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**An assessment of the palaeoecological potential of biological remains from
a site at Star Carr, Vale of Pickering, North Yorkshire**

by

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Summary

An assessment was undertaken of the palaeoecological potential of a series of samples from excavations at Star Carr, near Scarborough, North Yorkshire, as part of a research-driven evaluation of the archaeological potential of an area under threat of degradation of the buried archaeological record through a falling water table.

The deposits encountered at this site primarily consisted of natural peats and humic silts. Most of the layers examined during the assessment contained sufficient plant and insect remains to allow a useful reconstruction of depositional regime, local ecology and climate, as well as their development through the sequences, which probably include early Holocene sediments, as well as those associated with more conventionally 'Mesolithic' deposits.

The recovered biota were indicative of aquatic and marshland habitats: essentially swamp with evidence for open water at some stages. Strictly dryland habitats were only weakly represented. There were insects whose modern distributions are principally either to the north or south of the site.

There were some notable records of charred herbaceous material and sedge fruits from some levels, presumably equivalent to the charred reedswamp material recorded at nearby locations and confirming the likelihood of extensive burning.

Deposits of this date with good waterlogged preservation of plant and insect crofossils have rarely been studied in the area, and (in the case of the insects) are restricted to a few locations elsewhere (notably the Somerset Levels and Humberhead Levels). Consequently, full analysis of the plant and invertebrate assemblages from all of the current sediment samples is recommended.

KEYWORDS: STAR CARR; VALE OF PICKERING; NORTH YORKSHIRE; LATE HOLOCENE; MESOLITHIC; ASSESSMENT; PLANT MACROFOSSILS; INSECT REMAINS; DEGRADATION; WASTING PEATS

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An assessment of the palaeoecological potential of biological remains from a site at Star Carr, Vale of Pickering, North Yorkshire

Introduction

During summer 2006 excavations were carried out by a team from the Universities of York, Manchester, Cambridge, and University College London, and English Heritage, at Star Carr, near Scarborough, North Yorkshire, as part of a research-driven evaluation of the archaeological potential of an area under threat of degradation of the buried archaeological record through a falling water table. The primary interest of the deposits lay in their association with the classic Mesolithic site at Star Carr (Clark 1956 and many subsequent reworkings), namely a brushwood 'platform' which is at the very least an area of timber accumulation. The current bioarchaeological assessment aimed to determine the potential of integrated studies of a range of plant and animal remains in the context of an open-area excavation.

Routine 'GBA' samples (*sensu* Dobney *et al.* 1992) were examined from six contexts, together with two spot samples: the matrix associated with an antler recovered from Context 39; and sediment from around a bracket fungus (from Context 35). The GBA samples originated from a stratigraphic sequence shown in Fig 1. Samples were collected from thin, apparently wasting peats.

Methods

The samples were examined in the laboratory, where they were described using a *pro forma*. Subsamples of 1kg were used in each case, apart from Context 41, from which a 2kg subsample was used. The subsamples were processed using standard methods described by Kenward *et al.* (1980; 1986). This involved paraffin flotation in order to extract any insect remains; plant remains then being extracted by means of a 'washover' to concentrate the lighter, organic fraction. The volumes of this and of the heavier mineral fraction were measured, and the components of both fractions recorded whilst wet. The washover was stored wet, the residue dry.

Inspection of the washovers was carried out by RM and ARH, who recorded the nature of the plant material and other components after re-sieving into convenient fractions (usually 10, 4, 2, 1 and 0.3 mm). A four-point semi-quantitative scale of abundance was used, from '1' – one or a few specimens (less than an estimated six per kg of raw sediment) to '4' – abundant remains (many specimens per kg or a major component of the matrix). Data were recorded on paper and subsequently on a personal computer using a Microsoft Access database.

For technical reasons related to computer data-handling the convention 'sp(p)' to denote that more than one species was (or may have been) present, is used throughout, even where only one specimen of the taxon was recorded (and thus only one species could have been present). For plant remains, 'cf.' is used to indicate a 'best guess' as to the identity of fossil specimens.

The 'flots' resulting from the paraffin floatation were examined by LG, GAK and HK for insect and other macro-invertebrate remains, using a low-power binocular microscope. The fragments were kept on damp filter paper in Petri dishes, together with a few thymol crystals to prevent mould, before being identified with reference to identification manuals and modern specimens, and a list of taxa made with an approximate record of abundance. The preservational condition of the insect remains was recorded using the scales set forth by Kenward and Large (1998). In summary, preservation is recorded as chemical erosion (E) and fragmentation (F), in each case on a scale from 0.5 (superb) to 5.5 (extremely decayed or fragmented). Following this, the insect remains were left to dry for storage in an instantly accessible form.

Results

The results are presented in stratigraphic order, from oldest to youngest.

All of the samples yielded at least a few interpretatively useful plant and invertebrate remains. The material remaining after processing consisted mainly of undisaggregated plant and amorphous organic material preserved by anoxic waterlogging, with several samples (Contexts 35 and 39) also containing charred plant material. Amongst this was a modest range of identifiable plant macrofossils in the form mainly of fruits, seeds, and bud-scales. Many of the invertebrate remains were highly fragmented and some were poorly preserved, making identification difficult. The erosion and fragmentation ranges are listed below along with numbers of species and individuals.

Context 42, Sample 42

1kg subsample (sieved to 300 microns with paraffin floatation)

Laboratory Description: Moist, dark brown, firm to crumbly humic silt to silty, uniform amorphous organic matrix with randomly disturbed sand and gravel (to 15mm).

