Roman impact on the environment at Hadrian's Wall: precisely dated pollen analysis from Vindolanda, northern England

Adrian Manning[1], Robin Birley[2] and Richard Tipping[3]

([1]Department of Geography, University of Edinburgh, Drummond Street, Edinburgh EH8 9XP, Scotland, UK; [2]Vindolanda, Chesterholm, Bardon Mill, near Hexham, Northumberland NE47 7JN, JK; [3]Department of Environmental Science, University of Stirling, Stirling FK9 4LA, Scotland, UK)

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Abstract: The results of pollen analyses from two ditch fills of early Roman age from the fort at Vindolanda, close to Hadrian's Wall, are presented. The ditch fills can be closely dated to the periods *c.* AD 85–92 and *c.* AD 160–180, and this chronological precision provides insights into the timing of human impacts on the vegetation around this part of Hadrian's Wall which are unobtainable from more conventional radiocarbon dated stratigraphies. The analyses show that anthropogenic woodland clearance occurred before *c.* AD 85 around Vindolanda. Deforestation may have been by native farmers rather than by Roman troops. Clearance occurred prior to the construction of Hadrian's Wall in the second century AD, and was probably intended to allow an expansion of agricultural land, and in particular pasture for grazing animals. Cereal cultivation was possibly established at Vindolanda in the early to mid-second century AD.

Key words: Palynology, human impact, archaeology, ditch fills, Romans, Hadrian's Wall, Vindolanda, northern England, dating.

Introduction

There is currently considerable debate as to the degree of impact of Roman forces on the vegetation and land uses on and either side of Hadrian's Wall in northern England. Over much of the country between the Clyde-Tweed isthmus and Wensleydale, large areas of land appear to have undergone exceptionally abrupt and extraordinarily comprehensive phases of forest clearance, and this dramatic impact on the woodlands is thought to be clearly of late Iron Age data, from *c.* 500 cal. BC onwards (Bartley *et al.*, 1976; Davies and Turner, 1979; Turner, 1979; 1981; 1983; Wilson, 1981; Boyd, 1984; Dickson and Dickson, 1988; Fenton-Thomas, 1992; Tipping, 1992; 1995a; 1997; van der Veen, 1992; Dumayne, 1993a; Dickson, 1993; Ramsay, 1995; A. Fleming, personal communication).

On the line of Hadrian's Wall and close to it there is major uncertainty as to whether this comparably extensive clearance phase might have been significantly later, of Roman or Romano-British date, close to or after the arrival of Roman troops in the Carlisle region in the early AD 70s (McCarthy, 1991), and elsewhere in the early AD 80s under Agricola. Davies and Turner (1979) argued for a Roman-age clearance at the site of Fellend Moss, on Hadrian's Wall (Figure 1B). This idea was endorsed by Barber (1981) at Bolton Fell Moss, and has most recently been argued by Dumayne in a series of papers (Dumayne, 1993a; 1993b; 1994; Barber *et al.*, 1994; Dumayne and Barber, 1994; Dumayne *et al.*, 1995). Dumayne has also developed the thesis that forest clearance on and near the Wall was not only for agricultural expansion but was primarily generated by the needs of the troops themselves, for defensive purposes as well as for construction of Hadrian's Wall, accommodation and metal-working.

Such a debate has a wider significance, in understanding the role of Roman forces in commanding and controlling the native economy (Manning, 1975; Jones and Walker, 1983). Dumayne's arguments have been criticised by Tipping (1995a; 1997) in that the proportions of palynological indicators of increased pasture and arable at sites on Hadrian's Wall are as important as at sites away from it, where a native expansion of agricultural land has been convincingly argued (van der Veen, 1992). It may thus be more correct to consider clearance on the Wall to be for similar agrarian pursuits.

A cogent criticism by McCarthy (1995) of palaeo-ecological

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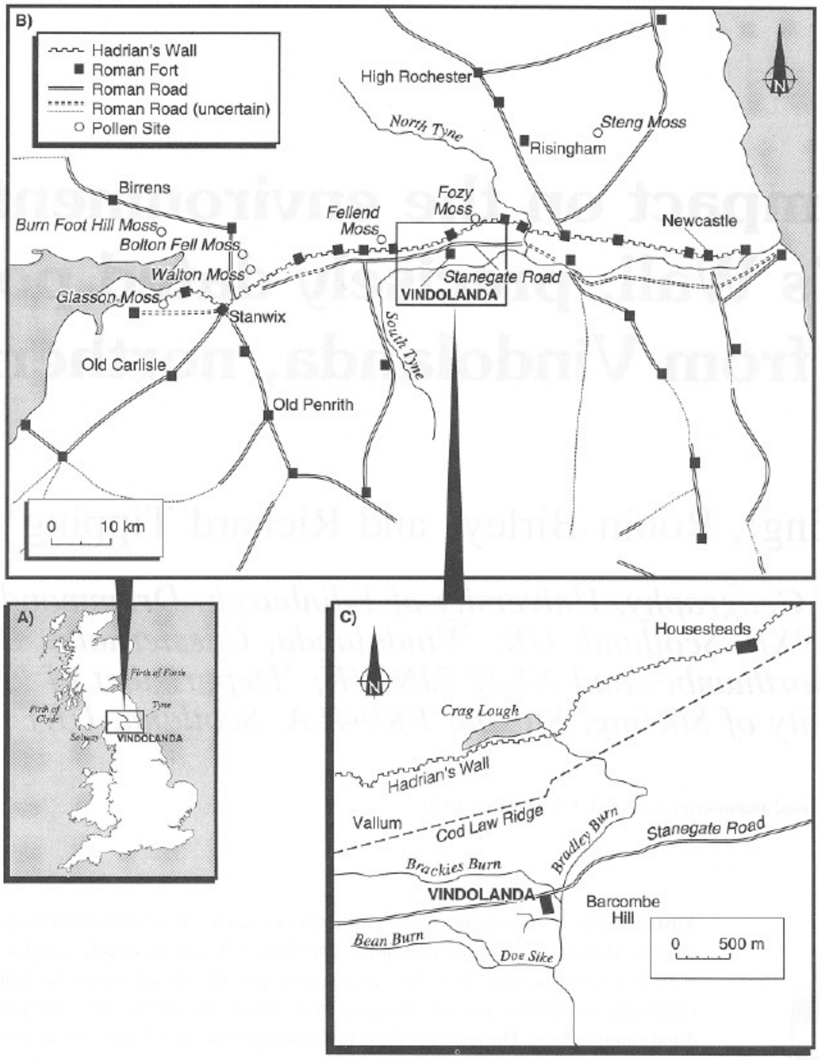

Figure 1 (A) The location of Hadrian's Wall within Britain; (B) Vindolanda on the line of Hadrian's Wall, with the Roman road network serving the north of the Empire and pollen sites used in former reconstructions; (C) the location of Vindolanda in relation to Hadrian's Wall, the Stanegate road and some natural features.

analyses related to the Roman period is the inevitable imprecision of radiocarbon dating mid- to late-Holocene peat and lacustrine mud deposits (Turner, 1979; Pilcher, 1991). This is recognized also by Dumayne *et al.* (1995). It is impossible using conventional dating techniques to reconcile calibrated radiocarbon assays and their inherent errors with historically attested calendar dates; to attempt this is to fall into well-chronicled traps (Baillie, 1991). Dumayne *et al.* (1995) attempt to combine radiocarbon calibration with palynological analyses and sediment inwashes at Fozy Moss, near Housesteads, on the central and highest part of the Wall, in suggesting that the forest clearance there was due to Roman impact. However, none of the lines of evidence assembled by Dumayne *et al.* (1995) are unambiguous indicators of a Roman presence. Other workers confronted with similarly imprecise calibrated radiocarbon assays on clearance phases close to the Wall have been more circumspect as to cultural origin (Roberts *et al.*, 1973; Tipping,1995b).

