APPENDIX 17: WATERLOGGED PLANT REMAINS

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Excavations along the CNDR indicated that significant waterlogged plant remains (WPR) were present at both Stainton West and Knockupworth (*Ch 1*). Those from Stainton West were confined to a series of organic and alluvial deposits within the *Principal palaeochannel* (*Ch 2*). Given the archaeological significance of this site, 73 bulk palaeoenvironmental samples were taken from these deposits and were assessed for both waterlogged plant and insect remains (*Appendix 14*), careful consideration being given to ensure that the sampled deposits included those that had also been examined for foraminifera/ostracods, diatoms (*Appendix 15*), and pollen (*Appendix 16*), and also those clearly associated with cultural material. This selection acted on the advice of the then English Heritage (now Historic England) Science Advisors for the North West (Sue Stallibrass) and Hadrian's Wall (Jacqui Huntley). Following assessment, 39 samples were selected for analysis (Fig 663), and, as part of a complementary study, the insect remains from 30 of these were also analysed (*Appendix 14*). At Knockupworth, during the excavation of Hadrian's Wall, 29 bulk samples were taken and, following assessment, five were analysed.

Methodology

Slightly different methodologies were adopted for processing the samples from the two sites. With the Stainton West samples, one litre sub-samples were extracted, and these were wet sieved through a series of different mesh sizes (2 mm, 500 μm, and 250 μm). The residues were then retained wet. In contrast, 10-40 litres of each of the Knockupworth samples were hand-floated for both waterlogged and charred plant remains (*Appendix 18*), and the resulting flots were collected onto a 250 μm mesh and air-dried, thus being examined as dry flots.

Following processing, the samples from both sites were examined with a Leica MZ6 binocular microscope, and the waterlogged remains were extracted, identified, where possible, and quantified. However, the residues from some of the Stainton West samples were extremely large and hence the plant remains were only extracted and quantified from a proportion of the sample, and then multiplied (details relating to these extrapolated samples are contained within the site archive). Identification was aided by Katz *et al* (1965), Cappers *et al* (2006), and Stace (2010), and by comparison with modern reference-material held at OA North. In addition, to aid identification, the Hohenheim Botanic Gardens, Stuttgart, supplied some modern seeds. Plant nomenclature follows Stace (*ibid*).

In all cases, up to a maximum of 100 of the seeds/fruits and other plant remains, such as catkins, bark, moss stems, buds, leaf fragments, wood, acorn fragments, and amorphous plant remains, as well as charcoal, were counted. However, it should be stressed that in terms of seeds, the numbers produced vary between individual taxon. For example, bristle club-rush (*Isolepis setacea*), rushes (*Juncus* sp), and common nettle (*Urtica dioica*) produce very large numbers of small seeds, while others, such as hawthorn (*Crataegus monogyna*), creeping buttercup-type (*Ranunculus repens*-type), bugle (*Ajuga repens*), and self-heal (*Prunella vulgaris*), produce relatively few fruits or seeds. In addition to the plant remains, any insect eggs, algae/cyanobacterium, fungal remains, and minerals present in the samples were also counted.

During counting, the total numbers of seeds and fruits were recorded. However, the other plant, animal, fungal, algae/cyanobacterium, and mineral remains were scored on a scale of 1-5, where 1 is rare (less than five items) and 5 is abundant (more than 100 items). All of the results were then catalogued and incorporated into the CNDR Finds Database.

Although many taxa can be found growing in more than one habitat, to assist analysis, each individual plant species, identified from the seeds/fruits, was also placed within a specific ecological group. These groupings were:

1. Aquatic and wet-ground plants;
2. Plants belonging to broad ecological groupings;
3. Grassland plants;

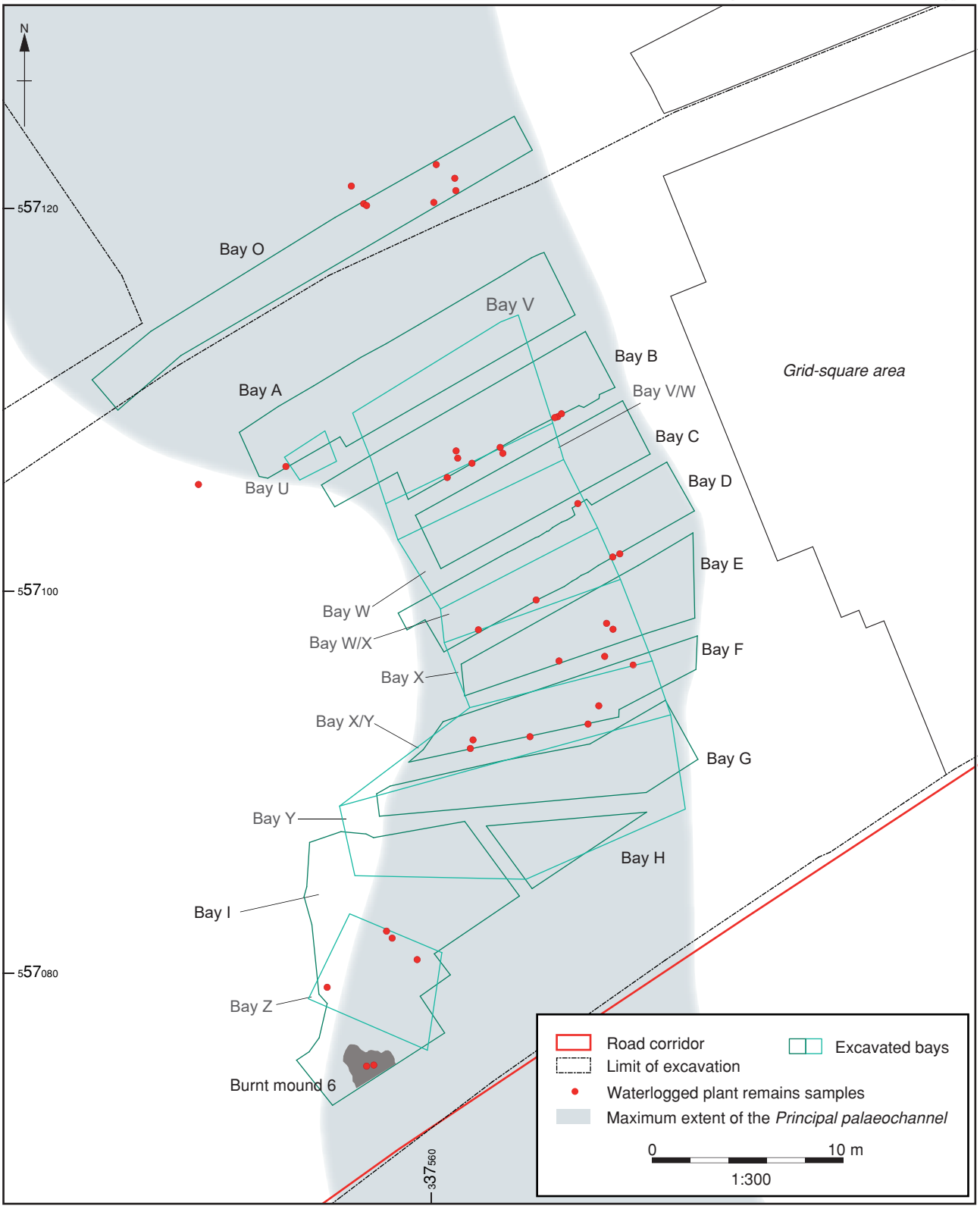

Figure 663: The analysed waterlogged plant-remains samples, Stainton West

4. Plants of scrub and waste ground;
5. Plants of waste and cultivated ground;
6. Woodland plants;
7. Plants found in woods and hedgerows;
8. Plants found in woods, hedgerows, and grassy places;
9. Plants found in woods, hedgerows, and waste ground;
10. Plants found in woods, hedgerows, and wet places;
11. Plants found in mires and heaths;
12. Plants found in woods, heaths, and moors.

To assist analysis further, aspects of the data from Stainton West were then diagrammatically summarised. The resultant diagrams plotted the actual and relative counts of the fruits and seeds from particular ecological groups, which were contained in the main stratigraphic units within the *Principal palaeochannel*. In addition, individual counts and relative values for alder (*Alnus glutinosa*), hazel (*Corylus avellana*), and rushes were presented within the diagrams, to show more clearly how these specific species fluctuated over time.

Results

The majority of the analysed samples from Stainton West were from the main stratigraphic units within the *Principal palaeochannel* dating to the Late Mesolithic to the Chalcolithic periods, and hence provide additional palaeoenvironmental data relevant to these periods. In addition, several samples were from Burnt Mound 6 (*Ch 11*), and these provide additional data for the Chalcolithic period.

The analysed samples from Knockupworth came from the primary Vallum ditch and its later recut (*Ch 13*). These probably relate to the environment existing during the Roman period, following the initial construction of the Hadrianic frontier (*c* AD 122-30), and after the subsequent redefinition of the Vallum ditch, which perhaps dates to *c* AD 160. The only exceptions to this were associated with a block of laminated turf (***51026***) within the primary Vallum ditch, as although this was probably from the Turf Wall, it contained sediment that produced an Iron Age radiocarbon date (360-170 cal BC; 2183±26 BP; SUERC-42030). Therefore, this turf had probably been accumulating for some considerable time before it was stripped from the adjacent area for use in the construction of the Hadrianic frontier.

Stainton West

Mesolithic organic deposit

In total, 12 samples were analysed from the *Mesolithic organic deposit* (*Ch 3*). These were derived from Bays V, X, and Z, and most contained moderate numbers of fruits and seeds (40-138), apart from deposit ***71142*** (Table 313), in Bay V, which only contained four identifiable items.

In this stratigraphic unit, hazel was the most common tree taxon (Table 314), with both mature and immature hazelnuts and fragments, which together comprised 47.74% of the total number of items recorded. Alder fruits were also present in eight samples, but were not abundant (6% of the total number of items recorded). A few stones of hawthorn (*Crataegus monogyna*) were recorded in nine samples, and apple (*Malus* sp) pips, which are most likely to be from crab apples (*Malus sylvestris* (L) Mill), were found in three samples. Birch seeds (*Betula* sp), and fragments of acorn cups from oak (*Quercus* sp), were also present, whilst occasional fruits of dogwood (*Cornus sanguinea*), holly (*Ilex aquifolium*), and bird cherry (*Prunus padus*) were recorded, especially from Bay X.

The fruits and seeds of herbaceous-woodland plants included those from wood sorrel (*Oxalis acetosella*), cow-parsley (*Anthriscus sylvestris*), red campion (*Silene dioica*), and greater stitchwort (*Stellaria holostea*). Other herbaceous-plant remains were from broad ecological categories, including creeping buttercup-type achenes, common nettles, and violet (*Viola* sp) seeds.

