Tables

(Table 1.1) Quaternary of northern England: tor evolution network

Site name	GCR selection criteria
Great Almscliff Crag, North Yorkshire	Representative of Pennine tors developed on Millstone Grit; within the Dimlington Stadial ice limit
Burbage Brook, High Peak	Representative of Pennine tors developed on Millstone Grit; demonstrates relationship between tors, geological structure and slope evolution
Brimham Rocks, North Yorkshire	Representative of Pennine scarp-edge ton developed on Millstone Grit
Wyns Tor, High Peak	Representative of Pennine tors developed on dolomitized limestone; evidence for a former weathering cover surrounding tor
Bridestones, North Yorkshire	Representative of North York Moors tors developed on limestone
Blackstone Edge, Greater Manchester	Representative of the Pennine weathering cover (Millstone Grit grus); demonstrates that the majority of weathering is mechanical in origin
Stiperstones, Shropshire	Representative of quartzite tors developed adjacent to Dimlington Stadial ice limit; demonstrates association with periglacial landforms and sediments
Cheviot Tors, Northumberland	Representative of tors developed in andesite and granite; demonstrates relationship with deeply weathered bedrock and glacial landforms and sediments

(Table 2.2) Relationships between the British Quaternary stratigraphical classification (after Mitchell *et al.,* 1973), selected lithostratigraphical units, oxygen isotope stratigraphy and polarity (from Bowen, 1999).

1st Edition (1973)	Lithostratigraphy	Aminozone	D-alle/L-Ile$	Age (ka)†	δ^{18}O and polarity
	Hailing Member	Hailing	0.036 ± 0.01 (3)	10.9 ± 0.12 (^{14}C)	2
Devensian	Stockport Formation δ Upton Warren Member	Upton Warren	0.07 ± 0.007 (3)		3
	Cassington Member	Cassington	0.08 ± 0.009 (6)	~80 (OSL)	5a
Ipswichian	Trafalgar Square Member	Trafalgar Square	0.1 ± 0.001 (11)	124 ± 5.4 (U)	5e
	Ridgacre Formation Δ Kidderminster Member			159.5 ± 13 (36Cl)	6
Wolstonian	Strensham Court Bed	Strensham	0.17 ± 0.01 (4)	~200 (OSL)*	7
	Rushley Green Member				8
	Hoxne Formation	Hoxne	0.26 ± 0.02 (9)	319 ± 38 (ESR)	9
Hoxnian	Spring Hill Member				10
	Swanscombe Member	Swanscombe	0.3 ± 0.017 (34)	~400 (U)* 471 ± 15 (TL)*	11
Anglian	Lowestoft Formation A				12

	West Runton Member	West Runton	0.35 ± 0.01 (9)	~500 (ESR)	13
Cromerian	Waverley Wood Member	Waverley Wood	0.38 ± 0.026 (5)		15
	Kenn Formation ∆				16
	Grace Formation ‡	Grace	0.43 ± 0.02 (4)	810 ± 140 (ESR)	21

$ Number of analyses in parentheses

† Age estimate – method in parentheses

* Age established at another locality of the aminozone

∆ Glacial formation

‡ Somme Valley, France

(Table 2.3) Proposed climatostratigraphical stages in Britain (after Mitchell *et al.,* 1973).

Stage	**Stratotype**	**Notes**
Flandrian		Begins 10 ka (^{14}C); base at bottom of pollen zone IV
Devensian	Four Ashes, Staffordshire [SJ 914 082]	Late: 26–10 ka (^{14}C) Middle: 50–26 ka (^{14}C): includes Upton Warren interstadial complex Early: preceding 50 ka (^{14}C): includes Chelford interstadial ~60 ka (^{14}C)
Ipswichian	Bobbitshole, Ipswich [TM 148 414]	Base at beginning of pollen zone II
Wolstonian	Wolston, Warwickshire [SP 411 748]	Includes Baginton–Lillington gravels, Baginton sand, Wolston series, Dunsmore gravels; base at bottom of Baginton–Lillington gravels
Hoxnian	Hoxne, Suffolk [TM 543 977]	Base at beginning of pollen zone HI
Anglian	Corton Cliff, Suffolk [TM 543 977]	Lowestoft Till, Corton Sands, Norwich Brickearth/Cromer Till; base at bottom of lower till
Cromerian	West Runton, Norfolk [TG 188 432]	Upper Freshwater Bed; base at bottom of pollen zone C1
Beestonian	Beeston, Norfolk [TG 169 433]	Arctic Freshwater Bed; base at bottom of pollen zone PI
Pastonian	Paston, Norfolk [TG 341 352]	Gravels, sands and silts; base at bottom of pollen zone BeI
Baventian	Easton Bavents, Suffolk [TM 518 787]	Marine silt; base at bottom of pollen zone L4
Antian	Ludham, Norfolk (borehole at [TG 385 199])	Marine shelly sand; base at bottom of pollen zone L3 (forams: Lv)
Thurman		Marine silt: base at bottom of pollen zone L2 (forams: Lm)

Ludhamian		Shelly sand: base at bottom of pollen zone L1 (forams: Ll)
Waltonian	Walton-on-the-Naze, Essex [TM 267 237]	Older Red Crag; base at bottom of Crag at Walton

(Table 4.4) Shell list from the Easington raised beach (based on Woolacott, 1920, 1922).

Species	
Littorina littorea	common
Littorina obtusata	common
Littorina rudis	
Patella vulgata	common
Nucella lapillus	
Cliona sp.	
Polydora sp.	
Saxicava sp.	
Buccinum undatum	
Arctica islandica	
Mytilus edulis	
Pecten sp.	
Rhynchonella psittacea	
Helix sp.	

(Table 4.5) Faunal list for the Speeton Shell Bed (after Lamplugh, 1881c; Thistlewood and Whyte, 1993).

Psammobia sp.
Mactra sp.
Cerastoderma edule (L.)
Tellina balthica
Cardium edule
Macoma balthica (L.)
Scrobicularia plan (da Costa)
Scrobicularia piperata
Littorina littorea (L.)
L. rudis
Hydrobia (Peringia or *Sabanaea) ulnae*
(Pennant)
Retusa obtusa (Montagu) var. *pretenuis*
Mytilus edulis (L.)
Utriculus obtusus
Littorina saxatilis (Olivi)
Littorina littoralis (L.)
Balanus crenatus echinoid spines

(Table 4.6) Amino acid (D/L) ratios of *Macoma balthica* from the Speeton Shell Bed (from Wilson, 1991).

Collection date	**Laboratory identification**	**D/L ratio**	**Mean**
1966	A	0.172	0.178 ± 0.005
(L.F. Penny)	B	0.173	
	C	0.182	
	D	0.184	
1988	50 cm*	0.154	0.203 ± 0.035
	1.20 cm*	0.224	

	1.60 cm*	0.230	

*Depth collected from top of shell bed

(Table 4.7) Pollen of the Speeton Shell Bed (from West, 1969).

Arboreal pollen	**Non-arboreal pollen**
Betula	*Corylus*
Pinus	Gramineae
Ulm us	Cyperaceae
Quercus	Compositae (Ligulatae)
Carpinus	*Filipendula*
Picea	*Plantago maritima*
	Umbelliferae
	Sparganium-type
	Filicales

(Table 4.8) Correlation of post-Hoxnian events, amino acid ratios and oxygen isotope stages (after Wymer, 1985; Bowen and Sykes, 1988).

Age (ka BP)	**Oxygen isotope stage**	**D/L ratio (Macoma)**	**Stage**
	2		Dimlington
24	3	0.085	
59	4		
71	5a–d		
122	5e	0.16	Ipswichian
128	6		Wolstonian 3
186	7	0.2	Ilfordian
245	8		
303	9	0.29	Hoxnian

(Table 4.9) Faunal list for the Sewerby sedimentary units (after Lamplugh, 1891b; Boylan, 1967; Catt, 1987c).

	Ipswichian beach gravel	**Colluvium**	**Aeolian dune sand**
Mammalia			
Crocuta crocuta (hyaena)	•		•
Ursus (bear)		•	
Palaeoloxodon antiquus (straight-tusked elephant)			•
Didermoceros hemitoechus (narrow-nosed rhinoceras)	•		•
Hippopotamus amphibius (hippopotamus)	•		
Megaloceros giganteus (giant deer)		•	
Bison cf. *Priscus* (bison)	•	•	•
Arvicola terrestris (water vole)		•	
Mollusca			
Littorina littorea L.	•		
Ostrea edulis L.	•		
Mytilus edulis L.	•		
Purpura lapillus L.	•		
Pholas sp.	•		
Saxicava sp.	•		

Helix hispida L.	•
Helix pulchella Mull	•
Pupa marginata Drap.	•
Zua subcyclindrica L.	•

(Table 5.1) The mammalian fauna from the Pin Hole Mammalian Zone, Lower Cave Earth, Pin Hole Cave, Cresswell, Derbyshire (after Currant and Jacobi, 2001).

***Homo* species**	**artefacts**
Lepus timidus	mountain hare
Spermophilus major	red-cheeked suslik
Canis lupis	wolf
Vulpes vulpes	red fox
Ursus arctos	brown bear
Mustela erminea	stoat
Mustela putorius	polecat
Crocuta crocuta	spotted hyaena
Panthera leo	lion
Mammathus primigenius	woolly mammoth
Equus ferus	wild horse
Coelodonta antiquitatis	woolly rhinoceros
Megaloceros giganteus	giant deer
Rangifer tarandus	reindeer
Bison priscus	bison

(Table 5.2) Radiocarbon dates (years BP) on spotted hyaena remains from the Cresswell area, Derbyshire (after Currant and Jacobi, 2001)

Robin Hood Cave	OxA-6115	22 800	± 240
Robin Hood Cave	OxA-6114	22 980	± 480
Church Hole	OxA-5800	24 000	± 260
Ash Tree Cave	OxA-5798	25 660	± 380
Church Hole	OxA-5799	26 840	± 420
West Pin Hole (Dog Hole)	OxA-5803	29 300	± 420
Robin Hood Cave	OxA-5802	31 050	± 500
Pin Hole	OxA-1206	32 200	± 1000
Robin Hood Cave	OxA-5801	33 450	± 700
Pin Hole	OxA-1207	34 500	± 1200
Pin Hole	OxA-4754	37 800	± 1600
Pin Hole	OxA-1448	42 200	± 3000

(Table 5.3) Coleoptera from the Chelford Formation (data from Coope, 1959).