We cannot as yet hope to achieve the required precision from naturally occurring and radiocarbon dated sediments. One hitherto poorly investigated approach that offers considerable scope is the pollen analysis of *in-situ* deposits related to anthropogenic structures (Hanson, 1975; Boyd, 1984). Wiltshire (1992; personal communication) has analysed for their pollen contents turves used in construction of the turf wall near Birdoswald, and has tried to distinguish between 'late Iron Age' and 'Roman' contexts, but there is no clear precision in her dating. Here we present original pollen and microscopic charcoal data from two Roman ditch fills from the earliest phases of the Roman fort at Vindolanda (Birley, 1977). Davies (1978) analysed a few samples from ditch deposits at Vindolanda, and these will also be used. These ditch fills, by their associated archaeological features and artifacts, can probably be very precisely dated, certainly at a resolution that cannot be approached from radiocarbon dated 'off-site' analyses. We discuss the implications and limitations of these analyses, and consider what they can tell us about the scale of Roman impact on the environment of the central section of Hadrian's Wall.

Vindolanda

Vindolanda (NY 771 663) is one of the best-known Roman sites on Hadrian's Wall. It lies on the highest ground of the Tyne-Solway ridge that the Wall follows, at *c.* 160 m OD (Figure 1A), close to the centre of and 1.5 km south of the Wall itself, and on the supply road known as the Stanegate (Figure 1B).

The successive phases of fort construction and abandonment are summarized in Table 1 (see also Birley (1994) for full discussion of the evidence). Roman presence in the area was initiated in the late AD 70s/early AD 80s, with Agricola's advance through Brigantian territory (Higham, 1986; Hartley and Fitts, 1988), broadly the region of northern England between the Humber-Mersey line and the Tyne (Figure 1A). The Stanegate road was

Table 1 Outline of the chronology of fort construction at Vindolanda (after Birley, 1977; 1994)

Date*	Archaeological period and fort size
c. AD 85–92	Period I: wooden fort (max. size 3.5 acres)
c. AD 92–97	Period II: wooden fort (max. size 7.5 acres)
c. AD 97–104	Period III: wooden fort (max. size 7.5 acres)
c. AD 104–130	Period IV: wooden fort (max. size 7.5 acres)
	Period V: wooden fort (max. size 7.5 acres)
c. AD 130–160	site probably abandoned
c. AD 160–200	Period VI: stone fort (max. size 7.5 acres)
c. AD 180–200	Period VI: timber annexe added to west of Period VI fort, sealing its western ditch
c. AD 200–212	Period VII: stone fort (max. size 5.0 acres)
c. AD 213–400+	Period VII: stone fort (max. size 3.5 acres)
	Period VII: stone-built *vicus*, largely abandoned by AD 300

* For detailed discussion of the chronology of the Period I and VI ditches sampled, see text.

constructed in the early AD 80s. The first (Period I) fort was built to defend this route in *c.* AD 85 (Breeze and Dobson, 1976; Birley, 1994), and was consolidated (Periods II and III) between *c.* AD 92–97 and *c.* AD 97–104 (Table 1). Two more wooden fort phases (Periods IV and V; Table 1) include the time when Hadrian's Wall was constructed, in the AD 120s and 130s, but after AD 138 the establishment of the Antonine Wall on the Forth-Clyde line (Maxwell, 1989) rendered the southerly defences redundant. Once again, however, defences were consolidated on the Tyne-Solway line and the Wall at around AD 160, and the first of several stone-built forts (Periods VI–VIII) was constructed at Vindolanda, persisting in numerous forms until *c.* AD 400 (Table 1).

Field sampling

Period I (south gate) ditch

The drainage ditch sampled lay beneath the south gate of the enlarged Period II fort (Figure 2), cut into till. At the time of construction, the ditch lay to the west of the earliest, Period I, fort (Birley, 1994: 19–39 and figures 2, 5 and 17–19). Its deliberate burial suggests that the period represented by the sediments is within the duration of Period I (*c.* AD 85–92), and, if normal Roman maintenance practice was observed, the sediments should

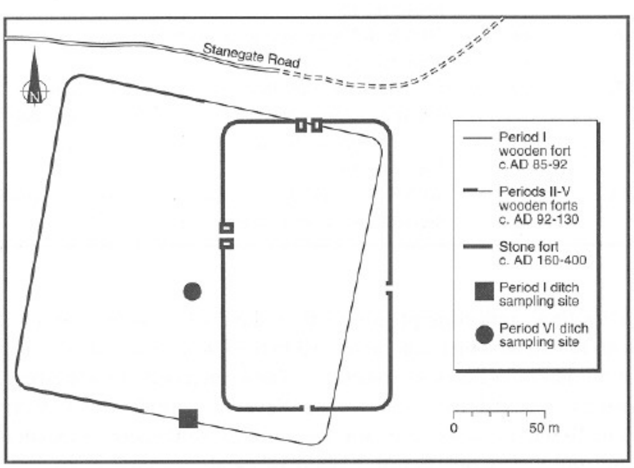

Figure 2 Locations of the two ditch deposits sampled within the simplified outlines of the pre-Hadrianic (AD 85–130 Period I–V) and post-Hadrianic (AD 160–400) stone forts.

date to the last months of that occupation. Figure 3 depicts the archaeological stratigraphy recorded and the positions of the three monolith tins ($25.0 \times 15.0 \times 15.0$ cm) sampled into the basal deposits of a cleaned section of the ditch. Depths are measured down-profile from an arbitrary datum at the base of the wood which represents a collapsed wattle fence (Figure 3). Figure 4 depicts the sediment stratigraphy (see also Table 2) and the locations of the 16 pollen subsamples, which were carefully positioned to avoid inwashed bands.

Although discrete anthropogenic dumps can be recognized (e.g., unit I/H) the sequence is interpreted as an acccumulation of ponded sediments. The basal primary sands and silts (units I/A–D) are replaced by increasingly organic sediments. Deposition may have been discontinuous, suggested by the occasional sharp and possibly erosional boundaries, and well-sorted bands (unit I/E) and stringers imply periods of flowing water. The sediments below the wattle fencing (Figure 3) are comprehensively sealed by the fencing and Period II turves and timber beams.

The deposits sampled are assigned an age of *c.* AD 85–92. It is difficult to establish exact dates for the construction and abandonment of a Roman military ditch, but the available evidence suggests that it was probably constructed in *c.* AD 85 and ceased to function some six or seven years later. Pottery within the ditch sediment is similar to that found within the floors of the Period II fort, but there are two important differences. First, there are no examples of Dragendorff 29 pottery among the considerable quantity of decorated samian ware derived from the La Graufesenque workshops, and that form's rarity in any deposits at Vindolanda is perhaps the most powerful indication that occupation did not commence until after the partial withdrawal of Roman forces from Scotland (see Dickinson in Carauna, 1992: 52). Second, the large deposit of unused samian ware included work by potters who had exported material to Pompeii just before the eruption of AD 79, and others whose wares are found at sites in Scotland constructed post-AD 80 (Birley, 1994). The only coin in the deposits was a worn *denarius* of M. Antonius (32–31 BC), and none of the timber could be accurately dated by dendrochronology. The ditch had been deliberately sealed with a substantial quantity of turf, topped with layers of timber and boulders, to permit the construction of the *praetorium* of the Period II fort, followed by the *praetorium* of Flavius Cerealis (Period II fort), dated by writing tablet evidence including consular dates for AD 101 to 104 (Bowman and Thomas, 1994; 1997).

