of this type and consist of two layers of parallel elongate cells approximately at right angles to one another. The upper layer is of transparent cells, the lower has varying amounts of brown pigment and sometimes cork cells.

Secale cereal (rye) (illus 13.1, d)

In well-preserved fragments the transverse cells overlying the testa in rye are distinguished from those of wheat by their greatly thickened rounded end walls. Unfortunately only rare cells protected by overlying cell layers or which have overriding end walls have retained their thickening in these sewage deposits. Most of the transverse cells have unthickened walls, sometimes losing the pitting of the side walls, a feature which more often remains on degraded wheat transverse cells. The other distinguishing feature of rye pericarp lies in the disposition of the longitudinal rows of the transverse cells; these are frequently interspersed with half or smaller cells. The dorsal part of a wheat grain can have small cells but these appear to be confined to groups or short longitudinal rows. It will be appreciated that small fragments of degraded wheat and rye pericarp cannot necessarily be distinguished. In this material only fragments with cells preserved from several rows across the grain are identified as rye. The short cells range from 30 to 55 × 22 to 25µm; the main cells range from 70 to 100

(–125) × (15–) 18 to 45µm. Rare fragments only, identified by these criteria, were determined from each level.

Triticum cf dicoccum (emmer)

Well-preserved transverse cells of emmer can be distinguished from those of *T. spelta* (spelt) and *T. aestivum* (bread wheat) by their shorter cells with less thickened walls. Also the end walls of emmer cells tend to be straight or slightly rounded, those of spelt clearly rounded and of bread wheat, angular. These distinctions are clearly shown by Körber-Grohne and Piening (1980), figs 6, 7 and 9). However, on these poorly preserved fossils where pitting and thickening is reduced or has disappeared, these characters are less obvious. Fragments were recovered from each of the examined levels. The transverse cells have straight or slightly rounded end walls, which measure 55 to 125µm × 10 to 18 (22)µm. Fossil fragments from the dorsal area with underlying tube cells show the greater range of cell sizes, those at the ends of the hilum are shorter as are those from the ends of the grain. Cells from the dorsal area are shorter than those from the sides of the grain. Nevertheless the range matches that from recent reference grains of emmer although the cell sizes of this emmer and the spelt/bread wheat cannot be compared directly with those given by Körber-Grohne and Piening (1980) which are taken from the sides of the grain. The transverse cell walls are thinner than those of spelt and do not seem to preserve as well. Some putative fragments are too poorly preserved to measure the cells; none of the fragments is sufficiently well-preserved to illustrate.

Triticum spelta/aestivum sl (spelt/bread wheat) (illus 13.1, b)

Rare fragments with fairly well-preserved transverse cells, with pitted or thickened side walls and more or less thickened slightly or clearly rounded end wall were recovered from three levels. The cells range from (80) 110 to 210 (280) × (15) 18 to 22µm. Mainly small fragments were found which though up to 26 cells deep are only two to three cells wise, although one fragment (illus 13.1, b) is 20 cells wide, there are no half cells. One fragment has tube cells preserved; these are only found in the dorsal region and ends of grain of *Triticum* species with the exception of *T. monococcum* (einkorn wheat) which has ubiquitous narrow tubes (Körber-Grohne & Pening 1980). These fragments are distinguished from those of emmer by their generally longer, broader cells which, having originally stouter cell walls, preserve better. The cells have weakly to strongly rounded end walls and resemble certain of those found in both spelt and club wheats (the latter formerly named *T. compactum*, now included with the bread wheats but seemingly distinct in some grain characters. Most fragments are darker and better preserved than those of the cf emmer. The clearest transverse cells are often those which have been replace by fungal hyphae (table 36, b) or protected by the outer pericarp. It must be noted that all the hexaploid wheats, which include spelt and bread wheats, are interfertile although tetrapoid wheats such as emmer do not produce fertile hybrids with hexaploid ones (Zohary 1971).

To see if processing and simulated ageing of the bran varied in its effect on the different cereals, small scale pounding and porridge making of hulled wheats and grinding and baking of wheat and rye meal for bread was attempted. After cooking the bran was heated with dilute acid for up to 40 minutes to simulate the degraded transverse cells of the fossil bran. It was noted that the thin transverse cells of emmer were mostly destroyed or highly degraded, those of spelt and bread wheats were less degraded and those of rye only slightly degraded. Some wheat bran fragments lost their transverse cells altogether. The relatively well-preserved state of the rye cells suggests that the rare fragments of recognisable rye bran probably represents its actual contribution to the cereal fraction, as a relatively uncommon weed in the crop.