Plant macrofossils: A small residue of 350ml was recovered, together with 600ml of washover material. The latter consisted mainly of fine herbaceous detritus. Sedges (*Carex* sp.), bogbean (*Menyanthes trifoliata*) and violet (*Viola* sp.) were the only seeds recorded and were of limited interpretative value.

Invertebrate remains: The number of insect remains found in this sample was very small, and only 11 beetle taxa and a single fly puparium were observed. Only one species indicated aquatic conditions: a hydrophiline. Emergent and waterside vegetation was indicated by Donaciinae sp. and *Notaris aethiops* (the glacial relict northern species usually found in Scotland, though with some records from Northern England) and *Limnobaris* sp. The ground-living upland weevil *Otiorhynchus nodosus*, is known from Wales, Northern England and Scotland. The remaining taxa have little interpretative value beyond indicating decaying matter of some kind. Overall, swampy conditions with adjacent drier ground are indicated.

The presence of the decomposer species *Xylodromus concinnus* and *Crataraea suturalis* are most likely to be laboratory contaminants.

Context 41, Sample 41

2kg subsample (sieved to 300 microns with paraffin flotation)

Laboratory description: Light to mid (lowish) brown unconsolidated humic matrix. Sand with gravel to 15mm. Locally finer and more humic.

Plant macrofossils: A rather large residue recovered from this subsample, together with a washover of approximately 150ml, consisting mainly of fine herbaceous matter, some of which was charred, and decayed wood. There were seeds of *Carex* sp., *Menyanthes trifoliata*, *Potamogeton* sp. and *Valeriana officinalis*, together with *Salix* buds, indicative of swamp with some open water (probably deposition in water close to fen carr).

Invertebrate remains: Fragmentation ranged from 3 to 5 with a mode of 4. Erosion ranged from 3 to 4.5 (mode 3.5). There were few insect remains, 18 species of beetle and bug being recorded. The dominant group of taxa was those representing plants, among them being *Chilacis typhae* (found on *Typha*, reedmace), *Anaspis* sp. (often found on flowers, though breeding in dead wood), and *Tanysphyrus lemnae* (whose host is *Lemna*, the duckweeds). Other aquatic species included *Ochthebius* sp. and *Hydraena* sp. There were a few decomposers, among them *Megasternum obscurum* and a *Corticaria* species.

Context 40, Sample 40

1kg subsample (sieved to 300 microns with paraffin flotation)

Laboratory Description: Moist dark brown to black (rubbing black), woody detritus peat with amorphous organic matrix, working crumbly.

Plant macrofossils: The washover (1300 ml) consisted mainly of wood and twig fragments and herbaceous detritus. Leafless moss stems were abundant could not be identified to species. Other constituents included birch bud-scales, frequent birch fruits, willow bud-scales, and seeds of *Carex* sp., *Menyanthes trifoliata*, *Potamogeton* sp., *Nymphaea alba*, and *Sparganium*. The presence of pondweed and white water-lily remains points to deposition in standing water rather than swamp conditions, though clearly remains from trees nearby were also being deposited into the lake.

Invertebrate remains: Insect remains were quite abundant in this subsample, and 52 species of beetle and bug were noted. Taxa associated with plants contributed a significant proportion of the recovered assemblage. There were also very large numbers of mites (estimated to be of the order of magnitude of a thousand, and surely with interpretative potential). Among the plant-associates some indicate host plants not recorded amongst the plant macrofossils: the little lygaeid bug *Chilacis typhae* lives on *Typha* (reedmace), *Micrelus ericae* is associated with *Calluna* (heather), *Adoxus* (= *Bromius*) *obscurus* with *Chamerion angustifolium* (L.) Holub (rose-bay willowherb), and *Phaedon tumidulus* with *Heracleum spondylium* L. (hogweed). *Micrambe* species are found on *Ulex* (gorse) in spring and summer, and *Kateretes* occur on vegetation in swampy places. Other plant-feeders indicate diverse herbaceous vegetation. The thornbug *Centrotus cornutus* is found mainly on trees. However, the only insect associated with dead wood was *Denticollis linearis*, despite the apparent association of these deposits with the platform: even this can probably breed in peaty soil.

Aquatic taxa included *Hydrobius fuscipes*, *Agabus* sp., *Ochthebius* sp., *Hydraena* sp., *Rhantus* sp., *Gyrinus* sp., Hydrophilinae sp. and the pond skater *Gerris* sp.; together these are indicative of the presence of open water.

One species of dung beetle was recorded—*Aphodius* sp.—and there were various decomposers probably associated with litter by water. The chafer *Serica brunnea* and the shieldbug *Odontoscelis* sp. indicate drier terrain; the later was probably *O. fuliginosa*, a mainly coastal bug found on sandy substrates. This record of *Odontoscelis* sp. is notable, as its recent range is considerably to the south of East Yorkshire (north to Norfolk), though there is a record from Lancashire (Southwood and Leston 1959). In contrast, the weevil *Notaris aethiops* is a northern and upland species usually restricted to Scotland. It is a characteristic component of cold period Late Glacial assemblages.

Adoxus obscurus was present in the Late Glacial of Britain, but was thought to have become extinct until it was discovered in the late 20th century. Subsequently, it was found fossil in a Mesolithic association at the Ling Lane site, near to Star Carr (Kenward and Large 1997).

The assemblage again suggests a swampy environment with areas of emergent vegetation and open water. Detailed analysis of a larger subsample is a high priority, and the material indicates the potential importance of studies of insect remains in the Star Carr area.

Context 39, Sample 39

1kg subsample (39/T: sieved to 300 microns with paraffin flotation)

Laboratory description: Moist dark brown to black, woody detritus peat with amorphous organic matrix.