Period VI (west gate) ditch

The deposits infilling this prominent 2-m-wide ditch of the Period VI fort, close to its west gate, are shown in Figure 5. The ditch, when open, lay outside the fort, between it and the first *vicus*. The basal pre-Period II ditch fill at the centre of Figure 5 was not exposed at the time of sampling, but corresponds in age to the deposits of the Period I fort at the south gate. Over this is a series of discrete turf layers, clay and wattling, penetrated by posts of Periods II, III, IV and V forts. The dating of the Period V deposits takes account of the fact that Period IV included a writing tablet with a consular date of AD 111, and coins of the emperor Trajan, minted within the years AD 112–114. A starting date of *c.* AD 120 is the most likely, with a new fort being erected in the knowledge that building of Hadrian's Wall was shortly to start. The Period V deposits included a wide selection of pottery found in the primary Wall sites, together with a single slightly worn *dupondius* of Hadrian, minted between AD 119 and 121. The ending of Period V was probably associated with the completion of new forts on the line of the Wall itself, *c.* AD 128.

Cut into the clay and post deposits of the Period V fort is a prominent gently sloping ditch, infilled with a simpler sequence of deposits than that found in the Period I ditch (Table 3; Figure 6). These sediments were sampled by two monolith tins of

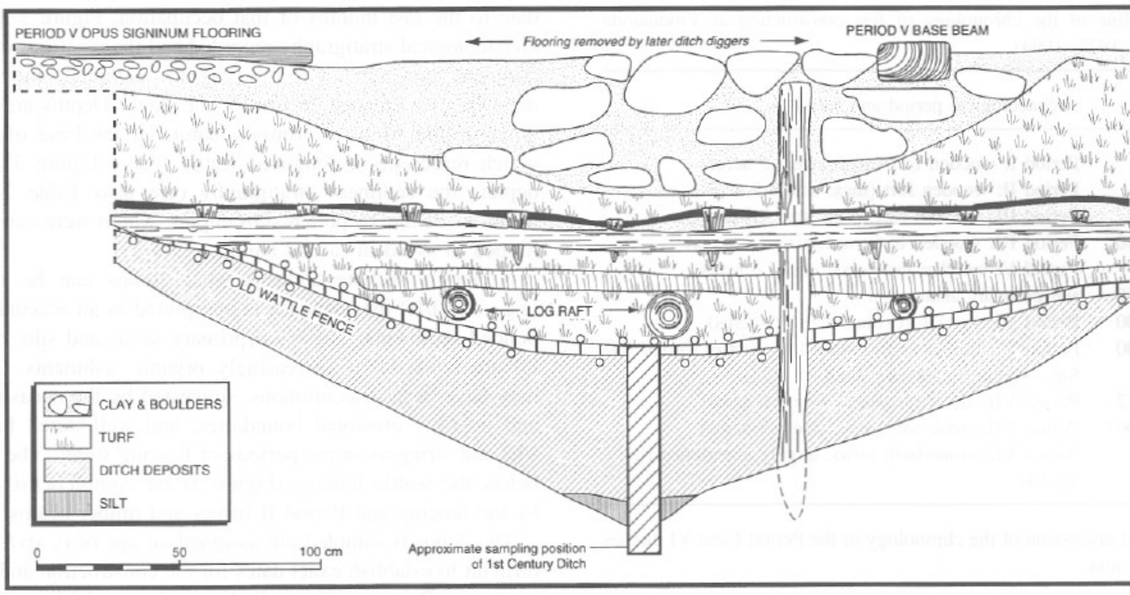

Figure 3 Simplified archaeological stratigraphy of the Period I (south gate) ditch fill, showing the position at the base of the ditch of the 75-cm monolith tin sequence sampled for pollen analysis.

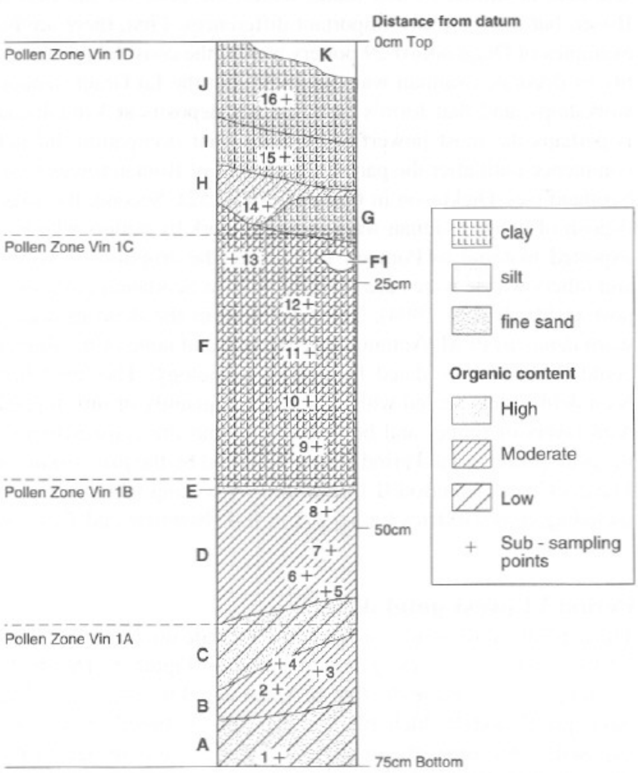

Figure 4 Sediment stratigraphy of the 75-cm monolith tin sequence sampled through the Period I deposits at the south gate showing the locations of pollen subsamples (see Table 2).

Table 2 Sediment description of the Period I (south gate) ditch

Unit	Depth (cm)	Description
I/K	0/0–4	Wood (wattle fence), black
I/J	0/4–8/10	10 YR 2/1 black organic-rich mud/peat with thin stringers and lenses of paler 10 YR 5/2 greyish brown minerogenic inwashes and occasional charcoal flecks; sharp boundary to
I/I	8/10–13/15	5 Y 2.5/1 black organic clay with small stringers of mineral matter; sharp boundary to
I/H	13/15–16.5	lens of 10 YR 4/2 dark greyish brown medium sand with mussel/oyster shells and macro-plant fragments; sharp boundary to
I/G	16.5–19/21	10 YR 2/2 very dark brown organic silty clay; sharp boundary to
I/F	19/21–44	10 YR 3/2 very dark greyish brown organic clayey silt with charcoal flecks towards top; occasional rotted small stones; contains a discrete lens (Unit F_1) of 10 YR 2/1 black peat/organic mud; sharp boundary to
I/E	44–45	10 YR 5/4 yellowish brown fine sand; sharp boundary to
I/D	45–57/60.5	5 YR 3/1 very dark grey silty clay, more organic towards unit-top (5 Y 2/5/1 black); sharp boundary to
I/C	57/60.5–61/67	10 YR 4/2 dark greyish brown coarse sand; sharp boundary to
I/B	61/67–68/70	5 Y 4/1 dark grey fine silty clay with weakly stratified coarser inwash bands (5 Y 3/1 very dark grey); some small fragments of bone; sharp boundary to
I/A	68/70–75	10 YR 4/1 dark grey coarse calciferous sandstone derived coarse structureless sand

dimensions 50.0 × 15.0 × 15.0 cm; the depths of sediment units described in Table 3 and Figure 6, and of pollen samples in Figures 9 and 10, are recorded from a datum represented by the top of the ditch deposits in Figure 5, 85 cm above the top of the monolith tins (sediment descriptions accord with the approaches adopted for the Period I ditch fill). These predominantly minerogenic fills are also stratified, containing inwash bands and evidence of ponding, and are regarded as an accumulating sequence of deposits, but with some anthropogenic dumps. However, the fewer artificial or suspect fills allowed a more regular pollen subsampling policy (Figure 6).

