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Ancient Monuments Laboratory
Report 14/90

MESOLITHIC AND LATER LANDSCAPES INTERPRETED FROM THE INSECT ASSEMBLAGES OF WEST HEATH SPA, HAMPSTEAD, LONDON.

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Summary

Organic samples from a spring on Hampstead Heath, north London contained a number of important beetle faunas. The results indicate old forest with lime, and rotting trees in the early part of the neolithic sequence. Dung beetles appear at the elm decline horizon (later neolithic), and there are less signs of forest and more of damp open soils, pools and of insects feeding upon aquatic vegetation.

Author's address :-

Maureen Girling

Mesolithic and later landscapes interpreted from the insect assemblages of West Heath Spa, Hampstead.

Maureen A. Girling

INRODUCTION

The excavation of the Mesolithic site at West Heath, Hampstead, the preliminary stages of which are described by Lorimer (1976), was carried out on a platform of Bagshot Sands. The dry, acidic soils afforded little opportunity for the survival of organic remains apart from charcoal. The existence, however, of a spring-line at the junction of sand and clay bedrock about 450m uphill of the excavation, had led to permanent waterlogging of the sediments which had filled a shallow basin. This had brought about preservation of pollen and macroscopic remains of seeds and insects. Accordingly, investigative techniques based on these remains could be applied to the deposits. In 1976, a pit was dug into the approximate centre of the spa-fed boggy area, and a column of sediments of approximately 150cm was exposed. From the base of the pit, a further depth of 30cm of grey, organic clays was proved by boring. Samples for botanical and insect work were collected at 5cm intervals and approximately 3kg was removed per layer. Additional samples were collected for possible radiocarbon dating. In the column, summarised in Fig. 000 the sediments graded from pebbly grey clay at the base, through to a darker organic mud. Higher up, the clays were less organic and at about 80 cm from the surface, a charcoal-rich layer was visible. Towards the top of the sample column, the organic content again increased and gleying was noted. Some roots penetrated the section to a depth of about 75cm, but a dense root-mat overlain by a thin soil and compressed ground vegetation occupied the upper 15cm and this was not sampled. An ordnance datum point was arbitrarily fixed at the top of the sample column (i.e. 15cm below the present ground surface) in order to relate the deposit to the excavation downhill (Fig 000).

At the time these first samples were taken it was not possible to estimate the age-span of the deposits but James Greig's pollen results suggested that the lowest samples represented a phase of Atlantic (pre-elm decline) forest (Girling & Greig 1977). On the basis of these results a second sample series was collected in 1977. Heavy machinery was used to excavate a trench in which a freshly exposed side was cut back.

In this second profile sediments were collected to a depth of 140cm and a sampling interval of 10cm was adopted, with approximately 5kg of material removed from each layer. Analysis of this second column indicated that the results were generally poorer than from the 1976 column. Apart from the upper 40cm, fewer macrofossils per kg of sediment were recovered in the lower half, and these were badly preserved. Also, it appears likely that the basal samples of the two columns do not correspond in age, with the oldest deposits not represented in the 1977 column whose basal layers relate to a higher level of the 1976 column. The upper 40cms with well preserved insects coincide with an upper band of 15cm in the upper column where the youngest layers appear to be compressed or truncated.

As a result of the poorer preservation, and the lack of correspondance of the 1977 insect fauna, that recorded from the 1976 samples provides the basis for the environmental reconstruction of this report.