Mesolithic organic deposit		***Mesolithic alluvium***		***Mesolithic/Neolithic alluvium***	
Deposit	**Number of samples analysed**	**Deposit**	**Number of samples analysed**	**Deposit**	**Number of samples analysed**
71091	1	***70059***	1	***70317***	1
71017	1	***70479***	1	***70318***	1
71010	1	***70323***	1	***70504***	1
71069	1	***70413***	1		
71022	1	***70345***	1		
71021	1	***70505***	1		
71024	1				
71089	1				
71026	1				
71028	2				
71142	1				
Total	***12***		***6***		***3***

Table 313: Mesolithic-age deposits analysed for waterlogged plant remains, Stainton West

Bay		**V**			**X**					**Z**				
Deposit		***71091***	***71089***	***71142***	***71017***	***71026***	***71028***	***71028***	***71069***	***71010***	***71021***	***71022***	***71024***	
Sample		71097	71099	71108	71025	71060	71062	71063	71164	71019	71041	71045	71050	
Seeds/fruits														***Total***
1. Aquatic and wet ground														
Alisma plantago-aquatica L	Water-plantain				2					2				***4***
Callitriche L sp	Water-starwort					2								***2***
Caltha palustris L	Marsh-marigold					2								***2***
Carex L biconvex nutlets	Sedges with biconvex nutlets				2	2		2			4			***10***
Carex L trigonous nutlets	Sedges with three-sided nutlets	2	6	1	8	1			8	2			8	***36***
Comarum palustre L	Marsh cinquefoils												4	***4***
Cyperaceae undifferentiated	Sedge family		2											***2***
Filipendula ulmaria (L) Maxim	Meadowsweet					1						1		***2***
Lycopus europaeus L	Gypsywort										1			***1***
Nasturtium officinale W T Aiton	Water-cress		4											***4***
Potamogeton L sp	Pondweed									2				***2***
Ranunculus flammula L	Lesser spearwort	2	4	1	2				1					***10***
Stachys palustris L	Marsh woundwort							2		6				***8***
2. Broad ecological groupings														
Caryophyllaceae undifferentiated	Pink family							2		1				***3***
Potentilla erecta (L) Raeusch-type	Tormentil-type				2			2						***4***
Ranunculus repens L-type	Creeping buttercup-type	2	3		1			11		2	2	2		***23***
Rumex obtusifolius L	Broad-leaved dock					1	1							***2***
Solanum dulcamara L	Bittersweet					2								***2***
Stachys L sp	Woundwort sp				1							1		***2***
Viola L undifferentiated	Violets		2		1	4			2		2			***11***
3. Grassland														
Poaceae with caryopses 2-4 mm	Grasses with medium fruits								2	2				***4***
Rumex acetosa L	Common sorrel						4							***4***
Rumex acetosella L	Sheep's sorrel				2									***2***

Table 314: Waterlogged plants and other remains from the Mesolithic organic deposit*, Stainton West*

Bay		**V**			**X**					**Z**				
Deposit		***71091***	***71089***	***71142***	***71017***	***71026***	***71028***	***71028***	***71069***	***71010***	***71021***	***71022***	***71024***	
Sample		71097	71099	71108	71025	71060	71062	71063	71164	71019	71041	71045	71050	
4. Scrub and waste ground														
Rubus sect 2 Glandulosus Wimm and Grabb (*Rubus fruticosus* L agg)	Brambles									11		1		***12***
5. Waste and cultivated ground														
Galeopsis cf *tetrahit* L	Common hemp-nettle				2									***2***
Persicaria lapathifolia (L) Delarbe	Pale persicaria								2					***2***
Urtica dioica L	Common nettles		10			5		6	2	6				***29***
6. Woodland														
Alnus glutinosa (L) Gaertan fruits	Alder fruits	2			8		5	4		28	1	1	4	***53***
Betula L sp seed	Birch	8	12	1	10	32	7	18	8			3	4	***103***
Cornus sanguinea L	Dogwood						1		1					***2***
Corylus avellana L immature nuts	Immature hazelnuts	2	2			2	2	2	3	5	3		13	***34***
Corylus avellana L nut fragments	Hazelnut fragments	16	17	1		21	13	12	73	36	28	22	94	***333***
Corylus avellana L nuts	Hazelnuts	1	2		3	3		2	6	2	1		2	***22***
Crataegus monogyna Jacq	Hawthorn		1			1	1	3	5	1	2	1	5	***20***
Ilex aquifolium L	Holly							1						***1***
Malus Mill /*Sorbus* L	Apple/rowan	1				4						1		***6***
Prunus padus L	Bird cherry					1			1	1		1		***4***
Silene dioica (L) Clairv	Red campion	2	2		2	2			2	6		1		***17***
Stellaria holostea L	Greater stitchwort									2				***2***
7. Woods and hedgerows														
Oxalis acetosella L	Wood-sorrel	2	4		2	13		2		4		3	4	***34***
8. Woodland, hedgerows, and grassy places														
Anthriscus sylvestris M Bieb	Cow parsley		1			3								***4***

Table 314: Waterlogged plants and other remains from the Mesolithic organic deposit*, Stainton West (cont'd)*

Bay		V			X					Z				
Deposit		***71091***	***71089***	***71142***	***71017***	***71026***	***71028***	***71028***	***71069***	***71010***	***71021***	***71022***	***71024***	
Sample		71097	71099	71108	71025	71060	71062	71063	71164	71019	71041	71045	71050	
9. Woods, hedgerows and waste ground														
Lapsana communis L	Nipplewort		1									1		***2***
Total		***40***	***73***	***4***	***48***	***102***	***34***	***69***	***116***	***119***	***44***	***39***	***138***	***826***
Other remains (Scale 1-5, where 1= 1-5 items and 5 = >100 items)														
Plant material														
Alnus glutinosa (L) Gaertan catkin scales	Alder catkin scales			2	4			4	2	5	2	2		
Alnus glutinosa (L) Gaertan catkins	Alder catkin	1	2			1				1			1	
Alnus glutinosa (L) Gaertan cone axis	Alder cone axis	1	1							1				
Amorphous plant remains				3	5	5	5	5	5	5	5	5	5	
Anthers, pollen-bearing part of stamen		5	2	3	4	5	5	5	4	5	5	5	5	
Bark		5	5				2	3			2	2	1	
Betula sp scale	Birch scale	2												
Bryophyte capsule	Moss capsule		1			1								
Bryophyte remains	Mosses					5	3	2	2	5	3	5	2	
Bud scales		3	2	4	5	5	5	5	5	5		5	5	
Buds		5	5	3	3	5	4	5	5	5	4	5	5	
Catkin scales		5	5	1	1	5	2	2	3				3	
Charcoal		1		1	2	2	1	1		2	1		1	
Corylus avellana L catkin scales	Hazel catkin scales							2						
Corylus avellana L catkins	Hazel catkin	2	2		1	1	1	1	1	2			2	
Corylus avellana L/*Alnus glutinosa* (L) Gaertan catkins	Hazel/alder catkin	1	1								1			
Leaf fragments		2		1	5	1	2	5	1	1		2	1	

Table 314: Waterlogged plants and other remains from the Mesolithic organic deposit*, Stainton West (cont'd)*

Bay		**V**			**X**					**Z**				
Deposit		***71091***	***71089***	***71142***	***71017***	***71026***	***71028***	***71028***	***71069***	***71010***	***71021***	***71022***	***71024***	
Sample		71097	71099	71108	71025	71060	71062	71063	71164	71019	71041	71045	71050	
Plant material														
Leaf scars		2					1							
Monocotyledonous remains			1			2		2						
Quercus sp acorn bud	Oak bud									1			1	
Quercus sp acorn fragments	Oak acorn fragments					1		1	1				2	
Rooty material			1							5				
Roundwood					2	2	3	5	5	5	5	3	5	
Ulmus sp stamens	Elm stamens	5							1					
Wood			1	3	5	2	5	5	5	5	5	5	5	
Animal		5	2											
Earthworm egg cases									2					
Mineralised wormcasts		1					1			2				
Ostracod		2										1		
Blue-green algae/cyanobacterium														
cf *Gloeotrichia* heterocyst		3	4									1	1	
Fungal														
Fungal sclerotia					1			1	1					
Kretzschmaria deusta		2	2											
Mineral														
Clay and silt		3			5	2		2		2	2	2	2	
Sand and gravel		5	2	5	2	5	5	5	2	2	2	5	5	

Table 314: Waterlogged plants and other remains from the Mesolithic organic deposit*, Stainton West (cont'd)*

During the assessment, a fruit of dog's mercury (*Mercurialis perennis*) was also identified in deposit ***71070*** (Bay X), a type rarely recorded in Quaternary or archaeological deposits (A Hall *pers comm*; W Carruthers *pers comm*).

Although the *Mesolithic organic deposit* was extremely waterlogged, the number of fruits and seeds from aquatic plants was low, only occurring sporadically throughout it. Those present included the fruits/seeds of water-starwort (*Callitriche* sp), water-plantain (*Alisma plantago-aquatica*), pondweed (*Potamogeton* sp), and lesser spearwort (*Ranunculus flammula*). Evidence of wet-ground plants was also sparse, being confined to some sedge (*Carex* sp) nutlets, and occasional fruits/seeds of marsh-marigold (*Caltha palustris*), marsh cinquefoil (*Comarum palustre*), and meadowsweet (*Filipendula ulmaria*). The deposit was, however, dominated by the remains of woody plants, in the form of wood fragments, buds, bud scales, and very abundant anthers (the pollen-bearing part of stamens), with hazel, alder, and some elm (*Ulmus* sp) stamens present. Amorphous plant and moss remains were also abundant. Interestingly, the possible heterocysts of *Gloeotrichia* sp, a blue-green alga/cyanobacterium, were also recorded in some samples (from deposits ***71089***, ***71022***, ***71024***, and ***71091*** in Bays V and Z).

This stratigraphic unit was characterised by considerable evidence for woodland, with 80% of the remains coming from woodland taxa (Fig 664). Hazel was the major tree/shrub, but elm, oak, hawthorn, and birch were also recorded, with evidence for an understorey of wood sorrel and creeping buttercup-type. The high numbers of anthers, wood fragments, buds, bud scales, and, in some samples, leaf fragments suggest that trees were overhanging the channel during this period. Given this, the presence of any open-ground plant indicators has probably been masked by the close proximity of the woodland. However, the counts for plants that favour waste and cultivated ground, grassland, and those from broad ecological groupings (Fig 665) do provide some evidence for possible small clearances within the Mesolithic woodland surrounding Stainton West.

Although the *Mesolithic organic deposit* was extremely waterlogged, there were only sporadic occurrences of

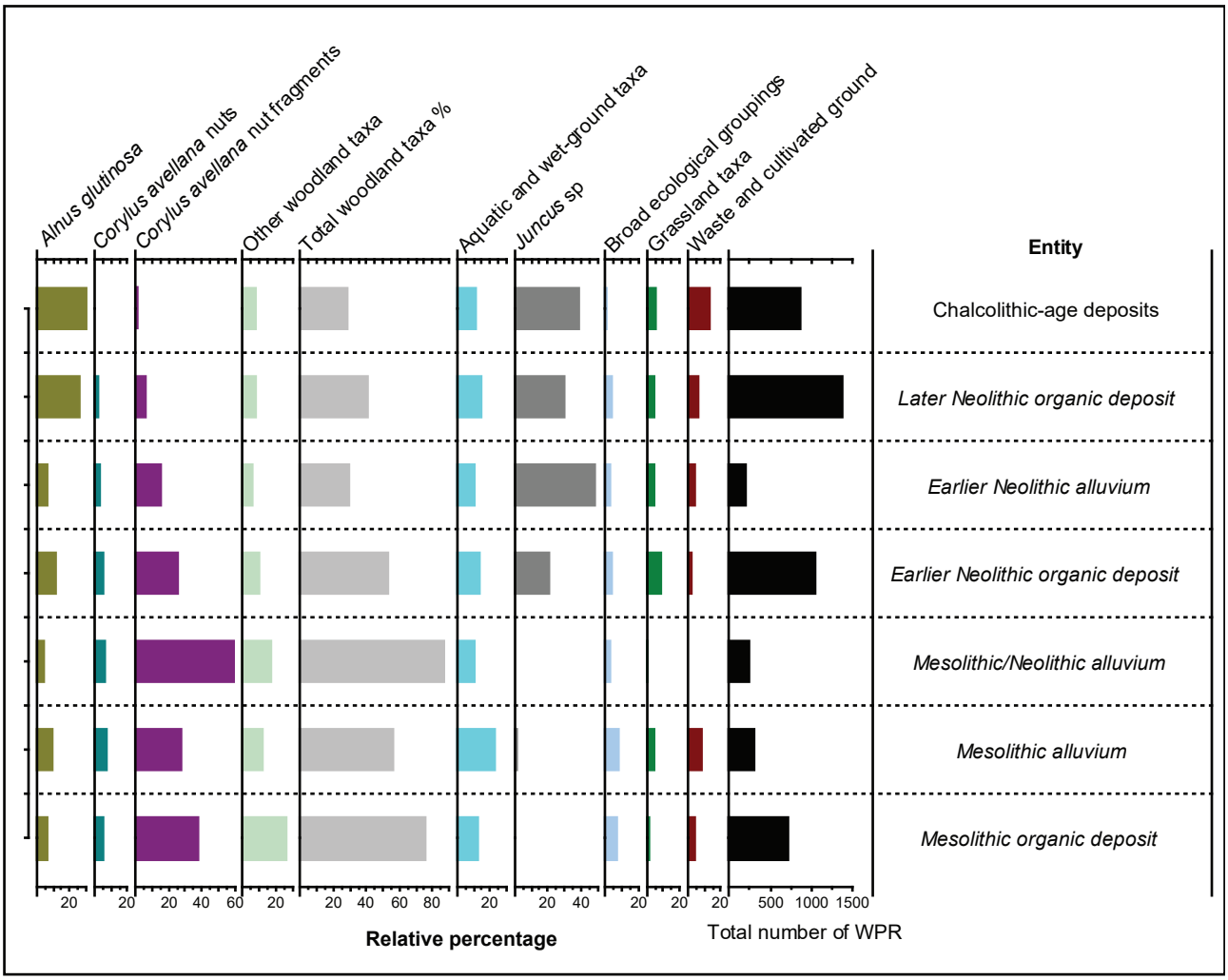

Figure 664: Relative percentages of waterlogged plant remains (WPR) from Stainton West