Family	**Number of species**
Carabidae	30
Dytiscidae	12
Hydrophilidae	4
Silphidae	3
Leiodidae	1
Staphilinidae	13
Elateridae	8
Helodidae	1
Byrrhidae	4

Coccinellidae	2
Scarabaeidae	2
Cerambycidae	1
Chrysomelidae	7
Curculionidae	10
Scolytidae	2

(Table 5.5) The flora and fauna of the Dimlington Silts.

Coleoptera
Agabus bipustulatus L.
Aleocharinae indet.
Amara alpina Paykull
Amara quenseli Sch.
Aphodius sp.
Arpedium brachypterum Gr.
Bembidion sp. (*lunatum* group)
Bledius fuscipes Rye
Byrrhus sp.
Cercyon sp.
Feronia blandulus Mill.
Hydrobius sp.
Notaris aethiops F.
Ostracoda
Candona neglecta Sars
Cypridopsis vidua (Mull.)
Cyprinotus salinus (Brady)
Eucypris gemella Bodina
Ilocypyris gibba (Ramdohr)
Plants
Daphnia ephippia
Eleocharis palustris (L.)
Menyanthes trifoliata (L.)
Pohlia wahlenbergii (Web. & Mohr) *glacialis* (Schleich.)
Potamogeton alpinus Potamogeton filiformis
Trees
Pinus (sparse pollen)
Betula (sparse pollen)

(Table 6.3) Stratigraphy at Gransmoor (after Walker *et al.,* 1993)

Lithological unit	**Depth (cm)**	**Description**
16	0–17/23	Fibrous peat; boundary is sharp but irregular, suggesting a possible hiatus. Blocks of reworked Late-Glacial clay occur within the Holocene peats.
15	17/23–37	Clay with sand laminae; laterally and vertically variable.
14	37–41	Angular and rounded chalk fragments.
13	41–88	Grey plastic day; clearly defined sand laminations at 49,74,82 and 89 cm.

12	90–112	Clay unit with abundant sandy laminations, varying from a few millimetres to 1 cm in thickness. Each lamination continuous and of uniform thickness.
11	112–115	Grey plastic day with small (<1 cm) pellets of chalk; latter appear flattened m the horizontal plane.
10	115–120	Silt/clay; black 'felted' peat layer at 120 cm
9	120–146	Laminated silt/clay with intercalations of 'felted' peat/plant debris.
8	146–147	Plastic grey clay.
7	147–172	Organic mud, but with clearly defined mineral/organic laminations in upper levels. Organic component variable, but maximum organic carbon values (~30%) towards the base of the unit. Bands of compressed plant debris occur in these lower levels.
6	172–187	Grey/brown silt/clay. Slightly organic (10% or less) throughout, but clearly defined clay-rich sub-unit from 174–178 cm; fibrous root material abundant.
5	187–203	Clay gyttja; organic content exceeds 20%, with maximum values (33%) near base of unit.
4	203–207	Transitional unit with intercalations of organic mud and grey silt/clay.
3	207–223	Clay marl with intermittent small (<2 cm) pellets of chalk; slightly organic (<10%) throughout.
2	223–235	Sand and clay laminae (up to 1 cm in thickness); some fine rootlet casts in the upper part.
1	Below 235	Sands and silts with intermittent horizons rich in gravel-sized particles of coal and occasional discrete lenses of slightly organic silt.

(Table 6.4) List of climatically significant Coleoptera species from the Gransmoor stratigraphy (from Walker *et al.,* 1993).

Cold-adapted species	**Warmth-adapted species**
Nebria nivalis	**Bembidion grisvardi*
**Diacheila arctica*	*Bembidion humerale*
**Diacheila polita*	*Bembidion quadripustulatus*
Elaphrus lapponicus	*Bembidion octomaculatum*
**Bembidion fellmanni*	*Pterostichus mater*
**Bembidion mckinleyi*	**Cymindis angularis*
**Agonum consimile*	*Ochthebius pedicularis*
Amara alpina	**Entomoscelis adonidis*
**Pycnoglypta lurida*	

**Olophrum boreale*
**Acidota guadrata*
**Boreaphilus henningianus*
**Boreaphilus nordenskioeldi*
Oreodytes alpinus
**Colymbetes dolabratus*
Dysticus lapponicus
Gyrinus opacus
**Helophorus sibiricus*
**Helophorus glacialis*
**Helophorus obscurellus*
**Simplocaria metallica*
**Hippodamia arctica*

(Table 6.5) Limnological characteristics of Hawes Water

Hawes Water	
Dimensions	~400 x 225 metres
Elevation	8 metres above sea level; distance to sea ~5 kilometres
Water depth	Marl shelf ~1.2 metres; maximum ~12 metres
Lake volume	~390 000 cubic metres
Water supply	Direct precipitation (~1350 mm/a), spring, groundwater
Water temperature	Surface water 5–18°C; deep water –5–8°C
Catchment area	1.77 km^2
Residence time	2–6 months?
Carbonate precipitation	Seasonal Biogenic (skeletal): gastropods, bivalves, ostracods, Chara Biologically mediated (plants/microbial)
Sediment record	'Marl': (bio)micrite, clay, peat, gyttja

(Table 7.2) The locations and lithologies of the main tors in Britain (compiled from various sources, including Goudie and Piggott (1981) and Ballantyne and Harris (1994)).

Area	**Lithology**	**References**
1. England		
Isles of Scilly	Granite	Scourse (1987)
Dartmoor (South-west England)	Granite	Linton (1955); Palmer and Neilson (1962); Eden and Green (1971); Gerrard (1974, 1978, 1988)
Exmoor (South-west England)	Sandstone	Mottershead (1967)
Weald (South-east England)	Sandstone	Robinson and Williams (1976)
Charnwood Forest (Midlands)	Granite, microdiorite and hornstone	Ford (1967)
Tabular Hills (Yorkshire)	Silicified grits	Palmer (1956)
Derbyshire	Dolomite	Ford (1963, 1969)
Derbyshire	Gritstone	Palmer and Radley (1961); Linton (1964); Cunningham (1964, 1965)
Stiperstones (Shropshire)	Quartzite	Goudie and Piggott (1981); Clark (1994a)
Cheviot Hills	Granite	Common (1954); Douglas and Harrison (1985)
2. Wales		
Central Wales	Igneous rocks, grits	Potts (1971)
Pembrokeshire	Rhyolite	Linton (1955)
Preseli Hills	Dolerite	Linton (1955)

3. Scotland		
Cairngorm Mountains	Granite	Linton (1949, 1955); King (1968); Ballantyne (1994)
North-east Scotland	Granite	Linton (1955)
Ochil Hills	Andesite	Linton (1955)
Ben Loyal (Sutherland)	Syenite	Linton (1955)
Caithness	Sandstones and grits	Linton (1955)
Trotternish, Skye	Basalt	Ballantyne (1990, 1991)

(Table 8.1) Radiocarbon dated pollen zone horizons at Scaleby Moss (after Godwin *et al.,* 1957)

Sample number	**Depth related to pollen diagram B or C (cm)**	**Pollen zonation**	**Age (years BP)**
Q172	67.0–69.0 B	Zone VIIb base	5030 ± 119
Q171	69.0–71.0 B	VIIa/VIIb boundary (Atlantic Sub-boreal/transition)	4975 ± 134
Q173	71.0–73.0 B	Zone Vila top	5037 ± 122
Q166	174.5–176.5 B	Zone VIIa base	6998 ± 131
Q165	176.5–178.S B	VINIIa boundary (Boreal/Atlantic transition)	7475 ± *c.* 350
Q167	178.5–180.5 B	Zone VI top	7404 ± 146
Q161	–0.5–1.5 C	Zone VI base (V/VI boundary)	9052 ± 194
Q162	3.5–5.5 C	Zone V fop	8859 ± 192
Q155	44.5–46.5 C	Zone V base	9790 ± 183
Q154	46.5–48.5 C	N/V boundary (Pre-boreal/Boreal transition)	9607 ± 209
Q152	69.5–71.5 C	Zone N base	10 203 ± 193
Q151	71.5–73.5 C	III/TV boundary (Post-glacial/Late-glacial transition)	10 307 ± *c.* 350
Q153	73.5–75.5 C	Zone III top	10 368 ± 215
Q144	109.5–111.5 C	Zone III base	10 878 ± 185
Q147	123.0–125.0 C	Zone II top I combined [with Q148]	10 748 ± 207
Q148	125.0–127.0 C	Zone II top — [see Q147 age]	

(Table 8.3) Stratigraphy at Valley Bog (after Chambers, 1978)

Depth (cm)	**Stratigraphy**
0–50	Not sampled
50–75	Sedge peat of low humification (H4) with some *Calluna* remains
75–100	Sedge peat of low humification-(H3) with some *Calluna*
100–150	Sedge peat of low humification (H4) with abundant pieces of *Calluna*
150–200	Slightly muddy sedge peat of medium humification (H5–6) with *Calluna*
200–250	Slightly muddy sedge peat of low humification (H3–4) with *Betula* wood
250–290	Slightly muddy sedge peat of low humification (H5–6) with less *Betula*
290–525	Slightly muddy sedge peat of low humification (HS-6) with abundant pieces of *Betula* wood