Plant macrofossils: There was no heavy residue from the sample as it was highly organic, and a 1200ml washover was inspected for plant remains and other components. This consisted mainly of wood and twig fragments, root or shoot fragments and clasts of undisaggregated matrix. Charred *Carex paniculata* fruits were also present, together with charred monocotyledon stem which may well have been reed, *Phragmites australis*. This seems to indicate an occurrence of reed burning. Waterlogged seeds/fruits of *Carex* sp., *Menyanthes trifoliata*, and birch, as well as *Populus* bud-scales also present, indicating the same kind of swamp with trees seen in the previous samples.

Invertebrate remains: Fragmentation ranged from 3 to 5 with a mode of 4. Erosion ranged from 2.5 to 4.5 (mode 3.5). Paraffin flotation left a substantial number of insect fragments in the residue (detected during recording of plant macrofossils), so it was re-sieved and re-floated. A rather small assemblage of insects was recovered, including 19 species of beetles and bugs. It was largely dominated by taxa associated with plants: the frog-hoppers, *Aphrodes* sp. and Delphacidae sp., and among the beetles, Donaciinae, Chrysomelidae and Ceutorhynchinae species. Aquatics such as Hydroporinae sp., *Agabus/Ilybius* sp. and *Hydrobius fuscipes* were present, as were three species of *Cyphon* sp., indicative of swampy conditions, and *Dryops* sp., found in waterside mud, are typically found in litter by water. *Megasternum obscurum* is found in dung and decaying matter, including waterside litter, and some other taxa probably lived in the same kind of material. Overall, the assemblage suggests swampy conditions, with some open water.

This sample showed evidence of mild degradation—though whether this was a phenomenon related to storage or was evidence of in-ground decay needs to be established. 

Sample 39/T2 (below antler)

1kg subsample (sieved to 300 microns with paraffin flotation)

Laboratory description: Moist dark brown to black, woody detritus peat with amorphous organic matrix.

Plant macrofossils: The plant remains recovered from this subsample had the same character as those from subsample 39/T1.

Invertebrate remains: Fragmentation ranged from 3 to 5.5 with a mode of 4. The state of erosion was 4. Only a few insects were recovered with 7 individuals of 5 species of beetle; they represented a random subsample of those recorded from Subsample 39/T.

Context 35, Sample 35

1kg subsample (sieved to 300 microns with paraffin flotation)

Laboratory description: Moist dark brown to black, woody detritus peat with amorphous organic matrix.

Plant macrofossils: There was a large (1200ml) washover of organic material, which was inspected for plant remains and other components. It consisted mainly of wood and twig fragments, together with clasts of undisaggregated matrix sediment. This subsample contained the most abundant and varied set of plant remains of any examined here, with remains of *Menyanthes trifoliata*, *Carex* sp., *Thalictrum flavum* (meadow-rue), *Sparganium* sp. (bur-reed), *Solanum*, *Cladium mariscus*, *Salix* sp. (willow), *Stachys* sp., *Galeopsis* sp. (hemp-nettle), *Galium* sp. (bedstraw) and *Ranunculus lingua* (greater spearwort). Wood charcoal fragments (to 30mm) were recorded, together with material thought to be charred reed culm nodes and charred sedge nutlets (identified as *Carex paniculata*, tussock sedge); these remains perhaps indicate reed burning. 

Invertebrate remains: Fragmentation ranged from 2.5 to 5 with a mode of 3.5. Erosion ranged from 2.5 to 4 (mode 3.5). The insect remains resulting from the paraffin flot were quite abundant and included 43 species of beetle and bug. Aquatic taxa and those associated with plants dominate the assemblage. *Microvelia* species inhabit areas along water margins and walk on the surface film; they indicate open water. Other aquatic taxa included water fleas (*Daphnia*), and the beetles *Hydrochus* sp., *Hydrobius fuscipes*, a hydroporine, *Agabus* sp. and *Gyrinus* sp. There were two aquatic weevils: *Tanysphyrus lemnae* (associated with duckweed, *Lemna*) and *Bagous* sp. *sensu lato* (associated as a genus with a range of aquatic plants). There were also two donaciine reed beetles, characteristic of emergent vegetation. *Cyphon* species are indicative of damp ground and *Dryops* sp. is associated with mud by water. Most of the non-aquatics, including at least three species of ‘froghoppers’, might have exploited damp ground habitats including lush vegetation and litter, but the two shield bugs (Cydnidae sp. and Pentatomidae sp.), along with *Drymus brunneus*, *Serica brunnea*, and two dung beetles—*Geotrupes* sp. and *Aphodius ater*—all suggest rather drier conditions.

Odacantha melanura is a ground beetle which is restricted to reed swamps and is usually found only to the south of Yorkshire (though it has been recorded in the extreme south of the county in the late 20th century. It has occasionally been found as a fossil in Yorkshire; both climate change and habitat destruction may have restricted its range.

The insect taxa represented in this sample suggest swampy land with drier areas and at least pools of open water.

Bracket Fungus (Sample 99)

Debris was washed from a bracket fungus (collected from Context 35) over a 300 micron mesh to gather any biological remains in it or the matrix immediately surrounding it.

Plant remains: There were twig and wood fragments, together with *Populus* bud-scales and seeds or fruits of *Carex*, *Rumex*, *Salix* and *Menyanthes trifoliata*.

Invertebrate remains: Fragmentation ranged from 3 to 5 with a mode of 4. Erosion ranged from 3 to 4 (mode 3). Very few taxa were recovered (5 species of beetle, some mites and fly puparia). Aquatic conditions were represented by ephippia of water fleas, *Daphnia* sp., and by *Hydraena* sp., while the presence of a donaciine indicates emergent or waterside plants. There were several *Cyphon* species, also denizens of swampy areas.

