

CHAPTER 19

Palaeoenvironmental Investigations

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Introduction

Palaeoenvironmental studies have been an integral part of research at Star Carr since Clark's first excavations at the site (Walker and Godwin 1954). Since then, a series of increasingly detailed studies have been undertaken, which have created an incredibly precise record of the local environment throughout the time the site was occupied (Cloutman and Smith 1988; Dark 1998a). Rather than replicate this work, the current project has sought to establish in more detail the environmental conditions associated with assemblages of archaeological material in order to provide a better record of the original depositional context. By bringing this together with the results of previous work at the site, it is possible to describe in more detail the environmental context in which the inhabitation of the site took place.

Previous work

The first palaeoenvironmental investigations at Star Carr were carried out between 1949 and 1951 by Harry Godwin and Donald Walker, and were undertaken as part of Grahame Clark's excavations at the site (Walker and Godwin 1954). Their work focused primarily on the analysis of the peat stratigraphy recorded in the trenches, and plant macrofossils from the archaeological horizons, which they used to establish the character of the environment contemporary with human activity. The results were brought together with pollen analysis from samples taken from Clark's cutting II, and data from a series of cores taken through the sediments beyond the extent of the excavations to create the first environmental history of the site.

By the mid-1980s developments in palaeoecological methods, and the greater availability of radiocarbon dating, allowed a more detailed study of the lake edge environments to be carried out, this time by Ed Cloutman under the auspices of the Vale of Pickering Research Trust (Cloutman and Smith 1988). Tim Schadla-Hall had recently completed large-scale excavations and surveys of the Mesolithic landscape at Seamer Carr, to the northeast of Star Carr. As part of this work, Cloutman had used pollen profiles taken at intervals through the lake edge deposits to map the extents of the wetland environments and track their development over time

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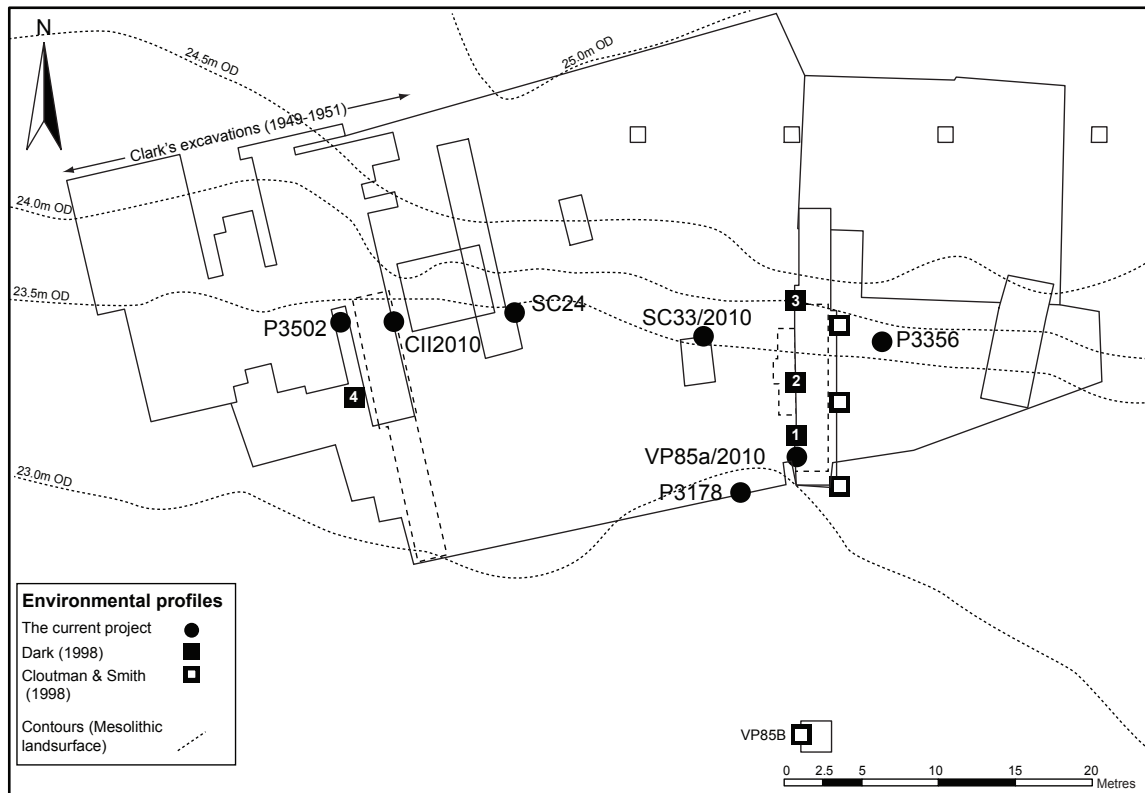


Figure 19.1: Location of environmental sampling points at Star Carr, 1985–2015. The profiles recorded by Dark (1998a) are 1: profile M1; 2: profile M2; 3: profile M3, 4: Clark Site profile (Adapted from Taylor et al. 2017. Copyright Cambridge University Press (2017) reprinted with permission).

(Cloutman 1988a; Cloutman 1988b). Adopting a similar approach at Star Carr, Schadla-Hall under the auspices of the Vale of Pickering Research Trust excavated two new trenches (trenches VP85A and B) through the lake edge deposits c. 30 m to the east of the area investigated by Clark. Four pollen profiles were recorded at points along their sections (three from VP85A, one from VP85B) (Figure 19.1). The profiles were correlated using horizons within the pollen and peat stratigraphies (Cloutman 1988b, 48–51), and an absolute chronology was established from radiocarbon dates obtained from samples taken from each of the pollen profiles and from sediments within the trench.

Cloutman's work demonstrated the dynamic nature of the lake edge environments, which exhibited a significant degree of change during the early centuries of the Mesolithic. However, subsequent re-evaluation of this work suggested that the radiocarbon chronology established by Cloutman was incorrect, and that the estimates for the timing and duration of environmental change and its relationship to the human occupation of the site were unreliable (Mellars 1990). To resolve this, further work was carried out at the site in the 1990s by Petra Dark, supported again by the Vale of Pickering Research Trust (Dark 1998b; Mellars and Dark 1998). Adopting a similar approach to that of Cloutman, Dark recorded three new pollen and plant macrofossil profiles from trench VP85A, and a fourth profile close to Clark's cutting II (Figure 19.1). High-resolution pollen analysis was undertaken on one of the profiles (profile M1) in order to detect subtle changes in vegetation that could be the result of human action, whilst the analysis of micro- and macro-charcoal was carried out to detect episodes of burning. New radiocarbon dates were obtained on two of the profiles, and Bayesian models were constructed to provide a more precise chronology for the environmental sequence.

Dark's work established a far more detailed record for the timing and nature of the wetland environments at the site. Though her work generally agreed with the environmental sequence defined by Cloutman, Dark

showed that the changes to the character of the wetland occurred throughout the time that people inhabited the site (Dark 1998b). What is more, some of the changes observed in the pollen profiles coincided with increased levels of micro- and macro-charcoal suggesting that changes to the local vegetation were actually the result of deliberate human action.

Objectives of the current project

Whilst these various research programmes have led to a very detailed record of the changing character of the environments at Star Carr, a number of issues remained unresolved by the time the current project began. The first and perhaps most crucial of these was the environmental context of the archaeological material recorded from the site. Initially, this related to the large assemblage of bone and antler artefacts recorded by Clark, the context of which has been debated and re-interpreted since the late 1970s but without the data to properly resolve the issue (e.g. Price 1982; Chatterton 2003; Mellars 2009). However, as it became clear that activity within the wetland was more extensive and varied than previously thought, the need to establish the environmental context of material from other parts of the site became increasingly important.

The second issue was the relationship between the local environment and the Mesolithic groups that inhabited the site. Although Dark's work had shown that the wetland vegetation was cleared by burning, there had been little discussion of other ways in which people would have engaged with the different plant communities, such as their potential as foods or raw materials. What is more, whilst the environmental records clearly showed that the nature of the environment, including the character of the local vegetation, changed during the time the site was occupied, little attention had been paid to the effects this would have had on people's lives.

As both of these issues require a good understanding of highly localised environmental conditions, it was decided to use a combination of plant macrofossil and insect analysis based on samples taken from a number of locations around the site close to the archaeological material. This included several contiguous sequences of samples taken through the lake edge deposits in order to record the changing character of the environment through time, as well as shorter sequences taken from discrete areas of archaeological activity. The results were correlated with the analyses carried out by Dark, and a programme of radiocarbon dating was undertaken to establish the chronology for the environmental sequences from the site (Chapter 17, Figures 17.22 and 17.23 and Table 17.6).

Sampling strategy

Insect and plant macrofossil analysis was carried out on samples taken from six locations during the excavations between 2010 and 2015 (Figure 19.1). Three profiles (VP85A/2010, CII/2010 and profile 3178) were recorded through the complete sequence of detrital muds and peats at the edge of the lake in order to define the character of the local environment throughout the period that Star Carr was occupied. Of these, two (VP85A/2010 and CII/2010) were analysed for both insects and plant macrofossils, whilst the third (P3178) was analysed for plant macrofossils only. A fourth profile (SC24) made up of non-contiguous samples from the sedimentary sequence in trench SC24, was analysed for insects.

Profile VP85A/2010 was recorded from samples taken from the west facing section of trench VP85A during the 2010 excavation. It lies immediately adjacent to Dark's profile M1 and includes deposits adjacent to the central platform. CII/2010 was recorded from samples taken from the east facing section of Clark's cutting II in 2010. The western platform runs through the deposits sampled by this profile, and flint deposited during later episodes of activity at the site were recorded on either side of the sampling point. Profile 3178 was recorded from the samples taken from the north-facing section of trench 34 during the 2014 excavation. The deposits sampled by this profile include part of the detrital wood scatter and associated faunal material.

A series of partial plant macrofossil profiles were recorded in order to establish the environmental context of particular assemblages of material. Profile 3052 was recorded from samples taken during the excavation of the baulk between Clark's cutting I and II and provides contextual information for the large assemblage of bone and antler artefacts recorded in this area. Profile SC33/2010 (insects and plant macrofossils) was taken from samples adjacent to a scatter of worked flint recorded in trench SC33, whilst profile 3356 was recorded from sediments closer to the edge of the Early Mesolithic wetland, in order to establish the context of several discrete scatters of flint and a red deer antler frontlet <113901>.

Plant macrofossil analysis

Methodology

All of the profiles were derived from a contiguous sequence of samples 25–50 mm thick taken during the excavations. These were subsampled in the laboratory (50 ml), and disaggregated by boiling in a 10% solution of sodium hydroxide. The material was then washed through nested sieves (2 mm–125 microns) and examined under a Nikon SMZ45T stereo microscope at $\times 10$ – $\times 40$ magnification. Material from the 2 mm–250 micron sieves that could be identified to a taxonomic level (typically seeds, fruits, nuts/nutlets, oospores and catkin bud scales) were counted, with the exception of moss stems and water lily seed fragments (see below). The results were quantified and displayed using the C2 data analysis software (Juggins 2010).

Small fragments of water-lily seed, indeterminate aquatic plant tissue, fern sporangia and any highly fragmented but identifiable plant macrofossils, were quantified on a scale of relative abundance (0=absent, 1=sparse, 2=present, 3=abundant).

Description of the results

The three complete profiles (VP85A/2010, CII/2010 and profile 3178) show a very similar pattern in terms of the range and quantities of plant macrofossils, and how these change over time. These have been divided into three main environmental/chronological zones on the basis of the changing composition of the assemblages. The partial profile recorded from samples taken during the excavation of the baulk between Clark's cuttings I and II (profile 3205) matches very closely the pattern observed in the lower half of the other three profiles (corresponding to Zone 1 and the base of Zone 2). Given their similarity, these profiles will be discussed together (Figures 19.2–19.4).

Zone 1

The basal samples contain plant macrofossils from a range of aquatic, emergent and terrestrial plant species. This is indicative of a lake edge location where the remains of plants growing in situ have become mixed with material that has washed in from other parts of the lake or has been transported from vegetation growing on the nearby lake shore.

At the sampling points, reeds were growing in standing water, given the consistent presence of aquatic plant and bryozoan macrofossils and the high proportion of *Phragmites* sp. leaf and rhizome within the matrix of the peat. This was presumably common reed (*Phragmites australis*) as this is the only native species (Haslam 1972). A diverse range of emergent species were also present in the surrounding area, notably sedge (*Carex*), including greater tussock edge (*C. paniculata*), species of bulrush (*Typha* sp.) and bur-reed (*Sparganium* sp.), club-rush (*Schoenoplectus lacustris*) and bogbean (*Menyanthes trifoliata*). With the exception of club-rush and bur-reed, these all occur consistently in each of the profiles and the plants were probably growing at the site itself.

Aquatic material is also well represented. Of this, the oospores of the aquatic algae stonewort (Characeae) and seeds of the floating aquatic plants white and yellow water-lily (*Nymphaea alba* and *Nuphar lutea*) are known to be highly dispersive, and the parent plants may have been growing some distance from the sampling points (Zhao et al. 2006; Koff and Vandel 2008). In contrast, species of pondweed (*Potamogeton* sp.), which are well represented in all three profiles, were probably growing more locally, as their seeds sink quickly and tend not to travel far from their source (Koff and Vandel 2008). The statoblasts of *Cristatella*, a freshwater bryozoan, may also have derived from communities growing close by, as the submerged stems of emergent plants form one of its principal habitats (e.g. Wood 2001, 501).