525–580	Bryophyte peat of low humification (H3) composed mainly of *Paludella squarrosa* together with some *Eriophorum* sedge remains
580–600	Sedge peat of low humification (H3–4) with some *Eriophorum*

(Table 8.4) Stratigraphy at TSI, Red Sike Moss (after Turner *et al.,* 1973)

Depth (cm)	**Description**
0–12	Dark brown crumbly *Calluna* peat with some *Eriophorum* remains, *Juncus* seeds, megaspores of *Selaginella selaginoides* with *Carex* seeds
12–25	Light brown, *Calluna–Eriophorum* peat containing remains of sedges and megaspores of *Selaginella*
25–40	Dark brown peat containing burnt *Calluna* stems
40–112	Dry, moderately humified, light brown *Phragmites* peat with burnt *Calluna* stems, seeds of *Carex* sp. and *Menyanthes trifoliata* and megaspores of *Selaginella*
112–135	Light brown *Phragmites* peat containing twigs of *Betula,* leaves and seeds of *B. nana,* seeds of *Menyanthes* and *Carex* sp., a single seed of *Lychnis flos-cuculi,* Chara oospores and megaspores of *Selaginella*
135–143	*Phragmites* peat with a few *Betula* fragments and seeds of *Carex* sp., *Carduus cirsium* sp., *Viola* sp. and *Lychnis flos-cuculi* and megaspores of *Selaginella*

(Table 8.6) PIC dates from TSI, Red Sike Moss. They were dated at the Gakushuin laboratory (Japan) and the dates were based on the Libby half-life of 5570 ± 30 years (after Turner *et al.,* 1973)

Laboratory code	**Depth (cm)**	**Pollen horizon**	**Age, in radiocarbon years BP (before 1950)**
GaK-2027	14	Rise in Gramineae *Callum* and *Plantago;* beginning of zone G	2570 ± 80
GaK-2028	44	Beginning of zone A	3390 ± 90
GaK-2029	70	Beginning of subzone Oc	6150 ± 160
GaK-2030	120	End of zone H	8250 ± 280
GaK-2031	135	End of zone J	9900 ± 190

(Table 8.8) Stratigraphy at Mere Sands Wood (after Baxter, 1983; Tooley, 1985; Wilson, 1985; Bateman, 1995).

Unit	**Depth (cm)**	**Lithology**
9	0–90	Mere Sands (Wilson, 1985)
8	90–98	Sandy substantia humosa
7	98–105	Fine detrital mud
6	105–139	*Turfa herbaceae*
5	139–140	*Turfa menyanthis*
4	140–141	Fine detrital mud
3	141–157	Fine–sandy detrital mud and *Turfa herbaceae*
2	157–160	Fine detrital mud and *Turfa herbaceae*

1	160–Locally up to 5 metres thick	Shirdley Hill Formation: loose fine to medium moderately to moderately well sorted sands displaying weak cross-bedding and cryoturbation structures

(Table 8.9) Generalized stratigraphy of Old Mere, Hornsea (source: Beckett, 1981)

Depth in core (cm)	**Description**
0.00–0.50	Made ground
0.50–1.40	Sandy clay
1.40–1.75	Clayey detritus mud with organic matter
1.75–9.30	Fine detritus mud with no recognizable plant material
9.30–12.30	Silty clay with occasional organic matter
12.30–12.60	Clayey fine detritus mus with some silt
12.60–13.80	Gravelly clay

(Table 8.10) Peat stratigraphy at Fen Bogs, North York Moors (after Atherden, 1976a; Chiverrell, 1998).

Bed	**Depth (cm)**	**Environment**	**Stratigraphy**
1	0–140	Ombrogenous mire	Poorly humified *Sphagnum* and Monocotyledonous peat
2	0–140	Ombrogenous mire	Well-humified Monocotyledonous peat
3	140–600	*Phragmites* reed-swamp	Well-humified *Phragmites australis* peat, with occasional other mire plant remains (Eriophorum spp., Ericaceae and *Sphagnum*)
	600–820	Partially wooded *Phragmites* reed-swamp	Well-humified *Phragmites* peat, with occasional wood remains (*Betula, Alnus* and *Salix*)
4	820–920	Fen/Carr woodland mire	Well-humified wood peat, with *Betula, Salix* and occasional *Phragmites* remains
5	920–960	Mire inception	Well-humified peat rich with inorganic material
6	960–	Periglacial valley	Blue-grey clay solifluction deposits

(Table 8.11) Characteristic pollen taxa of the 16 pollen assemblage zones and subzones from Thorpe Bulmer (Bartley *et al.,* 1976).

Phase	**Major taxa**	**Lesser taxa**
TBIXc	Gramineae, Cyperaceae	*Plantago lanceolata,* Ericaceae
TBIXb	Gramineae, *Taraxacum, Plantago lanceolata, P. majormedia*	*Alnus,* Cyperaceae
TBIXa	*Alnus,* Gramineae, *Cannabis*	*Plantago lanceolata*
TBVIII	*Corylus*	*Quercus, Alnus*
TBVII	*Corylus*	*Betula*
TBVI	*Betula*	*Salix, Filipendula*

TBVb	*Betula, Filipendula, Salix*	*Juniperus, Empetrum*
TBVa	Gramineae, *Empetrum*	Cyperaceae, *Betula, Galium*
TBIVc	Cyperaceae, *Thalictrum*	Gramineae, *Ranunculus, Artemisia*
TBIVb	Cyperaceae, Gramineae	*Thalictrum, Artemisia,* Caryophyllaceae
TBIVa	Cyperaceae, Gramineae	*Rumex,* Caryophyllaceae
TBIIIc	*Betula, Filipendula*	Gramineae, Cyperaceae, *Empetrum*
TBIllb	Gramineae, Cyperaceae	*Betula, Juniperus, Filipendula*
TBIIIa	*Betula, Empetrum*	*Juniperus, Filipendula*
TBII	*Juniperus*	*Helianthemum,* Cyperaceae, Gramineae
TBI	Cyperaceae, Gramineae	*Betula nana, Salix, Juniperus,* Ruderals

(Table 8.12) Radiocarbon determinations from Lindow Moss (data from Ambers *et al.,* 1986; Gowlett *et al.,* 1986; Otlet *et al.,* 1986; Housley *et al.,* 1995; Leah *et al.,* 1997)

Laboratory reference	Sample type	^{14}C age (years BP; ±1σ)reference
Lindow I		
OxA-114	Collagen from bone	1740 ± 80
Lindow II (Lindow man)		
OxA-531	Amino acids from hair	1920 ± 20
OxA-604	Amino acids from bone	1850 ± 80
Ox.A-605	Amino acids from soft tissue	2125 ± 80
OxA-781	Standard amino acids	1940 ± 80
OxA-782	Pre-bleach amino acids	1950 ± 80
OxA-783	Hyroxyproline	1920 ± 80
03(A-784	Standard amino acids	1900 ± 80
OxA-785	Proline	1900 ± 80
OxA-786	Collagen, Oxford preparation	1800 ± 80
OxA-787	Collagen, Harwell preparation	1870 ± 80
03(A-788	Collagen, Harwell preparation	1870 ± 80
OxA-789	Humic (standard amino acids)	2190 ± 100
OxA-790	Humic (bleach)	1970 ± 80
OxA-1040	Stomach contents	1910 ± 60
OxA-1041	Humic from stomach contents	2210 ± 60
HAR-6224	Wrist bone	2420 ± 100
HAR-6235a	Leg bone	1540 ± 100
HAR-6235b	Leg bone	1650 ± 80
HAR-6491	Skin	1550 ± 70
HAR-6492	Rib bone	1625 ± 80
HAR-6493	Skin and hair	1530 ± 110
HAR-6856a	Vertebra	1480 ± 90
HAR-6856b	Vertebra	1610 ± 80
Lindow III		
	Bone (P2255)	
OxA-1S17	Amino acids from unbleached collagen	1740 ± 90
OxA-1518	Amino acids from bleached collagen	1750 ± 90
HAR-9094	Unbleached collagen	2010 ± 80
	Skin (P2256)	
OxA-1519	Amino acids from unbleached collagen	1850 ± 90
OxA-1520	Amino acids from bleached collagen	1700 ± 120
HAR-9092	Unbleached collagen	1880 ± 80
	Skin (P2257)	
OxA-1521	Amino acids from unbleached collagen	1890 ± 100

0xA-1522	Amino acids from bleached collagen Bone (P2258)	1760 ± 150
OxA-152.3	Amino acids from unbleached collagen	2000 ± 100
OxA-1524	Amino acids from bleached collagen	2040 ± 90
HAR-9093	Unbleached collagen	1860 ± 70
UB-3237	Peat 20–22 cm depth	1488 ± 44
UB-3238	Peat 55–57 cm depth	1764 ± 48
HAR-6521	Peat between right arm and head	2300 ± 70
HAR-6562	Peat monolith 125 0–3 cm	2290 ± 90
HAR-6565	Peat, upper body contact (LII)	2280 ± 70
UB-3239	Peat 117–119 cm depth	2345 ± 45
BM-2398	Peat, underside of arm (LII) htunin	2590 ± 170
BM-2399	Peat, underside of arm (LII) humic	2470 ± 250
BM-2400	Peat below recurrence surface humin	2450 ± 80
BM-2401	Peat below recurrence surface humic	2400 ± 80
UB-3240	Peat 119–121 cm depth	2447 ± 43
UB-3241	Peat 188–190 cm depth	3724 ± 55
HAR-8875	Charcoal-rich soil	4980 ± 70
GU-5562	Peat	4060 ± 70
GU-5566	Peat	7780 ± 70