Context 34, Sample 34

1kg subsample (sieved to 300 microns with paraffin flotation)

Laboratory description: Moist, dark brown to black, woody detritus peat with an amorphous organic matrix. Fine in texture. Some small patches of grey (fine sandy) silt. Large wood fragments (up to 50mm in the subsample).

Plant macrofossils: The sample was highly organic and all of the material left after sieving was light enough to form a washover (of 1000 ml), which was inspected for plant remains and other components. The material consisted mainly of twig fragments and clasts of undisaggregated peat sediment matrix. Some wood charcoal was present, all the other material was uncharred. *Populus* (poplar) bud-scales were very abundant, along with various remains of *Betula* (*birch*), and various herbaceous species with broadly similar habitat requirements, such as *Menyanthes trifoliata* (bogbean), *Carex* spp. (sedges), *Solanum dulcamara* (bittersweet), *Cladium mariscus* (saw-sedge) and *Stachys* sp. (woundwort). Fragments of fruitstone of bird cherry, *Prunus padus* are not surprising in a wet woodland; it is not generally considered to be consumed by humans. Together, the plant remains point to wooded waterside or fen carr habitats.

Invertebrate remains: Fragmentation ranged from 2.5 to 5 with a mode of 4. Erosion ranged from 3.5 to 4.5 (mode 4). The flot obtained from paraffin flotation was rather small, and a limited assemblage of 20 species of beetle. Aquatics were relatively well represented, by the following taxa: *Hydrobius fuscipes*, *Agabus* sp., *Hydrochus* sp. and *Hydraena* sp. Waterside species of *Cercyon* were also present, together with *Cyphon*, which is associated with damp ground and waterside situations. One species associated with dung and rotting organic material was noted—*Geotrupes* sp.—but, apart from this, the whole fauna could have

exploited waterside habitats, probably indicating swampy conditions, with both wetter and drier areas.

Discussion

The deposits encountered at this site consisted of natural peats and humic silts, with some evidence for coarser mineral material in the lowermost levels investigated. Most of the layers examined during the assessment contained sufficient plant and insect remains to allow a useful reconstruction of depositional regime, local ecology and climate, though it would be necessary to process much larger subsamples in order to recover sufficient insect remains from most of the layers for detailed interpretation. Sample 40, in particular, yielded a rich and varied insect fauna including some unusual taxa. Given such assemblages, it will be possible to trace ecological and climatic development through these sequences of deposits, which probably include early Holocene strata as well as those associated with more conventionally 'Mesolithic' deposits.

Seeds and other plant remains together with insect fossils were preserved mainly by waterlogging and were recovered from all of the sub-samples investigated. While the plant remains were in a good state of preservation, many of the insects showed signs of moderate to severe degradation, largely resulting from fragmentation.

The recovered biota were indicative of aquatic and marshland habitats: essentially swamp with evidence for open water at some stages. The remains of *Populus* and *Betula* bud-scales, along with the presence of the beetle *Denticollis linearis*, the bug *Centrotus cornutus*, and the green flea beetle *Chalcoides* sp., support the existence of peripheral woodland or scrub. There is little evidence for human impact on vegetation, other than perhaps for burning of reedbeds. There were, however, a few insects indicative of short vegetation, probably grassland—though whether this was the result of human activity or natural grazing pressure will need to be established. The charred *Carex paniculata* present in two of the samples may evince an occurrence of deliberate clearance via burning, and therefore may show human activity which redirected the plant succession. This could be linked to the charcoal phase seen in some local sequences, which has been interpreted as a period of deliberate clearance as opposed to a natural fire (Mellars and Dark 1998). However, this hypothesis should be treated with caution in light of the lack of other evidence for human activity in the present assessment. There was certainly no evidence of human domestic activity in the immediate vicinity from the plant or insect remains.

A few of the insect records are notable: *Odacantha melanura* is a ground beetle of primarily southern distribution, although it has been found in South Yorkshire and may be more restricted by a requirement for extensive reed swamps than by climate; the shieldbug *Odontoscelis* sp. is suggestive of higher temperatures than the mid 20th century; while in contrast *Notaris aethiops* and *Otiorhynchus nodosus* are typically found in cold-stage faunas. An *Acidota* species appeared not to be one of the two British members of the genus.

Recommendations

Deposits of this date with good waterlogged preservation of insect remains have rarely been encountered in the area, and are restricted to a few locations elsewhere (notably the Somerset

Levels). Consequently, full analysis of the plant and invertebrate assemblages from all of the current sediment samples is recommended.

Careful work using museum collections will be required in order to confirm the identification of many of the insect species.

Any further excavation at this site should certainly be accompanied by comprehensive and systematic sampling of the full range of deposits encountered, assessment of organic remains present in the sediment, and subsequent integrated detailed analysis of the greatest possible range of biological remains where appropriate.

Retention and disposal

All of the sediment samples should be retained for further analysis, and subsequently for at least three years after publication to allow for further investigation. Flots and residues should be retained in the longer term.

Archive

All extracted fossils and flots are currently stored in the Department of Archaeology, University of York, along with paper and electronic work pertaining to the work described here.

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Table 1. Complete list of plant taxa recorded from deposits at Star Carr, Vale of Pickering, North Yorkshire. Taxonomy and nomenclature follow Tutin et al (1964-80). No. C = number of contexts in which taxon was recorded.