Sample processing techniques

Processing of the large samples for macrofossils (e.g. seeds, insects etc.) was undertaken at the Ancient Monuments Laboratory, whilst pollen preparations were carried out by James Greig at Birmingham University. Macrofossils were extracted from the same samples, with the standard techniques modified to suit their recovery. Insects, in view of their greater fragility were initially retrieved. The sediments were first soaked in a solution of sodium carbonate in hot water, with the compact clay layers being left for up to 5 days, the soda solution being renewed at intervals. Samples were disaggregated by hand, with as little mechanical pressure as possible although some manipulation was necessary as despite the prolonged soaking, the clays remained very cohesive. When the sediments were reduced to a slurry, they were washed on a 300 micron sieve, drained, mixed with paraffin (kerosene) in a bowl and the addition of cold water produced a flotant with the insect and lighter plant remains. This flotation process was repeated until no further remains were observed in the flotant. Flotants were then sorted microscopically. Although this technique usually recovers most insects, in the West Heath samples, many cylindrical sclerites (for instance complete beetle thoraces) had a dense packing of fine sediment or growths of crystals into the cavities and these tended not to float. Paraffined residues were therefore also microscopically scanned. Once insects had been recovered from the flotants, these and the parafinned residues were submitted to James Greig for extraction of the macroscopic plant remains after some further sieving and sorting. When the samples collected for C14 dating were washed and sieved to concentrate the organic fraction, this was found to contain roots and rootlets of uncertain age but clearly originating from a horizon or horizons post-dating the samples. In view of the error that would arise from the introduction of more recent 14C into prehistoric deposits, it was decided not to submit this material for 14C dating, but to rely on the pollen zonation.

RESULTS OF THE INSECT ANALYSIS

The species identified from West Heath Spa 1976 samples are given in Table 1. . There is a high degree of correspondance between the insects and the 1977 pollen results, in particular the pollen zones WHS 1-4, and therefore this division has been adopted for the presentation of the insect data.

WHS1 (130-100cm, samples A-G)

The samples are dominated by forest beetles, with generally 40% of species requiring tree-dependant habitats (the exception is layer 105-110 cm where the value falls to 34%. Other members of the fauna frequently occur in woodland, for instance those ground beetles which favour mull forest soils. The poorly preserved fauna from the basal sample contains six beetle taxa of which two, both weevils, are identified to species: *Rhynchaenus quercus* is the oak leaf-miner and *Strophosomus capitatus* occurs on oak and other trees. Freude, Harde and Lohse (1981) regard the latter species as polyphagous (eating various things) however, and noted its larvae on *Calluna vulgaris* (heather) although they state that the edult always occurs in well-shaded places. Of the remaining beetles there is one further tree feeder, a pond-edge species and two found in decaying vegetation. Also of interest in this sample are skeletonised deciduous leaf remains displaying small insect-formed galls, almost certainly attributable to Hymenoptera (bees and wasps). Immediately overlying this sample, the very pebbly sediments yielded no recognisable remains from 125 - 130cm but the next layer produced a comparatively rich fauna, with 10 of the 24 species dependant upon wood.

At this level are the earliest site records of *Ernoporus caucasicus*, a species of particular significance in the light of pollen data. This tiny bark beetle feeds upon *Tilia* (the lime tree), and therefore it would be strongly favoured by the lime dominated woodland interpreted at this stage for the site (see the botanical report). A subfossil pronotum from West Heath Spa is shown. It is an example of a beetle which was formerly widespread in prehistoric times before major forest clearance, but which has undergone a dramatic decline with the progressive removal of the lime-dominated forests of the South, East and Midlands of England. Sites such as Shustoke, Shropshire (Kelly & Osborne 1965) and Thorne Waterside, Humberside (Buckland, *pers. comm.*) noted that there were large populations of the species surviving until about the Bronze Age in the case of the latter, and two specimens were found in the Late Neolithic (but not the Bronze Age) levels at Runnymede, Surrey (Robinson in press). Today it is a recent addition to the British List (Allen 1969), and it is now known from a very few Midland localities (Cooter 1980) although its fossil record confirms its native status.

Another example from this layer of a recent addition to the British List of beetles, but with a number of prehistoric records which support its native status and subsequent decline, in *Gastrallus immarginatus*. Donisthorpe (1939) has recorded the species in Windsor Forest, and it is found on a variety of deciduous trees, including *Ulmus* (elm) and *Acer* (field maple). These implications for mature deciduous forest are emphatically reinforced by a beetle no longer found in Britain: *Pycnomerus terebrans* at present displays a very scarce, sporadic distribution in mainland Europe where it is regarded as a relict species of old forest. It lives in rot holes or under the bark of old decayed deciduous trees, especially of oak. The beetle frequently occurs with the ant *Lasius brunneus* and whilst Horion (1960) regards this as myrmecophilous (ant related) behaviour, Dajoz (1977) suggests rather that it is simply tolerated by the ant. There are now fossil records of this species from Neolithic peats in Shropshire and Somerset (Osborne 1972, Girling unpubl.). Its requirement for decayed wood, usually indicative of undisturbed forests, places the species at risk from both tree clearance and the utilisation of dead wood for fuel etc. and it is likely that *P. terebrans* was unable to survive man's encroachment and fragmentation of its woodland habitats.