Overlying these minerogenic ditch fills and the layer of 'natural vegetation', reflecting plant growth in the ditch, is a layer of earth with boulders, which can be related to the foundations and walling of the Period VI annexe structures. These included the stone-built structures dated by coins to the Severan period, which were demolished to make way for the civilian settlement associated with the fort of the Fourth Cohort of Gauls (erected *c*. AD 210–220; Bidwell, 1985). The date of this Period VI ditch has to lie after the abandonment of the Hadrianic Period V fort and before the construction of the military annexes which caused it to be

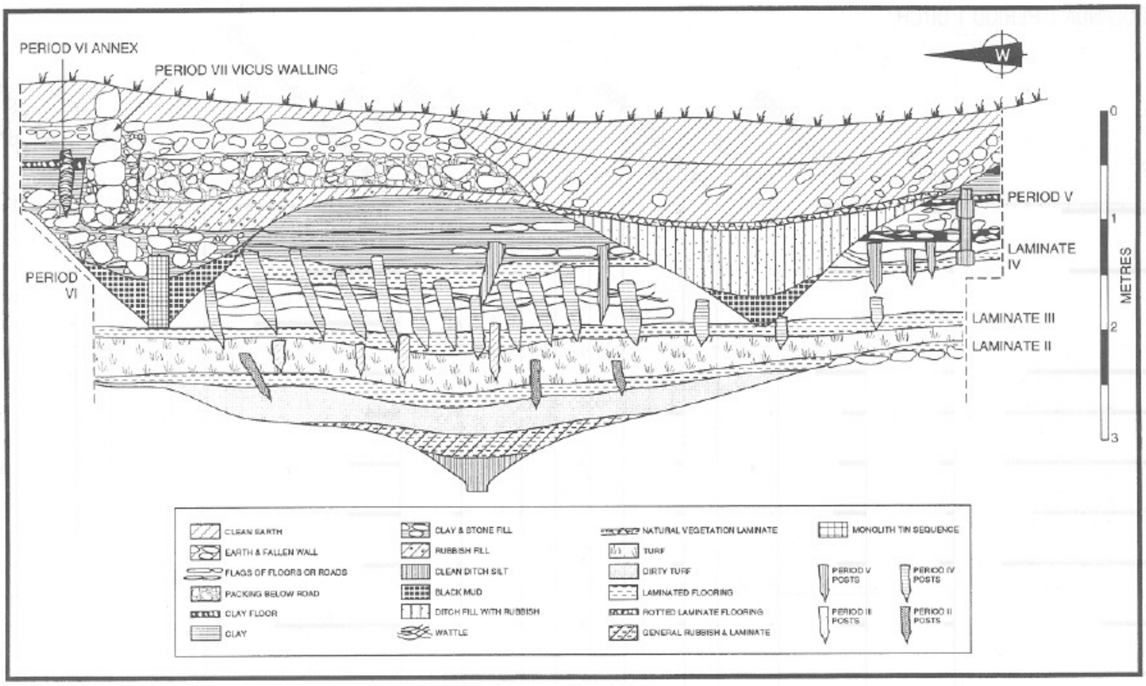

Figure 5 Simplified archaeological stratigraphy of the Period VI (west gate) ditch fill cut into earlier (Period II–IV) deposits, showing the position of the 100-cm monolith tin sequence sampled for pollen analysis.

Table 3 Sediment description of the Period VI (west gate) ditch

Unit	Depth (cm)	Description
VI/G	85–90	10 YR 4/2 dark greyish brown silt with flecks of charcoal and rare stones, including brick and tile
VI/F	90–120/127	10 YR 2/1 black organic silty clay, complexly stratified with lenses and patches of 10 YR 5/2 greyish brown silt, occasional charcoal flecks, rare stones and rare laterally extensive mineral inwash bands; sharp boundary to
VI/E	120/127–165/175	10 YR 2/1 black poorly organic silty/sandy clay with rare very large subangular and subrounded stones and rare rotted calciferous sandstone pebbles; sharp boundary to
VI/D	165–170	10 YR 2/1 black organic silty sand; sharp boundary to
VI/C	170/175–178	10 YR 3/2 very dark greyish brown poorly organic silty sand with discrete patches of rotted pebbles; sharp boundary to
VI/B	178–182	5 Y 4/1 dark grey structureless silty clay with fine sand; sharp boundary to
VI/A	182–185	5 Y 4/1 dark grey highly organic silty fine sand with fine lenses of better-sorted mineral bands; occasional subrounded stones

backfilled. On present evidence, that must lie within the years AD 160–c. 190, and perhaps nearer AD 180. Among the abundant pottery and artifacts recovered from the ditch, there was no clear dating evidence, and the only coin was a worn *as* of Faustina I (AD 141+).

Laboratory methods

Monolith tins containing the sediments were wrapped in aluminium foil and stored in a cold store at 4°C. Subsamples of 0.5-cm thickness were prepared for pollen analysis by standard chemical methods (acetolysis: Moore *et al*., 1991), with hot hydrofluoric acid treatment to remove siliceous sediment.

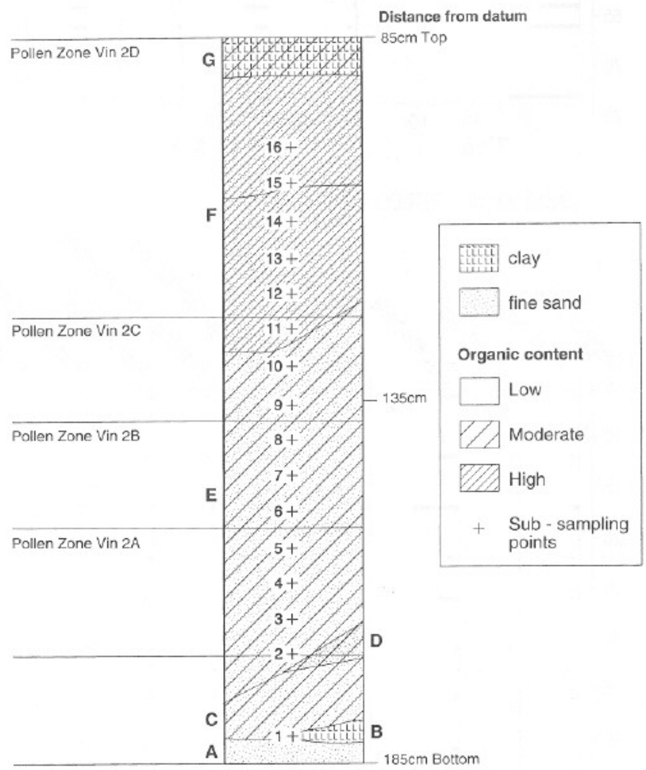

Figure 6 Sediment stratigraphy of the 100-cm monolith tin sequence sampled through the Period VI deposits at the west gate showing the locations of pollen subsamples (see Table 3).