Name	Vernacular	Parts	No. C
cf. <i>Thelypteris palustris</i> Schott	?marsh fern	immature fronds	1
<i>Salix</i> sp(p).	willow	bud(s)	2
		fruit(s)	2
<i>Populus</i> sp(p).	poplar/aspens	bud(s) and/or bud-scale(s)	6
<i>Betula</i> sp(p).	birch	bud(s) and/or bud-scale(s)	1
		female catkin scale(s)	2
		fruit(s)	3
		male catkin fragment(s)	1
		male catkin scale(s)	1
<i>Rumex</i> sp(p).	docks	fruit(s)	2
<i>Nymphaea alba</i> L.	white water-lily	seed(s)	1
<i>Ranunculus lingua</i> L.	greater spearwort	achene(s)	1
<i>Thalictrum flavum</i> L.	common meadow rue	achene(s)	1
<i>Potentilla palustris</i> (L.) Scop.	marsh cinquefoil	achene(s)	1
<i>Prunus padus</i> L.	bird cherry	fruitstone fragment(s)	1
<i>Viola</i> sp(p).	violets/pansies, etc.	seed(s)	1
<i>Cicuta virosa</i> L.	cowbane	mericarp(s)	1
<i>Menyanthes trifoliata</i> L.	bogbean	seed(s)	8
<i>Galium</i> sp(p).	bedstraws, etc.	fruit(s)	1
<i>Galeopsis</i> sp(p).	hemp-nettles	nutlet(s)	1
<i>Stachys</i> sp(p).	woundworts	nutlet(s)	2
<i>Solanum dulcamara</i> L.	woody nightshade	seed(s)	1
<i>Solanum</i> sp(p).		seed(s)	1
<i>Valeriana officinalis</i> L.	cornsalads	fruit(s)	1
<i>Carduus/Cirsium</i> sp(p).	thistles	achene(s)	1
<i>Potamogeton</i> sp(p).	pondweeds	pyrene(s)	2
Gramineae	grasses	stem/leaf epidermis fragment(s)	1
<i>Sparganium</i> sp(p).	bur-reeds	fruit(s)	2
<i>Cladium mariscus</i> (L.) Pohl	great sedge/saw-sedge	nutlet(s)	2
<i>Carex paniculata</i> L.	tussock sedge	charred nutlet(s)	2
<i>Carex</i> sp(p).	sedges	nutlet(s)	8

Table 2. Complete list of invertebrate remains recorded from samples from Star Carr, Vale of Pickering, North Yorkshire. Order and nomenclature follow Kloet and Hincks (1964-77) for insects. Where both secure and tentative identifications for a given taxon were recorded, only the former are listed here. The remains were of adults unless stated. *ec* - ecological code (explained in Table 4); '*sp.*' indicates that record was probably an additional taxon, '*sp. indet.*' that the material may have been of a taxon listed above it.

Taxon	<i>ec</i>	<i>Acidota</i> sp.	<i>oa</i>
		<i>Xylodromus concinnus</i> (Marsham)	rt-st
* <i>Daphnia</i> sp. (ephippium)	<i>oa-w</i>	Omaliiinae spp.	rt
		<i>Stenus</i> spp.	u
Cydnidae sp.	<i>oa-p</i>	<i>Paederus</i> sp.	<i>oa</i>
<i>Odontoscelis</i> sp.	<i>oa-p</i>	<i>Lathrobium</i> spp.	u
Pentatomidae sp.	<i>oa-p</i>	<i>Xantholinus</i> sp.	u
<i>Chilacis typhae</i> (Perris)	<i>oa-p-d</i>	<i>Philonthus</i> sp.	u
<i>Stygnocoris</i> sp.	<i>oa</i>	Staphylininae sp.	u
<i>Drymus ?brunneus</i> (Sahlberg)	<i>oa-p</i>	<i>Mycetoporus</i> sp.	u
Lygaeidae sp.	<i>oa-p</i>	<i>Tachinus</i> sp.	u
<i>Microvelia</i> sp.	<i>oa-w</i>	<i>Cratarea suturalis</i> (Mannerheim)	rt-st
<i>Gerris</i> sp.	<i>oa-w</i>	Aleocharinae sp.	u
<i>Centrotus cornutus</i> (Linnaeus)	<i>oa-p</i>	Pselaphidae sp.	u
<i>Aphrodes</i> sp.	<i>oa-p</i>	<i>Geotrupes</i> sp.	<i>oa-rf</i>
Cicadellidae spp.	<i>oa-p</i>	<i>Aphodius ater</i>	<i>oa-rf</i>
Delphacidae sp.	<i>oa-p</i>	<i>Aphodius</i> sp.	<i>ob-rf</i>
		<i>Serica brunnea</i> (Linnaeus)	<i>oa-p</i>
*Acarina sp.	u	<i>Cyphon</i> spp.	<i>oa-d</i>
*Bibionidae sp.	u	<i>Dryops</i> sp.	<i>oa-d</i>
*Chironomidae sp.	w	? <i>Dalopius marginatus</i> (Linnaeus)	<i>oa-p</i>
*Diptera sp. (puparium)	u	? <i>Denticollis linearis</i> (Linnaeus)	u
*Oligochaeta sp. (egg capsule)	u	Cantharidae sp.	<i>ob</i>
		? <i>Kateretes</i> sp.	<i>oa-p-d</i>
<i>Bembidion</i> sp.	<i>oa</i>	<i>Micrambe</i> sp.	u
<i>Pterostichus nigrata</i> (Paykull)	<i>oa-d</i>	<i>Atomaria</i> spp.	rd
<i>Pterostichus</i> sp.	<i>ob</i>	<i>Phalacrus</i> sp.	<i>oa-p</i>
<i>Agonum</i> sp.	<i>oa</i>	<i>Corylophus</i> sp.	rt
<i>Odacantha melanura</i> (Linnaeus)	<i>oa-d</i>	? <i>Enicmus</i> sp.	rt-sf
Carabidae spp. and spp. indet.	<i>ob</i>	<i>Corticaria</i> sp.	rt-sf
Hydroporinae sp.	<i>oa-w</i>	Corticariinae spp.	rt
<i>Agabus</i> spp.	<i>oa-w</i>	? <i>Anaspis</i> sp.	<i>ob</i>
<i>Agabus</i> or <i>Ilybius</i> sp.	<i>oa-w</i>	Donaciinae spp.	<i>oa-d-p</i>
<i>Rhantus</i> sp.	<i>oa-w</i>	<i>Adoxus obscurus</i> (Linnaeus)	<i>oa-p</i>
<i>Gyrinus</i> sp.	<i>oa-w</i>	<i>Phaedon tumidulus</i> (Germar)	<i>oa-p</i>
<i>Hydrochus</i> sp.	<i>oa-w</i>	<i>Phaedon</i> sp.	<i>oa-p</i>
<i>Sphaeridium</i> sp.	rf	<i>Phyllotreta</i> sp.	<i>oa-p</i>
<i>Cercyon</i> spp.	u	<i>Altica</i> sp.	<i>oa-p</i>
<i>Megasternum obscurum</i> (Marsham)	rt	? <i>Crepidodera</i> sp.	<i>oa-p</i>
<i>Hydrobius fuscipes</i> (Linnaeus)	<i>oa-w</i>	<i>Chalcoides</i> sp.	<i>oa-p</i>
<i>Chaetarthria seminulum</i> (Herbst)	<i>oa-w</i>	Chrysomelidae sp.	<i>oa-p</i>
Hydrophilinae spp.	<i>oa-w</i>	<i>Apion</i> spp.	<i>oa-p</i>
<i>Ochthebius</i> sp.	<i>oa-w</i>	<i>Otiorhynchus ?nodosus</i> (Muller)	<i>oa-p</i>
<i>Hydraena</i> sp.	<i>oa-w</i>	<i>Phyllobius</i> sp.	<i>oa-p</i>
<i>Ptenidium</i> sp.	rt	? <i>Sitona</i> sp.	<i>oa-p</i>
<i>Acrotrichis</i> sp.	rt	<i>Tanysphyrus lemnae</i> (Paykull)	<i>oa-w-p</i>
Scydmaenidae sp.	u	<i>Bagous</i> sp.	<i>oa-w</i>