Triticum diococcum/spelta (emmer/spelt) (illus 13.1, e, f)

After grinding or pounding, wheat glume bases become difficult to recognise (Ill oo c). All those from the sewage lack well-preserved veins, most are poorly preserved and not always readily distinguished from rachis segments. The 142 fragments from three samples (they were probably overlooked in other sewage levels) which have been tabulated as glume bases include some rachis segments. Well-preserved glume bases may be identified. Körber-Grohne et al (1983: pl 6) shows the differences in the sinuous walls of the long cells; those of spelt are zigzag whereas those of emmer are rounded. Occasional glums of emmer and rare ones of spelt were tentatively identified by the preservation of these cells (illus 13.1, e, f). Glume bases of emmer are usually as thick as they are broad and tend to be narrower than those of spelt as shown by Körbe-Grohne et al (1983: fig 15). Using the criteria of shape or cell pattern, several of the glumes together with the smaller rachis segments have been tentatively identified as those of emmer (illus 13.1, c). Those which, from their size and cell pattern, could be of spelt are rather rare. As is pointed out in the crop processing section, spelt glume bases sometimes shatter in the processing and thus are likely to be under-represented when only sieved bran is present; this is shown on the flow diagram.

Hordeum (barley) (illus 13.1, h, i, j)

The fossil grain fragments of barley show two distinct states of preservation. Most are dark brown, usually stouter than those of wheat though equally fragmentary as though ground with the wheat and rare fragments occur throughout the sewage. The testa cell wall appears double as though two layers of nearly identical cells are superimposed (Dickson, C 1987a: pl I). Fragments which include the hilum may show a line of darker pigment parallel to and about 1mm from the hilum on either side (illus 13.1, h), similar lines can be seen on the dorsal face. These lines, left by the adjoining glumes, are seen on hulled barley grains, they have not been seen on naked grains.

The other barley grain fragments each consist of a more or less intact hilum up to 7mm long and 70µm wide; the testa extends from 1mm to 3mm on either side of the hilum (illus 13.1, i). The very delicate testa is mainly transparent with occasional much degraded diagonal brown cells and the elongate perisperm cells may be visible (illus 13.1, j). One fragment has well-preserved transverse cells 30 to 70 × 10 to 20µm in two or more layers (illus 13.1, j), presumably a chance preservation protected by the overlying tissues in the ventral furrow. Ten of these fragments were recovered from 1.18m to 1.20mm and one each from 98mm to 1m and 690mm to 700mm.

Similar transparent fragments were obtained by adding water to reference grains of hulled barley in a mortar, dehusking by rubbing with a pestle or mallet and floating off the chaff. The process was adapted from the traditional Scottish method of processing barley to thicken broth or soup described by Fenton (1978: 396). The resultant whole grain, but with somewhat abraded tissues on the dorsal and ventral faces, was simmered in water for three or four hours. After subsequent heating with 5% hydrochloric or sulphuric acid in a water bath for at least five minutes, the pericarp and aleurone layers were removed leaving the hilum and now transparent testa. Pearl barley, when similarly cooked, produces rather similar testa fragments but with only about 1mm preserved on either side of the hilum due to the modern more thorough rounding of the barley kernel. Prolonged cooking seems necessary before the cell contents disappear and the cell walls break down into degraded state of the fossils.

Avena (wild or cultivated oats (table 13.1, g)

Rare fragments only were recovered, the hilums are incomplete and about 40µm wide. Hilar fragments may superficially resemble those of pearl barley, as the testa is similarly transparent. The very delicate testa of these fragments lacks cell wall structure but is identified by the ubiquitous, vermiform, tube-like cells which are 7 to 10µm wide (table 36, g); these are hypoderm cells which are often joined irregularly (Winton & Winton 1932: fig 78). Fossil grains commonly show the testa cells which are transversely elongate, side by side in rows in a modified herring bone pattern and/or the longitudinal cells with prominent hair bases of the outer pericarp (Dickson, C 1987a: pl I).