The weevil *Eremotes ater* is another decayed wood specialist. Today it occurs no further south that Sherwood Forest, and most capture records are for the pine-woods of Scotland, but again archaeological records have indicated that it was formerly widespread in Southern and Eastern England, for example Buckland (1979), Girling (1979). Its northwards retreat is at first suggestive of climatic warming, but this explanation finds no support amongst the overall beetle composition of the faunas where it occurs. Rather, it is known from Southern Britain at a time when warmer than present summers have been postulated (Girling 1984). A more likely reason for its loss from Southern Britain again appears to be the pressure on its dead wood habitats by the early farmers (Buckland *loc. cit.*). A further inhabitant of decayed deciduous trees from the sample is *Melasis buprestoides*. There are records of the bark beetle *Xyleborus dryophagus* which attacks various deciduous and coniferous hosts and *Scolytus scolytus* which feeds predominantly upon elm although it is also known from oak, hazel, poplar, willow and ash. Any record of *S. scolytus* of this age is of especial significance when related to the elm decline horizon about 20cm above this level (Girling & Greig 1985, Girling 1988). Whilst the anthropogenic mechanisms of foliage cutting or tree felling for cattle husbandry and cultivation have hitherto been used to explain the widespread reduction in elm pollen, the alternative view has been explored elsewhere that this could have been caused by an epidemic such as Dutch Elm Disease which devastated the populations of elms in the seventies (Rackham 1980). *S. scolytus*, the elm bark beetle can carry *Ceratocystis*, the fungus responsible for the disease. The faunal changes marking the elm decline are discussed at the end of the section on WHS 2. Another tree-dependant beetle from this sample includes *Curculio nucum* the "nut weevil" which develops inside hazel nuts: pollen of this shrub is represented throughout the pollen diagram. The weevil always occurs in low numbers in the samples, suggesting that hazel nuts were available but not common. Flowering and subsequent fruiting of the tree is inhibited by shading. Amongst other beetles are two examples of *Silpha atrata*, a predator on snails.

14 of the 23 beetles from layer 115 - 120cm are dependant on trees, the highest proportion at the site. An important record is that of *Isorhipis melasoides*, the other beetle from Hampstead Heath which has become extinct in Britain during or since prehistoric times. The species usually occurs on beech, a tree considered to be a later immigrant to Britain, and which is not represented in the pollen profile in this lower part of the pollen diagram here. Other host trees have however been reported for *I. melasoides*, including oak and poplar (Horion 1953, Auber 1960). Today in mainland Europe the beetle has a disjunct distribution, occurring (in the West of its range) in Central and South France, West Germany, Austria, Switzerland and North Italy, and (in the East) in Eastern Germany, Poland and Czechoslovakia. Where it does occur, it is usually rare and sporadic in its ancient woodland habitats. Fossil records from Britain indicate that it formerly occurred in prehistoric deposits from Somerset and Derbyshire (Girling 1980, Osborne *pers. comm.*). Other beetles from this level have very restricted distributions in present day Britain, amongst them the weevil *Dryophthorus corticalis* and *Hadrobregmus denticollis*, a member of the "woodworm" family. The former prefers damp, rotten wood of both deciduous and coniferous trees but the latter also attacks dry wood, especially oak and hawthorn, and it is known from worked timber. Reitter (1911) records it in forest clearings. Another Anobiid ("woodworm") is *Ptilinus pecticornis* known from various dead hardwoods including willow and oak. Decaying trees are required by *Cerylon ferrugineum* and *Rhizophagus parallelocollis* and they are often found under loose bark, preying on smaller arthropods (Horion 1953). Larval development of *Denticollis linearis* is in decaying stems of deciduous trees. The two longhorns (Cerambycidae) in the sample usually attack living deciduous trees including oak, elm and in the case of *Pogonocherus hispidus*, holly, the pollen record of which starts in WHS 2.