<i>Notaris</i> sp.	oa-d-p	Ceuthorhynchinae sp.	oa-p
<i>Micrelus ericae</i> (Gyllenhal)	oa-p-m	<i>Limnobaris</i> sp.	oa-p-d
<i>Ceutorhynchus</i> sp.	oa-p	Curculionidae spp.	oa

Table 3. Species lists and ecological codes for invertebrate macrofossils from samples from Star Carr, Vale of Pickering, North Yorkshire. For each sample assemblage the adult Hemiptera (bugs) and Coleoptera (beetles) are listed first, followed by the remaining invertebrates. Headers: weight is in kilogrammes; E - erosion; F - fragmentation (following Kenward and Large 1998. For translation of ecological codes, see Table 4.

Context: 34 Sample: 34/T ReM: A
Weight: 1.00 E: 4.00 F: 4.00

Notes: lithology as 35 and 39 but perhaps more brown in colour with small patches of grey (fine sandy) silt. Also finer in texture. Contained large wooden fragments - 5cm scale. Left to soak overnight.

Carabidae sp.	ob	Pselaphidae sp.	u
<i>Agabus</i> sp.	oa-w	<i>Geotrupes</i> sp.	oa-rf
<i>Hydrochus</i> sp.	oa-w	<i>Cyphon</i> sp.	oa-d
<i>Cercyon</i> spp.	u	? <i>Denticollis linearis</i>	u
<i>Hydrobius fuscipes</i>	oa-w	? <i>Enicmus</i> sp.	rt-sf
<i>Hydraena</i> sp.	oa-w	?Corticariinae sp.	rt
<i>Stenus</i> spp.	u	Ceuthorhynchinae sp.	oa-p
? <i>Lathrobium</i> sp.	u	Curculionidae sp.	oa
Aleocharinae sp.	u		

Context: 35 Sample: 35/T ReM: S
Weight: 1.00 E: 3.50 F: 3.50

Notes: lithology same as 39. Large numbers of unidentifiable fragments. Sample re-paraffin floated due to failure first time

Cydnidae sp.	oa-p	<i>Ochthebius</i> sp.	oa-w
Pentatomidae sp.	oa-p	<i>Hydraena</i> sp.	oa-w
<i>Drymus ?brunneus</i>	oa-p	<i>Ptenidiium</i> sp.	rt
<i>Microvelia</i> sp.	oa-w	Scydmaenidae sp.	u
Cercopidae sp.	oa-p	<i>Stenus</i> spp.	u
<i>Aphrodes</i> sp.	oa-p	<i>Paederus</i> sp.	oa
Cicadellidae sp.	oa-p	<i>Philonthus</i> sp.	u
<i>Bembidion</i> sp.	oa	Aleocharinae sp.	u
<i>Pterostichus nigrita</i>	oa-d	Pselaphidae sp.	u
<i>Pterostichus</i> sp. indet.	ob	<i>Geotrupes</i> sp.	oa-rf
<i>Odacantha melanura</i>	oa-d	<i>Aphodius ater</i>	oa-rf
Hydroporinae sp.	oa-w	<i>Serica brunnea</i>	oa-p
<i>Agabus</i> sp.	oa-w	<i>Dascillus cervinus</i>	oa-p
<i>Gyrinus</i> sp.	oa-w	<i>Cyphon</i> spp.	oa-d
<i>Hydrochus</i> sp.	oa-w	<i>Dryops</i> sp.	oa-d
<i>Sphaeridium</i> sp.	rf	<i>Corylophus</i> sp.	rt
<i>Cercyon</i> spp.	u	Donaciinae spp.	oa-d
<i>Megasternum obscurum</i>	rt	<i>Phaedon</i> sp.	oa-p
<i>Hydrobius fuscipes</i>	oa-w	? <i>Crepidodera</i> sp.	oa-p
<i>Chaetarthria seminulum</i>	oa-w	<i>Tanysphyrus lemnae</i>	oa-w-p
Hydrophilidae sp.	u	<i>Bagous</i> sp.	oa-w