(Table 8.13) Stratigraphy and pollen analyses from Wybunbury Moss (compiled from data in Poore and Walker, 1959)

Depth (metres)	**Description**	**Dominant pollen**
0.00–0.50	Unconsolidated peat	*Sphagnum*
0.50–0.75	*Sphagnum* peat	*Sphagnum*
0.75–1.26	*Sphagnum* pool peat	*Sphagnum, Calluna,* Gramineae, *Alnus, Quercus*
1.26–1.50	*Sphagnum* peat with rootlets	*Sphagnum, Quercus*
1.50–2.77	*Sphagnum* peat	*Sphagnum, Quercus*
2.77–3.20	*Sphagnum* pool peat with rare *Oxycoccus*	*Sphagnum, Quercus, Betula*
3.20–3.50	*Sphagnum* peat with *Calluna* fragments	*Sphagnum, Quercus, Betula*
3.50–6.50	*Sphagnum cuspidatum* peat with *Oxycoccus* and rare Eriophorum *vaginatum*	Cyperaceae, *Corylus*
6.50–8.80	Coarse detritus mud with *Phragmites, Carex* and *Menyanthes* remains; *Pinus* bark at 7.35 metres	*Pinus, Corylus*
8.80–8.90	Wood fragments	*Pinus, Corylus*
8.90–9.50	*Hypnum* mud with *Carex* and *Menyanthes* remains	*Pinus,* Corylus
9.50–10.00	Woody coarse detritus mud	*Pinus, Corylus*
10.00–10.20	Liquid mud	
10.20–10.40	Woody coarse detritus mud	*Pinus, Corylus, Betula,* Cyperaceae
10.40–10.46	Clay mud	*Pinus, Corylus, Betula,* Cyperaceae
10.46–10.50	Grey clay	*Pinus, Corylus, Betula*

(Table 8.14) Comparison of the timing of wet shifts from Bolton Fell Moss and Walton Moss (data from Hughes *et al.,* 2000). All ages are approximate and are years BP

Bolton Fell Moss	Bolton Fell Moss	Bolton Fell Moss	Bolton Fell Moss

(Barber, 1981)	(Stoneman, 1993)	(core BFMJ)(Barber *et al.,* 1994b)	(core WLM11)
c. 200			*c.* 100
c. 500	*c.* 350		*c.* 300–350
c. 1000		*c.* 1300	*c.* 1450
			c. 1650–1750
	c. 2400	*c.* 1900–2200	*c.* 2100 to 2040–2320
	c. 3100	*c.* 2650–2900	*c.* 2600 to 2680–3170
	c. 3550	*c.* 3300–3600	*c.* 3500
		c. 4000–4350	*c.* 3800 to 3990–4410
			c. 4900–5300
			c. 6800–7800

(Table 8.15) Stratigraphy for WH19 (data from Horton *et al.,* 1999c)

Unit	**Depth (cm)**	**Description**
12	0–4	*Limus* with herbaceous roots
11	4–10	Silty *limos*
10	10–14	Fine *limus*
9 -	14–22	Coarse *limus* with *Phragmites*
8	22–24	Fine *limus* with *Phragmites*
7	24–51	Blue-grey silty clay
6	51–55	Coarse *limos*
5	55–58	Silty *limos*
4	58–59	Sand
3	59–63	*Limus* with herbaceous roots
2	63–75	Silty *limus*
1	75+	Stiff clay

(Table 8.16) Stratigraphy for HB4 (data from Horton *et al.,* 1999c)

Unit	**Depth (cm)**	**Description**
10	0–17	Slightly organic clayey silt
9	17–40	Silty-clayey *limos* with some *Phragmites*
8	40–45	Laminated light grey-brown silty clay with some limus and *Phragmites*
7	*45–58*	Slightly clayey *limus* with herbaceous *detritus* and *Phragmites*
6	58–66	Woody detrital peat with *limus* and *Phragmites*
5	66–71	Dark brown *limus* with charcoal fragments and herbaceous *detritus*
4	71–76	Light grey, slightly organic silty clay with charcoal and some herbaceous *detritus*
3	76–79	Minero-organic sandy silt with plant rootlets and charcoal
2	79–82	Very sandy clay with some herbaceous rootlets
1	82+	Sandy blue clay with pebbles

(Table 8.17) Marine transgressions in the Fylde (after Tooley 1978a).

Transgression	**Time limits (radiocarbon years BP)**

Lytham I	9270–8575
Lytham II	8390–7800
Lytham III	7605–7200
Lytham IV	6710–6157
Lytham V	5947–5775
Lytham VI	5570–4897
Lytham VII	3700–3150
Lytham VIII	3090–2270
Lytham IX	1795–1370
Lytham X	*c.* 817

(Table 8.18) Radiocarbon dates from the New Cut (after Huddart, 1992; Middleton *et al.,* 2001).

Site name	**Coordinates**	**Grid reference**	**Material dated (after Troels-Smith, 1955)**	**Palaeoenvironment represented**	**Stratigraphical position of sample**	**Laboratory code**	**^{14}C date (years BP ±σ)**	**Height of top of sample (metres OD)**	**Thickness of sample (metres)**	**Depth of top of sample from ground surface (centimetres)**	**Interpretation**
New Cut-A	55°33'39''N 03°01'05''W	[SD 3260 0762]	Sh4, Th(Phra)^2 + Th(Cladii)^2 + Humous substance with *Cladium* and *Phragmites*	Saltmarsh to reedswamps	Silt overlaid by organic stratum	Hv.12540	6870 ± 235	+0.52	0.02	134	Regressive overlap
New Cut-A	55°33'39''N 03°01'05''W	[SD 3260 0762]	Sh4, Th(Phra)^2 + Humous substance with *Phragmites*	Reedswamps to saltmarsh	Organic stratum overlaid by silty clay	Hv.12539	6840 ± 95	+0.99	0.02	87	Transgressive overlap
New Cut-F	53°33'47.5''N 03°00'42''W	[SD 3304 0787]	Ld^{3}3, Th(Phra)^{2}1 Laminated *limus* with *Phragmites*	Saltmarsh to reedswamps	Silt overlaid by organic stratum	Hv.12537	7015 ± 90	–0.20	0.02	180	Regressive overlap
New Cut-F	53°33'47.5''N 03°00'42'''W	[SD 3304 0787]	Ld^{3}4, Th^3 + Laminated *limus*	Reedswamps to saltmarsh	Organic stratum overlaid by clayey silt	Hy.12538	7435 ± 300	+0.16	0.02	144	Transgressive overlap
New Cut			Th^2(Phra)3, Sh1, Dl$^+$ Dh^{++}	*Phragmites* turfa		Gu-7229	5670 ± 70	+0.73			

New Cut	Dh^{3}, Shl, Ag^{+} Dl^{+} Th(*Phra*)1+	Woody detritus	Gu-7230	5810 ± 80+0.60
New Cut	Th^{2}(*Phra*)3, Sh1, Ag^{+} Dh^{++}	*Phragmites* turfa	Gu-7231	6610 ± 80–0.19

(Table 8.19) Radiocarbon dates associated with the Hightown stratigraphy illustrated in (Figure 8.115).

Sample number	**Laboratory number**	**Date (years BP)**	**Description**
56.01	Beta-119011	1180 ± 50	Silver birch tree growing in organic sand
56.02	Beta-119012	4270 ± 60	Silver birch bark from the top of the peat bed
56.03	Beta-119013	4310 ± 50	*Osmunda regalis* (Royal fern) stems from the top of the peat bed
49.01	Beta-119007	4750 ± 80	Intermittent thin band of *Phragmites* peat covering the trackway
49.13	Beta-119009	4430 ± 80	Wooden peg into the trackway
49.16	Beta-119010	4910 ± 60	Part of lowest trackway resting on blue clay
49.11	Beta-119008	5080 ± 60	Part of wooden trackway

(Table 8.20) Tree and shrub species and the type of fossil remains at Hightown (from Travis, 1926).

Species	**Type of remains**
Pinus sylvestris	Bark, wood
Pinus sp.	Pollen
Myrica *gale*	Cones, seeds and leaves
Quercus sp.	Bark, wood, acorns, pollen
Betula sp.	Bark, wood, pollen
Alnus glutinosa	Cones, seeds
Corylus avellana	Wood, nuts, pollen
Tilia europaea	Pollen
Salix cinerea	Leaves
Salix aurita	Leaves
Salix sp.	Pollen, wood
Ilex aquifolium	Leaves

References

Site name	GCR selection criteria
Great Almscliff Crag, North Yorkshire	Representative of Pennine tors developed on Millstone Grit; within the Dimlington Stadial ice limit
Burbage Brook, High Peak	Representative of Pennine tors developed on Millstone Grit; demonstrates relationship between tors, geological structure and slope evolution
Brimham Rocks, North Yorkshire	Representative of Pennine scarp-edge tors developed on Millstone Grit
Wyns Tor, High Peak	Representative of Pennine tors developed on dolomitized limestone; evidence for a former weathering cover surrounding tor
Bridestones, North Yorkshire	Representative of North York Moors tors developed on limestone
Blackstone Edge, Greater Manchester	Representative of the Pennine weathering cover (Millstone Grit grus); demonstrates that the majority of weathering is mechanical in origin
Stiperstones, Shropshire	Representative of quartzite tors developed adjacent to Dimlington Stadial ice limit; demonstrates association with periglacial landforms and sediments
Cheviot Tors, Northumberland	Representative of tors developed in andesite and granite; demonstrates relationship with deeply weathered bedrock and glacial landforms and sediments