A similar pattern of mature, undisturbed, deciduous forest emerges from layer 110 - 115cm, with indications of lime, oak and hazel amongst the hosts of the tree-dependant beetles. In the layer above this there are two further records of bark beetles; *Kissophagus hederae* attacks stems of ivy, which is here represented in the pollen record, and *Acrantus vittatus* which is frequently found on elm. With these are continuing records of the lime feeder *E. caucasicus*. The decayed wood species *Gastrullus immarginatus* and *Ptilinus pecticornis* also recur, supporting the inference of the essentially undisturbed character of the woodland. Noticeable in the WHS 1 faunas is the poverty of beetles which feed on light-demanding plants and shrubs.

WHS 2 (95-75 cm, samples H - L)

A major faunal change occurs at 100 - 105cm, coinciding with the elm decline on the pollen diagram. The number of insects recovered is lower than that for earlier samples. Lime and oak and indicated by host tree requirements of two of the species and there is a decaying wood beetle, but the overall diversity of the lower layers is lacking. Even these few wood-dependant beetles are absent from layer 95 - 100cm, where two types of habitat are required by the very poor fauna. *Helophorus* species live in a range of ponds, swamps and flooded hollows, often occurring amongst weeds at the water's edge, and such habitats are also suitable for *Enochrus* species.

The significant arrivals at this horizon, however, are the dung beetles. *Aphodius* species are strong fliers and as only two individuals are present, their occurrence could be adventitious. This small number does, however, reflect the overall low productivity of the clays which infilled the small basin, which even at their most organic, yield relatively small suites of insect remains and seeds. Of more importance than the numbers is the fact that scarabeid dung beetles plus those staphylinids and hydrophilids which are frequently collected from dung, and which hitherto do not appear in the succession, are almost continuously present for ten samples at and above the elm decline horizon. This implies that grazing animals were present in the vicinity. One of the dung beetles from layer 95 - 100cm has been specifically identified as *Aphodius scropha*, today an exceedingly rare beetle in this country. Britten (1956), for instance, only records it from Lancashire and Cornwall. In France, where it is noted as rarely abundant, Paulian (1959) indicates that the beetle prefers dry sheep dung, and in Germany, where it occurs particularly on sandy soils, it has been found in sheep and horse dung and in human excrement (Freude, Harde and Lohse 1969). A preference for dry sandy substrata would be met by the Bagshot Sands formation on which the site is located.

In layer 90 - 95cm, there is continuing evidence for aquatic habitats, with *Coelostoma orbiculare* included in the water beetles. *Dryops*, usually found in swampy or wet, muddy ground is also present. The ground beetle *Trechus micros* frequently occurs on the banks of streams although it is know from rodent burrows (Lindroth 1974).

Wood-dependant beetles are present in this sample and include *Rhynchaenus quercus*, the oak leaf feeder. The others are decayed wood beetles; *Eremotes ater*, recorded from earlier samples, and *Synchita* sp. found in fungus infested bark and wood. *Trixagus elateroides* has been collected from wood and leaf litter in light woodland. Three ground beetle species are present in the next layer. *Pterostichus niger* is known in light forest where it is found for instance under tree bark, and *P. nigrita* is widespread, usually around water. *Bembidion biguttatum* also prefers the vicinity of water and is found in mull soils of meadows or light forests. The oak leaf-miner is again present at this level and there are a number of water beetles including *Helophorus aquaticus*, identified by the regular tooth pattern of the last abdominal sternite, and *Graptodytes pictus*, typically a pond or ditch inhabitant. A further water beetle from the next sample is *Hydrochus angustatus*, the elytra (wing-cases) characterised by the larger apical punctures than are seen in other members of the genus. The final WHS2 sample displays a sharp rise in insect numbers and diversity. The ground beetles *Trechus secalis*, *Bembidion unicolor* and *Agonum obscurum*, all found on damp organic soils of meadows or light woodland are represented by totals of 5, 5 and 3 respectively. The aquatic fauna includes *Chaetarthria seminulum* although certain other hydrophilids (*Megasternum obscurum* and *Cryptopleurum minutum*) are more typical of rotting vegetation or dung.