Leguminosae, seed fragments

Seeds of most legumes have smooth seed coats, hitherto mainly carbonised seeds have been found and identification is usually based on the size and shape of the seed and that of its hilum. None of the tiny fragments found at Bearsden includes the hilum and none is more that 3mm in diameter. Seeds of the family are characterised by having a palisade of thick-walled prismatic (malpighian) cells. The lumen is broader in the lower part of the cell and the cells are polygonal in surface view and often show radiating limes due to the pores separating the ribs which make up the thickened walls (Winton 1916). There is a hypoderm of hour-glass cells which are ribbed in some species. The testa cells may be diagnostic for individual species or groups of species and can be used to identify seed fragments, as demonstrated by Winton (1916). The testa fragments were recovered from the east annexe ditch, 680–700mm, 98mm–1m, 1.18m–1.20m.

Cf *Lens culinaris* Medicus (lentil) (illus 13.2, d, e)

Two seed fragments only 1.2mm × 0.5mm and 1.0mm × 0.6mm have palisade cells each about 33 × 5–6µm, which are rounded at their outer ends. The polygonal hypoderm cells are 18µm–22µm across with irregular brown centres. The very narrow palisade cells could not be matched on available reference seeds of British species but are remarkably similar to both palisade and hypoderm cells of *Lens culinaris* (lentil).

Cf *Vicia faba* (field bean, horse bean) (illus 13.2, a–c)

Rare dark brown testa fragments, the largest measuring 3mm × 2mm, have incomplete palisade cells measuring up to 135µm × 18–25µm across, the dark brown inner wall is 8µm–12µm across; the partly detached cuticle has impressions of the palisade cells with pores dividing each cell into six or seven sub-triangular areas. The hypoderm cells are up to 65µm across with ribs showing as radiating finger-like protrusions. Legume seeds with palisade cells of over 100µm in height include species of *Lupinus* and *Vicia faba* and *V. narbonensis*. *Lupinus* spp. Have a narrow inner part of the palisade cell which is geniculate and usually colourless. *V. narbonensis*, the possible progenitor of *V. faba*, has a very similar testa to that of the fossil but does not seem to have any history as a food plant. The cell characters are those of *V. faba* (Winton 1916) and the brown pigmented inner cell wall is very similar that found in the small brown forms of *V. faba*; this pigment is absent from the larger broad bean which is the form more usually eaten at the present time. The testa of *Pisum* (pea) has shorter palisade cells up to 100µm. Dr E Krzywinski kindly provided material from a medieval latrine from Bergen, Norway, and from a layer rich in *V. faba* pollen similar fragments of testa, up to 2mm, were found.

Cf *Vicia* sp (vetch) (illus 13.2, g, h, i)

The largest of four measures 2.0mm × 0.8mm, the palisade cells are up to 50µm long by about 9µm across. The detached cuticle bears impressions of a circular pattern of small polygonal areas each only about 2µm diameter, representing the tops of the palisade cells (table 36, g, i). At a lower level the lumen is rounded, golden brown and about 7µm across. The hypoderm cells are polygonal with a brown centre and average 22µm. The testa cells of British species of large-seeded legumes were compared but only *Vicia sativa* (common vetch) has cells of comparable size, shape and surface pattern.

Linaceae

Linum usitatissimum (flax, linseed) (illus 13.3, a)

Whole seeds of species of *Linum* occurring in Britain can be distinguished on size and shape but small fragments are less readily separable. The single fragment from the Roman levels of the inner west ditch though only 1.4mm × 1.1mm has the characteristic beak of *L. usitatissiumum*. Two fragments from the sewage levels, 2.9mm × 0.8mm and 2.4mm × 1.3mm represent parts of the backs of seeds. Each fragment has the tough sclerenchymatous fibres 100–150µm × 4.8µm which are characteristic of the genus, and the overlying round cells of 28µm–35µm diameter. Two of the fragments retain the brown squarish cells which underlie the fibres. These three cells layers appear to be similar in both *L. bienne* and *L. usitatissimum* but the former has smaller seeds, about 2.8mm × 1.6mm; seeds of *L.*

usitatissimum are much larger with a wider size range, a small sample range form 5.2–6.2mm × 2.4–3mm.