(Table 1.1) Quaternary of northern England: tor evolution network

1st Edition (1973)	Lithostratigraphy	Aminozone	D-alle/L-Ile§	Age (ka)†	$\delta^{18}O$ and polarity
Devensian	Halling Member	Halling	0.036 ± 0.01 (3)	10.9 ± 0.12 (^{14}C)	2
	Stockport Formation Δ				
	Upton Warren Member	Upton Warren	0.07 ± 0.007 (3)		3
	Cassington Member	Cassington	0.08 ± 0.009 (6)	~80 (OSL)	5a
Ipswichian	Trafalgar Square Member	Trafalgar Square	0.1 ± 0.001 (11)	124 ± 5.4 (U)	5e
Wolstonian	Ridgacre Formation Δ Kidderminster Member			159.5 ± 13 (^{36}Cl)	6
	Strensham Court Bed	Strensham	0.17 ± 0.01 (4)	~200 (OSL)*	7
	Rushley Green Member				8
Hoxnian	Hoxne Formation	Hoxne	0.26 ± 0.02 (9)	319 ± 38 (ESR)	9
	Spring Hill Member				10
	Swanscombe Member	Swanscombe	0.3 ± 0.017 (34)	~400 (U)* 471 ± 15 (TL)*	11
Anglian	Lowestoft Formation Δ				12
Cromerian	West Runton Member	West Runton	0.35 ± 0.01 (9)	~500 (ESR)	13
	Waverley Wood Member	Waverley Wood	0.38 ± 0.026 (5)		15
	Kenn Formation Δ				16
	Grace Formation ‡	Grace	0.43 ± 0.02 (4)	810 ± 140 (ESR)	21

* Age established at another locality of the aminozone

Δ Glacial formation

‡ Somme Valley, France

§ Number of analyses in parentheses

† Age estimate – method in parentheses

(Table 2.2) Relationships between the British Quaternary stratigraphical classification (after Mitchell et al., 1973), selected lithostratigraphical units, oxygen isotope stratigraphy and polarity (from Bowen, 1999).

Stage	Stratotype	Notes
Flandrian		Begins 10 ka (^{14}C); base at bottom of pollen zone IV
Devensian	Four Ashes, Staffordshire (SJ 914 082)	Late: 26–10 ka (^{14}C) Middle: 50–26 ka (^{14}C): includes Upton Warren interstadial complex Early: preceding 50 ka (^{14}C): includes Chelford interstadial ~60 ka (^{14}C)
Ipswichian	Bobbitshole, Ipswich (TM 148 414)	Base at beginning of pollen zone II
Wolstonian	Wolston, Warwickshire (SP 411 748)	Includes Baginton–Lillington gravels, Baginton sand, Wolston series, Dunsmore gravels; base at bottom of Baginton–Lillington gravels
Hoxnian	Hoxne, Suffolk (TM 543 977)	Base at beginning of pollen zone HI
Anglian	Corton Cliff, Suffolk (TM 543 977)	Lowestoft Till, Corton Sands, Norwich Brickearth/Cromer Till; base at bottom of lower till
Cromerian	West Runton, Norfolk (TG 188 432)	Upper Freshwater Bed; base at bottom of pollen zone C1
Beestonian	Beeston, Norfolk (TG 169 433)	Arctic Freshwater Bed; base at bottom of pollen zone PI
Pastonian	Paston, Norfolk (TG 341 352)	Gravels, sands and silts; base at bottom of pollen zone BeI
Baventian	Easton Bavents, Suffolk (TM 518 787)	Marine silt; base at bottom of pollen zone L4
Antian Thurnian Ludhamian	Ludham, Norfolk (borehole at TG 385 199)	Marine shelly sand; base at bottom of pollen zone L3 (forams: Lv) Marine silt: base at bottom of pollen zone L2 (forams: Lm) Shelly sand: base at bottom of pollen zone L1 (forams: Ll)
Waltonian	Walton-on-the-Naze, Essex (TM 267 237)	Older Red Crag; base at bottom of Crag at Walton

(Table 2.3) Proposed climato-stratigraphical stages in Britain (after Mitchell et al., 1973).

Species	
Littorina littorea	common
Littorina obtusata	common
Littorina rudis	
Patella vulgata	common
Nucella lapillus	
Cliona sp.	
Polydora sp.	
Saxicava sp.	
Buccinum undatum	
Arctica islandica	
Mytilus edulis	
Pecten sp.	
Rhynchonella psittacea	
Helix sp.	

(Table 4.4) Shell list from the Easington raised beach (based on Woolacott, 1920, 1922).

Psammobia sp.
Mactra sp.
Cerastoderma edule (L.)
Tellina balthica
Cardium edule
Macoma balthica (L.)
Scrobicularia plana (da Costa)
Scrobicularia piperata
Littorina littorea (L.)
L. rudis
Hydrobia (*Peringia* or *Sabanaea*) *ulvae* (Pennant)
Retusa obtusa (Montagu) var. *pretenuis*
Mytilus edulis (L.)
Utriculus obtusus
Littorina saxatilis (Olivi)
Littorina littoralis (L.)
Balanus crenatus
echinoid spines

(Table 4.5) Faunal list for the Speeton Shell Bed (after Lamplugh, 1881c; Thistlewood and Whyte, 1993).

Collection date	Laboratory identification	D/L ratio	Mean
1966 (L.F. Penny)	A B C D	0.172 0.173 0.182 0.184	0.178 ± 0.005
1988	50 cm* 1.20 cm* 1.60 cm*	0.154 0.224 0.230	0.203 ± 0.035
*Depth collected from top of shell bed			

(Table 4.6) Amino acid (D/L) ratios of Macoma balthica from the Speeton Shell Bed (from Wilson, 1991).

Arboreal pollen	Non-arboreal pollen
Betula	*Corylus*
Pinus	Gramineae
Ulmus	Cyperaceae
Quercus	Compositae (Ligulatae)
Carpinus	*Filipendula*
Picea	*Plantago maritima*
	Umbelliferae
	Sparganium-type
	Filicales

(Table 4.7) Pollen of the Speeton Shell Bed (from West, 1969).

Age (ka BP)	Oxygen isotope stage	D/L ratio (Macoma)	Stage
	2		Dimlington
24			
	3	0.085	
59			
	4		
71			
	5a–d		
122			
	5e	0.16	Ipswichian
128			
	6		Wolstonian 3
186			
	7	0.2	Ilfordian
245			
	8		
303			
	9	0.29	Hoxnian

(Table 4.8) Correlation of post-Hoxnian events, amino acid ratios and oxygen isotope stages (after Wymer, 1985; Bowen and Sykes, 1988).

	Ipswichian beach gravel	Colluvium	Aeolian dune sand
Mammalia			
Crocuta crocuta (hyaena)	•		•
Ursus (bear)		•	
Palaeoloxodon antiquus (straight-tusked elephant)	•		•
Didermoceros hemitoechus (narrow-nosed rhinoceras)	•		•
Hippopotamus amphibius (hippopotamus)	•		
Megaloceros giganteus (giant deer)		•	
Bison cf. *Priscus* (bison)	•	•	•
Arvicola terrestris (water vole)		•	
Mollusca			
Littorina littorea L.	•		
Ostrea edulis L.	•		
Mytilus edulis L.	•		
Purpura lapillus L.	•		
Pholas sp.	•		
Saxicava sp.	•		
Helix hispida L.		•	
Helix pulchella Müll		•	
Pupa marginata Drap.		•	
Zua subcyclindrica L.		•	

(Table 4.9) Faunal list for the Sewerby sedimentary units (after Lamplugh, 1891b; Boylan, 1967; Catt, 1987c).

Homo species	artefacts
Lepus timidus	mountain hare
Spermophilus major	red-cheeked suslik
Canis lupis	wolf
Vulpes vulpes	red fox
Ursus arctos	brown bear
Mustela erminea	stoat
Mustela putorius	polecat
Crocuta crocuta	spotted hyaena
Panthera leo	lion
Mammathus primigenius	woolly mammoth
Equus ferus	wild horse
Coelodonta antiquitatis	woolly rhinoceros
Megaloceros giganteus	giant deer
Rangifer tarandus	reindeer
Bison priscus	bison

(Table 5.1) The mammalian fauna from the Pin Hole Mammalian Zone, Lower Cave Earth, Pin Hole Cave, Cresswell, Derbyshire (after Currant and Jacobi, 2001).

Robin Hood Cave	OxA-6115	22 800 ± 240
Robin Hood Cave	OxA-6114	22 980 ± 480
Church Hole	OxA-5800	24 000 ± 260
Ash Tree Cave	OxA-5798	25 660 ± 380
Church Hole	OxA-5799	26 840 ± 420
West Pin Hole (Dog Hole)	OxA-5803	29 300 ± 420
Robin Hood Cave	OxA-5802	31 050 ± 500
Pin Hole	OxA-1206	32 200 ± 1000
Robin Hood Cave	OxA-5801	33 450 ± 700
Pin Hole	OxA-1207	34 500 ± 1200
Pin Hole	OxA-4754	37 800 ± 1600
Pin Hole	OxA-1448	42 200 ± 3000

(Table 5.2) Radiocarbon dates (years BP) on spotted hyaena remains from the Cresswell area, Derbyshire (after Currant and Jacobi, 2001)

Family	Number of species
Carabidae	30
Dytiscidae	12
Hydrophilidae	4
Silphidae	3
Leiodidae	1
Staphilinidae	13
Elateridae	8
Helodidae	1
Byrrhidae	4
Coccinellidae	2
Scarabaeidae	2
Cerambycidae	1
Chrysomelidae	7
Curculionidae	10
Scolytidae	2

(Table 5.3) Coleoptera from the Chelford Formation (data from Coope, 1959).