The disparity between the faunas of WHS 1 and WHS 2 provides clues to the reasons for the change. The histogram of main indicator species at each level (Table 2) shows that the tree dependent beetles dominate in the lower samples. The only phytophages not host-specific to trees or wetland plants are *Sciaphilus asperatus* and *Brachysomus echinatus* which are polyphagous on various shrubs and dry grasses and tend to occur under leaves or moss, often on sandy substrates. Lacking is clear cut evidence in host-plant requirements for light demanding herbs and flowers. This would suggest effective shading of the forest floor by an unbroken canopy of mature trees except for natural clearings around water. Occasional openings due to the fall of a moribund tree were likely to have been colonised by hazel while regeneration of the other forest trees took place. After the elm decline, forest beetle numbers are reduced although both are represented and the arrival of dung beetles is accompanied by an increase in aquatic species. Clearly there is a landscape change initially characterised by a reduction in elm pollen production followed by opening up of the former dense forest. Increased numbers of carabids, also seen in the histogram, are recorded elsewhere in clearings in present-day forest (Lenski 1982). The occurrence below the elm decline horizon of *S. scolytus* indicates that the main carrier of the present day Dutch Elm Disease fungus was present in the vicinity, but direct evidence of any fungus of sufficient virulence to cause such widespread damage to the elm population (e.g. fungal spores of *Ceratocystis ulmi* in preserved elm sapwood from this stage of the prehistoric) has yet to be recognised, if indeed it even survives since sapwood is more liable to decay than heartwood.

The dung beetle evidence argues for some movement of large herbivore animals to the area, although this would be a natural consequence of the opening up of the forest. The rise in aquatic species is suggestive of tree removal causing increased run-off of surface water. An anthropogenic explanation of early farmers bringing stock to the area and feeding it upon tree foliage and/or felling trees to open up the forest for grazing and cultivation can be accomodated in the overall faunal change at the site. Nevertheless, a disease mechanism is not ruled out, as widespread migration of early human populations could have been instrumental in introducing new viruses and if tree leaf fodder was gathered, the frequent removal of leafy branches from nutritous trees such as elm would render the trees very susceptible to disease. When considering the variation in insect assemblages at West Heath Spa, Rackham's (1980) theory of combined elm disease linked to early, intensive use by man of primaeval forest is attractive.

WHS 3 (70-30 cm, samples M - U)

The changes in the forest faunas which characterised the stage after the elm decline continue throughout WHS 3, with a further reduction in tree dependant beetles. A landscape reconstruction of open ground with small woods, copses and isolated tree stands is more in keeping with the fauna. One of the beetles of decayed wood, *Sinodendron cylindricolle*, favours beech stumps although it also develops in other deciduous trees such as willow. Oak and hazel are also indicated by host requirements of tree-phytophages. Other plant feeders, however, live on clovers and other legumes and on various crucifers. There are also water-edge dwellers, the commonest *Notaris acridularis* developing on *Glyceria* (reed) and sedges and with occasional records for *Hydrothassa marginella* found on *Caltha palustris* (kingcup) as well as other aquatic Ranunculi, *Prasocuris phellandrii* which attack aquatic umbellifers including *Oenanthe* (water dropwort) and *Rhinoncus perpendicularis* which has *Polygonum amphibium* among its aquatic polygonaceous hosts. Some acidification at the site, not unexpected once the supply of nutrients from woodland leaf-fall is reduced on the thin, sandy soils, is reflected in one possible host of *Plateumaris discolor* which is *Eriophorum* (cotton-grass), a plant of acid swamps (although macrofossils were not found). The Lycosid spider remains were found in these samples.

WHS 4 (25 - 0 cm, samples V - X)

Interpretation of this final layer is difficult because the insects are low in numbers and mostly made up of fairly ubiquitous species with no distinct habitat requirements. Again, a mosaic of open land with few trees, and some standing water surrounded by a water-edge plant community. The beetles, however, are not as sufficiently characteristic as the pollen recorded from the same layers, to provide clues either to indicate the age or allow any detailed landscape reconstruction. The uppermost three samples lying below the active modern soil and compressed vegetation layer have much better preserved insect remains so unlike those from 135 - 15cm that investigation was not carried out. An overall summary of the conditions at the site inferred from the beetles remains is given in Table 2.