Lycopodium grains (Stockmarr, 1971) were added at an early stage to determine pollen concentrations. The unstained residues were placed on microscope slides. Pollen and spores were analysed on a Vickers transmitted light microscope at a magnification of × 400, and a magnification of × 1000 for problematic grains and all size measurements. Recourse was made to numerous pollen keys (principally Faegri and Iversen, 1989; Moore *et al*., 1991) and a reference collection. A sum of 300 land pollen grains was attained in nearly all spectra (Figures 8 and 10). Numbers of

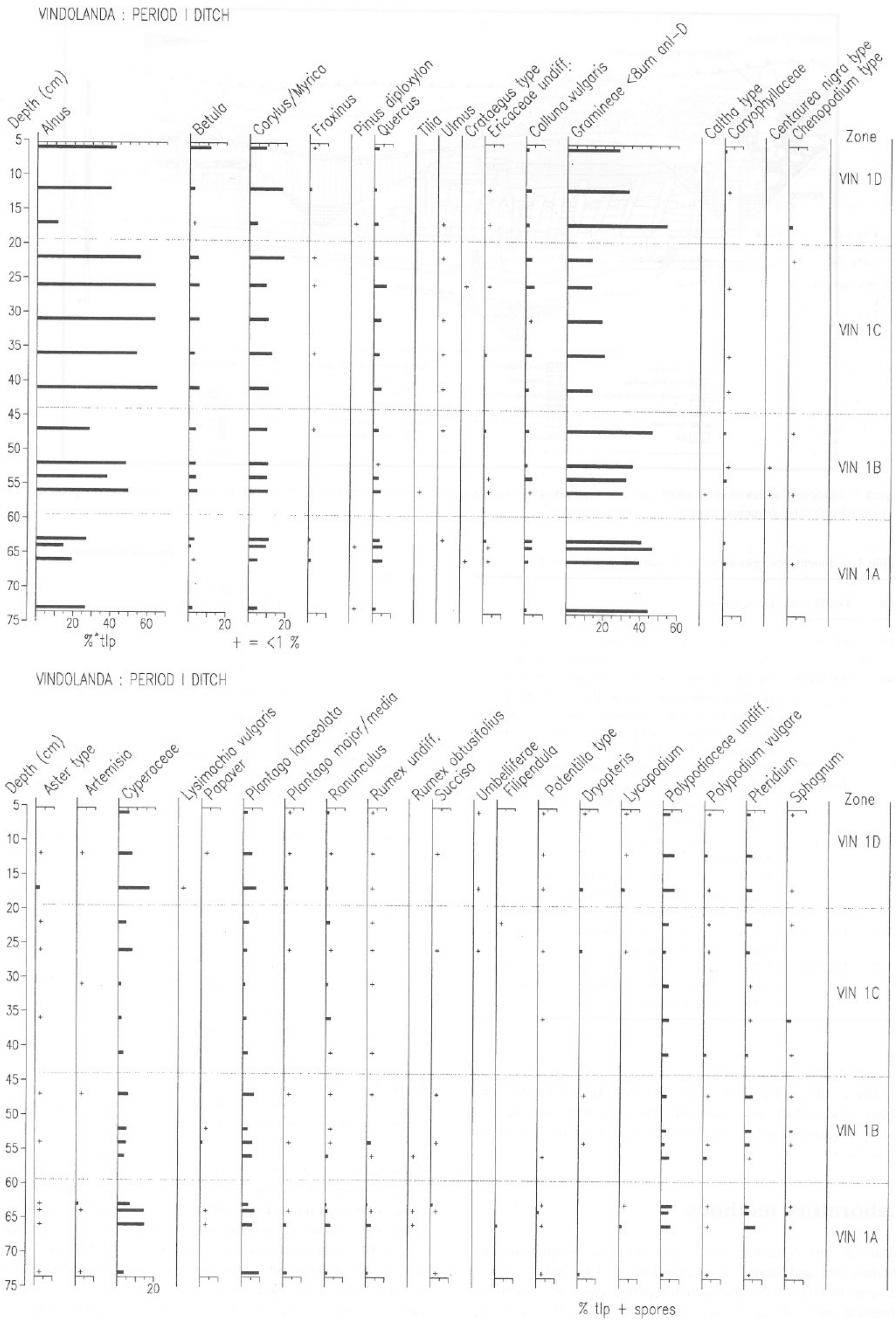

Figure 7 Complete percentage-based pollen diagram for the Period I (south gate) ditch fill.

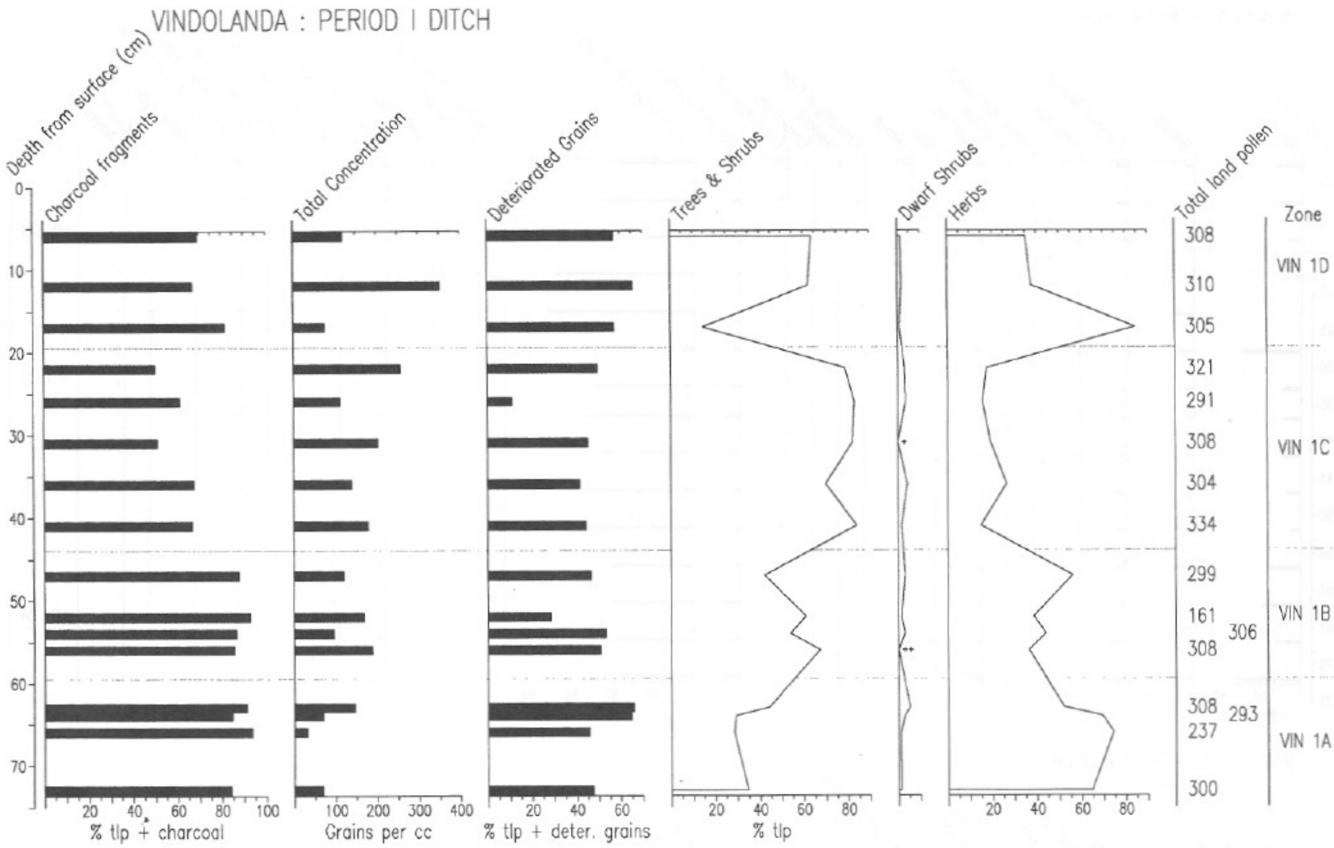

Figure 8 Microscopic charcoal fragments, total pollen concentrations, total numbers of deteriorated pollen grains, summary diagrams and numbers of land pollen grains counted for the Period I (south gate) ditch fill.

deteriorated but identifiable grains were recorded (Figures 8 and 10); numbers of grains rendered indeterminable through deterioration were recorded but are insignificant. Total numbers of microscopic charcoal fragments > 10 μm were recorded. Pollen diagrams (Figures 7–10) were constructed using TILIA and TILIAGRAPH (Grimm, 1991). Local pollen assemblage (l.p.a.) zones for each ditch fill were defined subjectively.