The source of the arboreal plant macrofossils is also likely to be local, indicating both the proximity of the sampling points to the shore, and the presence of birch (*Betula* sp.), which from the fruits was predominately white or downy birch (*B. pubescens*), species of poplar (*Populus* sp.), probably aspen (*P. tremula*) on the basis of the catkin scales, and to a lesser extent willow (*Salix* sp.) at the water's edge. Bud scales of birch have a limited dispersal, and their occurrence as macrofossils has been shown to reflect the nearby presence of this tree (Gretex 1983, 775, 784). This is probably also true of the large bud scales of poplar. Furthermore, the consistent

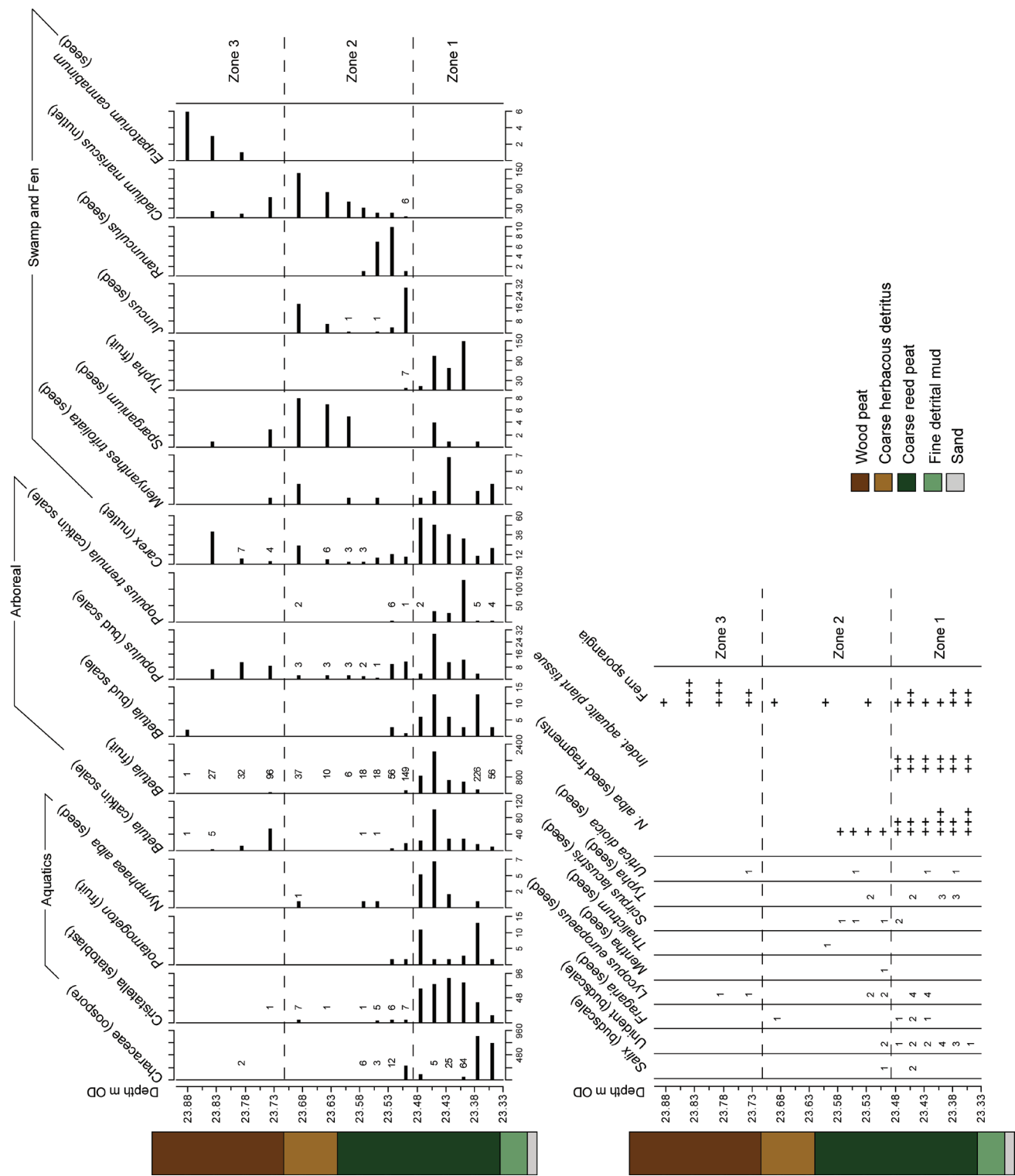


Figure 19.2: Plant macrofossils from profile VP85A/2010 (Adapted from Taylor et al. 2017. Copyright Cambridge University Press (2017) reprinted with permission).

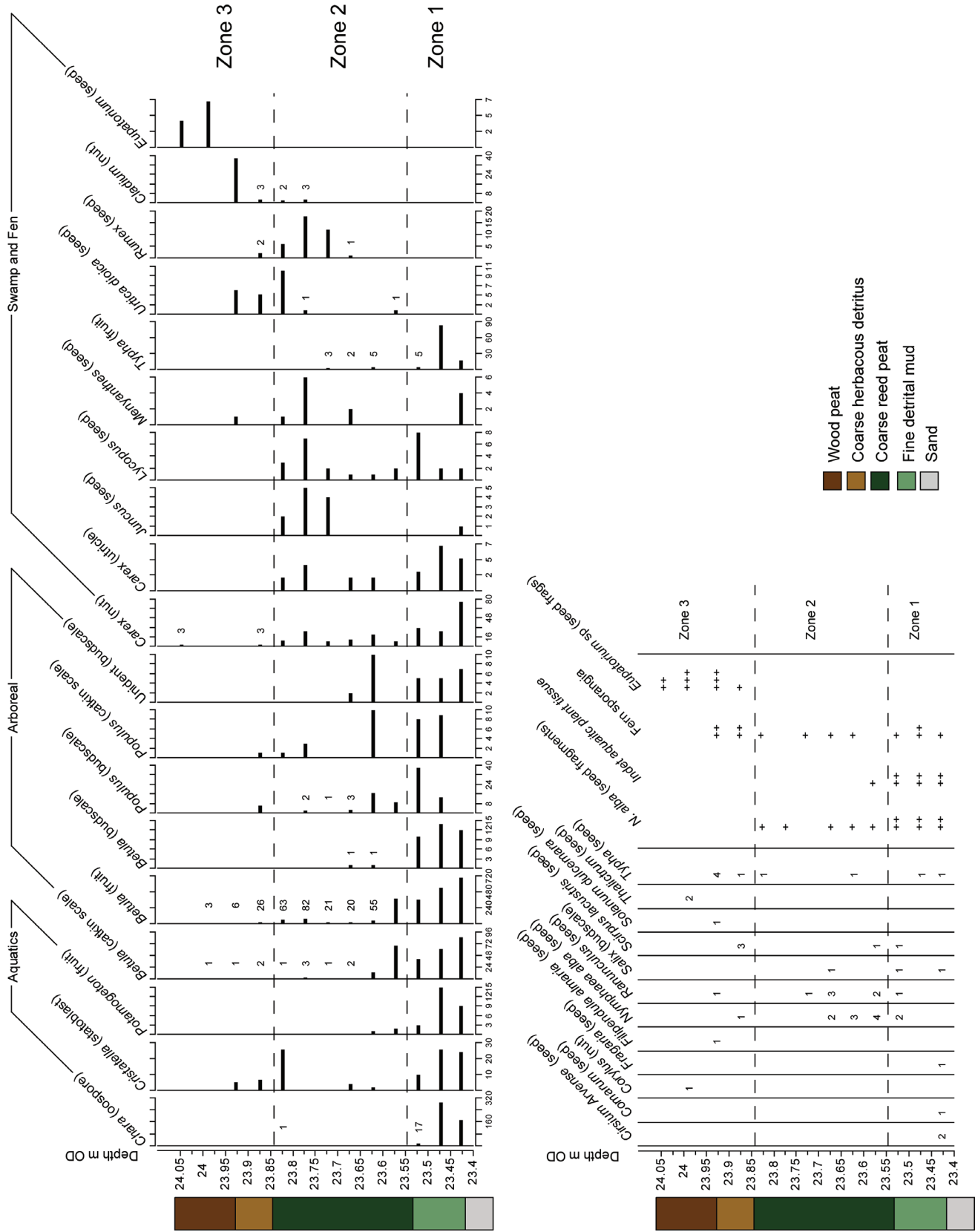


Figure 19.3: Plant macrofossils from profile CII/2010 (Adapted from Taylor et al. 2017. Copyright Cambridge University Press (2017) reprinted with permission).

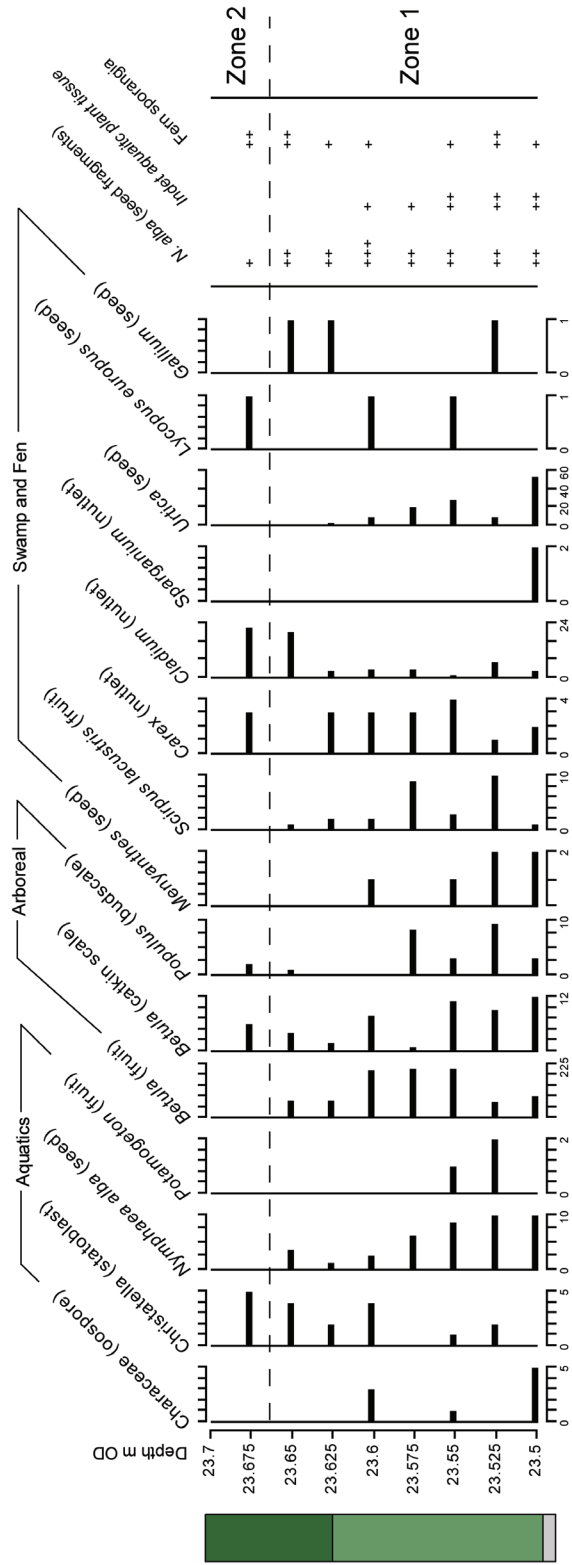
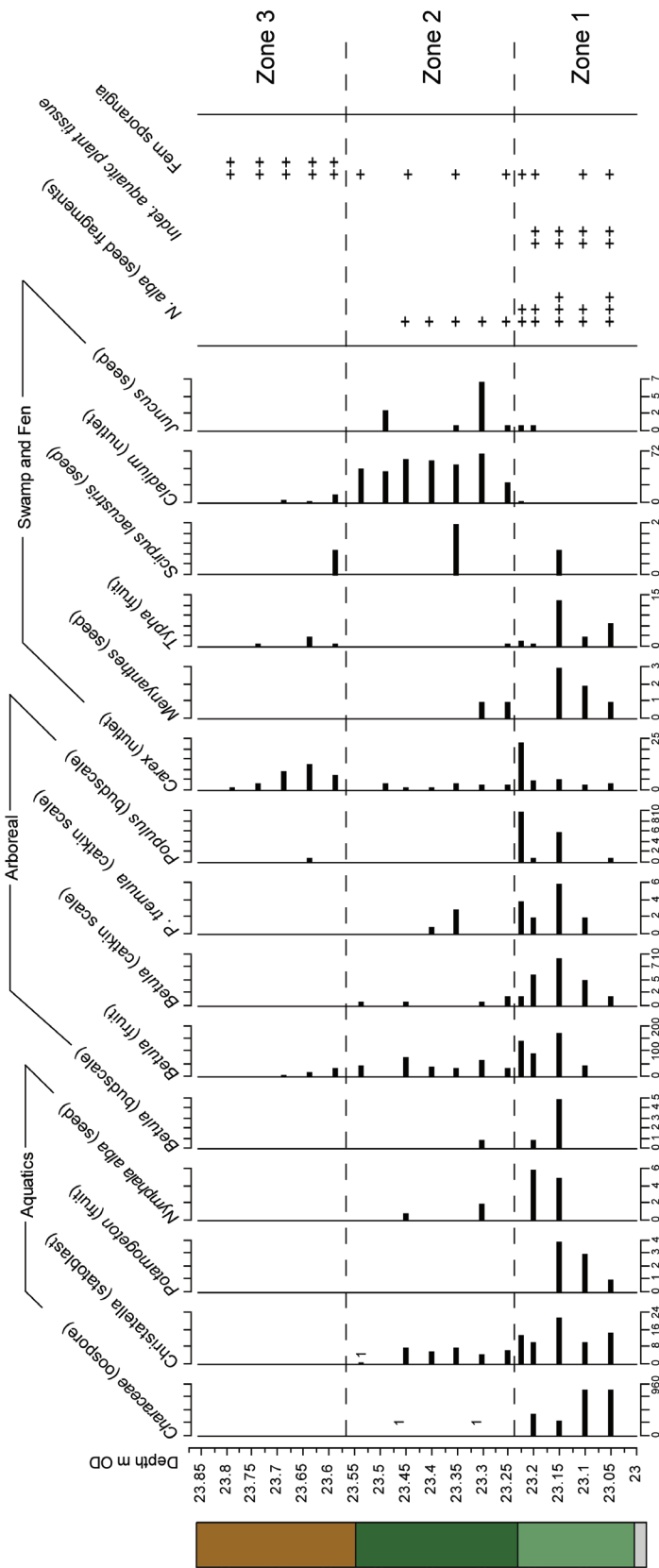


Figure 19.4: Plant macrofossils from profile P3178 (left) and P3502 (right) (Adapted from Taylor et al. 2017. Copyright Cambridge University Press (2017) reprinted with permission).

occurrence of leaf and bark fragments within the sample matrix, and roundwood within the peat suggests that shrubs or trees were present nearby, and that their branches extended out over the water. Other terrestrial or fen species are much more poorly represented, reflecting the more limited dispersal of their seeds. The exception is nettle (*Urtica dioica*), which occurs consistently in P3502, and was probably present on the adjacent shore. Gypsywort (*Lycopus europaeus*), a wetland plant suited to lake edges, may also have been growing locally given its sporadic occurrence in all of the profiles.