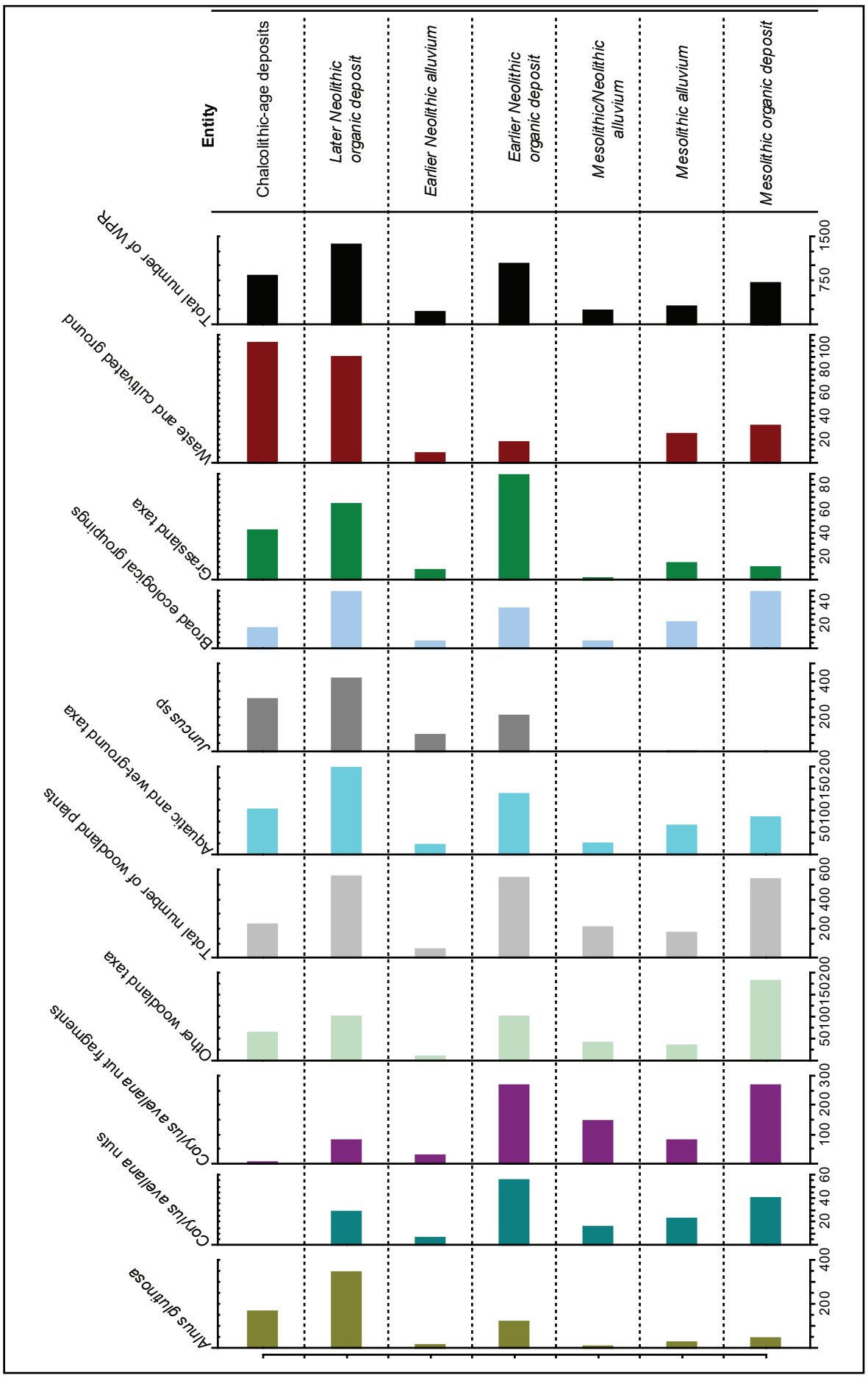

Figure 665: Actual counts of waterlogged plant remains (WPR) from Stainton West

plant remains that suggest a wetland environment. For instance, there was little evidence for true aquatic vegetation or wet-ground plants (11% of the total remains), suggesting that the channel was not being actively infilled. Given this, the presence of the heterocysts of blue-green algae/cyanobacterium is significant. Although the identification is tentative, if it is correct, it may be evidence of eutrophication (an excess of nutrients) caused by increased levels of phosphorus, perhaps causing growth conditions where nitrogen was limited (Mauquoy and van Geel 2007). Moreover, *Gloeotrichia* sp is a type of alga/cyanobacterium that grows in shallow freshwater deposits and is capable of nitrogen fixation (Carey *et al* 2008), and might therefore provide evidence for the character of the channel when the *Mesolithic organic deposit* was in the process of being formed.

Mesolithic alluvium

Six samples were analysed from the *Mesolithic alluvium* (*Ch 6*), from Bays B, D, F, and O (Table 313). Overall, these samples produced fewer plant remains than those from the more organic-rich deposits contained within the *Principal palaeochannel*. Therefore, only 297 items were recorded, with the totals for the individual samples being 9-95 items.

Anthers, moss remains, and wood fragments were present in all samples (Table 315), as were bud scales, although remains of the actual buds were only recorded in four of the deposits, being absent from ***70059*** and ***70323***. Overall, although there were occasional occurrences of alder, hazel was relatively more frequent. Plant remains from herbaceous plants were not abundant, although a few sedge nutlets were recorded.

Deposit ***70479*** contained the widest range of plant species, mainly being woodland taxa. This was found on the northern side of the *Principal palaeochannel* in Bay O, the sample containing fruits, seeds, and nut fragments (88 in total), from alder, birch, dogweed, hazel, wood sorrel, and wood rushes.

The sample with the lowest frequency of material was from deposit ***70505***, also in Bay O, though, in contrast to deposit ***70479*** (*above*), this was on the southern side of the *Principal palaeochannel*. It contained very few fruits, seeds, or hazelnut fragments (six in total), though fungal sclerotia and earthworm egg cases were abundant, along with amorphous and monocotyledonous remains, from plants such as sedges, rushes, and grasses, along with fragments of roundwood.

As with all alluvial deposits, the taphonomy of the plant remains from this stratigraphic unit is uncertain, as it is likely that some came from local sources, whilst others were probably transported from higher up the river catchment. In addition, the assemblage may possibly include older reworked remains.

With these taphonomic factors in mind, the *Mesolithic alluvium* was characterised by less material, when compared with the underlying *Mesolithic organic deposit*. Of the woodland species, hazel was more frequent than alder (Fig 665), although there was a slight increase in the numbers of alder fruits when compared to those recorded in the *Mesolithic organic deposit*. Woodland was again probably bordering the channel.

There was a relative increase in the numbers of aquatic or wet-ground plants, there being a greater variety in the northern section of the *Principal palaeochannel* (Bay O), which was also characterised by fewer hazelnut fragments and a larger number of alder seeds. In addition, the abundant amorphous and monocotyledonous plant remains, along with fungal sclerotia and earthworm-egg cases, identified in deposit ***70505*** from the northern side of Bay O, may suggest that that this part of the channel had stabilised during the Mesolithic period.

Mesolithic/Neolithic alluvium

Three samples were analysed from the *Mesolithic/Neolithic alluvium* (*Ch 6*), being extracted from Bays B, D, and O. The total number of fruits and seeds recorded in the samples varied from 36 in deposit ***70317*** (Bay B) to 152 in ***70504*** (Bay O), although, together, hazelnut fragments, hazelnuts, and immature hazelnuts comprised 103 of the items in the latter total (Table 315). Apart from these ubiquitous remains, deposit ***70504*** also contained the widest range of woodland plants in comparison to the other samples from this stratigraphic unit. These included the fruits and seeds of alder, hawthorn, crab apple, red campion, greater stitchwort, and wood-sorrel. This woody assemblage is therefore similar to that associated with underlying deposit ***70479***, part of the *Mesolithic alluvium* in Bay O (*above*). Other seeds/fruits associated with other ecological habitats were fewer in number, but included aquatic and wet-ground plants, and those that can grow across a range of habitats.

The samples also contained abundant amorphous plant remains, anthers, wood fragments, buds, and bud scales. Significantly, elm buds (A Hall *pers comm*) and anthers were recorded in the samples, and moss remains were also frequent.

The material, particularly those remains relating to woodland plants, is in many ways comparable to that present in the *Mesolithic alluvium*. Therefore, when the *Mesolithic/Neolithic alluvium* was forming, woodland probably still bordered the channel, which appears to

		Mesolithic alluvium							*Mesolithic/Neolithic alluvium*			
Bay		**B**	**D**	**F**	**F**	**O**			**B**	**D**	**O**	
Deposit		***70059***	***70413***	***70323***	***70345***	***70479***	***70505***		***70317***	***70318***	***70504***	
Sample		70460	70470	70472	70441	70503	70505		70424	70428	70504	
Seeds/fruits								***Total***				***Total***
1. Aquatic and wet ground												
Alisma plantago-aquatica L	Water-plantain			2		4		***6***				
Caltha palustris L	Marsh-marigold			4				***4***				
Carex L biconvex nutlets	Sedges with biconvex nutlets	4		4	2	13		***23***				
Carex L trigonous nutlets	Sedges with three-sided nutlets	8	3		6	4		***21***	4	4	4	***12***
Comarum palustre L	Marsh cinquefoils	4						***4***				
Filipendula ulmaria (L) Maxim	Meadowsweet					4		***4***				
Juncus L sp	Rushes					4		***4***				
Ranunculus flammula L	Lesser spearwort									8	2	***10***
Stachys palustris L	Marsh woundwort										4	***4***
Potamogeton natans L	Broad-leaved pondweed					2		***2***				
2. Broad ecological groupings												
Ajuga reptans L	Bugle	4						***4***				
Ranunculus repens-L type	Creeping buttercup-type		1	12	2			***15***			2	***2***
Rumex L sp	Sorrels					2		***2***		4		***4***
Rumex obtusifolius L	Broad-leaved dock					2		***2***				
3. Grassland												
Leontodon L sp	Hawkbits										1	***1***
Poaceae with caryopses 2-4 mm	Grasses with medium fruits					4		***4***				
Rumex acetosa L	Common sorrel			6				***6***				
Rumex acetosella L	Sheep's sorrel			4				***4***				
4. Scrub and waste ground								***Total***				***Total***
Rubus sect 2 Glandulosus Wimm and Grabb (*Rubus fruticosus* L agg)	Brambles			2	6			***8***			4	***4***