Interpretations

Period I (south gate) ditch fill

Four l.p.a. zones are defined (Figures 7 and 8), zones VIN 1A to D, determined principally by shifts in the proportions of *Alnus* and Gramineae < 8 μm anl-D. No estimate of the time covered by each pollen zone can be given, but the entire sequence probably accumulated in less than a decade at the very end of the first century AD.

L.p.a. zone VIN 1A is found in the predominantly minerogenic primary sediments of the ditch. Deteriorated pollen grains exceed 40% (Figure 8), but the appearance of thin-walled grains suggests that differential deterioration has not seriously distorted the pollen assemblages. Only *Sphagnum* sp. and possibly *Lycopodium* sp. suggest damp conditions on the ditch floor. No pollen taxon that can clearly be inferred to have grown within the ditch can be discerned, although some grains of Gramineae <8 μm anl-D resemble *Phragmites*. The zone is dominated by herb pollen, primarily of Gramineae <8 μm Anl-D, but with Cyperaceae, *Plantago lanceolata*, *P. major/media* and Compositae also common. Pollen of open ground herbs is well represented; Caryophyllaceae, *Artemisia*, *Papaver*, *Ranunculus* and two types of *Rumex*. Many types are associated with wet meadow or pasture (Behre, 1981). Some components of this assemblage strongly suggest that the grassland was grazed, with *Rumex obtusifolius* in particular associated with heavy grazing today in the northern Pennines (Hughes and Huntley, 1988), as are the records for *Potentilla* type (Behre, 1981) and *Plantago major/media* (Sagar and Harper, 1964). *Pteridium* is consistently recorded, but heath plants are not at all abundant in this or other zones. With the exception of *Alnus* and possibly *Corylus/Myrica*, there is no reason to suggest that any tree taxa recorded were growing locally. Microscopic charcoal fragments are abundant throughout the sequence (Figure 8).

Changes are minimal up-profile, and there appear to be few significant changes in the pollen record over the short period of sediment accumulation. The correlation of pollen zones with sediment units (Figure 4) suggests some depositional control on pollen recruitment, and the changes that do occur may be due to the intermittent deposition of units. The representation of *Alnus* increases substantially in l.p.a. zone VIN 1B, and more so in l.p.a. zone VIN 1C. Given the limited timespan of the deposits these increases are unlikely to represent colonisation of the ditch by *Alnus*, but they might derive from the flowering of trees already established; *Alnus* flowers within a few years of establishment (Godwin, 1975). *Alnus* pollen percentages suffered losses between l.p.a. zones VIN 1C and 1D. The suppression of proportions of herb taxa in l.p.a. zones VIN 1B and C are probably due to the enhanced representation of *Alnus*. Values of Gramineae <8 μm anl-D and *Plantago lanceolata*, for example, return to values seen in the basal p.a. zone when those of *Alnus* are reduced in the uppermost zone.

Period VI (west gate) ditch fill

Four l.p.a. zones are defined for this 1-m-thick ditch fill, l.p.a. zones VIN 2A–D. Again fluctuations between *Alnus* and Gramineae <8 μm anl-D pollen percentages determine pollen zone positions. Zone boundaries do not clearly coincide with sediment units (Figure 6), and it may be that this sequence accumulated gradually. Nevertheless, although the sediments probably

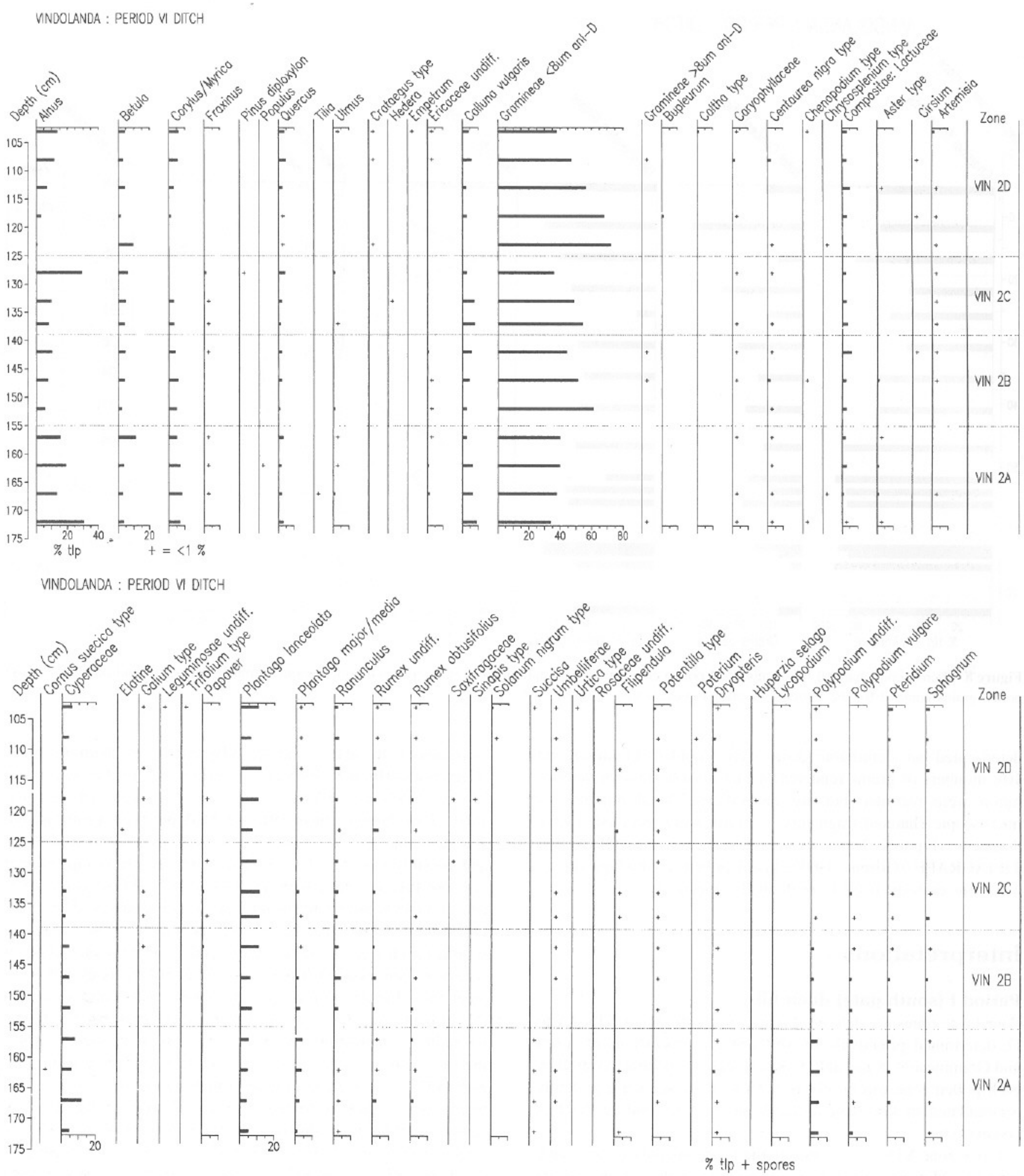

Figure 9 Complete percentage-based pollen diagram for the Period VI (west gate) ditch fill.

accumulated in *c.* 20 years, no temporal changes can be inferred within the sequence. Deterioration values are lower than within Ditch I (Figure 10).