Zone 2

The start of the second zone is marked by a reduction in the quantity of aquatic plant and bryozoan macrofossils, which then occur more sporadically and in lower quantities than before. This can be seen most clearly in VP85A/2010, where there is a simultaneous decline in the number of *Cristatella* statoblasts, and the abundance of water-lily seed fragments and aquatic plant material at 23.5 m OD, after which there is an overall reduction in the quantity of aquatic material. A similar pattern can be seen in CII/2010 and P3178, and to a lesser extent P3502 where the fall in the abundance of water-lily seed fragments occurs around the same time as a reduction in the overall number of aquatic material.

This does not reflect a decline in the overall abundance of these species within the lake, as they are all well represented in contemporary deposits in other parts of the basin (e.g. Taylor 2011; 2012). Instead, it suggests a shift to a shallower environment, due to either a fall in lake level, the accumulation of sediments or a combination of the two. This reduced the amount of material being transported onto the site, and limited the local growth of aquatic communities (particularly in the case of *Cristatella*). More tentatively, it could mark the point where deposits went from being permanently to seasonally submerged.

The number and range of wetland and terrestrial plant macrofossils also changes from the start of this zone, with the remains of the emergent plants sedge, bogbean, and bulrush, the arboreal species birch and poplar, and nettles all becoming more sparse. Given that these plants are suited to different habitats, and that their decline corresponds with the fall in aquatic material, this is probably the result of the lower volume of material being transported to the sampling points by water and the reduced source area of the samples. That said, it is possible that some of the plants, particularly those that prefer to grow in deeper water, may have moved further from the lake edge. The exception is the emergent plant saw-sedge (*Cladium mariscus*), which increases in VP85A/2010 and profile 3178, and at the top of profile 3205. As this rise occurs at the same stratigraphic position in three of the four profiles, it probably reflects the local growth of the plant across the site. Common reed was also growing in the local area, as its tissue continued to be recorded within the coarse component of the peat.

Zone 3

The absence of aquatic material, including water-lily seed fragments from the matrix of the peat, and the paucity of aquatic plant macrofossils from the samples marks the point where the deposits began to form above the level of the lake. This would have further reduced the source area of the profiles, leading to the lower range and number of plant macrofossils present in the samples. Based on the composition of the peat, herbaceous plants were growing at all of the sampling points, whilst the increase in sporangia reflects the local growth of ferns. Seeds of the fen plant hemp agrimony (*Eupatorium cannabinum*) also occur in all three of profiles, albeit in very small numbers, suggesting its presence within the local area.

Profile SC33/2010

Only a small number of samples were analysed from this trench, with the aim of establishing the environmental context of a scatter of lithic material. As such, they have not been divided into environmental zones in the same way as the more complete profiles (Figure 19.5).

Within the lower samples (between 23.63 m and 23.73 m OD) aquatic, terrestrial and emergent taxa was well represented. Aquatic material occurred as both complete plant macrofossils (water-lily seeds, pondweed fruits), and statoblasts of *Cristatella*, and as fragmentary plant material within the sample matrix, and its presence suggests that the lake water was reaching the area as the deposits were forming. Common reed stems formed much of the coarse component of the peat and probably reflect the local growth of the plant. However,

Height m OD VP85A	Height m OD CII	Height m OD P3178	Height m OD P3178	Description
	23.37–23.42	22.98–23.0	23.48–23.50	Coarse sand with a high proportion of fine detrital mud. (Context 320)
23.29–23.35	23.42–23.56	23.00–23.24	23.50–23.62	Fine detrital mud with a high coarse component of monocot stem/leaf (inc. <i>Phragmites cf. australis</i>) and unidentifiable herbaceous material, with smaller quantities of round wood. (Context 317)
23.35–23.61	23.56–23.87	23.24–23.54	23.62–23.72	Coarse reed peat of horizontally bedded monocot stem/leaf (inc. <i>Phragmites cf. australis</i>) and unidentifiable herbaceous material. Levels of preservation deteriorated in the upper half of the deposit and the quantity of unidentifiable herbaceous material increased. Large quantities of roundwood were recorded in the lower half of this deposit in cutting II. (Context 312)
23.61–23.71	23.87–23.96	23.54–23.85	Not present	Coarse herbaceous detritus made up of unidentifiable herbaceous plant material (some forming thin layers and including <i>Phragmites cf. australis</i> stem/leaf), <i>Cladium mariscus</i> rhizomes, and smaller quantities of woody detritus and aerial round wood. (Context 312)
23.71–23.93	23.96–24.09	Not present	Not present	Coarse wood peat made up of horizontally bedded aerial round wood and root wood, unidentifiable woody detritus and smaller quantities of unidentifiable herbaceous material. (Context 310)

Table 19.1: Sediment descriptions for profiles VP85A/2010, CII/2010, P3178 and P3502 and the corresponding archaeological context. The reed peat and the overlying coarse herbaceous detritus both correspond with context (312).

sedges were also present at the site given the high numbers of nutlets. The terrestrial material is dominated by arboreal taxa, reflecting the presence of birch and poplar (probably aspen) at the nearby shore.

Above 23.73 m OD, aquatic material was only present in the form of water-lily seed fragments within the peat matrix, which disappeared in the uppermost sample (23.78–23.82 m OD). Arguably, this decline began in the lower samples, as both the quantity and range of aquatic material fell after 23.68 m OD. This is likely to reflect a gradual reduction in the volume of water reaching the area, after which the deposits began to form above the level of the lake (from 23.78 m OD). Common reed continued to be recorded within the peat and was probably still growing in the immediate area, though a range of other emergent and fen plants, notably bogbean, gypsywort and a species of meadow-rue (*Thalictrum* sp.) were present in the wider area. The rise in sporangia in the upper sample may reflect the local growth of ferns.

Profile 3356

A short sequence of samples was taken through sediments close to a red deer antler frontlet and several caches of flint. The sediments were highly humified and plant macrofossil preservation was extremely poor. Given the small quantities of material present, this profile has not been tabulated and the results will simply be described.

The basal samples (spanning a depth of 0.1 m) contained a small assemblage of very poorly preserved aquatic and arboreal plant macrofossils (pondweed fruits and birch catkin scales and fruits respectively), sedge nutlets, and very large numbers (over 1700) of rush (*Juncus* sp.) seeds. Though the preservation of the material was generally poor, making a full interpretation difficult, these deposits are likely to have been forming below the level of the lake, with rushes growing in the area.

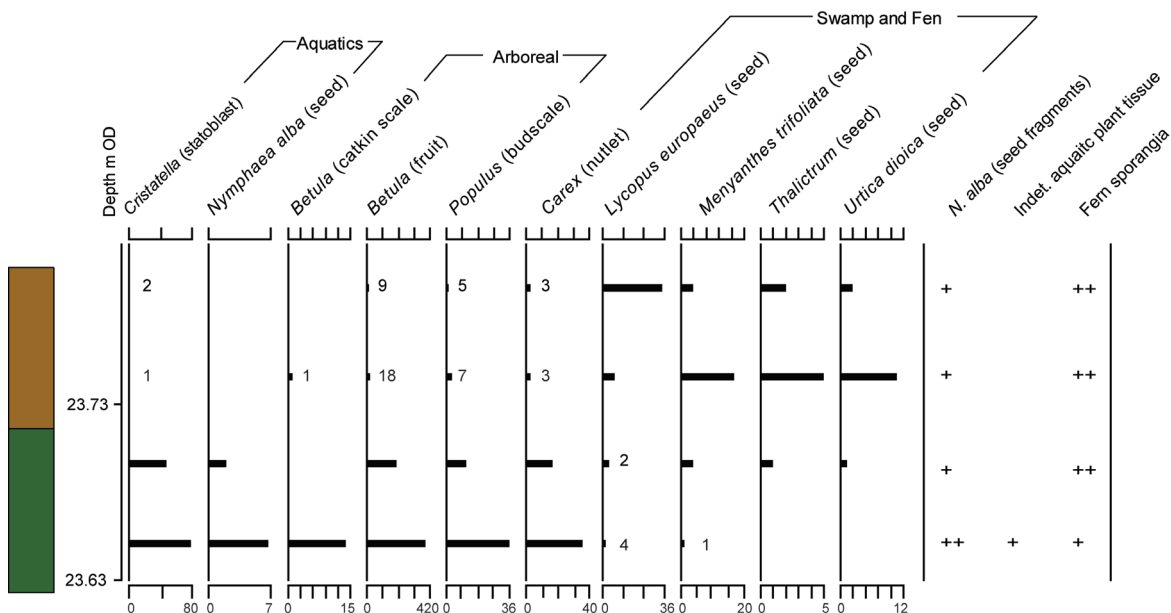


Figure 19.5: Plant macrofossils from profile SC33/2010 (Copyright Star Carr Project, CC BY-NC 4.0).

Above this, both the quantities and preservation of material declined sharply. Aquatic material was absent; birch catkin scales and sedge nutlets occurred occasionally. Given the decline in preservation it is difficult to tell the nature of the environment that these deposits formed in.

Comparison with Dark's environmental profiles

Plant macrofossil analysis was carried out by Dark on samples from V85A (profiles M1-3) and from the core taken adjacent to Clark's cutting II (Clark Site profile) (Dark 1998b). The samples were taken primarily for the analysis of macro-charcoal and in some cases were based on relatively small volumes of material (see Dark 1998a, 116). It should be noted that the levels (in metres OD) cited in Dark (1998b) are incorrect, and that the following discussion will refer to the corrected levels that are based on surveys carried out during the current programme of fieldwork.

Plant macrofossil profile M1

This profile lay immediately adjacent to profile VP85A/2010 and sampled the same deposits. However, whilst the results should be closely comparable there is considerable divergence. The basal samples of Dark's profile show a similar pattern to Zone 1 in VP85A/2010, with both aquatic and arboreal material well represented. However, above a level of 23.49 m OD (Dark's Zone M1-2 and above), the two profiles diverge; aquatic material disappears from M1 earlier than it does in VP85A/2010, whilst sedge occurs more sporadically, and saw-sedge appeared much later and had a more limited distribution. Given the proximity of the two profiles this cannot be the product of taphonomy or differences in patterns of vegetation. Instead, as the profiles diverge at the point where the overall number of plant macrofossil declines, it is likely to be a product of the smaller sample size recorded by Dark, with the assemblage significantly under-represented in profile M1.

Plant macrofossil profiles M2-3

Again, these profiles were based on a smaller sample size, and some material may be under-represented. That said, a comparable range of plant species were present, including the aquatic plant pondweed, and the emergent

plants sedge, bogbean, and (to a lesser extent) saw-sedge in M2, and the fen plant hemp-agrimony in the upper half of M3.

Dark's Clark Site profile

This profile lay just over 6 m south of CII/2010 and 28 m west of VP85A/2010 and was based on a larger sample volume than the other profiles recorded by Dark. Broadly speaking, it shows a far greater similarity with the profiles recorded as part of this project, both in terms of the range of plants represented and their changing quantities. The basal samples show relatively high levels of aquatic, emergent and arboreal plant macrofossils, all of which subsequently decline, after which saw-sedge becomes more abundant. As the aquatic material disappears towards the top of the profile the range of plant macrofossils declines further.

Dark's pollen profile M1

Broadly speaking, the results of Dark's pollen analysis and the plant macrofossils from VP85A/2010 compare well, with each detecting a range of emergent, aquatic and terrestrial flora. The records for emergent vegetation compare particularly well, with the high Poaceae pollen values corresponding with the abundance of common reed stem and leaf in the peat, whilst the occurrence of the pollen of bulrush (*Typha latifolia*), would suggest that this is the source of the bur-reed fruits recorded in the plant macrofossil profiles. Similarly, the increase and decline in Cyperaceae pollen (Dark's zone M1-3) matches that of the saw-sedge nutlets in Zone 2, again suggesting that both profiles are recording the same local patterns of vegetation. The short-term increase in marsh fern spores in Dark's Zone M1-2b is not matched by any change in the occurrence of sporangia, and the plant was probably not growing around the sampling point.