Table 315: Waterlogged plants and other remains from the Mesolithic alluvium *and* Mesolithic/Neolithic alluvium*, Stainton West*

		Mesolithic alluvium							*Mesolithic/Neolithic alluvium*			
Bay		**B**	**D**	**F**	**F**	**O**			**B**	**D**	**O**	
Deposit		***70059***	***70413***	***70323***	***70345***	***70479***	***70505***		***70317***	***70318***	***70504***	
Sample		70460	70470	70472	70441	70503	70505		70424	70428	70504	
5. Waste and cultivated ground												
Galeopsis cf *tetrahit* L	Common hemp-nettle		1		2			***3***				
Stellaria media (L) Vill	Common chickweed			2				***2***				
Urtica dioica L	Common nettles	4	3		8	4		***19***				
6. Woodland												
Alnus glutinosa (L) Gaertan fruits	Alder fruits		1	1	2	20	4	***28***			10	***10***
Betula L sp fruit	Birch			2		2	2	***6***	4	4		***8***
cf *Salix* L seed	*cf* Willow seed								1			***1***
Cornus sanguinea L	Dogwood					1		***1***				
Corylus avellana L immature nuts	Immature hazelnuts	4		5	1	6		***16***	2		2	***4***
Corylus avellana L nut fragments	Hazelnut fragments	50		17	3	11		***81***	20	35	90	***145***
Corylus avellana L nuts	Hazelnuts	6				1		***7***	1		11	***12***
Crataegus monogyna Jacq	Hawthorn	5		2				***7***		3	8	***11***
Malus Mill /*Sorbus* L	Apple/rowan										2	***2***
Prunus L sp	Cherries	1						***1***				
Prunus padus L	Bird cherry			1				***1***				
Silene dioica (L) Clairv	Red campion										2	***2***
Stellaria holostea L	Greater stitchwort	4						***4***			8	***8***
7. Woods and hedgerows								***Total***				***Total***
Luzula DC undifferentiated	Wood-rushes					2		***2***				
Oxalis acetosella L	Wood-sorrel			3		2		***5***	4		2	***6***
10. Woodland, hedgerows, and wet places												
Dipsacus pilosus L	Small teasel	1						***1***				
Total		***95***	***9***	***67***	***32***	***88***	***6***	***297***	***36***	***58***	***152***	***246***

Table 315: Waterlogged plants and other remains from the Mesolithic alluvium *and* Mesolithic/Neolithic alluvium*, Stainton West (cont'd)*

		Mesolithic alluvium							*Mesolithic/Neolithic alluvium*			
Bay		**B**	**D**	**F**	**F**	**O**			**B**	**D**	**O**	
Deposit		***70059***	***70413***	***70323***	***70345***	***70479***	***70505***		***70317***	***70318***	***70504***	
Sample		70460	70470	70472	70441	70503	70505		70424	70428	70504	
Other remains (Scale 1-5, where 1= 1-5 items and 5 = >100 items)												
Plant material												
Alnus glutinosa (L) Gaertan catkin scales	Alder catkin scales						1		5	5	3	
Alnus glutinosa (L) Gaertan catkins	Alder catkins									1	1	
Alnus glutinosa (L) Gaertan cone axis	Alder cone axis									1		
Amorphous plant remains			5	5	5	4	5			5	5	
Anthers, pollen-bearing part of stamen		5	5	5	5		5		5	2	5	
Bark				4			2		5			
Bryophyte capsule	Moss capsule				1				4			
Bryophyte remains	Moss remains	2	2	5	5		5			2	2	
Bud scales		5	2	5	5	1	3		5	5	5	
Buds			3		5	1	2		5	5	5	
Catkin scales			1	5	2							
Charcoal		1	2	2	2	2	1		5	1	2	
Corylus avellana L catkins	Hazel catkins								2	1	2	
Leaf fragments			1		2		1			2	2	
Leaf scars		1	1									
Monocotyledonous remains			3	2			5			4	2	
Quercus sp acorn bud	Oak acorn bud								2	1		
Quercus sp acorn fragments	Oak acorn fragments										1	
Rooty material			5				2				2	
Roundwood		5	5	5	5	4	2				5	

Table 315: Waterlogged plants and other remains from the Mesolithic alluvium *and* Mesolithic/Neolithic alluvium*, Stainton West (cont'd)*

		Mesolithic alluvium							*Mesolithic/Neolithic alluvium*			
Bay		**B**	**D**	**F**	**F**	**O**			**B**	**D**	**O**	
Deposit		***70059***	***70413***	***70323***	***70345***	***70479***	***70505***		***70317***	***70318***	***70504***	
Sample		70460	70470	70472	70441	70503	70505		70424	70428	70504	
Plant material												
Salix L sp bud	Willow bud				1				5	1		
Wood	Wood	5	5	5	5	4	2			5	5	
Animal												
Earthworm egg cases				1						1	1	
Mineralised wormcasts										1	1	
Fungal												
Fungal sclerotia		2	3			1	5					
Kretzschmaria deusta			1									
Mineral												
Clay and silt						5						
Sand and gravel		5		5	5	5	5			5	5	
Reworked Plant												
Pre-Quaternary trilete spore			1						5			

Table 315: Waterlogged plants and other remains from the Mesolithic alluvium *and* Mesolithic/Neolithic alluvium*, Stainton West (cont'd)*

have been dominated by hazel, with smaller amounts alder and other woodland species (Figs 664-5). There is also some evidence for the existence of wet ground at this time.

Earlier Neolithic organic deposit

Six samples from the *Earlier Neolithic organic deposit* (*Ch 6*) were analysed (Table 316), all from highly organic and waterlogged deposits in Bays A (deposit ***70353***), B (deposit ***70308***), D (deposit ***70315***), F (two samples from deposit ***70325***), and O (deposit ***70498***). Waterlogged remains were abundant, especially in Bays A and O, and reflected a wide range of species types. Over 1073 fruits and seeds were recorded, with individual deposits containing between 90 and over 299 items, although together, hazelnuts, fragments, and immature hazelnuts formed a substantial element of the assemblage, totalling 349 items (Table 317). In addition, the fruit/seed total was skewed by the presence of over 100 rush seeds, and over 100 alder fruits in deposit ***70353*** (Bay A).

This assemblage indicates that a wet environment existed when the *Earlier Neolithic organic deposit* was being formed. For example, water-plantain, sedges, and meadowsweet were recorded in four of the bays (A, B, D, and O), whilst rushes were present in the deposits from Bays A and O. The very high numbers of alder fruits, catkin scales, and catkin axes in deposit ***70353*** (Bay A) are also striking, whilst a few catkins and a catkin axis were present in deposit ***70308*** (Bay B), associated with *cf* alder wood.

Amorphous plant remains, anthers, bark, buds, and bud scales were frequent to abundant. The fruiting bodies of the fungus *Kretzchmaria deusta* were also identified in samples from deposits ***70353*** (Bay A), ***70308*** (Bay B), and ***70315*** (Bay D). This fungus is associated with rotting wood and the spores are often recorded in pollen diagrams at the time of the elm decline (*Appendix 16*). In addition, some charcoal fragments were recorded in several of the samples.

Two samples (70115 and 70124) from deposit ***70325***, in Bay F, were analysed, which were extracted from immediately adjacent to stone axe 70325.41 (*Appendix 2*). Although the total number of fruits and seeds in both samples was quite high, hazelnut fragments made up 37.5% of the total in 70115 and 68% in 70124. Other woody taxa in sample 70124 included nine fruits from hawthorn, one from dogwood, whilst alder was represented by two fruits and two fragments of seed cones. Bramble (*Rubus* sect *Glandulosus* (formerly *Rubus fruticosus* agg)) and elder (*Sambucus nigra*) pips were also recorded in sample 70115, and these, along with hazel, might represent Neolithic foodstuffs. Generally, herbaceous plants were not well represented in these samples, although occasional wood-sorrel seeds suggest the existence of woodland ground flora close to the site. The only aquatic or wet-ground plants present were a few sedge nutlets and marsh woundwort fruits (*Stachys palustris*). Grasses (Poaceae), with fruits of 2-4 mm, were present in both samples, and in 70115 they made up nearly 42% of the assemblage. In addition, occasional seeds of common nettle and common chickweed suggest some open ground or grassland. The only plants recorded that can grow in many different environments were bugle (*Ajuga repens*) and creeping buttercup-type. As in the other samples from the *Earlier Neolithic organic deposit*, samples 70115 and 70124 also contained large amounts of amorphous plant remains and wood fragments, including roundwood. Abundant buds and bud scales, and the remains of monocotyledonous plants, were also recorded in sample 70124.

Interestingly, the assemblage suggests that during the earlier Neolithic period significant changes to the character of the vegetation surrounding the channel occurred. Although hazel was still dominant, the samples from Bay A and, to a lesser extent, Bays B and O contained increasing numbers of alder fruits, catkin scales, and catkin axes, suggesting the beginning of the transition to alder woodland at the northern end of the site. The number of hawthorn and birch remains also decreased when compared to the *Mesolithic organic deposit* and there is greater evidence for plants of wet

Earlier Neolithic organic deposit		*Earlier Neolithic alluvium*		*Later Neolithic organic deposit*	
Deposit	**Number of samples analysed**	**Deposit**	**Number of samples analysed**	**Deposit**	**Number of samples analysed**
70308	1	***70154***	1	***70307***	1
70315	1	***70187***	1	***70314***	1
70325	2	***70482***	1	***70326***	1
70353	1			***70478***	2
70498	1			***70121***	1
Total	***6***		***3***		***6***

Table 316: Neolithic-age deposits analysed for waterlogged plant remains, Stainton West

ground, especially rushes, which again spatially appear to have been present in the northern parts of the *Principal palaeochannel*, in Bays A and O. The waterlogged remains of grassland and waste-ground plants also increased, although the grass fruits may in fact have derived from floating sweet-grass. These differences are more apparent when the actual number of remains are considered (Fig 665), as opposed to their relative values (Fig 664). Wood remains and amorphous plant remains were also very abundant in this stratigraphic unit.

Taken as a whole, the assemblage suggests that woodland along the banks was becoming more open and the ground wetter in the earlier Neolithic period. The very marked increase in the representation of rushes may also suggest that the channel was beginning to be infilled; however, because rushes produce large numbers of very small seeds, these could have been originating from single plants in the respective parts of the *Principal palaeochannel*.

Earlier Neolithic alluvium

Three samples from the *Earlier Neolithic alluvium* (*Ch 6*) were analysed (Table 316), from deposits ***70187*** (Bay B), ***70154*** (Bay F), and ***70482*** (Bay O). Over 205 fruits and seeds were recorded, 69 in deposit ***70187***, four in deposit ***70482***, and more than 132 in deposit ***70154*** (Table 317). However, the total from this latter deposit included more than 100 seeds of compact rush (*Juncus conglomeratus*).

In terms of the species present, the widest range was associated with deposits ***70187*** and ***70154***. These included the seeds of aquatic and wet-ground plants, and smaller quantities of seeds/fruits from plants found in grassland, scrub, and waste ground, and those which can occupy a broad range of ecological habitats. These two deposits also included seeds/fruits from woodland species, particularly hazel and alder. Hawthorn fruits were also present in deposit ***70187***, whilst elder pips were recorded in ***70154***. Wood fragments, including roundwood, and monocotyledonous and amorphous plant remains, were abundant in all the samples, along with small amounts of buds, bud scales, and anthers.

As with the other alluvium stratigraphic units, the *Earlier Neolithic alluvium* was characterised by fewer plant remains, when compared with those present in the organic deposits from the channel. The taphonomy of the remains identified was also uncertain, making interpretations of the data difficult. However, although there is a clear decrease in the total number of remains from all the plant categories, when the groups are compared, woodland taxa declined, and aquatic and wet-ground taxa increased (Fig 664).