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Note

This text is largely as it was completed by Maureen Girling herself in 1984. She died at the end of that year, so her text has been slightly amended and updated by Peter Osborne and James Greig, on the basis of the typescripts available to us. Had she lived, Maureen would doubtless have rewritten the report in accordance with her high standards.

Table 1

WEST HEATH SPA INSECT SPECIES

Table 1

BY MAUREEN GIRLING

The nomenclature is that given in Kloet & Hincks (1977). Sample A = 130-135 (base), sample y = 15-20 (top)

sample	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	total
depth	130	120		110		100		90			80		70		60			50		40		30		20		10
COLEOPTERA																										
CARABIDAE																										
Carabus sp.	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Clivina fossor (L.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Patrobus atrorufus (Str.)	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	3
Trechus secalis (Payk.)	-	-	-	1	-	-	-	-	-	-	-	5	1	-	-	4	-	-	-	-	1	-	-	-	-	12
T. micros (Herbst)	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	1	1	-	1	-	-	-	5
Bembidion biguttatum (F.)	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	2
B. unicolor Chaud.	-	-	1	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	6
Tachys sp.	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Pterostichus diligens (Sturm)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
P. minor (Gyll.)	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	1	-	-	-	-	-	-	-	-	-	3
P. niger (Schall.)	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	2
P. nigrita (Payk)	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	2
Agonum dorsale (Pont.)	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
A. obscurum (Herbst)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	2
Harpalus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
DYTISCIDAE																										
Hydroporus longicornis Sharp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydroporus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Graptodytes pictus (F.)	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Agabus bipustulatus (L.)	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	3
Agabus sp.	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
HYDROPHILIDAE																										
Hydrochorus angustatus Germ.	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Helophorus aquaticus (L.)	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	3
H. brevipalpis Bed.	-	-	-	-	-	-	-	-	2	1	9	-	-	-	1	-	1	2	1	-	1	-	1	-	-	19
H. grandis Ill.	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	1	1	-	-	-	-	-	-	-	-	4
Helophorus spp.	-	-	-	-	1	-	1	4	3	3	2	-	-	1	-	-	1	1	-	2	-	-	-	3	-	22
Coleostoma orbiculare F.	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	1	-	2	-	5
Cercyon spp.	-	-	-	-	-	1	-	-	-	-	-	1	-	1	-	-	-	-	-	-	1	-	-	-	-	4
Megasternum obscurum (Marsh.)	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Cryptopleurum minutum (F.)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	2
Anacaena sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	2

sample	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	total
depth	130	120		110		100		90			80		70		60			50		40		30		20		10
Laccobius sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	2	–	3
Enochrus sp.	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1	–	–	3
Chaetarthria seminulum (Herbst)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	4	–	–	–	–	2	1	–	1	–	9
HISTERIDAE																										
Hister sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1
HYDRAENIDAE																										
Ochthebius minimus (F.)	–	–	–	2	2	3	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	8
Hydraena riparia Kug.	–	–	1	1	–	1	–	–	2	3	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	9
Hydraena sp.	1	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
PTILIIDAE																										
Gen. et spp. indet.	1	–	1	1	1	4	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9
LEIODIDIAE																										
Agathidium sp.	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1
SILPHIDAE																										
Silpha atrata L.	–	–	2	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
STAPHYLINIDAE																										
Olophrum sp.	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Lesteva heeri Fauv.	–	–	2	–	1	–	–	–	–	–	–	2	–	–	–	2	–	–	–	–	–	–	–	–	–	7
L. longoelytrata (Goez.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	2
Carpelimus or Thinobius sp.	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Anotylus rugosus (F.)	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	1	–	–	–	–	–	–	–	–	3
Anotylus sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1
Stenus spp.	2	–	4	4	2	2	–	–	–	1	1	1	–	1	–	2	1	3	3	–	–	1	–	2	–	30
Lathrobium brunnipes (F.)	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	2
L. terminatum Grav.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	–	1	–	3
Lathrobium sp.	–	–	–	–	–	–	1	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	3
Rugilus erichsoni (Fauv.)	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	2
R. geniculatus (Er.)	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	2
Xantholinus longiventris Heer	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Xantholinus sp.	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1
Erichsonius signaticornis (Muls. & Rey)	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	3
Philonthus sp.	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	2	–	3
Staphylinus sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1
Aloecharinae indet.	1	–	1	–	4	2	1	1	2	5	1	1	–	–	–	–	4	2	1	–	1	2	1	4	–	34