However, the more substantial rise in its spores in the upper half of the profile occurs at roughly the same time as the increase in sporangia and probably reflects the expansion of the plant across this part of the site. Unsurprisingly, terrestrial flora is better represented in the pollen profile, reflecting its wider source area. Of the arboreal species, birch is well represented in both profiles and shows a broadly similar pattern of abundance. The lack of aspen in Dark's profile may be an issue of taphonomy, as its pollen is known to survive very poorly and the species is often better represented as a plant macrofossil (Dark 1998a). However, the low levels of willow macrofossils in relation to the pollen cannot be explained in this way and suggest that either the tree was not close enough to the shore for material to be deposited into the peat or that its macrofossils were not recognised.

Insect analysis

Methodology

Sub-samples with weights of up to 1 kilogram were processed in the Archaeology Department, University of York. Each was washed onto 0.3 mm mesh and paraffin flotation was carried out to extract insect remains broadly following the methods of Kenward et al. (1980). The peats were rather intractable and processing was carried out as gently as possible to avoid damaging delicate organic remains which resulted in the incomplete disaggregation of some material. The paraffin flots were initially stored in water but subsequently transferred to jars of industrial methylated spirits. Scanning was carried out using a low-power binocular microscope ($\times 10$ – $\times 45$) and remains of beetles (Coleoptera) and bugs (Hemiptera) were removed onto damp filter paper for examination. The state of preservation of remains was recorded using the system of Kenward and Large (1998) where fragmentation (F) and erosion (E) are scored on a scale from 0.5 (superb) to 5.5 (extremely decayed or fragmented). Identification was by comparison with modern material and reference to standard published works. Ecological groups used in analysis are based on those of Kenward et al. (1986) and Kenward (1997). Proportions of aquatics in each sample have been calculated as percentages of the whole assemblage while proportions of all other groups, including wetland/waterside taxa, have been calculated as percentages of the terrestrial fauna. Nomenclature follows Duff (2012) for Coleoptera, Aukema and Rieger (1995–2006) for Heteroptera and Wilson et al. (2015) for Homoptera. Other invertebrate remains were recorded semi-quantitatively as present, common or abundant.

Description of the results

Taxa recorded from the main three sequences are listed in Table 19.2; hosts of plant and tree associated species are shown in Table 19.3.

The uppermost samples from VP85A/2010, CII/2010 and SC24 produced few identifiable remains (corresponding to plant macrofossil Zone 3). The insect assemblages from lower in the sequences (corresponding to plant macrofossil Zones 1 and 2) all show a similar pattern in terms of the species that are present and their distribution throughout the profiles and will be discussed together (Figure 19.6).

Aquatic insects account for between 10% and 32% of the assemblages from individual samples and water-side and wetland taxa, for 18% to 49% of terrestrial taxa. Generally, the species present are indicative of still to slowly flowing, well-vegetated, swampy water margins, with some evidence of more open water from insects such as pond skaters (*Gerris*), which hunt their prey on the surface film. *Haliplus confinis*, found in base-rich waters where stoneworts (Characeae) are present, occurs throughout the profiles (though slightly sporadically in CII/2010 and SC24), as do *Cyphon* spp. and donaciine beetles, which are characteristic of swampy well-vegetated environments with standing water. Submerged vegetation within the lake is indicated by the leaf beetle *Donacia versicolore* found on pondweeds, while the weevil *Tanysphyrus lemnae* would have lived on duckweed (*Lemna*) growing on the water's surface. Other commonly recorded taxa found among aquatic vegetation in still water include *Hygrotus inaequalis* and the water bug *Microvelia*. Many of the aquatics are found in rather shallow water but *Hyphydrus ovatus* is typical of deep, richly vegetated, permanent, still-water bodies (Foster and Friday 2011, 106) which must have existed further from the sampling point.

There were consistent records of three species of riffle beetle (Elmidae) in the lower parts of CTII/2010 and VP85A/2010. Riffle beetles require clean, clear, well-oxygenated water and the species represented are typically found under stones in running water in streams and rivers or more rarely in stony lakes (Holland 1972). *Hydraena gracilis* (recorded from a single sample) is found in running water under stones or in moss upon them (Hansen 1987, 63). Although the basal substrate of the lake does include gravel and some larger boulders, much of this was covered by detrital mud and marl by the time these insects were deposited. It is possible that sands and gravels remained exposed further out in the lake, with the disappearance of riffle beetles higher in the sequences being a result of increased or wider accumulation of sediments. However, a more likely source for this group of insects might perhaps have been a small stream entering the lake close to the site.

A number of the insects recorded are associated with particular species of emergent and waterside vegetation. *Donacia obscura* found on Cyperaceae, especially sedges, occurs throughout much of the lower half of CII/2010 and VP85A/2010, and sedges are also indicated by the weevil *Limnobaris dolorosa*. *Donacia marginata* and *D. simplex* are both found on bur-reeds, *Prasocuris phellandrii* feeds on waterside Ranunculaceae, especially marsh marigold (*Caltha palustris*); the ladybird *Coccidula rufa* is usually associated with a growth of reeds (*Phragmites*), rushes and bulrush (Majerus 1994, 142); while waterside moss was indicated by *Hebrus* species. *Coelostoma orbiculare* (a typical fenland water beetle recorded throughout the sequences) is usually associated with mosses in rafts of floating vegetation and at water margins (Foster et al. 2014, 72). There were some indications of muddy conditions: *Elaphrus cupreus*, for example, is usually found on muddy, densely vegetated ground at the water's edge, and *Ilybius ater* occurs in stagnant water over vegetated mud or peat, typically at the very edges of ponds (Foster and Friday 2011, 55). *Dryops*, which lives in wet waterside mud, was recorded only from the upper half of VP85A/2010 and SC24/2010.

The assemblages also reflect the proximity of the sampling points to the drier ground beyond the water's edge, providing evidence for terrestrial habitats above the shore. A range of insects indicate that trees and/or shrubs grew close to the lake, in some places probably shading the water. *Elasmucha grisea* and *Oncopsis* cf. *tristis* are well represented in the lower samples in all three sequences, whilst *Elasmotethus interstictus* and *Kleidocerys resedae* occur more sporadically; all these bugs are associated with birch. Species of *Phratora*, which feed on willow and poplars, are also well represented (particularly *P. vitellinae* which occurred in most samples from SC24/2010). The occurrence of *Crepidodera* and *Chrysomela* (not *C. aenea*) throughout the profiles also reflects the presence of willows and/or poplars. The local growth of oak (*Quercus*) is hinted at by the presence of *Calosoma inquisitor* (identified from a partial elytron with distinctive asperities) in one of the lower samples from VP85A/2010. This arboreal ground beetle feeds on caterpillars associated with oaks (Luff 2007, 39), and the record tentatively suggests that the tree was present in the local landscape (though this remains to be confirmed through plant macrofossil analysis). Based on the occurrence of *Brachypterus* in the lower samples of

Thirty samples were examined; the number of samples in which each taxon occurred is shown in curved brackets. Nomenclature of beetles (Coleoptera) and bugs (Hemiptera) follows Duff (2012), Aukema and Rieger (1995–2006) and Wilson et al. (2015). Ecological codes are shown in square brackets as follows: d – damp ground/waterside; l – wood; m – heath/moorland; oa – outdoor taxa (unable to live and breed in buildings or accumulations of decomposing matter); ob – probable outdoor taxa; p – herbaceous plants; rd – dry decomposer; rf – foul decomposer; rt – eurytopic decomposer; sf – facultative synantropes; st – typical synanthropes; t – trees/scrub; u – uncoded; w – aquatic.

ANNELIDA

Oligochaeta sp. (earthworm) egg capsules (4)

CRUSTACEA

Cladocera spp. (water flea) ephippia (9)

INSECTA

DERMAPTERA (earwigs)

Dermaptera sp. (2)

HEMIPTERA: HETEROPTERA (true bugs)

Elasmostethus interstictus (Linnaeus) [oa-t] (2)

Elasmucha grisea (Linnaeus) [oa-t] (14)

Sehirus sp. [oa-p] (4)

Cydnidae sp. [oa-p] (3)

Pentatomoidea sp. and sp. indet. [oa] (11)

Anthocoris sp. [oa-p] (3)

Temnostethus gracilis Horvath [oa-t] (3)

Cymus sp. [oa-p] (1)

Drymus sylvaticus (Fabricius) [oa-p] (3)

Drymus sylvaticus or *ryei* [oa-p] (3)

Drymus sp. indet. [oa-p] (3)

Ischnodemus sabuleti (Fallén) [oa-p] (1)

Kleidocerys resedae (Panzer) [oa-t] (2)

Peritrechus geniculatus (Hahn) [oa-p] (1)

Scolopostethus decoratus (Hahn) [oa-p-m] (1)

Stygnocoris sabulosus (Schilling) [oa-p] (6)

Stygnocoris sp. [oa-p] (2)

?*Stygnocoris* sp. [oa-p] (1)

Trapezonotus sp. [oa-p] (4)

Lygaeidae spp. and sp. indet. [oa-p] (13)

Mecomma ambulans Fallén [oa-p] (1)

Miridae sp. [u] (1)

Corixidae sp(p). [oa-w] (9)

Corixidae sp(p). nymphs (4)

Gerris sp. [oa-w] (13)

Hebrus pusillus (Fallén) [oa-p-d] (2)

Hebrus ?*pusillus* (Fallén) [oa-p-d] (2)

Hebrus ruficeps Thomson [oa-p-d] (7)

Hebrus sp. indet. [oa-p-d] (6)

Chartoscirta sp. [oa-d] (6)

Saldidae sp. indet. [oa-d] (3)

Microvelia sp. [oa-w] (12)

Heteroptera spp. and sp indet. [u] (10)

HEMIPTERA: HOMOPTERA (planthoppers etc)

?*Aphrophora* sp. [oa-p] (5)

Oncopsis cf. *tristis* (Zetterstedt) [oa-t] (7)

Delphacidae spp. [oa-p] (25)

Centrotus cornutus (Linnaeus) [oa-t] (1)

Auchenorhyncha/Fulgoromorpha spp. [oa-p] (23)

Strophingia ericae (Curtis) [oa-p-m] (3)

Psylloidea sp. [oa-p] (3)

TRICHOPTERA (caddis flies)

Trichoptera sp(p). wing fragments (7)

Trichoptera sp(p). larval fragments (8)

Trichoptera sp. larval cases (5)

DIPTERA (flies)

Bibionidae sp. leg spines and fragments (18)

?Bibionidae sp. puparia (2)

Hippoboscidae sp. puparia ?*Lipoptena cervi* (Linnaeus) (1)

Diptera spp. (1)

Diptera spp. puparia (16)

HYMENOPTERA (ants, wasps and bees)

Formicidae spp. (ants) (5)

Hymenoptera Aculeata spp. (10)

Hymenoptera Parasitica spp. (15)

COLEOPTERA

GYRINIDAE (whirligig beetles)

Gyrinus spp. [oa-w] (17)

HALIPLIDAE (crawling water beetles)

Haliplus confinis Stephens [oa-w] (14)

Haliplus ?*confinis* Stephens [oa-w] (5)

Haliplus (*Haliplus*) sp. [oa-w] (4)

Haliplus sp. [oa-w] (2)

NOTERIDAE (burrowing water beetles)

Noterus crassicornis (Müller) [oa-w] (1)

Noterus sp. indet. [oa-w] (10)

DYTISCIDAE (predaceous diving beetles)

Agabus bipustulatus (Linnaeus) [oa-w] (3)

Agabus or *Ilybius* spp. [oa-w] (21)

Ilybius ater (De Geer) [oa-w] (10)

Colymbetes fuscus (Linnaeus) [oa-w] (1)

Rhantus sp. [oa-w] (8)

Acilius sp. [oa-w] (2)

Hygrotus inaequalis (Fabricius) [oa-w] (11)

Hygrotus sp. indet. [oa-w] (3)

Hyphydrus ovatus (Linnaeus) [oa-w] (3)

Hydroporinae spp. [oa-w] (18)

Dytiscidae spp. [oa-w] (7)

CARABIDAE (ground beetles)

Calosoma inquisitor (Linnaeus) [oa-t] (1)

Leistus sp. [oa] (1)

Notiophilus sp. [oa] (1)

Elahrus cupreus Duftschmid [oa-d] (4)

Trechus rivularis (Gyllenhal) [oa-d] (3)

Trechus obtusus or *quadristriatus* [oa] (4)

Trechus sp. indet. [oa] (2)

Ocys harpaloides (Audinet-Serville) [oa] (1)

Bembidion spp. [oa] (3)

Table 19.2: Continued

Pterostichus minor (Gyllenhal) [oa-d] (3)
Pterostichus nigrita or *rhaeticus* [oa-d] (3)
Pterostichus diligens (Sturm) [oa-d] (6)
Pterostichus strenuus (Panzer) [oa] (2)
Pterostichus diligens or *strenuus* [oa] (2)
Pterostichus sp. and sp. indet. [oa] (3)
Agonum cf. *fuliginosum* (Panzer) [oa-d] (1)
Agonum thoreyi Dejean [oa-d] (7)
Agonum sp(p). and sp. indet. [oa] (10)
Bradycellus ?*harpalinus* (Audinet-Seville) [oa] (1)
Harpalini sp. [oa] (1)
Paradromius linearis (Olivier) [oa] (1)
Odacantha melanura (Linnaeus) [oa-d] (2)
Carabidae spp. and sp. indet. [ob] (21)