Later Neolithic organic deposit

Six samples from the *Later Neolithic organic deposit* (*Ch 10*) were analysed (Table 316), which were extracted from Bays A, B, D, F, and O. Significantly, all of the samples were rich; indeed, they contained the highest numbers of seeds and fruits, when compared with the other stratigraphic units from the *Principal palaeochannel*, with a total of over 1453 items, with individual samples containing between 82 and 327 items (Table 318). However, it should be noted that more than 100 rush seeds were present in four samples (70360, 70294, 70381, and 70485).

The remains of woodland plants were recorded in quite large numbers in most samples. Alder appeared to dominate the assemblage, replacing hazel, which had dominated earlier assemblages, although hazel was still well represented, and in deposit ***70121*** (Bay A) hazelnut fragments made up 41% of the total number of items recorded. Other woodland species included elder, hawthorn, bird cherry (*Prunus padus*), and an unidentified cherry-type (*Prunus* sp) fruit. There were also subtle differences in the woodland plant assemblages spatially across the *Principal palaeochannel*, as the only woodland taxa noted in deposit ***70326*** in Bay F, in the southern part of the channel, was elder.

Small numbers of fruits and seeds of herbaceous taxa were recorded, especially from the northern part of the channel, in Bay O, where generally more taxa were identified than in the other bays. Grass caryopses (fruits 2-4 mm) were identified in all of the samples, apart from that from deposit ***70121***, suggesting the presence of nearby grassland. However, the fruits of floating sweet-grass (*Glyceria fluitans*) have a similar size range, representing plants that commonly grow in, or by, water, and also on wet ground (Körber-Grohne 1964; Stace 2010). Other fruits and seeds from this stratigraphic unit included those, such as common chickweed (*Stellaria media*), that grow on waste or cultivated ground.

Aquatic and wet-ground plants were recorded in all of the samples, with a more diverse range of plant species in those from the northern part of the channel, in Bay O and, to a lesser extent, in Bay D, in the central part of the *Principal palaeochannel*. Rush seeds were also abundant in deposits ***70307***, ***70314***, ***70326***, and ***70478*** (Bays B, D, F, and O). The remains of sedges, including Cyperous sedge (*Carex pseudocyperus*) and brown sedge (*Carex disticha*), water-plantain, water-starwort, meadowsweet, marsh marigold, gipsywort (*Lycopus europaeus*), and ragged-robin (*Silene flos-cuculi*), were also recorded. These plant species grow in wet or muddy places in, or beside, rivers, ponds, and ditches (Stace 2010).

In addition to the seeds and fruits, very abundant amorphous plant remains and wood fragments, including roundwood, were present. Fragments of acorn cups and oak buds were noted from Bay O,

		Earlier Neolithic organic deposit							*Earlier Neolithic alluvium*			
Bay		**A**	**B**	**D**	**F**		**O**		**B**	**F**	**O**	
Deposit		***70353***	***70308***	***70315***	***70325***	***70325***	***70498***		***70187***	***70154***	***70482***	
Sample		70148	70400	70427	70115	70124	70487		70341	70367	70498	
Seeds/fruits								***Total***				***Total***
1. Aquatic and wet ground												
Alisma plantago-aquatica L	Water-plantain	8	4	8			8	***28***				
Callitriche L sp	Water-starwort	4		4				***8***				
Carex cf *pseudocyperus* L	Cyperus sedge		1					***1***				
Carex cf *acuta* L	Slender tufted sedge						6	***6***				
Carex elongata L	Elongated sedge		2					***2***				
Carex hostianna DC	Tawny sedge			4				***4***				
Carex L biconvex nutlets	Sedges with biconvex nutlets	6	6	4	10	6	7	***39***				
Carex L trigonous nutlets	Sedges with three-sided nutlets		2				2	***4***	8			***8***
Carex L undifferentiated but with utricle	Sedge undifferentiated but with utricle		4					***4***				
Cyperaceae undifferentiated	Sedge family											
Filipendula ulmaria (L) Maxim	Meadowsweet	4	1	4			2	***11***		2		***2***
Juncus cf *conglomeratus* L	Compact rush									>100		***>100***
Juncus effusus L-type	Soft rush	>100			2			***>102***	8			***8***
Juncus L sp	Rushes		6	4			>100	***>110***				
Lycopus europaeus L	Gypsywort	4						***4***	4			***4***
Montia L sp	Blinks			4				***4***				
Ranunculus flammula L	Lesser spearwort	1		4				***5***				
Stachys palustris L	Marsh woundwort					2		***2***				
Stellaria cf *palustris* L	Marsh stitchwort	6						***6***				
2. Broad ecological groupings												
Ajuga reptans L	Bugle					2		***2***				
Caryophyllaceae undifferentiated	Pink family						8	***8***				

Table 317: Waterlogged plants and other remains from the Earlier Neolithic organic deposit *and* Earlier Neolithic alluvium*, Stainton West*

		Earlier Neolithic organic deposit							*Earlier Neolithic alluvium*			
Bay		**A**	**B**	**D**	**F**		**O**		**B**	**F**	**O**	
Deposit		***70353***	***70308***	***70315***	***70325***	***70325***	***70498***		***70187***	***70154***	***70482***	
Sample		70148	70400	70427	70115	70124	70487		70341	70367	70498	
2. Broad ecological groupings								***Total***				***Total***
Chenopodiaceae undifferentiated	Goosefoot family									2		***2***
Cirsium Mill sp	Thistles						2	***2***				
Poaceae with caryopses <2 mm	Grasses with small fruits						2	***2***				
Polygonaceae undifferentiated	Knotweed family, includes docks, sorrels, knotweeds, and other genera	2			2			***4***				
Prunella vulgaris L	Selfheal		2					***2***				
Ranunculus repens L-type	Creeping buttercup-type	4				8	4	***16***			4	***4***
Rumex L sp	Sorrels	1						***1***				
Solanum dulcamara L	Bittersweet		2				2	***4***				
Sonchus L sp	Sow-thistle						2	***2***				
Viola L undifferentiated	Violets	2					2	***4***				
3. Grassland												
Poaceae with caryopses 2-4 mm	Grasses with medium fruits	7	5	12	57	4	7	***92***		8		***8***
4. Scrub and waste ground												
Rubus sect 2 Glandulosus Wimm and Grabb (*Rubus fruticosus* L agg)	Brambles	8			6		3	***17***		3		***3***
5. Waste and cultivated ground												
Chenopodium album L	Fat-hen	2						***2***				
Galeopsis cf *tetrahit* L	Common hemp-nettle		1					***1***				
Stellaria media (L) Vill	Common chickweed					2	4	***6***				
Urtica dioica L	Common nettles	2				2	8	***12***	8			***8***
6. Woodland												
Alnus glutinosa (L) Gaertan fruits	Alder fruits	>100	12			2	22	***>136***	9	4		***13***
Betula L sp seed	Birch	2		4			5	***11***				

Table 317: Waterlogged plants and other remains from the Earlier Neolithic organic deposit *and* Earlier Neolithic alluvium*, Stainton West (cont'd)*

		Earlier Neolithic organic deposit							*Earlier Neolithic alluvium*			
Bay		**A**	**B**	**D**	**F**		**O**		**B**	**F**	**O**	
Deposit		***70353***	***70308***	***70315***	***70325***	***70325***	***70498***		***70187***	***70154***	***70482***	
Sample		70148	70400	70427	70115	70124	70487		70341	70367	70498	
6. Woodland								***Total***				***Total***
Cornus sanguinea L	Dogwood					1		***1***				
Corylus avellana L immature nuts	Immature hazelnuts	3	7	4	4	6	2	***26***	3	1		***4***
Corylus avellana L nut fragments	Hazelnut fragments	23	25	48	51	110	46	***303***	26	5		***31***
Corylus avellana L nuts	Hazelnuts	6	8			1	5	***20***	1	1		***2***
Crataegus monogyna Jacq	Hawthorn	2				9	2	***13***	2			***2***
Luzula sylvatica (Huds) Gaudin	Great wood-rush						4	***4***				
Sambucus nigra L	Elder				6			***6***		6		***6***
Silene dioica (L) Clairv	Red campion	1						***1***				
Stellaria holostea L	Greater stitchwort	1	2	4			20	***27***				
7. Woods and hedgerows												
Oxalis acetosella L	Wood-sorrel					6	2	***8***				
Total		***>299***	***90***	***108***	***138***	***161***	***>277***	***>1073***	***69***	***>132***	***4***	***>50***
Other remains (Scale 1-5, where 1= 1-5 items and 5 = >100 items)												
Plant material												
Alnus glutinosa (L) Gaertan catkin scales	Alder catkin scales	5		2			3					
Alnus glutinosa (L) Gaertan catkins	Ader catkins	2	2	1			1			1		
Alnus glutinosa (L) Gaertan cone axis	Alder cone axis	3	1			2	1					
Amorphous plant remains		5	5	5	5	5	5		5	5	5	
Anthers, pollen-bearing part of stamen		4	2	4	2	3	5		2	2		
Bark		5	3	3	4	3	2			1		
Bryophyte remains	Moss remains	2	2	5	2	2	2			1	2	
Bud scales		5	2	2	2	5	5		2	2		

Table 317: Waterlogged plants and other remains from the Earlier Neolithic organic deposit *and* Earlier Neolithic alluvium*, Stainton West (cont'd)*

		Earlier Neolithic organic deposit							*Earlier Neolithic alluvium*			
Bay		**A**	**B**	**D**	**F**		**O**		**B**	**F**	**O**	
Deposit		***70353***	***70308***	***70315***	***70325***	***70325***	***70498***		***70187***	***70154***	***70482***	
Sample		70148	70400	70427	70115	70124	70487		70341	70367	70498	
Plant material												
Buds		4	5		2	5	5		2	2		
Catkin scales						2				3		
Charcoal			2		2	3	2		2	2	1	
Corylus avellana L catkins	Hazel catkins	1		1	1	2			1			
Corylus avellana L/*Alnus glutinosa* (L) Gaertan catkins	Hazel/alder catkins	2			1		1		2	1		
Leaf fragments		2		2			1					
Leaf scars				1								
Monocotyledonous remains		2	1	5		4	2		5	5	5	
Quercus sp acorn bud	Oak acorn bud	1					1					
Rooty material	Rooty material										2	
Roundwood	Roundwood	5	5	5	5	5	5		5	5	5	
Wood	Wood	5	5	5	5	5	5		5	5	2	
Animal												
Daphnia ephippia					1							
Earthworm egg cases										1		
Mineralised wormcasts		1										
Algae												
Chara/*Nitella* oospores									1			
Fungal												
Fungal sclerotia		2		1					3	1		
Honey fungus			3			1					2	
Kretzschmaria deusta		1	2	1								
Mineral												
Clay and silt		2	5	5	2	3	3			3		
Sand and gravel		1	5				5		5	5	5	

Table 317: Waterlogged plants and other remains from the Earlier Neolithic organic deposit *and* Earlier Neolithic alluvium*, Stainton West (cont'd)*