Curculionidae spp.	oa	*Diptera sp. (puparium)	u
*Daphnia sp. (ephippium)	oa-w	*Acarina sp.	u

Context 35: Bracket fungus Sample: 99 ReM: S
E: 3.00 F 4:00

? <i>Hydraena</i> sp.	oa-w	*Acarina sp.	u
<i>Stenus</i> sp.	u	*Daphnia sp. (ephippium)	u
<i>Cyphon</i> spp.	oa-d	*Diptera sp. (puparium)	u
Donaciinae sp.	oa-d-p	*Oligochaeta sp. (egg capsule)	u

Context: 39 Sample: 39/T ReM: S
Weight: 1.00 E: 3.50 F: 4.00

Notes: Moist, very dark brown to black, woody detritus peat (firm working crumbly) with amorphous organic matrix

<i>Aphrodes</i> sp.	oa-p	<i>Lathrobium</i> spp.	u
Delphacidae sp.	oa-p	<i>Philonthus</i> sp.	u
Carabidae spp.	ob	<i>Cyphon</i> spp.	oa-d
<i>Hydroporinae</i> sp.	oa-w	<i>Dryops</i> sp.	oa-d
<i>Agabus</i> or <i>Ilybius</i> sp.	oa-w	<i>Corylophus</i> sp.	rt
<i>Cercyon</i> spp.	u	<i>Corticaria</i> sp.	rt-sf
<i>Megasternum obscurum</i>	rt	Donaciinae sp.	oa-d-p
<i>Hydrobius fuscipes</i>	oa-w	Chrysomelidae sp.	oa-p
<i>Acidota</i> sp.	oa	Ceuthorhynchinae sp.	oa-p
<i>Stenus</i> sp.	u	*Acarina sp.	u

Context: 39.20 Sample: 39/T ReM: S
Weight: 1.00 E: 4.00 F: 4.00

Notes: Sample taken beneath antler!! Moist, very dark brown to black, woody detritus peat with amorphous organic matrix, working crumbly, rubbing black.

<i>Agabus</i> or <i>Ilybius</i> sp.	oa-w	Donaciinae spp.	oa-d-p
?Hydrophilidae sp.	u	Curculionidae spp.	oa
? <i>Corylophus</i> sp.	rt	*Diptera sp. (puparium)	u

Context: 40 Sample: 40/T ReM: S
Weight: 1.00 E: 0.00 F: 0.00

Notes: Moist, very dark brown to black, rubbing black, amorphous organic with a little sand and some small (<10mm) gravel.

<i>Odontoscelis</i> sp.	oa-p	Delphacidae sp.	oa-p
<i>Chilacis typhae</i>	oa-p-d	<i>Agonum</i> sp.	oa
<i>Stygnocoris</i> sp.	oa	? <i>Agabus</i> sp.	oa-w
<i>Gerris</i> sp.	oa-w	<i>Rhantus</i> sp.	oa-w
<i>Centrotus cornutus</i>	oa-p	<i>Gyrinus</i> sp.	oa-w
Cicadellidae spp.	oa-p	<i>Megasternum obscurum</i>	rt

<i>Hydrobius fuscipes</i>	oa-w	<i>Atomaria</i> spp.	rd
Hydrophilinae sp.	oa-w	<i>Phalacrus</i> sp.	oa-p
<i>Ochthebius</i> sp.	oa-w	Corticariinae sp.	rt
<i>Hydraena</i> sp.	oa-w	Donaciinae spp.	oa-d-p
<i>Acrotrichis</i> sp.	rt	<i>Adoxus obscurus</i>	oa-p
Scydmaenidae sp.	u	<i>Phaedon tumidulus</i>	oa-p
<i>Acidota</i> sp.	oa	<i>Phaedon</i> spp. indet	oa-p
Omalinae sp.	rt	<i>Phyllotreta</i> sp.	oa-p
<i>Stenus</i> spp.	u	<i>Altica</i> sp.	oa-p
<i>Xantholinus</i> sp.	u	<i>Chalcoides</i> sp.	oa-p
<i>Mycetoporus</i> sp.	u	Chrysomelidae sp.	oa-p
<i>Tachinus</i> sp.	u	<i>Apion</i> spp.	oa-p
Aleocharinae sp.	u	<i>Phyllobius</i> sp.	oa-p
<i>Aphodius</i> sp.	ob-rf	? <i>Sitona</i> sp.	oa-p
<i>Serica brunnea</i>	oa-p	<i>Notaris aethiops</i>	oa-p-d
<i>Cyphon</i> sp.	oa-d	<i>Micrelus ericae</i>	oa-p-m
? <i>Dalopius marginatus</i>	oa-p	<i>Ceutorhynchus</i> sp.	oa-p
? <i>Denticollis linearis</i>	u	Curculionidae spp.	oa
Cantharidae sp.	ob	*Bibionidae sp.	u
? <i>Kateretes</i> sp.	oa-p-d	*Acarina	u
<i>Micrambe</i> sp.	u		