HELOPHORIDAE (grooved water scavengers)
Helophorus sp. [oa-w] (1)

HYDROCHIDAE

Hydrochus brevis or *carinatus* [oa-w] (1)
Hydrochus sp. indet. [oa-w] (6)

HYDROPHILIDAE

Anacaena ?*limbata* (Fabricius) [oa-w] (4)
Anacaena sp. indet. [oa-w] (9)
Chaetarthria sp. [oa-d] (6)
Enochrus sp. [oa-w] (3)
Hydrobius fuscipes (Linnaeus) [oa-w] (21)
Laccobius sp. [oa-w] (6)
Hydrophilinae spp. [oa-w] (27)
Coelostoma orbiculare (Fabricius) [oa-w] (13)
Cercyon convexiusculus Stephens [oa-d] (6)
Cercyon ?*convexiusculus* Stephens [oa-d] (3)
Cercyon ?*sternalis* Sharp [oa-d] (2)
Cercyon tristis or *granarius* [oa-d] (1)
Cercyon convexiusculus/tristis group [oa-d] (14)
Cercyon sp. indet. [u] (5)
Megasternum concinnum (Marsham) [rt] (14)

HYDRAENIDAE

 (minute moss beetles)

Hydraena gracilis Germar [oa-w] (1)
Hydraena spp. [oa-w] (27)
Limnebius aluta Bedel [oa-w] (13)
Limnebius sp. [oa-w] (8)
Ochthebius minimus (Fabricius) [oa-w] (11)
Ochthebius cf. *minimus* (Fabricius) [oa-w] (8)
Ochthebius sp. indet. [oa-w] (4)
PTILIIDAE (featherwing beetles)
Ptenidium sp. [rt] (1)
Acrotrichis sp(p). [rt] (12)

LEIODIDAE

 (round fungus beetles)

Leiodidae spp. [u] (7)

SILPHIDAE

 (carrion beetles)

Silpha atrata Linnaeus [u] (3)
Silphidae sp. [u] (2)

STAPHYLINIDAE

 (rove beetles)

Acidota crenata (Fabricius) [oa] (2)
Acidota cruentata Mannerheim [oa] (13)
Acidota sp. [oa] (3)

Anthobium sp. [oa] (2)
Lesteva longoelytrata [oa-d] (1)
Lesteva sp. [oa-d] (1)
Olophrum spp. [oa] (2)
Eusphalerum minutum (Fabricius) [oa-d] (5)
Omalium sp. [rt] (1)
Omaliinae sp(p). [u] (13)
Megarthus sp. [rt] (3)
Metopsia clypeata (Müller) [rt] (3)
Proteinus sp. [rt] (1)
Arrhenopeplus tesserula (Curtis) [rt] (2)
Pselaphinae spp. [u] (19)
Mycetoporus spp. [u] (4)
Sepedophilus spp. [u] (3)
Tachinus rufipes (Linnaeus) [u] (2)
Tachinus spp. [u] (13)
Tachyporus sp. [u] (6)
Tachyporinae sp. [u] (1)
Aleocharinae spp. [u] (29)
Scaphisoma agaricinum (Linnaeus) [l] (1)
Scaphisoma boleti (Panzer) [l] (1)
Anotylus rugosus (Fabricius) [rt] (6)
Oxytelus laqueatus (Marsham) [rf] (1)
Aploderus caelatus (Gravenhorst) [rt] (1)
Bledius sp. [oa] (1)
Carpelimus sp(p). [u] (8)
Oxytelinae sp. [u] (1)
Stenus spp. [u] (29)
Euasthetus sp. [oa] (1)
Lathrobium sp. [u] (10)
Ochtheophilum fracticorne (Paykull) [oa-d] (2)
Paederus sp. [oa-d] (3)
Rugilus sp. [rt] (4)
Paederinae sp. [u] (1)
Erichsonius cinerascens (Gravenhorst) [oa-d] (5)
Erichsonius sp. indet. [oa] (2)
Neobisnius sp. [u] (2)
Xantholinus linearis or *longiventris* [rt-sf] (1)
Xantholinini sp. [u] (2)
Staphylininae spp. [u] (23)

LUCANIDAE

 (stag beetles)

Sinodendron cylindricum (Linnaeus) [l] (4)
? *Sinodendron cylindricum* (Linnaeus) [l] (1)

GEOTRUPIDAE

 (earth-boring dung beetles)

Geotrupes sp. s.l. [oa-rf] (10)

SCARABAEIDAE

 (dung beetles and chafers)

Aphodius spp. [ob-rf] (8)
Euheptaulacus villosus (Gyllenhal) [oa] (5)
Euheptaulacus sp. indet. [oa] (2)
Serica brunnea (Linnaeus) [oa-p] (22)
? *Scarabaeoidea* sp. [u] (1)

SCIRTIDAE

 (marsh beetles)

Microcara testacea (Linnaeus) [oa-d] (2)
Cyphon padi (Linnaeus) [oa-d] (21)
Cyphon spp. and sp. indet. [oa-d] (30)

DASCILLIDAE

 (orchid beetles)

Dascillus cervinus (Linnaeus) [oa-p] (1)

BYRRHIDAE (pill beetles)

Simplocaria sp. [oa-p] (1)

Cytilus sericeus (Forster) [oa-p-m] (1)

Byrrhus sp. [oa-p] (2)

Byrrhidae sp. [u] 91)

ELMIDAE (riffle beetles)

Esolus or *Normandia* [oa-w] (6)

Limnius volkmari (Panzer) [oa-w] (1)

Oulimnius sp. [oa-w] (3)

Elmidae sp. indet. [oa-w] (1)

DRYOPIDAE (long-toed water beetles)

Dryops sp. [oa-d] (4)

HETEROCERIDAE (mud beetles)

Heterocerus sp. [oa-d] (2)

ELATERIDAE (click beetles)

Denticollis linearis (Linnaeus) [u] (3)

?*Agriotes* sp. [oa-p] (2)

Dalopius marginatus (Linnaeus) [oa-t] (21)

Elateridae spp. [ob] (19)

CANTHARIDAE (soldier beetles)

Cantharis sp. [ob] (1)

Cantharidae sp. [ob] (3)

PTINIDAE (woodworm and spider beetles)

Ptilinus pectinicornis (Linnaeus) [l-sf] (4)

Dorcatoma ?dresdensis Herbst [l] (2)

DASYTIDAE (soft-winged flower beetles)

Dasytes sp. [l] (4)

SPHINDIDAE

Aspidiphorus orbiculatus (Gyllenhal) [oa] (3)

KATERETIDAE (short-winged flower beetles)

Brachypterus sp. [oa-p] (7)

NITIDULIDAE (sap and pollen beetles)

Epuraea sp. [u] (1)

Glischrochilus sp. [u] (1)

Nitidulidae sp. [u] (6)

SILVANIDAE (flat bark beetles)

Silvanus sp. [l-t] (1)

Silvanidae sp. [l-t] (1)

LAEMOPHLOEIDAE (lined flat bark beetles)

Cryptolestes sp. [u] (1)

PHALACRIDAE

Phalacridae sp(p). [oa-p] (3)

CRYPTOPHAGIDAE (silken fungus beetles)

Cryptophagus spp. [rd-sf] (2)

?*Micrambe* sp. [u] (1)

Atomaria spp. [rd] (5)

?*Atomaria* sp. [rd] (2)

Cryptophagidae sp(p). [u] (6)

CERYLONIDAE

Cerylon ferrugineum Stephens [l-t] (2)

Cerylon sp. and sp. indet. [l-t] (8)

COCCINELLIDAE (ladybirds)

Coccidula rufa (Herbst) [oa-p-d] (11)

Scymnus sp. [oa-p] (3)

Chilocorus bipustulatus (Linnaeus) [oa-p-m] (9)

Coccinella undecimpunctatus Linnaeus [oa-p] (2)

Coccinellidae sp. [oa-p] (3)

CORYLOPHIDAE

Orthoperus sp. [rt] (1)

Corylophidae sp. [rt] (10)

LATRIDIIDAE (minute brown scavenger beetles)

Latridius minutus group [rt-st] (6)

Corticaria sp. [rt-sf] (4)

Corticariinae spp. [rt] (21)

Latridiidae sp. [u] (1)

MYCETOPHAGIDAE (hairy fungus beetles)

Pseudotriphyllus suturalis (Fabricius) [l] (1)

Litargus connexus (Geoffroy) [l] (1)

CIIDAE (minute tree fungus beetles)

Ciidae spp. [l-t] (2)

?Ciidae sp. [l-t] (1)

SALPINGIDAE

Salpingus planirostris (Fabricius) [l-t] (1)

Salpingus sp. indet. [l-t] (3)

?Salpingidae sp. [l-t] (2)

ANTHICIDAE (ant-like flower beetles)

Omonadus sp. [rt] (1)

SCRAPTIDAE (false flower beetles)

Scraptidae sp. [u] (5)

CERAMBYCIDAE (longhorns)

Rhagium mordax (De Geer) [l] [l-t] (1)

Grammoptera sp. [l-t] (1)

Pogonocherus hispidus (Linnaeus) [l-t] (1)

Cerambycidae sp. [l-t] (1)

CHRYSOMELIDAE (leaf and seed beetles)

Bruchinae sp. [u] (1)

Macrolea sp. [oa-p-w] (2)

Donacia cinerea Herbst [oa-p-d] (1)

Donacia marginata Hoppe [oa-p-d] ((5)

Donacia obscura Gyllenhal [oa-p-d] (11)

Donacia semicuprea Panzer [oa-p-d] (1)

Donacia simplex Fabricius [oa-p-d] (4)

Donacia versicolore (Brahm) [oa-p-d] (2)

Donacia ?versicolore (Brahm) [oa-p-d] (1)

Donacia spp. and sp. indet. [oa-p-d] (13)

Plateumaris discolor (Panzer) [oa-p-d] (1)

Plateumaris ?discolor (Panzer) [oa-p-d] (2)

Plateumaris sericea (Linnaeus) [oa-p-d] (1)

Plateumaris sp. [oa-p-d] (3)

?*Plateumaris* sp. [oa-p-d] (2)

Plateumaris or *Donacia* sp(p). [oa-p-d] (20)

Table 19.2: *Continued*

Lema or *Oulema* sp. [oa-p] (1)
Bromius obscurus (Linnaeus) [oa-p] (12)
Chrysolina fastuosa (Scopoli) [oa-p] (1)
Prasocuris phellandrii (Linnaeus) [oa-p-d] (7)
 ?*Chrysomela populi* Linnaeus [oa-t] (1)
Chrysomela sp. (not *aenea*) [oa-t] (8)
Phratora laticollis Suffrian [oa-t] (1)
Phratora vitellinae (Linnaeus) [oa-t] (8)
Phratora ?*vitellinae* (Linnaeus) [oa-t] (1)
Phratora vulgatissima (Linnaeus) [oa-t] (3)
Phratora sp. indet. [oa-t] (4)
 ?*Phratora* sp. indet. [oa-t] (2)
Chrysomelinae sp(p). [oa-p] (6)
Galerucella sp. [oa-p] (6)
Galeruca tanaceti (Linnaeus) [oa-p] (2)
Lochmaea caprea (Linnaeus) [oa-t] (1)
Galerucinae sp. indet. [oa-p] (3)
Phyllotreta nemorum group [oa-p] (1)
Altica sp. [oa-p] (1)
Crepidodera spp. [oa-p] (9)
Sphaeroderma ?*testaceum* (Fabricius) [oa-p] (2)
Alticini spp. [oa-p] (3)
Chrysomelidae spp. [oa-p] 16)

RHYNCHITIDAE (tooth-nosed snout weevils)

Rhynchitidae sp. [oa-p] (1)

APIONIDAE (seed weevils)

Oxystoma sp. [oa-p] (1)

Apionidae spp. [oa-p] (17)

ERIRHINIDAE (wetland weevils)

?*Notaris acridulus* (Linnaeus) [oa-p-d] (1)

?*Thryogenes* sp. [oa-p-d] (1)

Tanysphyrus lemnae (Paykull) [oa-p-w] (10)

CURCULIONIDAE (weevils)

Anthonomus sp. [oa-p] (2)

Gymnetron/Mecinus sp. [oa-p] (2)

Isochnus ?*foliorum* (Müller) [oa-t] (8)

?*Rhamphus* sp. [oa-t] (2)

Bagous sp. [oa-p-w] (1)

Limnobaris dolorosa (Goeze) [oa-p-d] (2)

Limnobaris sp. indet. [oa-p-d] (5)

Ceutorhynchus contractus (Marsham) [oa-p] (2)

Ceutorhynchus ?*contractus* (Marsham) [oa-p] (1)

Micrelus ericae (Gyllenhal) [oa-p-m] (4)

Nedus quadrimaculatus (Linnaeus) [oa-p] (2)

Rhinoncus sp. [oa-p] (1)

Ceutorhynchinae spp. [oa-p] (14)

?*Cossonus linearis* (Fabricius) [l] (1)

Cossoninae sp. [l] (1)

Phyllobius ?*argentatus* Linnaeus) [oa-p] (1)

Phyllobius roboretanus or *viridicollis* [oa-p] (4)

Phyllobius sp. [oa-p] (8)

Polydrusus pterygomalis Boheman [oa-t] (8)

Phyllobius or *Polydrusus* sp(p). [oa-p] (5)

Sitona sp. [oa-p] (3)

?*Sitona* sp. [oa-p] (2)

Tropiphorus sp. [oa-p] (1)

Scolytus rugulosus (Müller) [l-t] (1)

Taphrorhynchus sp. [l-t] (2)

Scolytinae sp. [l-t] (1)

Curculionidae spp. and sp. indet. [oa-p] (26)

Coleoptera spp. and spp. indet. [u] (29)

Insecta spp. larval fragments (22)

ARACHNIDA

Acarina spp. (mites) (28)

Aranae spp. (spiders) (4)

Pseudoscorpiones sp. (pseudoscorpions) (1)

BRYOZOA

Cristatella mucedo Cuvier statoblast

Table 19.2: Insects and other invertebrates from profiles VP85a/2010, CTII/2010 and SC24.