Coleoptera
Agabus bipustulatus L.
Aleocharinae indet.
Amara alpina Paykull
Amara quenseli Sch.
Aphodius sp.
Arpedium brachypterum Gr.
Bembidion sp. (*lunatum* group)
Bledius fuscipes Rye
Byrrhus sp.
Cercyon sp.
Feronia blandulus Mill.
Hydrobius sp.
Notaris aethiops F.
Ostracoda
Candona neglecta Sars
Cypridopsis vidua (Mull.)
Cyprinotus salinus (Brady)
Eucypris gemella Bodina
Ilocypyris gibba (Ramdohr)
Plants
Daphnia ephippia
Eleocharis palustris (L.)
Menyanthes trifoliata (L.)
Pohlia wahlenbergii (Web. & Mohr) *glacialis* (Schleich.)
Potamogeton alpinus
Potamogeton filiformis
Trees
Pinus (sparse pollen)
Betula (sparse pollen)

(Table 5.5) The flora and fauna of the Dimlington Silts.

Lithological unit	Depth (cm)	Description
16	0–17/23	Fibrous peat; boundary is sharp but irregular, suggesting a possible hiatus. Blocks of reworked Late-Glacial clay occur within the Holocene peats.
15	17/23–37	Clay with sand laminae; laterally and vertically variable.
14	37–41	Angular and rounded chalk fragments.
13	41–88	Grey plastic clay; clearly defined sand laminations at 49, 74, 82 and 89 cm.
12	90–112	Clay unit with abundant sandy laminations, varying from a few millimetres to 1 cm in thickness. Each lamination continuous and of uniform thickness.
11	112–115	Grey plastic clay with small (<1 cm) pellets of chalk; latter appear flattened in the horizontal plane.
10	115–120	Silt/clay; black 'felted' peat layer at 120 cm
9	120–146	Laminated silt/clay with intercalations of 'felted' peat/plant debris.
8	146–147	Plastic grey clay.
7	147–172	Organic mud, but with clearly defined mineral/organic laminations in upper levels. Organic component variable, but maximum organic carbon values (~30%) towards the base of the unit. Bands of compressed plant debris occur in these lower levels.
6	172–187	Grey/brown silt/clay. Slightly organic (10% or less) throughout, but clearly defined clay-rich sub-unit from 174–178 cm; fibrous root material abundant.
5	187–203	Clay gyttja; organic content exceeds 20%, with maximum values (33%) near base of unit.
4	203–207	Transitional unit with intercalations of organic mud and grey silt/clay.
3	207–223	Clay marl with intermittent small (<2 cm) pellets of chalk; slightly organic (<10%) throughout.
2	223–235	Sand and clay laminae (up to 1 cm in thickness); some fine rootlet casts in the upper part.
1	Below 235	Sands and silts with intermittent horizons rich in gravel-sized particles of coal and occasional discrete lenses of slightly organic silt.

(Table 6.3) Stratigraphy at Gransmoor (after Walker et al., 1983).

Cold-adapted species	Warmth-adapted species
Nebria nivalis	**Bembidion grisvardi*
**Diacheila arctica*	*Bembidion humerale*
**Diacheila polita*	*Bembidion quadripustulatus*
Elaphrus lapponicus	*Bembidion octomaculatum*
**Bembidion fellmanni*	*Pterostichus macer*
**Bembidion mckinleyi*	**Cymindis angularis*
**Agonum consimile*	*Ochthebius pedicularis*
Amara alpina	**Entomoscelis adonidis*
**Pycnoglypta lurida*	
**Olophrum boreale*	
**Acidota guadrata*	
**Boreaphilus henningianus*	
**Boreaphilus nordenskioeldi*	
Oreodytes alpinus	
**Colymbetes dolabratus*	
Dysticus lapponicus	
Gyrinus opacus	
**Helophorus sibiricus*	
**Helophorus glacialis*	
**Helophorus obscurellus*	
**Simplocaria metallica*	
**Hippodamia arctica*	

(Table 6.4) List of climatically significant Coleoptera species from the Gransmoor stratigraphy (from Walker et al., 1993).

Hawes Water	
Dimensions	~400 × 225 metres
Elevation	8 metres above sea level; distance to sea ~ 5 kilometres
Water depth	Marl shelf ~1.2 metres; maximum ~12 metres
Lake volume	~390 000 cubic metres
Water supply	Direct precipitation (~1350 mm/a), spring, groundwater
Water temperature	Surface water 5–18°C; deep water –5–8°C
Catchment area	1.77 km^2
Residence time	2–6 months?
Carbonate precipitation	Seasonal Biogenic (skeletal): gastropods, bivalves, ostracods, Chara Biologically mediated (plants/microbial)
Sediment record	'Marl': (bio)micrite, clay, peat, gyttja

(Table 6.5) Limnological characteristics of Hawes Water.

Area	Lithology	References
1. England		
Isles of Scilly	Granite	Scourse (1987)
Dartmoor (South-west England)	Granite	Linton (1955) Palmer and Neilson (1962) Eden and Green (1971) Gerrard (1974, 1978, 1988)
Exmoor (South-west England)	Sandstone	Mottershead (1967)
Weald (South-east England)	Sandstone	Robinson and Williams (1976)
Charnwood Forest (Midlands)	Granite, microdiorite and hornstone	Ford (1967)
Tabular Hills (Yorkshire)	Silicified grits	Palmer (1956)
Derbyshire	Dolomite	Ford (1963, 1969)
	Gritstone	Palmer and Radley (1961) Linton (1964) Cunningham (1964, 1965)
Stiperstones (Shropshire)	Quartzite	Goudie and Piggott (1981) Clark (1994a)
Cheviot Hills	Granite	Common (1954) Douglas and Harrison (1985)
2. Wales		
Central Wales	Igneous rocks, grits	Potts (1971)
Pembrokeshire	Rhyolite	Linton (1955)
Preseli Hills	Dolerite	Linton (1955)
3. Scotland		
Cairngorm Mountains	Granite	Linton (1949, 1955) King (1968) Ballantyne (1994)
North-east Scotland	Granite	Linton (1955)
Ochil Hills	Andesite	Linton (1955)
Ben Loyal (Sutherland)	Syenite	Linton (1955)
Caithness	Sandstones and grits	Linton (1955)
Trotternish, Skye	Basalt	Ballantyne (1990, 1991)

(Table 7.2) The locations and lithologies of the main tors in Britain (compiled from various sources, including Goudie and Piggott (1981) and Ballantyne and Harris (1994)).

Sample number	Depth related to pollen diagram B or C (cm)	Pollen zonation	Age (years BP)
Q172	67.0–69.0 B	Zone VII*b* base	5030 ± 119
Q171	69.0–71.0 B	VII*a*/VII*b* boundary (Atlantic Sub-boreal/transition)	4975 ± 134
Q173	71.0–73.0 B	Zone VII*a* top	5037 ± 122
Q166	174.5–176.5 B	Zone VII*a* base	6998 ± 131
Q165	176.5–178.5 B	VI/VII*a* boundary (Boreal/Atlantic transition)	7475 ± *c.* 350
Q167	178.5–180.5 B	Zone VI top	7404 ± 146
Q161	−0.5–1.5 C	Zone VI base (V/VI boundary)	9052 ± 194
Q162	3.5–5.5 C	Zone V top	8859 ± 192
Q155	44.5–46.5 C	Zone V base	9790 ± 183
Q154	46.5–48.5 C	IV/V boundary (Pre-boreal/Boreal transition)	9607 ± 209
Q152	69.5–71.5 C	Zone IV base	10 203 ± 193
Q151	71.5–73.5 C	III/IV boundary (Post-glacial/Late-glacial transition)	10 307 ± *c.* 350
Q153	73.5–75.5 C	Zone III top	10 368 ± 215
Q144	109.5–111.5 C	Zone III base	10 878 ± 185
Q147	123.0–125.0 C	Zone II top } Combined	10 748 ± 207
Q148	125.0–127.0 C	Zone II top } Combined	

(Table 8.1) Radiocarbon dated pollen zone horizons at Scaleby Moss (after Godwin et al., 1957)

Depth (cm)	Stratigraphy
0–50	Not sampled
50–75	Sedge peat of low humification (H4) with some *Calluna* remains
75–100	Sedge peat of low humification (H3) with some *Calluna*
100–150	Sedge peat of low humification (H4) with abundant pieces of *Calluna*
150–200	Slightly muddy sedge peat of medium humification (H5–6) with *Calluna*
200–250	Slightly muddy sedge peat of low humification (H3–4) with *Betula* wood
250–290	Slightly muddy sedge peat of low humification (H5–6) with less *Betula*
290–525	Slightly muddy sedge peat of low humification (H5–6) with abundant pieces of *Betula* wood
525–580	Bryophyte peat of low humification (H3) composed mainly of *Paludella squarrosa* together with some *Eriophorum* sedge remains
580–600	Sedge peat of low humification (H3-4) with some *Eriophorum*

(Table 8.3) Stratigraphy at Valley Bog (after Chambers, 1978)

Depth (cm)	Description
0–12	Dark brown crumbly *Calluna* peat with some *Eriophorum* remains, *Juncus* seeds, megaspores of *Selaginella selaginoides* with *Carex* seeds
12–25	Light brown, *Calluna–Eriophorum* peat containing remains of sedges and megaspores of *Selaginella*
25–40	Dark brown peat containing burnt *Calluna* stems
40–112	Dry, moderately humified, light brown *Phragmites* peat with burnt *Calluna* stems, seeds of *Carex* sp. and *Menyanthes trifoliata* and megaspores of *Selaginella*
112–135	Light brown *Phragmites* peat containing twigs of *Betula*, leaves and seeds of *B. nana*, seeds of *Menyanthes* and *Carex* sp., a single seed of *Lychnis flos-cuculi*, *Chara* oospores and megaspores of *Selaginella*
135–143	*Phragmites* peat with a few *Betula* fragments and seeds of *Carex* sp., *Carduus cirsium* sp., *Viola* sp. and *Lychnis flos-cuculi* and megaspores of *Selaginella*

(Table 8.4) Stratigraphy at TSI, Red Sike Moss (after Turner et al.