Context: 41 Sample: 41/T ReM: S

Weight: 2.00 E: 3.50 F: 4.00

<i>Chilacis typhae</i>	oa-p-d	Aleocharinae sp.	u
<i>Stygnocoris</i> sp.	oa	<i>Corticaria</i> sp.	rt-sf
Lygaeidae sp.	oa-p	? <i>Anaspis</i> sp.	ob
Cicadellidae sp.	oa-p	Donaciinae sp.	oa-d-p
<i>Megasternum obscurum</i>	rt	<i>Tanysphyrus lemnae</i>	oa-w-p
<i>Ochthebius</i> sp.	oa-w	<i>Notaris</i> sp.	oa-d-p
<i>Hydraena</i> sp.	oa-w	Curculionidae sp.	oa
<i>Acidota</i> sp.	oa	*Bibionidae sp.	u
?Omalinae sp.	rt	*Chironomidae sp.	w
<i>Stenus</i> spp.	u	*Acarina sp.	u
Staphylininae sp.	u		

Context: 42 Sample: 42/T ReM: S

Weight: 1.00 E: 0.00 F: 0.00

? <i>Pterostichus</i> sp.	ob	Aleocharinae sp.	u
Carabidae sp.	ob	Donaciinae sp.	oa-d-p
<i>Megasternum obscurum</i>	rt	<i>Otiorhynchus ?nodosus</i>	oa-p
Hydrophilinae sp.	oa-w	<i>Notaris aethiops</i>	oa-p-d
<i>Xylodromus concinnus</i>	rt-st	<i>Limnobaris</i> sp.	oa-p-d
<i>Cratarea suturalis</i>	rt-st	*Diptera sp. (puparium)	u

Table 4. Abbreviations for ecological codes and statistics used for interpretation of insect remains in text and tables. Lower case codes in parentheses are those assigned to taxa and used to calculate the group values (the codes in capitals). See Table 2 for codes assigned to taxa from the present site. Indivs - individuals (based on MNI); No - number. N.B. This is a standard table and refers to statistics not used in the present text.

No taxa	S	Percentage of indivs of grain pests	PNG
Estimated number of indivs (MNI)	N	No decomposer taxa (rt + rd + rf)	SRT
Index of diversity (α)	alpha	Percentage of RT taxa	PSRT
Standard error of alpha	SE alpha	No RT indivs	NRT
No 'certain' outdoor taxa (oa)	SOA	Percentage of RT indivs	PNRT
Percentage of 'certain' outdoor taxa	PSOA	Index of diversity of RT component	alpha RT
No 'certain' outdoor indivs	NOA	Standard error	SEalphaRT
Percentage of 'certain' outdoor indivs	PNOA	No 'dry' decomposer taxa (rd)	SRD
No OA and probable outdoor taxa (oa+ob)	SOB	Percentage of RD taxa	PSRD
Percentage of OB taxa	PSOB	No RD indivs	NRD
No OB indivs	NOB	Percentage of RD indivs	PNRD
Percentage OB indivs	PNOB	Index of diversity of the RD component	alphaRD
Index of diversity of the OB component	alphaOB	Standard error	SEalphaRD
Standard error	SEalphaOB	No 'foul' decomposer taxa (rf)	SRF
No aquatic taxa (w)	SW	Percentage of RF taxa	PSRF
Percentage of aquatic taxa	PSW	No RF indivs	NRF
No aquatic indivs	NW	Percentage of RF indivs	PNRF
Percentage of W indivs	PNW	Index of diversity of the RF component	alphaRF
Index of diversity of the W component	alphaW	Standard error	SEalphaRF
Standard error	SEalphaW	No synanthropic taxa (sf+st+ss)	SSA
No damp ground/waterside taxa (d)	SD	Percentage of synanthropic taxa	PSSA
Percentage D taxa	PSD	No synanthropic indivs	NSA
No damp D indivs	ND	Percentage of SA indivs	PNSA
Percentage of D indivs	PND	Index of diversity of SA component	ALPHASA
Index of diversity of the D component	alphaD	Standard error	SEALPHASA
Standard error	SEalphaD	No facultatively synanthropic taxa (sf)	SSF
No strongly plant-associated taxa (p)	SP	Percentage of SF taxa	PSSF
Percentage of P taxa	PSP	No SF indivs	NSF
No strongly P indivs	NP	Percentage of SF indivs	PNSF
Percentage of P indivs	PNP	Index of diversity of SF component	ALPHASF
Index of diversity of the P component	alphaP	Standard error	SEALPHASF
Standard error	SEalphaP	No typical synanthropic taxa (st)	SST
No heathland/moorland taxa (m)	SM	Percentage of ST taxa	PSST
Percentage of M taxa	PSM	No ST indivs	NST
No M indivs	NM	Percentage of ST indivs	PNST
Percentage of M indivs	PNM	Index of diversity of ST component	ALPHAST
Index of diversity of the M component	alphaM	Standard error	SEALPHAST
Standard error	SEalphaM	No strongly synanthropic taxa (ss)	SSS
No wood-associated taxa (l)	SL	Percentage of SS taxa	PSSS
Percentage of L taxa	PSL	No SS indivs	NSS
No L indivs	NL	Percentage of SS indivs	PNSS
Percentage of L indivs	PNL	Index of diversity of SS component	ALPHASS
Index of diversity of the L component	alphaL	Standard error	SEALPHASS
Standard error	SEalphaL	No uncoded taxa (u)	SU
No indivs of grain pests (g)	NG	Percentage of uncoded indivs	PNU