Bay		**A**	**B**	**D**	**F**	**O**		
Deposit		***70121***	***70307***	***70314***	***70326***	***70478***	***70478***	
Sample		70344	70360	70294	70381	70483	70485	
Seeds/fruits								***Total***
1. Aquatic and wet ground								
Alisma plantago-aquatica L	Water-plantain				12	8	6	***26***
Callitriche L sp	Water-starwort			2		8	6	***16***
Caltha palustris L	Marsh-marigold			1				***1***
Carex cf *pseudocyperus* L	Cyperus sedge						2	***2***
Carex cf *disticha* Huds	Brown sedge						1	***1***
Carex L biconvex nutlets	Sedges with biconvex nutlets	12		27	7	34	20	***100***
Carex L trigonous nutlets	Sedges with three-sided nutlets			4		8	10	***22***
Carex L undifferentiated but with utricle	Sedge undifferentiated but with utricle						1	***1***
Carex rostrata Stokes	Bottle sedge					14		***14***
Filipendula ulmaria (L) Maxim	Meadowsweet			4			2	***6***
Juncus effusus L-type	Soft rush		>100					***>100***
Juncus L sp	Rushes			>100	>100	14	>100	***>314***
Lycopus europaeus L	Gypsywort			4		6	1	***11***
Montia L sp	Blinks					4		***4***
Ranunculus flammula L	Lesser spearwort	4			2			***6***
Schoenus nigricans L	Black bog-rush			1				***1***
Silene flos-cuculi (L) Clairv	Ragged-robin	4						***4***
Stachys palustris L	Marsh woundwort	4			2			***6***
2. Broad ecological groupings								
Ajuga reptans L	Bugle			1			1	***2***
Caryophyllaceae undifferentiated	Pink family							
Chenopodiaceae undifferentiated	Goosefoot family						2	***2***
Mentha sp L	Mints					2		***2***
Poaceae with caryopses <2 mm	Grasses with small fruits							
Prunella vulgaris L	Selfheal	4			1	4	4	***13***
Ranunculus repens L-type	Creeping buttercup-type	1	2	3		11	15	***32***
Stachys L sp	Woundwort sp			1				***1***
Viola L undifferentiated	Violets	1			1			***2***
3. Grassland								
Poaceae with caryopses 2-4 mm	Grasses with medium fruits		2	7	23	8	12	***52***
Poaceae with caryopses >4 mm	Grasses with large fruits			1	1			***2***
Rumex acetosa L	Common sorrel	4				8		***12***
Rumex acetosella L	Sheep's sorrel					2		***2***
4. Scrub and waste ground								
Rubus sect 2 Glandulosus Wimm and Grabb (*Rubus fruticosus* L agg)	Brambles		2	22	2	6	3	***35***

Table 318: Waterlogged plants and other remains from the Later Neolithic organic deposit*, Stainton West*

Bay		**A**	**B**	**D**	**F**	**O**		
Deposit		***70121***	***70307***	***70314***	***70326***	***70478***	***70478***	
Sample		70344	70360	70294	70381	70483	70485	
5. Waste and cultivated ground								***Total***
Chenopodium album L	Fat-hen		2	5		2		***9***
Galeopsis cf *tetrahit* L	Common hemp-nettle						1	***1***
Persicaria maculosa Gray	Redshank			2				***2***
Stellaria media (L) Vill	Common chickweed	4		13	1	16	4	***38***
Urtica dioica L	Common nettles	4	2	1	1	38	2	***48***
6. Woodland								
Alnus glutinosa (L) Gaertan fruits	Alder fruits	4	>100	90		99	58	***>351***
Betula L sp seed	Birch		2			6	6	***14***
Corylus avellana L immature nuts	Immature hazelnuts	1	5			3	1	***10***
Corylus avellana L nut fragments	Hazelnut fragments	34	43	13		14	11	***115***
Corylus avellana L nuts	Hazelnuts		13			2	4	***19***
Crataegus monogyna Jacq	Hawthorn	1	2			1	1	***5***
Luzula sylvatica (Huds) Gaudin	Great wood-rush					4		***4***
Prunus L sp	Cherries					1	1	***2***
Prunus padus L	Bird cherry					2	1	***3***
Sambucus nigra L	Elder			18	13			***31***
Stellaria holostea L	Greater stitchwort		2			2	2	***6***
7. Woods and hedgerows								
Oxalis acetosella L	Wood-sorrel						2	***2***
8. Woodland, hedgerows, and grassy places								
Anthriscus sylvestris M Bieb	Cow parsley						1	***1***
Total		***82***	***>277***	***>320***	***>166***	***327***	***>281***	***>1453***
Other remains (Scale 1-5, where 1= 1-5 items and 5 = >100 items)								
Plant material								
Alnus glutinosa (L) Gaertan catkins	Alder catkins		2	1		1	2	
Amorphous plant remains		5	5	5	5	5	5	
Anthers, pollen-bearing part of stamen		5	4		2	5	3	
Bark				2	1			
Bryophyte remains	Moss remains	2				1	5	
Bud scales		5	5	2	1	5	5	
Buds		3	5	2	1	4	4	
Catkin scales		2	5	5	1		4	
Charcoal		1	1	2	2	3	2	
Corylus avellana L catkins	Hazel catkins			1		1	1	
Corylus avellana L/*Alnus glutinosa* (L) Gaertan catkins	Hazel/Alder catkins		3	2		2	2	

Table 318: Waterlogged plants and other remains from the Later Neolithic organic deposit, *Stainton West (cont'd)*

Bay		**A**	**B**	**D**	**F**	**O**		
Deposit		***70121***	***70307***	***70314***	***70326***	***70478***	***70478***	
Sample		70344	70360	70294	70381	70483	70485	
Plant material								***Total***
Leaf fragments			2				1	
Leaf scars		2	1					
Monocotyledonous remains			2	2		2	2	
Quercus sp acorn bud	Oak acorn bud					1	1	
Quercus sp acorn fragments	Oak acorn fragments					1	1	
Roundwood	Roundwood	2	5	5	5	5	5	
Salix L sp catkin with anthers	Willow catkin with anthers					1		
Thorns	Thorns						1	
Wood	Wood	5	5	5	5	5	5	
Animal								
Earthworm egg cases		1	1	2	1			
Mineralised wormcasts				1	1			
Algae/Cyanobacterium								
Chara/Nitella oospores			1			1		
cf *Gloeotrichia* heterocyst						1		
Fungal								
Fungal sclerotia				2	1		2	
Honey fungus					1	1	2	
Kretzschmaria deusta					1			
Mineral								
Clay and silt	Clay and silt	2	5	2	5		2	
Sand and gravel	Sand and gravel		2	2	3		2	

Table 318: Waterlogged plants and other remains from the Later Neolithic organic deposit*, Stainton West (cont'd)*

while anthers were recorded in most samples, except that from deposit ***70314*** (Bay D), and catkins were also present in the majority, apart from that extracted from deposit ***70326*** (Bay F). Although buds or bud scales were present in all of the samples, their numbers were lower than in the earlier organic deposits.

Another feature within this stratigraphic unit was the tentative identification of the heterocysts of the cyanobacterium/blue-green alga *Gloeotrichia* sp. These were present in deposit ***70478*** (sample 70483), in Bay O and, as with those identified in the *Mesolithic organic deposit*, they may provide evidence for possible eutrophication within the channel during the later Neolithic period.

The local environment had changed quite considerably by this time. The material indicates that alder had replaced hazel as the dominant tree taxon, though stands of hazel still existed (Fig 664). It is also likely that the woodland close to the channel was more open, and scrubby in character, with brambles, elder, and cherries/sloes in the assemblage. In addition, grasses, with medium-sized caryopses of between 2 mm and 4 mm, were consistently identified, with creeping buttercup-type achenes in many of the samples, providing further evidence for open ground.

Rushes were present in all parts of the channel during this period (Fig 665). However, there appears to be more evidence of marsh and fen conditions in Bays O and D, rather than in Bays B and F, with water-starwort, sedges, including Cyperus sedge, brown sedge, and bottle sedge (*C rostrata*), together with some meadowsweet and marsh woundwort. Bay O also contained heterocysts of blue-green algae/cyanobacterium, perhaps relating to possible eutrophication within the channel. More generally, the channel appears to have filled during the later Neolithic period, and a stabilisation layer was possibly developing in places. This is supported by an increase in rootwood in this stratigraphic unit (*Appendix 13*). Charcoal fragments were also recorded throughout the samples.

Chalcolithic-age deposits: Burnt Mound 6 and the *Chalcolithic alluvium*

Three samples came from Chalcolithic-age deposits within the *Principal palaeochannel* (Table 319), one from a soil (***70398***) in Bay I. This filled the trough (***70250***) of Burnt Mound 6 *(Ch 11*), which has been radiocarbon dated to *2280-2340 cal BC* (*SUERC-42017; Appendix 20*). The plant remains comprised more than 406 fruits and seeds, including more than 100 rush seeds (Table 320). Fat-hen and medium-sized grass caryopses were frequently recorded, whilst the remains of sedges and lesser spearwort were also identified; along with the rush seeds, these are indicative of wet conditions (Stace 2010). The fruits of alder and elder were also identified, together with evidence for plants that favour waste or cultivated ground. Other remains relating to alder included catkins, cone axes, and catkin scales.

Abundant amorphous-plant remains and wood fragments, including roundwood, were noted, although there were fewer buds and bud scales than in the earlier channel deposits. Other plant remains included bryophyte fragments, leaf scars, and a few charcoal fragments, and several earthworm-egg cases were also present.

The other two samples were taken from two separate deposits (***70313***, Bay D, and ***70395***, Bay I), both elements of the *Chalcolithic alluvium*. This was later in date than Burnt Mound 6 and certainly formed following the last use of this feature, as evidenced by deposit ***70395***, which sealed its remains (*Ch 11*), the material from both deposit ***70395*** and soil ***70398*** (*above*), contained within the trough of Burnt Mound 6, being comparable. More than 205 fruits and seeds were recorded in deposit ***70395***, again including more than 100 rush seeds, which, together with the remains of sedges and lesser spearwort, again indicate that wet conditions existed during this period. As in soil ***70398***, alder and elder were noted, along with brambles, and also plants that are often associated with waste and cultivated ground. Again, in a comparable way to soil ***70398***, abundant amorphous-plant remains and wood fragments were present, along with buds and bud scales, bryophyte fragments, leaf scars, charcoal fragments, and earthworm-egg cases.

The sample from deposit ***70313*** contained a sizable assemblage of plant remains, with over 197 items recorded, though again more than 100 of these were rush seeds. These were also comparable to material in soil ***70398*** and deposit ***70395***. Alder dominated the woodland species, though elder pips and a few hazelnut fragments were also recorded, along with small quantities of birch and hawthorn. In addition to woodland plants, the fruits and seeds from species that grow in waste or cultivated ground were present (Stace 2010), including fat-hen (*Chenopodium album*), redshank (*Persicaria maculosa*), and common chickweed. Other species included grasses (fruits 2-4 mm), creeping buttercup-type, common nettle, and brambles. Aquatic and wet-ground taxa were limited to abundant soft rush-type seeds (*cf Juncus effusus*-type), along with smaller quantities of water-plantain, sedges, and ragged-robin. Abundant wood fragments, including roundwood, alder catkins, and amorphous plant remains, were also present, but there were fewer buds and bud scales than in the other sampled channel deposits. Bark fragments were frequent, and charcoal was more abundant than in other deposits.

The samples suggest that the channel was beginning to stabilise during this period and there is some evidence of waste-, or even cultivated, ground (Fig 665), given the presence of plants such as fat-hen, redshank, and common chickweed. Rushes dominated the assemblage (Fig 664), with a few sedges. The large numbers of alder-catkin scales, together with moderate numbers of alder fruits, suggest this was growing close by, whilst bramble and elder were also growing in some areas.