Laboratory code	Depth (cm)	Pollen horizon	Age, in radiocarbon years BP (before 1950)
GaK-2027	14	Rise in Gramineae *Calluna* and *Plantago*; beginning of zone G	2570 ± 80
GaK-2028	44	Beginning of zone A	3390 ± 90
GaK-2029	70	Beginning of subzone Oc	6150 ± 160
GaK-2030	120	End of zone H	8250 ± 280
GaK-2031	135	End of zone J	9900 ± 190

(Table 8.6) 14 C dates from TSI, Red Sike Moss. They were dated at the Gakushuin laboratory (Japan) and the dates were based on the Libby half-life of 5570 ± 30 years (after Turner et al., 1973)

Unit	Depth (cm)	Lithology
9	0–90	Mere Sands (Wilson, 1985)
8	90–98	Sandy substantia humosa
7	98–105	Fine detrital mud
6	105–139	*Turfa herbaceae*
5	139–140	*Turfa menyanthis*
4	140–141	Fine detrital mud
3	141–157	Fine–sandy detrital mud and *Turfa herbaceae*
2	157–160	Fine detrital mud and *Turfa herbaceae*
1	160– Locally up to 5 metres thick	Shirdley Hill Formation: loose fine to medium moderately to moderately well sorted sands displaying weak cross-bedding and cryoturbation structures

(Table 8.8) Stratigraphy at Mere Sands Wood (after Baxter, 1983; Tooley, 1985; Wilson, 1985; Bateman, 1995).

Depth in core (cm)	Description
0.00–0.50	Made ground
0.50–1.40	Sandy clay
1.40–1.75	Clayey detritus mud with organic matter
1.75–9.30	Fine detritus mud with no recognizable plant material
9.30–12.30	Silty clay with occasional organic matter
12.30–12.60	Clayey fine detritus mus with some silt
12.60–13.80	Gravelly clay

(Table 8.9) Generalized stratigraphy of Old Mere, Hornsea (source: Beckett, 1981)

Bed	Depth (cm)	Environment	Stratigraphy
1	0–140	Ombrogenous mire	Poorly humified *Sphagnum* and Monocotyledonous peat
2	0–140	Ombrogenous mire	Well-humified Monocotyledonous peat
3	140–600	*Phragmites* reed-swamp	Well-humified *Phragmites australis* peat, with occasional other mire plant remains (*Eriophorum* spp., Ericaceae and *Sphagnum*)
	600–820	Partially wooded *Phragmites* reed-swamp	Well-humified *Phragmites* peat, with occasional wood remains (*Betula*, *Alnus* and *Salix*)
4	820–920	Fen/Carr woodland mire	Well-humified wood peat, with *Betula*, *Salix* and occasional *Phragmites* remains
5	920–960	Mire inception	Well-humified peat rich with inorganic material
6	960–	Periglacial valley	Blue-grey clay solifluction deposits

(Table 8.10) Peat stratigraphy at Fen Bogs, North York Moors (after Atherden, 1976a; Chiverrell, 1998).

Phase	Major taxa	Lesser taxa
TBIXc	Gramineae, Cyperaceae	*Plantago lanceolata*, Ericaceae
TBIXb	Gramineae, *Taraxacum*, *Plantago lanceolata*, *P. major-media*	*Alnus*, Cyperaceae
TBIXa	*Alnus*, Gramineae, *Cannabis*	*Plantago lanceolata*
TBVIII	*Corylus*	*Quercus*, *Alnus*
TBVII	*Corylus*	*Betula*
TBVI	*Betula*	*Salix*, *Filipendula*
TBVb	*Betula*, *Filipendula*, *Salix*	*Juniperus*, *Empetrum*
TBVa	Gramineae, *Empetrum*	Cyperaceae, *Betula*, *Galium*
TBIVc	Cyperaceae, *Thalictrum*	Gramineae, *Ranunculus*, *Artemisia*
TBIVb	Cyperaceae, Gramineae	*Thalictrum*, *Artemisia*, Caryophyllaceae
TBIVa	Cyperaceae, Gramineae	*Rumex*, Caryophyllaceae
TBIIIc	*Betula*, *Filipendula*	Gramineae, Cyperaceae, *Empetrum*
TBIIIb	Gramineae, Cyperaceae	*Betula*, *Juniperus*, *Filipendula*
TBIIIa	*Betula*, *Empetrum*	*Juniperus*, *Filipendula*
TBII	*Juniperus*	*Helianthemum*, Cyperaceae, Gramineae
TBI	Cyperaceae, Gramineae	*Betula nana*, *Salix*, *Juniperus*, Ruderals

(Table 8.11) Characteristic pollen taxa of the 16 pollen assemblage zones and subzones from Thorpe Bulmer (Bartley et al., 1976).

Laboratory reference	Sample type	^{14}C age (years BP; $\pm 1\sigma$)	Laboratory reference	Sample type	^{14}C age (years BP; $\pm 1\sigma$)
Lindow I			Lindow III		
OxA-114	Collagen from bone	1740 ± 80		Bone (P2255)	
			OxA-1517	Amino acids from unbleached collagen	1740 ± 90
Lindow II (Lindow man)			OxA-1518	Amino acids from bleached collagen	1750 ± 90
OxA-531	Amino acids from hair	1920 ± 20	HAR-9094	Unbleached collagen	2010 ± 80
OxA-604	Amino acids from bone	1850 ± 80			
OxA-605	Amino acids from soft tissue	2125 ± 80		Skin (P2256)	
OxA-781	Standard amino acids	1940 ± 80	OxA-1519	Amino acids from unbleached collagen	1850 ± 90
OxA-782	Pre-bleach amino acids	1950 ± 80	OxA-1520	Amino acids from bleached collagen	1700 ± 120
OxA-783	Hyroxyproline	1920 ± 80	HAR-9092	Unbleached collagen	1880 ± 80
OxA-784	Standard amino acids	1900 ± 80			
OxA-785	Proline	1900 ± 80		Skin (P2257)	
OxA-786	Collagen, Oxford preparation	1800 ± 80	OxA-1521	Amino acids from unbleached collagen	1890 ± 100
OxA-787	Collagen, Harwell preparation	1870 ± 80	OxA-1522	Amino acids from bleached collagen	1760 ± 150
OxA-788	Collagen, Harwell preparation	1870 ± 80		Bone (P2258)	
OxA-789	Humic (standard amino acids)	2190 ± 100	OxA-1523	Amino acids from unbleached collagen	2000 ± 100
OxA-790	Humic (bleach)	1970 ± 80	OxA-1524	Amino acids from bleached collagen	2040 ± 90
OxA-1040	Stomach contents	1910 ± 60	HAR-9093	Unbleached collagen	1860 ± 70
OxA-1041	Humic from stomach contents	2210 ± 60	UB-3237	Peat 20–22 cm depth	1488 ± 44
HAR-6224	Wrist bone	2420 ± 100	UB-3238	Peat 55–57 cm depth	1764 ± 48
HAR-6235a	Leg bone	1540 ± 100	HAR-6521	Peat between right arm and head	2300 ± 70
HAR-6235b	Leg bone	1650 ± 80	HAR-6562	Peat monolith 125 0–3 cm	2290 ± 90
HAR-6491	Skin	1550 ± 70	HAR-6565	Peat, upper body contact (LII)	2280 ± 70
HAR-6492	Rib bone	1625 ± 80	UB-3239	Peat 117–119 cm depth	2345 ± 45
HAR-6493	Skin and hair	1530 ± 110	BM-2398	Peat, underside of arm (LII) humin	2590 ± 170
HAR-6856a	Vertebra	1480 ± 90	BM-2399	Peat, underside of arm (LII) humic	2470 ± 250
HAR-6856b	Vertebra	1610 ± 80	BM-2400	Peat below recurrence surface humin	2450 ± 80
			BM-2401	Peat below recurrence surface humic	2400 ± 80
			UB-3240	Peat 119–121 cm depth	2447 ± 43
			UB-3241	Peat 188–190 cm depth	3724 ± 55
			HAR-8875	Charcoal-rich soil	4980 ± 70
			GU-5562	Peat	4060 ± 70
			GU-5566	Peat	7780 ± 70

(Table 8.12) Radiocarbon determinations from Lindow Moss (data from Ambers et al., 1986; Gowlett et al., 1986; Otlet et al., 1986; Housley et al., 1995; Leah et al., 1997)

Depth (metres)	Description	Dominant pollen
0.00–0.50	Unconsolidated peat	*Sphagnum*
0.50–0.75	*Sphagnum* peat	*Sphagnum*
0.75–1.26	*Sphagnum* pool peat	*Sphagnum*, *Calluna*, Gramineae, *Alnus*, *Quercus*
1.26–1.50	*Sphagnum* peat with rootlets	*Sphagnum*, *Quercus*
1.50–2.77	*Sphagnum* peat	*Sphagnum*, *Quercus*
2.77–3.20	*Sphagnum* pool peat with rare *Oxycoccus*	*Sphagnum*, *Quercus*, *Betula*
3.20–3.50	*Sphagnum* peat with *Calluna* fragments	*Sphagnum*, *Quercus*, *Betula*
3.50–6.50	*Sphagnum cuspidatum* peat with *Oxycoccus* and rare *Eriophorum vaginatum*	Cyperaceae, *Corylus*
6.50–8.80	Coarse detritus mud with *Phragmites*, *Carex* and *Menyanthes* remains; *Pinus* bark at 7.35 metres	*Pinus*, *Corylus*
8.80–8.90	Wood fragments	*Pinus*, *Corylus*
8.90–9.50	*Hypnum* mud with *Carex* and *Menyanthes* remains	*Pinus*, *Corylus*
9.50–10.00	Woody coarse detritus mud	*Pinus*, *Corylus*
10.00–10.20	Liquid mud	
10.20–10.40	Woody coarse detritus mud	*Pinus*, *Corylus*, *Betula*, Cyperaceae
10.40–10.46	Clay mud	*Pinus*, *Corylus*, *Betula*, Cyperaceae
10.46–10.50	Grey clay	*Pinus*, *Corylus*, *Betula*