Species	Food and habitat preferences
<i>Elasmotethus interstictus</i>	Main food is birch
<i>Elasmucha grisea</i>	Associated with birch and birchwoods
<i>Ischnodemus sabuleti</i>	Hosts include reed-grass (<i>Phalaris</i>), tufted hair-grass (<i>Deschampsia cespitosa</i>) and reeds in marshes, in summer can be found in dry sunny fields
<i>Kleidocerys resedae</i>	On catkins of birch and alder
<i>Scolopostethus decoratus</i>	On heathland
<i>Temnostethus gracilis</i>	On the trunks and twigs of lichen encrusted deciduous trees, rocks or walls, feeding on bark lice and other small insects
<i>Oncopsis cf tristis</i>	Associated with birch
<i>Strophingia ericae</i>	On heathers (<i>Calluna vulgaris</i> and <i>Erica</i>)
<i>Calosoma inquisitor</i>	The adults are arboreal in oak woodland

Species	Food and habitat preferences
<i>Odacantha melanura</i>	Reed beds
<i>Serica brunnea</i>	The larvae feed at the roots of turf
<i>Dascillus cervinus</i>	The larvae feed at the roots of short vegetation
<i>Cytilus sericeus</i>	Mostly found on heaths and moorland in Britain
<i>Dalopius marginatus</i>	In wooded places or scrub
<i>Denticollis linearis</i>	Typically in woodland or scrub
<i>Aspidophorus orbiculatus</i>	On slime moulds
<i>Brachypterus</i> spp.	On nettles (<i>Urtica</i>)
<i>Coccidula rufa</i>	Principally on reeds (<i>Phragmites</i>), rushes (<i>Juncus</i>) and bulrushes (<i>Typha</i>) in wetland
<i>Chilocorus bipustulatus</i>	Heather heathland and conifer scrub
<i>Bruchinae</i> sp.	Associated with leguminous plants (Fabaceae)
<i>Macroplea</i> sp.	On submerged vegetation
<i>Donacia cinerea</i>	Adults usually found on bulrushes (<i>Typha</i>)
<i>Donacia marginata</i>	Found on branched bur-reed (<i>Sparganium erectum</i>)
<i>Donacia obscura</i>	Usually found on various Cyperaceae, especially bottle sedge (<i>Carex rostrata</i>)
<i>Donacia semicuprea</i>	Adults and larvae usually found on reed sweet grass (<i>Glyceria maxima</i>)
<i>Donacia simplex</i>	Adults eat the leaves of bur-reeds (<i>Sparganium</i>) which are probably also the larval food plant
<i>Donacia versicolore</i>	Adults and larvae usually on pondweeds (<i>Potamogeton</i>) especially broad-leaved pond weed <i>P. natans</i>
<i>Plateumaris discolor</i>	Adults usually found on sedges (<i>Carex</i>)
<i>Plateumaris sericea</i>	Adults usually found on bur-reeds (<i>Sparganium</i>)
<i>Lema</i> or <i>Oulema</i> sp.	Feeds on the leaves of grasses and cereals
<i>Bromius obscurus</i>	Principally found on rosebay willowherb (<i>Chamerion angustifolium</i>); also other willowherbs (<i>Epilobium</i>)
<i>Prasocuris phellandrii</i>	Adults feed on marsh marigold (<i>Caltha palustris</i>) and also on other waterside Ranunculaceae; also found on leaves of other marginal plants including waterside umbellifers
? <i>Chrysomela populi</i>	Adults and larvae usually feed on the leaves of willows and poplars
<i>Phratora laticollis</i>	Adults and larvae feed on poplars including aspen
<i>Phratora vitellinae</i>	Adults and larvae feed on the leaves of willows and poplars
<i>Phratora vulgatissima</i>	Adults usually on willows, possibly on aspen, larvae usually on willows and goat willow
<i>Galeruca tanacetii</i>	In open habitats feeding on a wide range of food plants including yarrow (<i>Achillea millefolium</i>), common knapweed (<i>Centaurea nigra</i>), cuckooflower (<i>Cardamine pratensis</i>), mouse-ears (<i>Cerastium</i>), devil's-bit scabious (<i>Succisa pratensis</i>) and speedwells (<i>Veronica</i>)
<i>Lochmaea caprea</i>	Adults are usually found on willows and birches, the larvae usually feed on willow
<i>Phyllotreta nemorum</i> gp	On wild and cultivated crucifers
<i>Crepidodera</i> spp.	On willows, poplars and aspen
<i>Sphaeroderma</i> ? <i>testaceum</i>	On Asteraceae, especially thistles (<i>Carduus</i> and <i>Cirsium</i>), and sometimes common knapweed (<i>Centaurea nigra</i>)
<i>Oxystoma</i> sp.	On vetches (<i>Vicia</i> and <i>Lathyrus</i>)
<i>Notaris acridulus</i>	On semi-aquatic grasses; reed sweet-grass (<i>Glyceria maxima</i>) is a common host in Continental Europe
<i>Isochnus</i> ? <i>foliorum</i>	On willows

Table 19.3: Continued

Species	Food and habitat preferences
<i>Limnobaris dolorosa</i>	On sedges (<i>Carex</i>)
<i>Limnobaris</i> spp.	On sedges (<i>Carex</i>)
<i>Ceutorhynchus contractus</i>	In waste and open places on crucifers (Brassicaceae)
<i>Micrelus ericae</i>	On heathers (<i>Calluna</i> and <i>Erica</i>)
<i>Nedyus quadrimaculatus</i>	On nettles (<i>Urtica</i>)
<i>Rhinoncus</i> sp.	The various species are found on <i>Persicaria</i> and <i>Rumex</i>
<i>Sitona</i> spp.	The foodplants are various legumes (Fabaceae)
<i>Scolytus rugulosus</i>	Bark beetle usually found on trees and shrubs of the Rosaceae family
<i>Tanysphyrus lemnae</i>	On duckweed (<i>Lemna</i>)

Table 19.3: Habitat and food preferences of plant-associated beetles and bugs. Eurytopic taxa have been excluded. Main sources: Cox (2007), Majerus (1994), Morris (2002, 2008, 2012), Nau (2004), Southwood and Leston (1959).

all three profiles, nettles (*Urtica*) were also present locally and may have been growing along with willow and poplar on the damp soils at the water's edge.

Areas of relatively open ground with herbaceous vegetation and grasses were also present. *Bromius obscurus*, a leaf beetle associated with the shade intolerant rosebay willow-herb (*Chamaerion angustifolium*), was found in 12 samples spanning the range of the peat sequence, indicating areas of open ground close to the shore. Willow-herb is a pioneer species often associated with clearings, burnt areas and beaver activity, and its presence may reflect disturbance and clearance events in the local woodlands. Areas of open, and possibly disturbed, ground were also indicated by records of *Galeruca tanacetii* found in a variety of open habitats on herbaceous vegetation, *Sphaeroderma ?testaceum* found on members of the daisy family (Asteraceae, particularly thistles (*Cirsium* and *Carduus*)), and the occasional occurrence of the ground beetle *Paradromius linearis* (single find in the base of CII/2010). The scarabaeid beetle *Euheptaulacus villosus* recorded from samples towards the bases of all three sequences is found in exposed sunny places in vegetable matter or dung, or under stones (Jessop 1986, 19).

Insects associated with heather (*Calluna vulgaris* and *Erica*) and heathland habitats are a consistent presence in all three sequences, albeit in small numbers. The ladybird *Chilocorus bipustulatus* is present throughout the deposits, while *Strophingia ericae*, a jumping plant louse, and the weevil *Micrelus ericae* were represented in the lower parts of the profiles. There were also occasional records of *Scolopostethus decoratus* and *Cytilus sericeus*, both typical of heathland.

Decomposer beetles were represented in limited numbers with the majority of taxa typical of decaying organic material on damp ground or by water. Very few can be regarded as synanthropic to any degree (i.e. favoured by human activities). *Latridius minutus* group, recorded from several samples across the three sequences, is a typical synanthrope but also occurs in grass tussocks and other natural situations. At least some parts of the sequences would have formed during periods of human activity beside the lake, but intensive activity very close to the shore (that might have attracted greater numbers of decomposers) may have been restricted because of the swampy conditions. Beetles found on dead and rotting wood occur throughout the profiles in small numbers and they may be largely related to the presence of older trees and associated dead wood habitats. They include *Dasytes* in the lower samples in CII/2010, the larvae of which live in rotting wood, and *Ptilinus pectinicornis*, a member of the woodworm family, in the lower half of VP85A/2010. Some species associated with rotting wood occur in the same samples as the timbers of the western and central platforms, such as *Sinodendron cylindricum* (in VP85A/2010) and a bark beetle (Scolytinae) in CII/2010. However, there is no notable increase in the abundance of this group within these deposits compared to elsewhere in the sequences.

Evidence for the presence of larger animals (in the form of dung) occurs at low levels throughout the profiles (1–2% of the fauna in some samples). The dung beetle *Geotrupes* occurs throughout the lower half of VP85A/2010 and more sporadically elsewhere, while records of *Aphodius* spp. were from the lower half

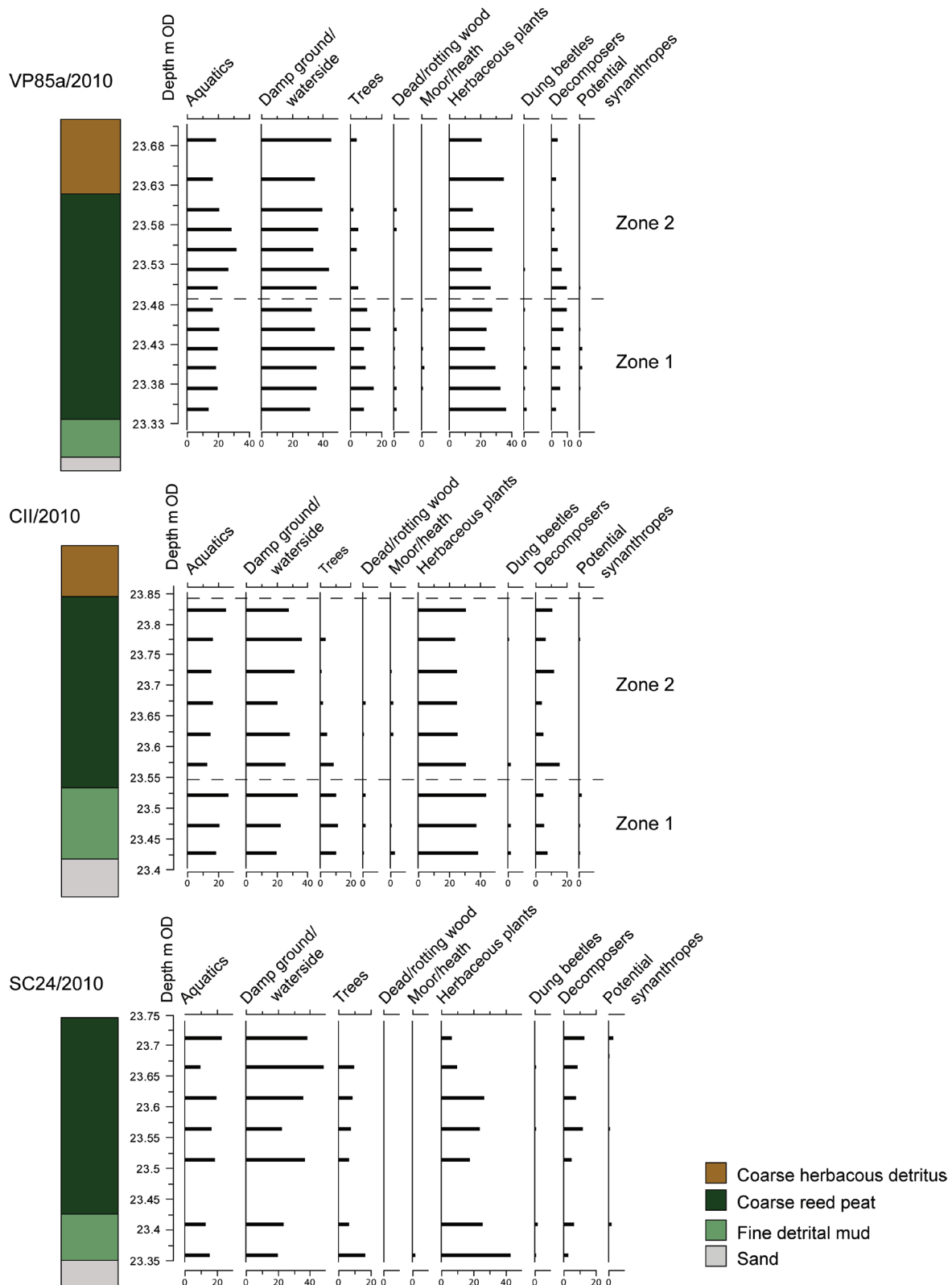


Figure 19.6: Proportions of insect taxa representing different ecological groups from VP85a/2010, CII/2010 and SC24/2010. Proportions of aquatics have been calculated as percentages of the whole assemblage. The remaining groups have been calculated as percentages of terrestrial taxa. (R - Riffle beetles present, B - *Bromius obscurus* present) (Copyright Star Carr Project, CC BY-NC 4.0).

of all three profiles. Both taxa are primarily associated with herbivore dung but some *Aphodius* are more rarely found in rotting vegetable matter and they can occur in flood debris, while *Geotrupes* can be found at exuding sap (Jessop 1986, 15, 20-25). The rove beetle *Oxytelus laqueatus*, recorded from the upper half of CII/2010, is generally found in dung while *Euheptaulacus villosus*, recorded from the basal samples in all three sequences, occurs in dung but not exclusively. The proportions of this group of beetles indicate low level and perhaps irregular grazing by natural populations of herbivores. Puparia of a hippoboscid fly, possibly *Lipoptena cervi* an ectoparasite of deer, were recovered from single samples from VP85A/2010 and SC33. The puparia drop from the host onto the ground where they remain until the adult deer ked emerges to find a new host.