The two entire seeds of *L. catharticum* (purging flax), also from the sewage levels, are readily distinguished by their much smaller size, 1.3mm × 0.7mm.

Papaveraceae

Papaver somniferum (opium poppy)

Two seed fragments were recovered; the measurements are of the flattened mounted seeds, one nearly complete seed measures 1.2mm × 0.8mm, the other is a fragment 1.5mm long. The straight-walled polygonal cells are generally about 200µm in diameter, these and the underlying testa cells accord with those of *Papaver somniferum* (opium poppy) which has seeds measuring 1.2–1.4mm × 0.8–1.2mm. Seeds of British species of *Papaver* are less than 1mm long and the epidermal cells under 160µm diameter.

Umbelliferae

Anethum graveolens (dill) (illus 13.3, g)

Two incomplete fruits, now measuring 22mm × 18mm and 25mm × 15mm, each consist of part of the commissural face with remains of two segmented vittae which are about 180µm wide, these have polygonal cells 10–60µm × 18–25µm which are mainly longitudinally elongated. The underlying cells of the endocarp are well preserved and measure 35–70 µm× 3–7µm, they are in groups mainly transversely orientated. Palisade cells, 22µm × 35µm, with thickened corners are visible on one of the fruit. A third fruit is more tentatively identified since it lacks the vittae and ribs but size, shape and transverse and palisade cells are similar. The fruit match the cells and vittae of reference fruit although they lack the spongy wing margin and only one rib survives on one of the fruit.

Coriandrum sativum (coriander) (illus 13.3, j)

The identification is based on fragments of the stout fruit wall with diagnostic wavy ridges formed by sclerenchymatous fibres, the largest fragment of which measures 4.5mm × 3mm. The outer cell layers were removed from recent pericarps to show the thickened ridges of these cells as shown by Wilson (1979). The non-septate resin ducts which lie on the inside walls of the fruit were not recovered.

APPENDIX 2: DETERMINING THE THERMAL HISTORY OF THE BRAN WITH ELECTRON SPIN RESONANCE SPECTROSCOPY

It is fortunate that ESR spectroscopy is being developed as a technique to estimate the maximum temperature of previous heating of archaeological grain samples (Robins et al 1986). A sample from the Bearsden east annexe ditch taken at 1.38m depth was dispersed in dilute alkali, sieved, and the bran component carefully collected. Only the bran fragments of *Tricicum*/*Secale* (wheat/rye) were selected. A fragment of the cross cells of *T. spelta*/*T. aestivum* sl (spelt/bread wheat) was recognised (Ill oo b) and two glume bases of *T. dicoccum*/*spelta* (emmer/spelt) were recorded from the samples.

The bran was submitted to Dr D Robins for ESR determination. He noted (pers comm) that the sample gave a g value of 2.0041 and line width (6H) of 7.45 Gauss. The signal was relatively weak which indicated a short heating time, this observation is only qualitative at this time. The result was compared in the first instance with the cereal grain calibration curve. The reading is consistent with a temperature in the region of 180–200°C and therefore indicative of a bread rather than porridge or dumplings.

This result may be compared with that from a preliminary sample of cereal chaff from the stomach contents of Lindow Man, the Cheshire Iron Age bog body. The chaff gave a maximum temperature of between 200 and 250° and preliminary measurements suggested a short cooking time (Robins et al 1986). Hillman (1986) noted two charred farinaceous fragments, both *c* 0.5mm diameter and also from the stomach contents, and suggests that they were most likely to have derived from some sort of bread. Robins observed that the presence of charred material 'indicates severe heating or burning of the bread, an event that is likely to occur much more often during the high-speed griddling of flat bread over an open fire than during the slower, oven-baking of a leavened loaf' (Robins et al 1986). No such burnt fragments were found in the Bearsden sewage though especially looked for; it is notable that ovens have been recorded at a number of Roman forts. The lower temperature of the Bearsden bran could be connected with the baking method or the possibility that the dispersed bran may be from a mixture of bread and porridge. However, until more ESR studies have been carried out on a variety of cereal remains it would be premature to draw any definite conclusions especially on a single sample.