The ditch filled with sediment some 70–90 years after the Period I ditch was sealed. The plant communities suggested from the pollen data (Figure 9) are, however, strikingly similar to those of the first century AD. The assemblage is dominated by Gramineae $<8\ \mu m$ anl-D, with *Plantago lanceolata*, Compositae, Lactuceae and Cyperaceae, and taxa of grazed pasture, wet grassland and tall-herb communities are common. Open- or disturbed-ground herb taxa are accompanied by a few grains of Gramineae $<8\ \mu m$ anl-D, possibly of Cerealia but too crumpled to assign to a more specific pollen type. *Calluna* and other heath taxa are still of very limited importance. The tree taxa recorded are almost certainly not present locally, except for *Alnus*, but even this taxon may not have been present locally above the basal p.a. zone. Microscopic charcoal fragments are abundant throughout, the reductions in l.p.a. zone VIN 2C and at the beginning of l.p.a. zone VIN 2D being an artifact of the sum induced through the increasing abundance (rising concentrations) of pollen grains compared to charcoal fragments (Figure 10).

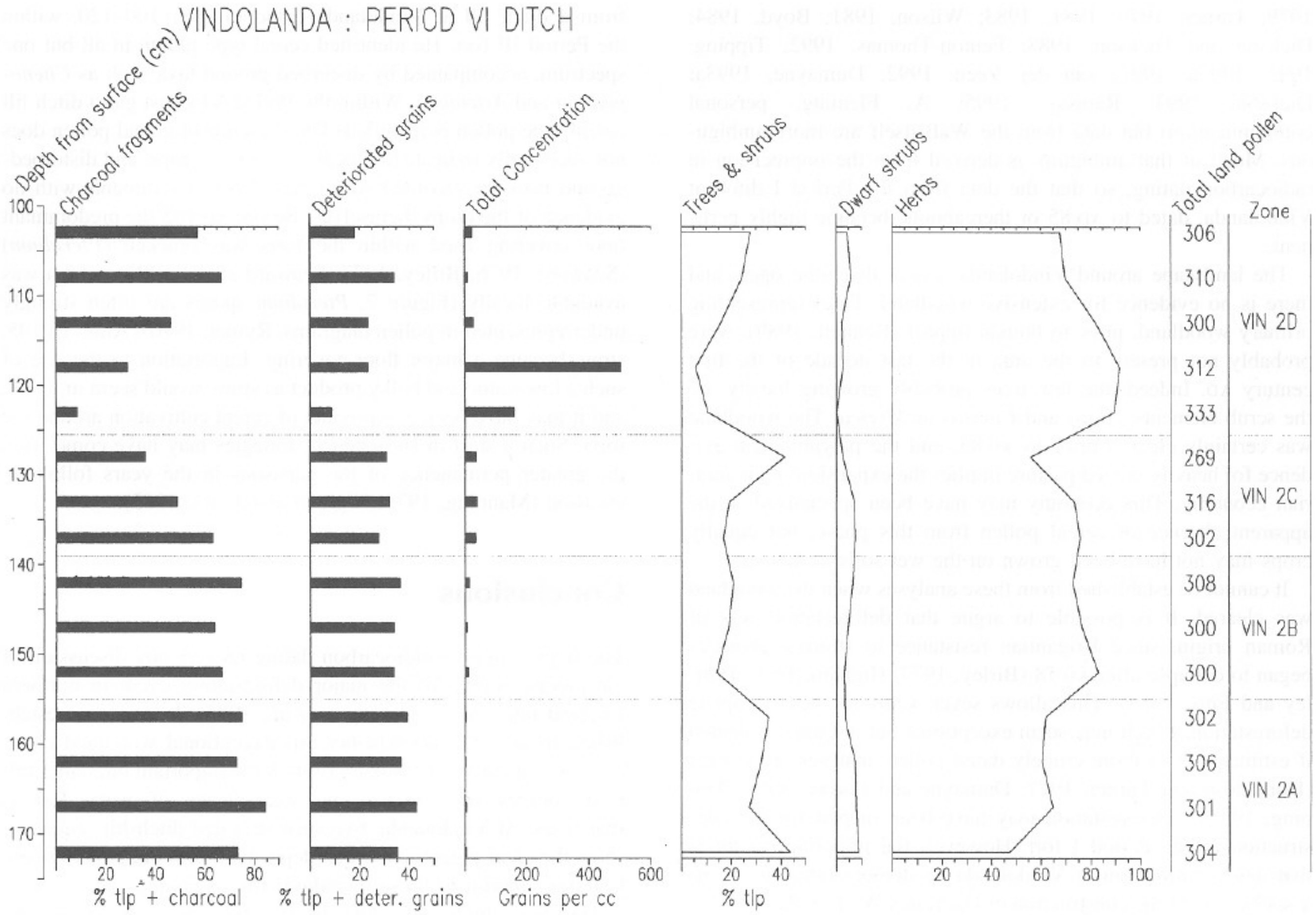

Figure 10 Microscopic charcoal fragments, total pollen concentrations, total numbers of deteriorated pollen grains, summary diagrams and numbers of land pollen grains counted for the Period VI (west gate) ditch fill.

Discussion

Limitations of the data

There are three principal constraints on interpretation associated with pollen analyses from ditch fills. First, Dimbleby (1985) argued that much pollen could derive from ditch sides, and so be reworked. Mineral inwashes are recognized in the ditches examined here, and, although palynological subsamples avoided these, other inwash bands may not be so distinct. Pollen preservation is poor, but this cannot be used as a guide to reworking (cf. Birks, 1970) in such minerogenic sediments as postdepositional abrasion is likely. It is likely, if deforestation occurred in the area close to the age of the Period I ditch (discussed further below) then soils/sediments containing noncontemporaneous pollen would be laden with arboreal pollen (cf. Tipping, 1992). The observation that pollen spectra from the ditch fills at Vindolanda are not dominated by tree taxa is argued to be good evidence that the pollen is largely contemporaneous with sediment accumulation, and do represent faithfully the two periods AD 85–92 and AD 160–180.

Second, one model of pollen recruitment to sites (Jacobson and Bradshaw, 1981) suggests that a depositional site as small as the Vindolanda ditches will receive pollen from only a few metres away; there is thus the possibility that the vegetation being recorded is untypical of the wider landscape, which is seen better in pollen diagrams from mires. There is, however, no indication from Figures 7 and 9 that plants growing within the ditches dominate or distort the pollen records. Indeed, it seems that both ditches were kept largely free of vegetation except mosses (*Sphagnum*), perhaps purposefully to promote efficient drainage or through a high rate of sediment buildup. Probably more importantly in this regard, pollen recruitment to small basins is believed to be restricted only in forested landscapes (Tauber, 1965; 1977; Jacobson and Bradshaw, 1981; Groenman-van Waateringe, 1988; Edwards, 1991). We have few data on pollen recruitment in open landscapes, but the wider region can be expected to make a more important contribution to small pollen sites, though how wide remains an important caveat. The herb pollen assemblages are interesting in this respect, for they are more readily interpreted as agrarian than from close to buildings. Critical to later discussion is the seeming scarcity of arboreal pollen in the Vindolanda ditches, and in this regard it can be argued that, if trees were present within the region, the prodigious pollen production and dispersal of most temperate arboreal taxa would ensure their representation within these sediments.