Finally, several insect species recorded from various parts of the profiles are either confined to, or at least more typical of, the southern parts of England at the present day, suggesting a relatively warm climate at Star Carr throughout much of the period represented by the sample profiles (though the resolution of the samples may not be sufficient to detect short-lived climatic fluctuations).

Chronological variations

Broadly speaking, the character of the assemblage reflects a mixed wetland of well-vegetated standing water with areas of open water and muddy, wetland edge throughout the time that the deposits were being laid down. There is a slight tendency towards an increase in both aquatic and waterside/wetland species through the profiles, though no evidence for a major increase in water level or the development of more open conditions.

Insect evidence indicated that trees and/or shrubs were growing close to the lake at least throughout the time period corresponding to plant macrofossil Zones 1 and 2, the proportion of insects associated with trees falling somewhat in Zone 2. There is also some indication that fen-like conditions with litter became more prevalent over time, with species indicative of mud, such as *Limnebius aluta* and *Dryops*, becoming more frequent in samples corresponding approximately to plant macrofossil Zone 2. However, conditions at the site remained wet, with areas of standing water either at, or in the vicinity of, the sampling points.

In all of the profiles there is a gradual reduction in the concentration of insect remains within the samples over time, with a pronounced fall in VP85A/2010 occurring after 23.611 m OD, in CII/2010 after 23.8211 m OD and in SC24 after 23.71 m OD. This most likely corresponds primarily to a gradual shift to a drier depositional environment resulting in incomplete anoxic waterlogging of the deposits and consequent poorer survival of insect material. However, a reduction in the quantities of material being transported to the site may also have been a factor. Numbers of individual specimens were particularly low in the uppermost samples in all three sequences (from 23.711 m OD in VP85A/2010, 23.8711 m OD in CII/2010 and 23.76 m OD in SC24). Conditions close to the sampling points appear to have remained wet, however, with aquatic and waterside species present throughout, albeit in much smaller numbers than previously.

The state of preservation of sclerites was varied throughout the deposits and also within samples, and no overall trend towards poorer levels of preservation in different parts of the sequences was observed. The variability in preservation can at least partly be explained by the robusticity of particular species. Whirligig beetles (*Gyrinus*), Donaciinae species, ground beetles (Carabidae) and taxa associated with dead wood and bark were consistently better preserved than many other remains. Many of the wood-associated beetles are relatively robust species, but it is also possible that their particularly good preservation in comparison with other remains may be a result of them having entered the deposits within wood, which provided some protection against decay. *Cyphon*, *Halplus* and various Hydrophilinae, which were common in many of the samples, are relatively poorly sclerotised and therefore likely to be more easily affected by any factors causing erosion. Remains of some leaf beetles (Chrysomelidae other than donaciines) and some weevils (Curculionidae) were often particularly poorly preserved, which limited their close identification.

SC33

In addition to the main sequences described above, a short sequence of four samples was recorded from trench 33 in order to characterise the environments within which an assemblage of archaeological material had been recorded. As this was only a partial profile it has been described separately.

Insect remains were common in the lowermost sample with frequency declining with depth. The main implications are for well vegetated water margins. *Cyphon* species were particularly common, indicating swampy conditions with shallow standing water. Several species of donaciine leaf beetles, found on emergent and water-side vegetation, were also represented. As in the lower parts of the main profiles, a riffle beetle suggested an input of clean clear running water and terrestrial environments were hinted at by the weevils *Micrelus ericae* and *Nedyus quadrimaculatus* which feed on heathers and nettles respectively.

Another species worthy of note is *Aspidophorus orbiculatus*, a beetle found on slime moulds (Myxomycetes) which generally occur on very moist decayed material such as old tree stumps (Findlay 1967, 190).

Above 23.78 m OD, the quantities of insect material declined, though the taxa present suggested a similar range of local environments (notably the continued presence of *Cyphon* species, as well as *Dryops*, which is indicative of waterside muds).

The environmental context of activity at Star Carr

Introduction

Drawing together the results of the insect and plant macrofossil analyses, and the results of Dark's work at the site, it is possible to present a revised environmental record for the site, and to establish the depositional environment of much of the archaeological material and as such, the environmental context of human activity at the site.

The environmental sequence

The environmental sequence has been divided into three zones, reflecting changes to the lake edge wetland identified in the plant macrofossil profiles. As previous research has shown, these changes were driven by the ongoing accumulation of organic sediments in the shallow waters of the lake margins, which began shortly before the start of the Early Mesolithic. As these accumulated, the surface of the sediment came closer to the level of the lake, allowing plants less tolerant of deeper water to colonise the edges of the lake, whilst plants suited to deeper conditions began to expand further into the lake (Figure 19.7).

Zone 1

Based on both the radiocarbon dating (Figure 17.22) and the stratigraphic relationships between artefacts and the environments sequences, wetland environments were already well established at Star Carr by the time Mesolithic groups first inhabited the site and organic sediments were starting to form in the shallow lake margins. The plant macrofossils and the composition of the peat indicates that this early wetland consisted of a reedswamp of emergent vegetation growing in standing water. Common reed formed a significant component of this environment and probably formed extensive beds across much of the excavated area. However, both the insect and plant macrofossils also indicate the presence of a suite of other emergent plants growing at the site, notably bulrush, bogbean, several species of sedge and species of bur-reed and rush. Common club-rush may also have been present, possibly forming discrete stands in deeper water beyond the reed beds, along with some of the aquatic plants, particularly pondweed but perhaps also water-lily.

The depth of the water and the location of the shoreline is difficult to determine, though minimum lake levels can be estimated from the presence of aquatic plant material in the basal samples of the environmental profiles. Water was clearly above the sampling points at P3178 and CII/2010 by the time Mesolithic activity began (which would also place the VP85A/2010 and SC24 sampling points under water). Of these, the base of CII/2010 lies at the highest elevation (23.42 m OD), which provides an absolute minimum level for the lake at this date, though given that this sampling point was probably permanently submerged, the water level must have been above that (+23.42 m OD). Aquatic material was also present in several of the spot samples taken from the peat where it overlay the basal land-surface at an elevation of 23.92 m OD. Given that water must have been present for this material to be deposited, this provides an upper minimum level for the lake. However, it was not possible to date these samples due to the paucity of identifiable plant material within them, and it is possible that the peat they were within was slightly later than (i.e. formed after) the bases of the main plant

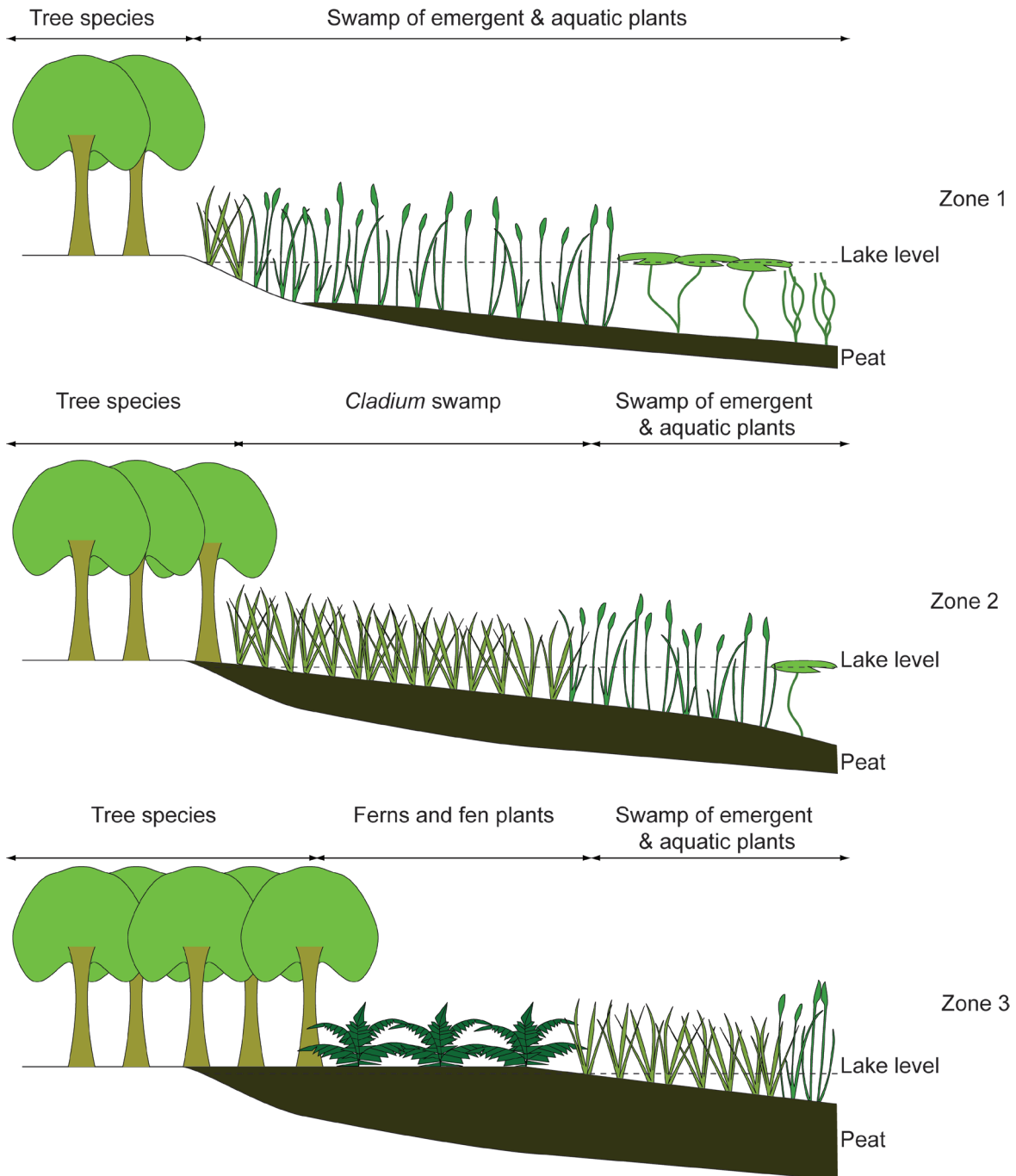


Figure 19.7: Schematic representation of the hydrosereal succession at Star Carr (Adapted from Taylor et al. 2017. Copyright Cambridge University Press (2017) reprinted with permission).

macrofossil profiles. As such, 23.92 m OD is an estimated minimum level for the Early Mesolithic lake, but it is possible that the water was slightly shallower (+23.42 m OD) when people first arrived at Star Carr, and that it then rose in the early centuries of activity at the site. From this, the minimum depth of water over each of the sampling points can be established as P3178 +0.36 m–0.86 m; VP85A/2010 +0.09 m–0.59 m; SC24 +0.07 m–0.57 m; CII/2010 up to 0.5 m; S3502 up to 0.43 m.

The maximum level of the lake is unlikely to have been significantly higher given the tolerances of the main plant species. Common reed can grow in up to 2 m of water (Haslam 1970), but its optimum conditions in lake edge environments occur in up to 1.2 m of water (Haslam 1970, 874, table 5) and it performs best in up to 0.5 m of water (Rodwell 1995, 142). With the exception of club-rush, the other emergent plants tend to be found at the shallower end of this range. Bur-reed can grow in up to 1 m of water (though some species are more common in shallower water), and bulrush is rare in water more than 0.5 m deep (Preston and Croft 1997, 270). Assuming plant growth occurred within similar tolerances in the Early Holocene, it is unlikely that the depth of water over the deepest sampling points (P3178) was more than 1 m and was probably lower.

The area around the lake shore is likely to have been at least periodically submerged (perhaps seasonally flooded), maintaining a damp waterlogged substrate where plants such as marsh fern (which was present in low quantities at the base of Dark's M2 pollen profile (Dark 1998b, 134 figure 11.6a)), nettles and (perhaps) gypsywort were present, probably along with common reed, rushes and sedges. White/downy birch, aspen and probably willow were also growing at the water's edge, their branches probably extending out over the reedswamp and perhaps shading out some of the emergent vegetation leaving areas of open, shallow water. Dead and rotting wood and plant litter may also be present in this area, probably accumulating from branches falling from the lake-side trees and from material washed onto the shore through the regular rising and falling of the lake.

Determining the character of the local vegetation on the drier ground beyond the limit of the lake is harder. From Dark's pollen analysis, birch woodland with an understory of male fern was clearly present in the surrounding area (Dark 1998b, 127) and may have covered parts of the dry ground area at Star Carr. However, areas of open, possibly disturbed ground colonised by rosebay willow-herb were present, and grasses, nettles, and other herbaceous plants may also have been established. The insect remains suggest the presence of a stream running into the lake somewhere on the site, though its exact location cannot be established.