(Table 8.13) Stratigraphy and pollen analyses from Wybunbury Moss (compiled from data in Poore and Walker, 1959)

Bolton Fell Moss (Barber, 1981)	Bolton Fell Moss (Stoneman, 1993)	Bolton Fell Moss (core BFMJ) (Barber *et al.*, 1994b)	Bolton Fell Moss (core WLM11)
c. 200			*c.* 100
c. 500	*c.* 350		*c.* 300–350
c. 1000			
		c. 1300	*c.* 1450
			c. 1650–1750
	c. 2400	*c.* 1900–2200	*c.* 2100 to 2040–2320
	c. 3100	*c.* 2650–2900	*c.* 2600 to 2680–3170
	c. 3550	*c.* 3300–3600	*c.* 3500
		c. 4000–4350	*c.* 3800 to 3990–4410
			c. 4900–5300
			c. 6800–7800

(Table 8.14) Comparison of the timing of wet shifts from Bolton Fell Moss and Walton Moss (data from Hughes et al., 2000). All ages are approximate and are years BP

Unit	Depth (cm)	Description
12	0–4	*Limus* with herbaceous roots
11	4–10	Silty *limus*
10	10–14	Fine *limus*
9	14–22	Coarse *limus* with *Phragmites*
8	22–24	Fine *limus* with *Phragmites*
7	24–51	Blue-grey silty clay
6	51–55	Coarse *limus*
5	55–58	Silty *limus*
4	58–59	Sand
3	59–63	*Limus* with herbaceous roots
2	63–75	Silty *limus*
1	75+	Stiff clay

(Table 8.15) Stratigraphy for WH19 (data from Horton et al., 1999c)

Unit	Depth (cm)	Description
10	0–17	Slightly organic clayey silt
9	17–40	Silty-clayey *limus* with some *Phragmites*
8	40–45	Laminated light grey-brown silty clay with some *limus* and *Phragmites*
7	45–58	Slightly clayey *limus* with herbaceous *detritus* and *Phragmites*
6	58–66	Woody detrital peat with *limus* and *Phragmites*
5	66–71	Dark brown *limus* with charcoal fragments and herbaceous *detritus*
4	71–76	Light grey, slightly organic silty clay with charcoal and some herbaceous *detritus*
3	76–79	Minero-organic sandy silt with plant rootlets and charcoal
2	79–82	Very sandy clay with some herbaceous rootlets
1	82+	Sandy blue clay with pebbles

(Table 8.16) Stratigraphy for HB4 (data from Horton et al., 1999c)

Transgression	Time limits (radiocarbon years BP)
Lytham I	9270–8575
Lytham II	8390–7800
Lytham III	7605–7200
Lytham IV	6710–6157
Lytham V	5947–5775
Lytham VI	5570–4897
Lytham VII	3700–3150
Lytham VIII	3090–2270
Lytham IX	1795–1370
Lytham X	*c.* 817

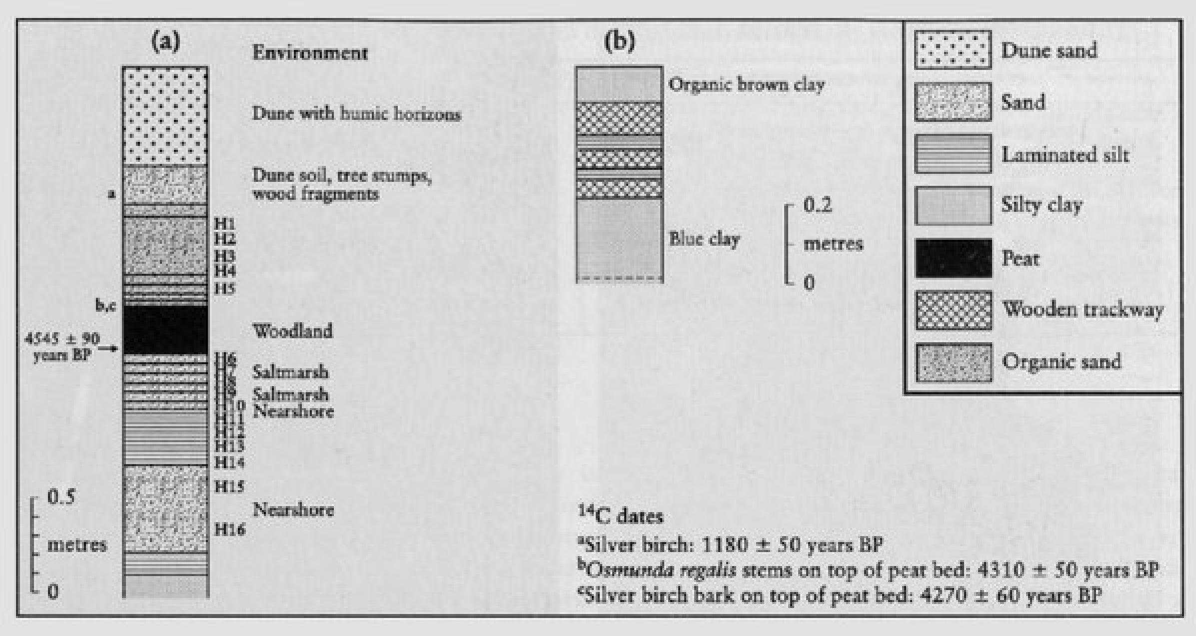
(Table 8.17) Marine transgressions in the Fylde (after Tooley 1978a).

Site name	Coordinates	Grid reference	Material dated (after Troels-Smith, 1955)	Palaeoenvironment represented	Stratigraphical position of sample	Laboratory code	^{14}C date (years BP ±1σ)	Height of top of sample (metres OD)	Thickness of sample (metres)	Depth of top of sample from ground surface (centimetres)	Interpretation
New Cut-A	55°33'39"N 03°01'05"W	SD 3260 0762	Sh4, Th(*Phra*)^2 + Th(*Cladi*)^2 + Humous substance with *Cladium* and *Phragmites*	Saltmarsh to reedswamps	Silt overlaid by organic stratum	Hv.12540	6870 ± 235	+0.52	0.02	134	Regressive overlap
New Cut-A	55°33'39"N 03°01'05"W	SD 3260 0762	Sh4, Th(*Phra*)^2 + Humous substance with *Phragmites*	Reedswamps to saltmarsh	Organic stratum overlaid by silty clay	Hv.12539	6840 ± 95	+0.99	0.02	87	Transgressive overlap
New Cut-F	53°33'47.5"N 03°00'42"W	SD 3304 0787	Ld^{3}3, Th(*Phra*)^{2}1 Laminated *limus* with *Phragmites*	Saltmarsh to reedswamps	Silt overlaid by organic stratum	Hv.12537	7015 ± 90	−0.20	0.02	180	Regressive overlap
New Cut-F	53°33'47.5"N 03°00'42"W	SD 3304 0787	Ld^{3}4, Th^3 + Laminated *limus*	Reedswamps to saltmarsh	Organic stratum overlaid by clayey silt	Hv.12538	7435 ± 300	+0.16	0.02	144	Transgressive overlap
New Cut			Th^2(*Phra*)3, Sh1, Dl$^+$ Dh^{++}	*Phragmites* turfa		Gu-7229	5670 ± 70	+0.73			
New Cut			Dh^3, Sh1, Ag$^+$ Dl$^+$ Th(*Phra*)1$^+$	Woody detritus		Gu-7230	5810 ± 80	+0.60			
New Cut			Th^2(*Phra*)3, Sh1, Ag$^+$ Dh^{++}	*Phragmites* turfa		Gu-7231	6610 ± 80	−0.19			

(Table 8.18) Radiocarbon dates from the New Cut (after Huddart, 1992; Middleton et al., 2001).

Sample number	Laboratory number	Date (years BP)	Description
56.01	Beta-119011	1180 ± 50	Silver birch tree growing in organic sand
56.02	Beta-119012	4270 ± 60	Silver birch bark from the top of the peat bed
56.03	Beta-119013	4310 ± 50	*Osmunda regalis* (Royal fern) stems from the top of the peat bed
49.01	Beta-119007	4750 ± 80	Intermittent thin band of *Phragmites* peat covering the trackway
49.13	Beta-119009	4430 ± 80	Wooden peg into the trackway
49.16	Beta-119010	4910 ± 60	Part of lowest trackway resting on blue clay
49.11	Beta-119008	5080 ± 60	Part of wooden trackway

(Table 8.19) Radiocarbon dates associated with the Hightown stratigraphy illustrated in (Figure 8.115).



(Figure 8.114) a. A view of the submerged forest at Hightown taken from De Rance (1877). b. Submerged forest at Hightown. Note surface log and root system through the peat. (Photo: S. Gonzalez.)

Species	Type of remains
Pinus sylvestris	Bark, wood
Pinus sp.	Pollen
Myrica gale	Cones, seeds and leaves
Quercus sp.	Bark, wood, acorns, pollen
Betula sp.	Bark, wood, pollen
Alnus glutinosa	Cones, seeds
Corylus avellana	Wood, nuts, pollen
Tilia europaea	Pollen
Salix cinerea	Leaves
Salix aurita	Leaves
Salix sp.	Pollen, wood
Ilex aquifolium	Leaves

(Table 8.20) Tree and shrub species and the type of fossil remains at Hightown (from Travis, 1926).