Knockupworth

The material from five samples taken from the Vallum ditch at Knockupworth were analysed (Table 321), three being extracted from the fills of the primary ditch (***51050***) and two from its later recut (***51051***). One was taken from an extremely sandy deposit (***51024***), the primary fill of the primary ditch, and this contained only a few fruits and seeds, indicative of wet-ground conditions, including bristle club-rush, rushes, blinks (*Montia* sp), and lesser spearwort. There were also single seeds from grassland taxa (Table 322). In addition to the seeds, it contained

Burnt mound 6			***Chalcolithic alluvium***		
Feature	**Fill**	**Number of samples analysed**	**Stratigraphic Group**	**Deposit**	**Number of samples analysed**
Trough ***70250***	***70398***	1	***70299***	***70313***	1
				70395	1
Total		***1***			***2***

Table 319: Chalcolithic-age deposits analysed for waterlogged plant remains, Stainton West

		Burnt mound 6	*Chalcolithic alluvium*	
Bay		**I**	**D**	**I**
Deposit		***70398***	***70313***	***70395***
Sample		70435	70293	70436
Seeds/fruits				
1. Aquatic and wet ground				
Alisma plantago-aquatica L	Water-plantain	16	2	
Carex L biconvex nutlets	Sedges with biconvex nutlets	22	8	12
Carex L trigonous nutlets	Sedges with three-sided nutlets	5	2	8
Juncus effusus L-type	Soft rush		>100	
Juncus L sp	Rushes	>100		>100
Lycopus europaeus L	Gypsywort	12		
Montia L sp	Blinks	4		
Ranunculus flammula L	Lesser spearwort	5		8
Silene flos-cuculi (L) Clairv	Ragged-robin		2	
2. Broad ecological groupings				
Brassica L sp	Mustard/cabbage		2	
Lamiaceae undifferentiated	Dead-nettle family			
Mentha L sp	Mints	4		
Ranunculus repens L-type	Creeping buttercup-type		3	
Viola L undifferentiated	Violets	8		1
3. Grassland				
Poaceae with caryopses 2-4 mm	Grasses with medium fruits	35	6	
Poaceae with caryopses >4 mm	Grasses with large fruits		1	
4. Scrub and waste ground				
Rubus sect 2 Glandulosus Wimm and Grabb (*Rubus fruticosus* L agg)	Brambles		10	8
5. Waste and cultivated ground				
Fallopia convolvulus (L) A Love	Black-bindweed	4		
Chenopodium album L	Fat-hen	41	4	
Persicaria lapathifolia (L) Delarbe	Pale persicaria			4
Persicaria maculosa Gray	Redshank		6	8
Stellaria media (L) Vill	Common chickweed	4	4	4
Urtica dioica L	Common nettles		6	
6. Woodland				
Alnus glutinosa (L) Gaertan fruits	Alder fruits	85	32	44
Betula L sp seed	Birch		2	
Corylus avellana L nut fragments	Hazelnut fragments		7	
Crataegus monogyna Jacq	Hawthorn		1	
Sambucus nigra L	Elder	44	6	8
Stellaria holostea L	Greater stitchwort	4		
7. Woods and hedgerows				
Oxalis acetosella L	Wood-sorrel			
8. Woods, hedgerows, and waste ground				
Lapsana communis L	Nipplewort	5		
Total		***298***	***104***	***105***

Table 320: Waterlogged plants and other remains from Burnt mound 6, *and the* Chalcolithic alluvium, *Stainton West*

		Burnt mound 6	*Chalcolithic alluvium*	
Bay		**I**	**D**	**I**
Deposit		***70398***	***70313***	***70395***
Sample		70435	70293	70436
Other remains (Scale 1-5, where 1= 1-5 items and 5 = >100 items)				
Plant material				
Alnus glutinosa (L) Gaertan catkin scales	Alder catkin scales		5	
Alnus glutinosa (L) Gaertan catkins	Alder catkins	2	2	2
Alnus glutinosa (L) Gaertan cone axis	Alder cone axis	2		2
Amorphous plant remains			5	5
Anthers, pollen-bearing part of stamen		2	2	2
Bark		2	4	2
Bryophyte remains	Moss remains	2	2	2
Bud scales				1
Buds		2	2	1
Catkin scales		2		5
Charcoal		3	3	1
Corylus avellana L catkins	Hazel catkins		1	
Corylus avellana L/Alnus glutinosa (L) Gaertan catkins	Hazel/alder catkins		1	
Leaf scars				2
Monocotyledonous remains		1		
Roundwood		5	5	5
Thorns			1	
Wood		5	5	5
Animal				
Earthworm egg cases		2		2
Fungal				
Fungal sclerotia				
Mineral				
Clay and silt		5	5	5
Sand and gravel		5	2	2

Table 320: Waterlogged plants and other remains from Burnt mound 6, *and the* Chalcolithic alluvium, *Stainton West (cont'd)*

Primary Vallum ditch *51050*		**Recut Vallum ditch *51051***	
Deposit	**Number of samples analysed**	**Deposit**	**Number of samples analysed**
51024	1	***51025***	1
51026	2	***51041/51042***	1
Total	*3*		*2*

Table 321: Deposits analysed for waterlogged plant remains, Knockupworth

abundant amorphous plant remains, bark and wood fragments, including roundwood, and also quite frequent fragments of coal.

Two of the samples were taken from laminated turf deposit ***51026***, within the primary Vallum ditch. This seems to have derived from the Roman frontier system, possibly the Turf Wall, or one of the Vallum mounds (*Ch 13*). However, sediment from this deposit returned an Iron Age radiocarbon date of 360-170 cal BC (2183±26 BP; SUERC-42030), which suggests that it had probably been accumulating for

		Primary Vallum ditch *51050*			Recut Vallum ditch *51051*	
Fill		***51024***	***51026***		***51025***	***51041/51042***
Sample		51004	51006	51017	51005	51018
Volume of sample litres		50	40	40	20	20
Seeds/fruits						
1. Aquatic and wet ground						
Callitriche L sp	Water-starwort	4			36	
Carex L biconvex nutlets	Sedges with biconvex nutlets		36	18	>100	
Carex L trigonous nutlets	Sedges with three-sided nutlets	1	>100	56	>100	48
Eleocharis palustris (L) Roem	Common spike-rush				4	
Epilobium hirsutum L	Great willowherb				4	
Isolepis setacea (L) R Br	Bristle club-rush	9	>100	>100	>100	>100
Juncus L sp	Rushes	12	>100	>100	>100	>100
Montia L sp	Blinks	5	2		>100	40
Potamogeton L sp	Pondweed			2	4	
Ranunculus flammula L	Lesser spearwort	6	32	34	92	13
Ranunculus subgenus 3 *Batrachium* (DC) A Gray-type	Crowfoots				>100	
2. Broad ecological groupings						
Ajuga reptans L	Bugle		2	2		4
Brassica L sp	Mustard/cabbage				8	
Chenopodiaceae undifferentiated	Goosefoot family				44	
Cirsium Mill sp	Thistles				4	
Mentha L sp	Mints					8
Poaceae with caryopses <2 mm	Grasses with small fruits			2	16	
Polygonum aviculare L	Knotgrass		2		8	8
Potentilla erecta (L) Raeusch-type	Tormentil-type	2	>100		>100	48
Prunella vulgaris L	Selfheal		12	8	40	
Ranunculus repens L-type	Creeping buttercup-type	2	18	12	>100	8
Viola L undifferentiated	Violets		2	8		9
3. Grassland						
Leontodon L sp	Hawkbits			2		
Linum catharticum L	Fairy flax		8			
Poaceae charred	Grasses with charred seeds		8			
Poaceae glumes	Grass glumes	1	2	2		
Poaceae with caryopses 2-4 mm	Grasses with medium fruits	1		8	>100	8
Rumex acetosa L perianth	Common sorrel perianth				4	
Rumex acetosella L	Sheep's sorrel	1			24	
Stellaria graminea L	Lesser stitchwort				20	
Carex flacca Schreb	Glaucous sedge				12	
4. Scrub and waste ground						
Rubus sect 2 Glandulosus Wimm and Grabb (*Rubus fruticosus* L agg)	Brambles					34
5. Waste and cultivated ground						
Aphanes arvensis L	Parsley-piert				12	
Chenopodium album L	Fat-hen					24

Table 322: Waterlogged plants and other remains from the Vallum ditch, Knockupworth

		Primary Vallum ditch *51050*			Recut Vallum ditch *51051*	
Fill		***51024***	***51026***		***51025***	***51041/51042***
Sample		51004	51006	51017	51005	51018
Volume of sample litres		50	40	40	20	20
5. Waste and cultivated ground						
Galeopsis cf *tetrahit* L	Common hemp-nettle					4
Persicaria lapathifolia (L) Delarbe	Pale persicaria	1	2	4	21	
Persicaria lapathifolia (L) Delarbe/ *Persicaria maculosa* Gray	Pale persicaria/redshank				12	
Stellaria media (L) Vill	Common chickweed				12	
Urtica dioica L	Common nettles			8	32	
7. Woods and hedgerows						
Luzula DC undifferentiated	Wood-rushes				8	
11. Mires and heaths						
Calluna vulgaris (L) Hull flowers	Heather flowers				16	4
Calluna vulgaris (L) Hull leaves	Heather leaves					4
Calluna vulgaris (L) Hull seeds	Heather seeds		16			
Calluna vulgaris (L) Hull shoots	Heather shoots				64	4
12. Woods, heaths, and moors						
Pteridium aquilinum (L) Kuhn frond fragment	Bracken frond fragment				8	
Total		***45***	***>542***	***>366***	***>1405***	***>468***
Other remains (Scale 1-5, where 1= 1-5 items and 5 = >100 items)						
Plant material						
Amorphous plant remains		5	5	5	5	5
Bark		5				
Buds			1			
Charcoal			2	2	3	3
Charred stems						2
Leaf fragments				1		2
Monocotyledonous remains			5	5		
Moss fragments		2	5	5	5	5
Roundwood		2	2		3	
Wood		5				
Animal						
Earthworm egg cases			2	2	4	2
Fly puparia			2	2		1
Insects		2	3	4	4	2
Fungal						
Fungal sclerotia			2			3
Mineral						
Coal		4				
Sand and gravel		5	5	5	5	5
Clay and silt						5

Table 322: Waterlogged plants and other remains from the Vallum ditch, Knockupworth (cont'd)

some considerable time before it was stripped from the adjacent area for use in the construction of the Hadrianic frontier.

In a similar fashion to the material from lower fill ***51024*** (*above*), both samples from the turf were dominated by plants which grow on wet ground, such as lesser spearwort, bristle club-rush, *cf* soft rush-type, and sedges with both three-sided and lenticular nutlets. The second major group of fruits and seeds were those that can grow across a broad range of ecological habitats, the most common being creeping buttercup-type and tormentil-type (*Potentilla erecta*-type). Although the latter has a fairly wide habitat range, it often grows on raised and blanket mires (Stace 2010); the presence of mires, or heath, close to the site during the Iron Age/early Roman period was also indicated by heather seeds. There was also evidence for the presence of grassland, with some grass fruits (2-4 mm) and occasional seeds of fairy flax (*Linum catharticum*) being recorded. In addition, the presence of waste or cultivated ground was also evident, given the presence of pale persicaria (*Persicaria lapathifolia*) fruits. The existence of a largely cleared landscape during the Iron Age/early Roman period is also supported by the palynological evidence (*Appendix 16*). Apart from the seeds/fruits, the matrix of the laminated turf deposit was rich in amorphous and monocotyledonous plant remains, and moss fragments, and there were also some invertebrate remains and earthworm-egg cases.

The remaining two samples came from two fills (***51041***/***51042*** and ***51025***) contained in the reconfigured Vallum ditch. Given their stratigraphic position, the material presumably post-dates *c* AD 160 (*Ch 13*). The earlier fill (***51041***/***51042***) was extremely sandy, with silt and clay, and contained an assemblage dominated by wet-ground plants, such as bristle club-rush, rushes, and blinks. Other fruits and seeds were derived from plants that favour waste or cultivated ground, and those that grow within a broad range of habitats. Amorphous plant remains and moss fragments were also abundant and there were some charcoal fragments, charred monocotyledonous stems, fungal sclerotia, and insect remains.