Whilst there is little evidence for any significant change in the character of this environment throughout the remainder of the zone, the accumulation of organic sediments would have caused conditions to become boggy, and the depth of water to gradually become shallower (though the surface level of the lake does not appear to have fallen).

Zone 2

The start of this zone is marked by a transition to shallower conditions within the lake edge wetland, and more tentatively a shift from a permanent to a periodically flooded environment. Whilst this appears as an abrupt change in the environmental profiles, it may have been the result of an ongoing process, as the accumulation of sediment gradually brought the surface of the peat closer to the level of the lake.

This transition to a shallower environment altered the composition of the wetland vegetation. Saw-sedge, a wetland plant tolerant of shallow or waterlogged conditions, was probably present from the start of the zone, perhaps initially limited to shallower areas close to the shore. However, the increase in the quantities of its macrofossils, and the corresponding rise in Cyperaceae pollen in Dark's M1 and Clark Site profiles, suggests that it gradually expanded across the site throughout the zone. Common reed was still growing within the excavated area, though this may have become more sparse later in the zone, given the decline in its pollen (Dark 1998b), and may have begun to colonise the areas of deeper water further from the shore.

The character of the wetland vegetation was also altered by deliberate human action during this period. The first episode of burning recorded by Dark began during the later stages of Zone 1, but its impact on the local vegetation occurred at the transition to Zone 2. In Dark's pollen profile M1, this is marked by a dramatic reduction in the quantity of grass (Poaceae) pollen, probably reflecting the clearance of areas of the reedbed by burning (Dark 1998b, 130). These lower levels of Poaceae persist for some time, suggesting that the open areas were maintained or new clearings were being created.

The depth of water in this zone is hard to establish. Based on the modern habitat preferences of saw-sedge (e.g. Preston and Croft 1997, 278), the excavated area is unlikely to have been under more than 0.4 m of water at the start of the zone, whilst the paucity of aquatic plant macrofossils and the more limited source area of the profiles would strongly suggest that it was considerably shallower. What is more, the volume of water reaching the site continued to fall throughout the zone, as reflected in the increasingly sporadic occurrence of aquatic

plant and bryozoan macrofossils and the more limited source area of the profiles. However, conditions clearly remained wet, with the insect assemblages indicating the presence of areas of stagnant standing water in the local area.

Closer to the shore, where the basal topography was higher, the deposits may have been more consistently above the level of the lake allowing plants less tolerant of permanently submerged conditions to become more established. This may have included wetland species of fern (perhaps marsh fern), given the increased quantities of sporangia in P3502. Many of the other wetland plants recorded in the plant macrofossil and insect samples may also have been growing in this environment, particularly gypsywort (which is intolerant of standing water), but perhaps also species of rush, bur-reed and wetland members of the *Ranunculus* family. Aspen and/or willow may also have been growing at the water's edge, given the continued presence of roundwood within the deposits (particularly in the area of cutting II and trench 24), and birch trees (including white/downy birch) were close enough for fruits and catkin scales to be deposited within the peat.

Zone 3

From the start of this zone the wetland deposits were forming above the level of the lake, and the area was only subjected to very occasional flooding. The radiocarbon dating shows that the transition to this zone was not contemporaneous between the different dated sampling points (Figure 17.22), and parts of the site may have been intermittently flooded whilst others remained beyond the reach of the lake waters. Ground conditions would have remained wet and boggy, and the occurrence of insect taxa suited to stagnant standing water from cutting II/2010 and VP85A/2010 could reflect the presence of small, discrete pools.

The composition of the peat indicates the local growth of herbaceous plants, whilst the increased levels of sporangia, coupled with the much higher fern spore values in Dark's profiles (Figure 19.7, see also Dark 1998b, 126, figure b), probably reflects the expansion of ferns onto the peat. The fen plant hemp agrimony occurs in several of the macrofossil profiles and may have been growing at the site. The continued presence of trees at the wetland edge is indicated by the presence of two large trunks in trench SC24 (species unknown). Species of poplar (probably aspen) were still growing close enough to deposit bud scales into the peat, and birch was still growing at the site (though not necessarily in the immediate vicinity of the wetland).

The archaeological contexts

The detrital wood scatter

The detrital wood scatter lies on a northwest-southeast alignment, with its southeastern side running c. 1 m from VP85A/2010, and its southern edge running into the trench section at P3178 (Chapter 6). The lowest lying material lay directly upon the basal sand (320), whilst the assemblage spanned the detrital mud (317) and extended into the lower part of the reed peat (312). Associated with the scatter is an assemblage of antler and animal bone (including an antler frontlet and pieces of worked antler beams), which was densest towards the south of the trench. This material also spanned the basal sand, detrital mud and the base of the reed peat. The vertical distribution of the wood and associated faunal material spans much of Zone 1, which is in agreement with the radiocarbon dating of the material (Figures 17.7 and 17.22). Where the scatter runs into profile 3178, it lies towards the base of the zone, whilst the levels of most of the wood and all the artefacts in the southern part of the scatter spans the vertical range of the zone in both P1378 and VP85A/2010.

The earliest material was deposited into standing water, between approximately half a metre and a metre deep at its southern extent, but shallower at its northern end as the basal topography rose towards the shore. Common reed was growing across this part of the site, though a range of other emergent plants may also have been present. Deposits of detrital mud and peat would have built up during the time that this assemblage was being deposited, probably burying older material, and causing conditions to become shallower and boggy. There is no indication of any change in the local vegetation during this time. By the time the latest artefacts were deposited, the level of the lake was much closer to the surface of the sediments (though the area was probably still permanently submerged). As sediments continued to accumulate, the area of the detrital wood scatter

may have been built up slightly higher than the surrounding parts of the site, possibly remaining visible as a ridge of higher ground and/or taller vegetation.

Brushwood

Small quantities of wood-working debris, worked antler and several pieces of flint were recorded from the detrital mud (317) and reed peat (312) between cutting II and SC24, within a dense concentration of unworked roundwood (Chapter 6). Both the worked and unworked material spanned the range of Zone 1 and much of Zone 2 in profile CII/2010. This indicates that the earliest episodes of deposition occurred in standing water, probably no more than half a metre deep, and possibly less, becoming increasingly shallow towards its northern extent as the basal topography rose towards the shore. Material continued to be deposited as conditions became shallower and, potentially, only periodically flooded. The composition of the peat suggests the local presence of common reed throughout this period.

The context of the timber platforms

Timbers from each of three platforms lay within the deposits sampled by the environmental profiles (Chapter 6). The lowest layer of timbers from the central platform lay 1.3 m to the north of VP85A/2010, and one of the overlying timbers was immediately adjacent to the profile. A timber from the western platform ran 0.45 m to the south of CII/2010, whilst the southern extents of eastern platform ran through the same sedimentary sequence that was sampled in P3178. In all three cases, the basal timbers lay at or just above the transition to Zone 2. This would place the platforms in very shallow water, certainly no more than 0.4 m deep, and probably significantly less. In the case of the central platform, which was constructed from three layers of timber that included entire trees, its upper surface may have been permanently above the water, whilst the eastern and western platforms, which were laid down slightly later, may have been at least seasonally exposed. Insects from samples directly below a timber in SC24 (Sample 411/H) and from samples at the same level as the timbers in CII/2010 and VP85A/2010 indicate well-vegetated water margins and permanently wet conditions.

Broadly speaking, saw-sedge had begun to grow across parts of the site during the time the platforms were laid down, though other species were also present, notably sedges, common reed, and bur-reed (the presence of the latter is indicated in the insect samples). Local patterns of vegetation are harder to deduce. In VP85A/2010, the composition of the peat directly beneath one of the timbers shows that common reed was growing at or close to the area when the central platform was constructed, and the lack of saw-sedge in profile CII/2010 could (tentatively) reflect the absence of this plant around the western platform. A final point worth noting is that the preservation of the material in both of the complete insect profiles is markedly poorer in samples adjacent to the timbers of the platform. This could possibly reflect a greater degree of ground disturbance caused by more intensive human activity in the areas around the platforms.

Central platform lithics cache

A small, discrete concentration of worked flint was recorded on the southern edge of the central timber platform (Chapter 8). The material has a very narrow vertical range (c. 35 mm) and spans the transition between Zones 1 and 2 in profile VP85A/2010. As such, its depositional context will be the same as that of the central platform.

The context of Clark's area

Profile 3502 established the context of the large assemblage of faunal material, and worked flint, bone, and antler recorded from the baulk between Clark's cuttings I and II. The lowest artefacts rested directly over the basal substrate and the assemblage spanned the lower part of the sequence of deposits, corresponding with Zone 1 in P3502. A more diffuse scatter of material, including faunal remains, flint, and worked wood and antler, extended to the south and west of this area. These artefacts were recorded from the fine detrital mud (317) and the base of the overlying reed peat (312), and correspond (in terms of their levels) with Zone 1 and

the base of Zone 2 in profiles 3502 and CII/2010. However, the radiocarbon dating shows that this assemblage was deposited in a short-lived event early in Zone 2 and has probably sunk into the underlying sediments (Figures 17.15 and 17.22). As such, deposition occurred in a similar environment to the western platform, in an area of very wet, boggy ground that was either periodically flooded by the lake or which lay beneath very shallow water, with wetland plants, including reeds and saw-sedge in the local area. Localised variations in the rates of deposition may have created small areas of relatively drier ground, whilst the insect assemblages indicate the continued presence of areas of permanent, stagnant water. In addition, towards the southern extent of the assemblage, conditions would have got significantly wetter, as a slight slope in the basal topography would have left the area under a greater depth of water.

The burnt area 318 and associated flint scatter

Profile SC33 provides the environmental context for a dense scatter of flint that was recorded in the north east of trench SC33 during the 2010 excavations, and which forms part of a more extensive scatter that was recorded in 2013 (Chapter 8). In SC33, the base of the densest part of the scatter lay at c. 23.71 m OD. The plant macrofossil and insect samples were taken from the south-facing section of the trench, c. 1 m from the centre of the scatter, and the samples span the deposits within which the flint was recorded. A discrete burnt area within the peat, context [318], was recorded c. 2 m to the west and lay between 23.72 m and 23.75 m OD (Chapter 32).

The plant macrofossils show that the lake waters were still reaching this part of the site at the time the flint was deposited and the burning occurred, though the volume of water was decreasing and conditions were becoming more shallow. This fits well with the results of the radiocarbon dating, which places the formation of the burnt area after the transition to Zone 2 (Table 17.8). Local conditions would have been wet but not necessarily permanently flooded, though discrete areas of standing water would have persisted in the surrounding area. The insects reflect a swampy, well-vegetated environment whilst the coarse component of the peat indicates the growth of reed in the immediate area.

The bark mat

The bark mat was recorded during the 2013 excavations (Chapter 30). It lies at an elevation of c. 23.6 m OD within the upper deposits of reed peat. Profile CII/2010 lies c. 10 m to the west. The level of the mat in relation to the CII/2010 profile places it within Zone 2, indicating wet conditions, possibly periodically flooded. Insect remains from a sample from the same horizon in trench SC24 (2.5 m to the east, sample 411/E) reflect fen-like conditions and the presence of bur-reeds, sedges and wetland members of the Ranunculaceae family.

Later wetland activity

A relatively dense scatter of flint was recorded from the top of the reed peat and the base of the overlying wood peat just to the east of the area investigated by Clark (Chapter 8). Part of this assemblage ran through the deposits sampled by CII/2010 (several pieces were recorded as the samples were being taken), the majority falling between 23.79 m and 23.85 m OD. This places it at the top of Zone 2, just before the local transition to a terrestrial fen environment. At this point the deposits were probably only subjected to occasional flooding, though ground conditions would have still been wet and boggy. Ferns and herbaceous plants (possibly including hemp agrimony) were present in the immediate area, and trees may have been growing at the wetland edge a few metres to the east (around trench SC24).

Lake edge flint cache (Finds No <113150-170>) and red deer frontlet <113901>

The flint caches (Chapter 8) and frontlet (Chapter 26) lay in moderately humified wood peat, c. 1.2 m south of profile 3356. Plant macrofossil preservation in this area was very poor, with no material surviving at the level at which the artefacts were recorded. The point at which aquatic material was no longer being deposited in the peat was detected within the samples some 0.15 m lower than the artefacts, and could tentatively indicate that the area was above the level of the lake by the time these were deposited.

Conclusions

The palaeoenvironmental investigations have provided a more detailed account of the context in which archaeological material was deposited and within which human activity took place. It is clear from the contexts of the archaeological material that people engaged with these environments, wading through water or thick mud as they walked from the shore into the lake edge reedswamp. It is also clear that the character of the environments forming around the edge of the lake at Star Carr changed throughout the time that people inhabited the site. Whilst wetland succession was too slow to be perceived, people would have been aware of earlier episodes of activity within (and buried by) the wetland. The detrital wood scatter may have remained visible as a topographic feature by the time the later platforms were built, and pieces of timber, animal bone and antler may also have been visible amongst the plant detritus and forming peat. Later, the platforms themselves became buried, but again may have remained visible as features within the reed and saw-sedge swamp. At some times it may have appeared that the lake edge was consuming the objects and materials that were deposited into it. The large assemblage of bone and antler artefacts in the area investigated by Clark had sunk into a lower context, a process that may have occurred during the lives of people living at the site. This perception of things being consumed by the wetland may also have been apparent during times of lower lake level, when animal bones and other artefacts may have become visible amongst the vegetation.