Third, although the major advantage of these analyses is the precision with which these deposits can be dated, this is also one of their limitations. Local p.a. zone VIN 1A records the vegetation at AD 85. It tells us nothing of the vegetation at AD 84, and this is a weakness in interpretation (below). In addition, although the pollen assemblages from the Period I and VI ditches are very closely comparable, we should not assume there to be no changes in the *c.* 70 years separating these deposits. In this regard the analyses of Davies (1978) from an early second century AD ditch fill assist (below).

The Roman impact on the environment of Hadrian's Wall

The central problem that needs to be addressed is the nature of the landscape that confronted Agricola's troops on arrival at the Tyne-Solway gap, later to become the major defensive line in Britain. Areas to the south and north of the Wall were deforested in the late Iron Age (Bartley *et al.*, 1976; Davies and Turner,

1979; Turner, 1979; 1981; 1983; Wilson, 1981; Boyd, 1984; Dickson and Dickson, 1988; Fenton-Thomas, 1992; Tipping, 1992; 1995a; 1997; van der Veen, 1992; Dumayne, 1993a; Dickson, 1993; Ramsay, 1995; A. Fleming, personal communication) but data from the Wall itself are more ambiguous. Much of that ambiguity is derived from the imprecision in radiocarbon dating, so that the data from the Period I ditch at Vindolanda, dated to AD 85 or thereabouts, become highly pertinent.

The landscape around Vindolanda was at that time open, and there is no evidence for extensive woodland. Trees representing primary woodland, prior to human impact (Bennett, 1989), were probably not present in the area in the last decade of the first century AD. Indeed, the few trees probably growing locally are the scrub elements, *Alnus* and *Corylus* or *Myrica*. The woodland was certainly cleared prior to AD 85, and the palynological evidence for heavily grazed pasture implies the expansion of an agrarian economy. This economy may have been specialized in the apparent absence of cereal pollen from this phase, but equally crops may not have been grown on the wet soils at this site.

It cannot be established from these analyses when the woodland was cleared. It is possible to argue that deforestation was of Roman origin, since Brigantian resistance to Roman advances began to collapse after AD 78 (Birley, 1977; Higham, 1986; Hartley and Fitts, 1988). This allows seven years for near-complete deforestation, which may seem exceptional but not unprecedented if estimates from more crudely dated pollen analyses are correct (Donaldson and Turner, 1977; Dumayne and Barber, 1994; Tipping, 1995b). Deforestation may have been in part for the construction of the Period I fort. However, the important factor is that deforestation can at Vindolanda be demonstrated not to be associated with the construction of Hadrian's Wall, in the AD 120–130s, as argued by Dumayne at Fozy Moss (1993b; 1994; Dumayne *et al.*, 1995); Vindolanda lies 7.5 km south west of Fozy Moss (Figure 1B).

There are suggestions that agricultural activities date to the pre-Roman Iron Age at Vindolanda and other sites on the line of the Wall. The temporal context of ridged arable fields beneath Hadrianic structures on and near the Wall (Gillam *et al.*, 1973; Welfare, 1985) have been discussed (Topping, 1989), but it is difficult to demonstrate their origins within the late Iron Age (Hanson and MacInnes, 1981; Carter, 1994). Birley (1977; 1994) has suggested that a native settlement existed at Vindolanda prior to Roman occupation, from the name of the fort itself being a Romanized form of the celtic 'white lawns' or 'white enclosed land'. The pollen diagram from the Period I ditch suggests that the 'lawns' were a species-rich pasture, and, together, the data imply a native, pre-Roman agricultural presence.

The scarcity of readily available timber may have inconvenienced the constructors of the first Roman fort, but the troops used whatever was available (Hanson and MacInnes, 1981). The principal species used at Vindolanda was *Betula*, argued to have been growing locally (Seaward, 1976). This poor-quality timber suggests that there were few alternatives, a view endorsed by our analyses. *Quercus* timber at Vindolanda had been seasoned and fashioned (Seaward, 1976), and it may have been imported. Its reuse in later forts suggests its scarcity in the vicinity of the fort (Hanson, 1975). *Alnus* is not a common building material (Seaward, 1976) but its abrupt reductions in l.p.a. zone VIN 1D suggest it to have been felled on occasions.

Changes in land use during the second century AD

The landscape and land uses appear to have changed little between the end of the first century AD and the beginning of the second century. Only in one respect is there palynological and archaeological evidence for modifications to the agricultural economy, in the inferred cultivation of cereals. Davies (1978) analysed samples from a ditch fill at Vindolanda dated to *c.* AD 100–120, within the Period III fort. He identified cereal-type pollen in all but one spectrum, accompanied by disturbed-ground taxa such as *Chenopodium* and *Artemisia*. Within the Period VI (west gate) ditch fill cereal-type pollen is recorded. The presence of cereal pollen does not necessarily indicate the local growing of crops, and disturbed-ground taxa are recorded within the Period I sediments with no evidence of the crops themselves. Before AD 105 the predominant floor covering used within the forts was bracken (*Pteridium*) (Seaward, 1976; Birley, 1977; Seaward *et al.*, 1993), which was available locally (Figure 7: *Pteridium* spores are often strongly underrepresented in pollen diagrams; Rymer, 1976). After AD 105, straw became a major floor-covering. Importation to the site of such a low-value and bulky product as straw would seem unlikely, and it may have been a byproduct of cereal cultivation around the forts. Such a shift in subsistence strategies may have come from the greater permanence of the garrisons in the years following invasion (Manning, 1975; Higham and Jones, 1985).

Conclusions

The imprecision of radiocarbon dating renders any discussion of the precise timing of the major deforestation event in northern England impractical (Dumayne *et al.*, 1995). It cannot be established from such data whether this exceptional woodland clearance was of native or Roman origin. Very important but underutilized sources of evidence are excavations of early Roman structures. At Vindolanda, two such stratified ditch-fill sequences show the clear potential of such deposits in providing dating controls far superior to those of radiometric techniques.

The two ditch fills date to the periods *c.* AD 85–92 and *c.* AD 160–180. Pollen analyses from the earliest depicts a landscape around the fort that is already open, cleared of nearly all woodland. Only scrub elements persisted. The cleared land was used, seemingly quite intensively, as pasture for grazing animals. By the beginning of the second century AD this pastoral economy had begun to be augmented by cereal cultivation.

The precise dating of these deposits allows the ideas developed by Dumayne and Barber at nearby Fozy Moss (Dumayne, 1993a; 1993b; 1994; Barber *et al.*, 1994; Dumayne and Barber, 1994; Dumayne *et al.*, 1995) to be challenged. The woodland clearance in this part of what was to become Hadrian's Wall occurred prior to AD 85, and cannot be linked with the construction of the Wall some forty years later. The clearance is more likely to have been of native origin than Roman, although this is less securely established. The separation in time of the woodland clearance and Wall construction in the AD 120s undermines another important facet of Dumayne and Barber's argument, that, on the Wall, deforestation was primarily for military rather than agrarian purposes. The purpose behind woodland clearance on the line of the Wall appears to have been, as in other parts of northern England and southern Scotland, for the expansion of agricultural land. What lay behind the need to expand agricultural production in such a dramatic way remains to be explored (van der Veen, 1992).

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