Overlying fill ***51041***/***51042,*** fill ***51025*** was exceptionally rich in plant remains. The taxa recorded included a large proportion of aquatic and wet-ground plants. including bristle club-rush and rushes, as well as a large number of seeds of water-crowfoots (*Ranunculus* subgenus 2 Batrachium), water-starwort, and blinks (*Montia* sp). The other seeds/fruits derived from plants which grow in grassland, mire, heath, and cultivated and waste-ground habitats (Stace 2010). There were, for instance, large numbers of medium-sized grass caryopses, with some lesser stitchwort (*Stellaria graminea*) and sheep's sorrel (*Rumex acetosella*), indicating the presence of grassland. Mires and heaths were indicated by heather flowers, seeds, and shoots, and fragments of bracken (*Pteridium aquilinum*) fronds. As in deposit ***51026*** (*above*), the fruits and seeds of plants from broad ecological groupings were also frequent, with large numbers of fruits and seeds of tormentil-type, creeping buttercup, selfheal, and members of the goosefoot family (*Chenopodium* sp). Insect remains and earthworm-egg cases were also frequent, the latter suggesting possible bioturbation.

The presence of fruits and seeds from some obligate aquatic plants (water-crowfoot and water-starwort), as well as wet-ground plants, suggests the Vallum was much wetter when this fill was accumulating. However, alongside these aquatics were other plants that grow in grassland and on mires and heaths. Debris from the aquatic and wet-ground plants may therefore have accumulated in the Vallum ditch, resulting in slightly drier conditions which allowed the heather and mosses to colonise the surface. The very large numbers of grass caryopses may have originated from the vegetation growing at the edges of the ditch. An alternative explanation is that turves from the mound or the surrounding countryside were deliberately used as backfill to consolidate the ditch when the frontier temporarily fell out of use (*Ch 13*), making it easier to cross.

Discussion

The analysis of waterlogged plant remains can greatly enhance the data derived from other palaeonvironmental sources, particularly the palynological record, and, as such, allows a greater understanding of a site's local ecology. For instance, some macrofossils, such as rushes and bristle club-rush, are rarely identified in pollen records, whilst others can be more easily identified to a specific plant family, such as those members of the carrot family (Apiaceae). Another distinct advantage of waterlogged material concerns taphonomy, as generally plant macrofossils are also less influenced by external factors of preservation, such as burning or mineralisation. Importantly, plant macrofossils are also often found *in situ*, and hence they reflect the plant types that were growing directly on, or close to, the site. However, at fluvial sites, such as Stainton West, some of the material may have been transported by the movement of water, and it is also possible that some windborne material may have been present within any given assemblage; this might specifically include those plant remains relating to dandelions (*Taraxacum*), rosebay willowherb (*Chamerion angustifolium*), and birch.

Fortunately, waterlogging in the *Principal palaeochannel* at Stainton West and within the lower fills of the *Vallum* ditch at Knockupworth produced suitable anoxic conditions (*cf* Campbell *et al* 2011), which proved ideal for the preservation of plant remains, allowing a programme of detailed analysis. The plant remains from the *Mesolithic organic deposit* at Stainton West suggested that a mixed woodland, dominated by hazel, with some elm, oak, hawthorn, and birch, interspersed with some small clearances, was present directly adjacent to the *Principal palaeochannel* throughout the latter part of the sixth and early part of the fifth millennia BC. It also appears that the channel was not being actively infilled during this time and probably contained water. Similarly, the plant remains from the *Mesolithic alluvium* and *Mesolithic/Neolithic continuum* indicate that the woodland bordering the channel during the fifth millennium BC was also dominated by hazel, though there was an increase in aquatic or wet-ground plants. Significantly, the evidence accords well with the other palaeoenvironmental interpretations derived from the analysis of the Mesolithic-period waterlogged wood, insects, and pollen. For instance, the waterlogged-wood assemblage from the *Mesolithic organic deposit* was dominated by hazel and oak (*Appendix 13*), whilst the combined Mesolithic pollen assemblage indicated that the woodland was dominated by hazel, though it also contained oak and elm, as well as lesser amounts of birch, ash, and pine (*Appendix 16*). The pollen evidence also indicates that small clearings were present in the woodland, some of which may been associated with, or even created by, fire.

Together, this evidence indicates that there was an absence of alder surrounding the site during this period. However, the Mesolithic-period insect remains did include bark beetles that are known to feed on alder (*Appendix 14*), suggesting that some trees were growing locally, but that these were perhaps less abundant close to the channel, being confined to nearby damp or wet areas. The insect remains also suggest that during this period the channel contained slow-flowing, still, or stagnant water, as does the amount of aquatic plants in the assemblage.

The plant remains from the *Earlier Neolithic organic deposit* indicate that the character of the vegetation surrounding the channel changed during the first half of the fourth millennium BC. It appears, for example, that there was a rise in alder as a woodland component during this period, and that this was becoming more open. There was also an increase in wet-ground plants, particularly rushes, suggesting that the channel was beginning to become filled. Increasing numbers of aquatic and wet-ground plants were also a feature of the waterlogged assemblage from the *Earlier Neolithic alluvium*. Plant remains from this later stratigraphic unit also suggest a decline in woodland taxa during the mid-fourth millennium BC. Significantly, the pollen record from the *Earlier Neolithic organic deposit* and the *Earlier Neolithic alluvium* is characterised by the elm decline, which began in the initial centuries of the fourth millennium BC and resulted in the decline of elm pollen to a presence only during the mid-fourth millennium BC (*Appendix 16*). During this period, the pollen evidence indicates that this decline was associated with increases in open-ground or agricultural indicator taxa and a rise in alder, which is also reflected in the waterlogged-wood assemblage from the channel (*Appendix 13*); these remains again tally well with the evidence of the plant remains.

The material in the *Later Neolithic organic deposit* indicates that, during the late fourth and early third millennia BC, alder replaced hazel as the dominant tree taxon, and the woodland surrounding the channel had an open and scrubby character. Again, the dominance of alder is confirmed by the waterlogged-wood assemblage (*Appendix 13*) and the pollen remains (*Appendix 16*). The *Principal palaeochannel* became infilled during the later Neolithic period and alder continued to grow close to this channel in the Chalcolithic period, when it was beginning to stabilise and become overgrown with rushes and sedges.

At a regional level, relating the evidence from Stainton West to other sites in north-west England is problematic, as there are few comparable prehistoric sites where waterlogged plant remains have been recovered and subjected to the same level of analysis. For instance, at the Mesolithic and Neolithic site at Williamson's Moss, on the West Cumbrian coastal plain, although the pollen from the site was studied and the sediments were dated, no waterlogged remains were examined (Bonsall *et al* 1994; Tipping 1994a). Moreover, at other sites, it has proved difficult to relate the plant macrofossils explicitly to archaeological remains. For example, at Ehenside Tarn, West Cumbria (*Ch 7*), an important Neolithic archaeological site discovered during the late nineteenth century (Darbishire 1874), while the plant macrofossils were examined and a programme of dating was undertaken, their exact relationship to the Neolithic remains is uncertain (Walker 1966; 2001).

The numerous mire deposits have been studied extensively across the region by the North West Wetlands Survey (NWWS; Cowell and Innes 1994; Hall *et al* 1995; Middleton *et al* 1995; 2013; Leah *et al* 1997; 1998; Hodgkinson *et al* 2000), and also in northern Cumbria and the adjacent border region by Keith Barber and his co-workers (*inter alia*; Barber 1981; Barber *et al* 1994a; Mauquoy and Barber 1999; Hughes *et al* 2000). However, generally these remains were unrelated to any archaeological sites, the only exception being the

plant macrofossils associated with the Mesolithic flint scatter at Nook Farm, Chat Moss, Greater Manchester (Hall *et al* 1995, 52). Indeed, the only site where waterlogged plant remains can be directly related to prehistoric archaeological stratigraphy is at Drigg, West Cumbria, where a small assemblage from the excavation of a Chalcolithic burnt mound, together with the pollen evidence, allowed some insights into the changing vegetation surrounding the site prior to, and after, the formation of the burnt mound in the third millennium BC (Brown 2014). It appears that possible small-scale human clearance of the vegetation surrounding the site may have occurred prior to the creation of the burnt mound, probably reflecting Late Mesolithic or Early Neolithic activity. The palaeoenvironmental remains also indicated that the environment was drier immediately prior to the formation of the burnt mound, given the presence of birch trees, and it was suggested that this might have attracted people to the site (*ibid*). The palaeoenvironmental remains suggested that wetter conditions prevailed after the burnt mound fell into disuse.

Across the Pennines, in North Yorkshire, several cores dating to both the Mesolithic and the Neolithic periods have been analysed, taken during the Swale-Ure project (ASUD 2006a; 2006b; Bridgland *et al* 2011). However, these studies were again unrelated to archaeological sites. While the Mesolithic site at Star Carr in North Yorkshire has produced a significant assemblage of waterlogged remains, these are of considerably earlier date than those from Stainton West (Taylor and Allison 2018).

The situation is similar across southern England, in that there are comparatively few Mesolithic, Neolithic, or Chalcolithic archaeological sites that are associated with sizeable assemblages of waterlogged plant remains. For instance, although material has been examined from several prehistoric sites along the Thames Valley, and in London, dating from the Palaeolithic period onwards, the concentration of such remains was lower than those studied from Stainton West (Bates and Stafford 2013). However, one important prehistoric site in southern England, the Sweet Track in the Somerset Levels, is broadly dated to 4050-3800 cal BC and is therefore roughly contemporary with the *Earlier Neolithic organic deposit* at Stainton West (Coles and Dobson 1989). Significantly, plant macrofossils from along the Sweet Track indicated that, during the earlier Neolithic period, the environment was considerably wetter than at Stainton West (Caseldine 1984; J Jones 2013). Within the assemblage, birch fruits and female cones were also quite common, and hazelnuts were abundant, at and around the level of track, with clear evidence of these being eaten by small rodents, such as dormice and bank voles (Caseldine 1984). It also appears that the vegetation changed at the level of the trackway from a base-rich fen to a local fen wood, dominated by birch, and then to more acidic conditions. In contrast, at Stainton West, alder fen wood was developing during the earlier Neolithic period.

Further afield, a prehistoric site at Clowanstown, Co Meath, in Ireland, on the edge of a raised mire, has produced Mesolithic conical baskets, a probable Mesolithic fishing platform, and Neolithic burnt mounds (ASUD 2009; Mossop 2009). The baskets dated to the early sixth and early fifth millennia cal BC, and the plant remains suggested an open-water body at that time, continuing into the Neolithic period, in the area close to the burnt mounds, but also with evidence of poolside vegetation and nearby alder carr (*ibid*). The changing nature of the plant remains suggested that there may have been a period of abandonment dating to *c* 4000-3850 BC, following Mesolithic activity and prior to the construction of the burnt mounds, perhaps as a result of changing water levels and a drying out of the lake edge (*ibid*). This period of abandonment roughly equates with the possible infilling of the channel at Stainton West and the formation of alder fen vegetation, as evidenced by those plant remains associated with the *Earlier Neolithic organic deposit*.

Similarly, there is little in the way of comparative studies from Hadrian's Wall. Two samples from the Turf Wall at Appletree failed to provide firm evidence for the nature of the vegetation in the turves (Hall 2009), but the list of plant taxa was not inconsistent with the acid grassland present today. Alison Donaldson (1978) also examined the plant remains from an early ditch associated with Hadrian's Wall at Tarraby Lane, near Carlisle, which is thought to have been backfilled when the Vallum was constructed. These included abundant grass florets, and suggest wet meadow or fen, with some plants of waste ground and pasture, therefore being not dissimilar to those recorded at Knockupworth.

Conclusion

Given the general paucity of prehistoric archaeological sites containing waterlogged plant remains from the North West, and associated with Hadrian's Wall, the material from Stainton West and Knockupworth hold great significance (*cf* Hall and Huntley 2007). Moreover, when allied with other lines of palaeoenvironmental evidence, these provide a vivid picture of the local vegetation that once surrounded the respective sites. Hence, they furnish valuable insights into the environment that existed during the Late Mesolithic, Neolithic, Chalcolithic, and late Iron Age/Roman periods close to the River Eden.