ADDENDUM

JAMES H DICKSON

When the archaeobotanical work on both pollen and macroscopic plant remains began in the mid-1970s there was little understanding of the great potential of waterlogged deposits containing dispersed faeces. Written very largely by the hand of Camilla Dickson who died in 1998, the report was submitted in 1985 when much less was known archaeobotanically about Roman sites in Scotland and in Britain as a whole than now. Stemming from the Bearsden discoveries, relevant lines of investigation were pursued by both CD and JHD together and separately. For instance, CD continued processing cereals experimentally and JHD grew figs in both Glasgow and Haute-Saône, France. Working with the Dicksons several researchers produced long and short pollen diagrams from bogs and turves relevant to the last 3,000 years in the Glasgow area. The archaeobotany of the Bearsden fort remains by far the most comprehensive in Scotland and one of the most detailed from any fort in the Roman Empire. This is primarily because of the highly detailed very rewarding investigation of the rich waterlogged, sewage-impregnated deposits in the east annexe ditch. Rather than alter substantially the extensive original report, the following points give some indication of the most important archaeobotanical developments that have taken place during the years since the mid-1980s.

1. It would have been better to have stated 'mainly plant-based diet' rather than 'mainly vegetarian diet'; vegetarianism is a life style choice which few if any Roman would have made. Biochemical and stable isotope analyses revealing diet have developed enormously since the early 1980s with a great many publications. As a mere two examples involving JHD, see Dickson, J H, Oeggl K, Holden T, Handley L L, O'Connell T, Preston T 2000, and Dickson J H, Richards M P, Hebda R J, Mudie P J, Beattie O, Ramsay S, Turner N J, Leighton B J, Webster J M, Hobischak N R, Anderson G S, Troffe P M & Wigen R J 2004.
2. Spelt has been recovered from the Oakbank Crannog in Loch Tay occupied for some 400 years during the transition from the Bronze to Iron Ages: see Miller, J, Dickson, J H, Dixon, N 1998 and Miller, J 2002.
3. There is now no need to wonder if fig trees might have been grown in the fort, or indeed anywhere else in Scotland, even if the Romans grew parthenocarpic varieties which produce ripe fruit without pollination. Very sugary and consequently long-lasting when dried, figs were part of the Roman military diet and distributed from the Mediterranean areas to all parts of the Empire: see Dickson, J H and Dickson, C 1996, Dickson, C 1994 and Dickson, J H, Lyth, J R S, Lécrivain, G M-J, Lyth, M M H 2011. Sparse fig pips were found at Elginhaugh fort: see Clapham, A J 2007.
4. There is now abundant evidence from widespread sites in Europe extending back to the Neolithic that large weft-forming mosses were used not just for many small scale domestic purposes including hygiene but even caulking boats, both log boats and more complex craft. It may well be that large mosses when locally available were commonly used by Roman troops: see Dickson J H 1973, Dickson, C & Dickson, J 2000 and Dickson, J H 2000. The recent book by Hobson (2009) on Roman toilets mentions the Bearsden fort.
5. The experimental processing of cereals and the making of bread is a large topic: see, for example, Dickson, C 1990, Procopiou, H and Treuil R 2002, Samuel, D 2009 and Valamoti, S M 2013.
6. During the last few decades much has been learned about former woodland management in Scotland, though not for Roman times: see, for instance, Smout, T C 1997.
7. The nature of the landscape when the Romans invaded west central Scotland has been investigated by several researchers supervised by JHD and CD. It is clear in all the well carbon-dated pollen diagrams that major woodland clearances had taken place before the Romans arrived, sometimes long before, sometimes shortly before but nonetheless before. Lenzie Moss, near Kirkintilloch, Lochend Loch Bog, near Coatbridge, Walls Hill Bog, near Johnstone, and Gartlea Bog, near Gartocharn, all have long pollen sequences which strikingly make the point; this was the doctoral work of Susan Ramsay. Judith Turner's important pollen diagrams from Bloak Moss in Ayrshire and Flanders Moss in the upper Forth Valley were produced in the early 1960s. However, it is unfortunate that the radiocarbon dates cannot to be trusted; this was long before the advent of AMS dating. For other work see: Boyd, W E 1984; Dickson, C 2007; Dickson, J H 1992; Dickson, J H, Dickson, C, Boyd, W E, Newall, P J & Robinson, D E 1985; Ramsay, S 1996; Ramsay, S & Dickson, J H 1997.