Table 1 (continued)

sample	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	total
depth	130	120		110		100		90			80		70		60			50		40		30		20		10
PSELAPHIDAE																										
Bryaxis bulbifer (Reichen.)	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Bryaxis sp.	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
Pselaphus heisei (Herbst)	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
LUCANIDAE																										
Sinodendron cylindricum (L.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	–	–	–	2
GEOTRUPIDAE																										
Geotrupes sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1
SCARABAEIDAE																										
Aphodius scrofa (F).	–	–	–	–	–	–	–	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	2
Aphodius spp.	–	–	–	–	–	–	–	1	1	1	–	1	2	1	1	3	1	–	2	1	–	–	–	2	–	17
Onthophagus sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1
Melolontha melolontha (L.)	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
SCIRTIDAE																										
Elodes minuta (L.)	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Gen. et sp. indet.	–	–	–	1	2	1	–	–	1	–	–	–	–	1	–	–	–	–	2	1	–	–	–	–	–	9
DRYOPIDAE																										
Dryops spp.	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	1	1	–	–	4
ELATERIDAE																										
Dalopius marginatus (L.)	–	–	1	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
Denticollis linearis (L.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1
THROSCIDAE																										
Trixagus elateriodes (Heer)	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
EUCNEMIDAE																										
Isorhipis melasoides (Lap.)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Melasis buprestoides (L.)	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
CANTHARIDAE																										
Cantharis rufa L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1
Rhagonycha sp.	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1

Table 1
(continued)

sample depth	A 130	B 120	C	D 110	E	F 100	G	H 90	I	J	K 80	L	M 70	N	O 60	P	Q	R 50	S	T 40	U	V 30	W	X 20	Y	total 10
ANOBIIDAE																										
Gastrallus immarginatus (Müll.)	–	–	1	2	–	2	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
Hadrobregmus denticollis (Cr.)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Ptilinus pecticornis (L.)	–	–	–	2	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
NITULIDAE																										
Brachypterolus sp.	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
RHIZOPHAGIDAE																										
Rhizophagus depressus (F.)	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
SILVANIDAE																										
Psammoecus bipunctatus (F.)	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
CERYLONIDAE																										
Cerylon ferrugineum Steph.	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
COLYDIIDAE																										
Synchita sp.	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Pycnomerus terebrans Ol.	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
CERAMBYCIDAE																										
Grammoptera ruficornis (F.)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Pogonocherus hispidus (L.)	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
CHRYSOMELIDAE																										
Plateumaris affinis (Kunz.)	–	–	–	–	3	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
P. discolor (Panz.)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	2	1	–	–	–	–	–	2	–	6
Chrysolina sp.	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1
Hydrothassa marginella (L.)	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	–	2
Prasocurus phellandrii (L.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	?
Phyllotreta vittula Redt.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	1
Chaetocnema confusa (Boh.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1
APIONIDAE																										
Apion spp.	–	–	–	–	–	–	–	–	–	1	1	1	1	1	–	1	1	–	–	1	–	–	–	–	–	8

Table 1
(continued)

sample	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	total
depth	130	120		110		100		90			80		70		60			50		40		30		20		10
CURCULIONIDAE																										
Polydrusus sp.	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
Sciaphilus aspiratus (Bons.)	–	–	4	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
Brachysomus echinatus (Bons.)	–	–	1	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
Strophosomus capitatus (De G.)	1	–	3	3	1	4	1	–	–	–	–	5	–	–	–	3	–	–	–	–	–	–	–	–	–	21
Strophosomus sp.	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Sitona susturalis Steph.	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Sitona sp.	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Eremotes ater (L.)	–	–	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
Dryophthorus corticalis (Payk.)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Acalles ptinoides (Marsh.)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–	1	–	–	–	–	3
Bagous sp.	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1
Notaris acridulus (L.)	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	2	–	–	1	–	5
Rhinoncus perpendicularis (Reich.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1
Curculio nucum L.	–	–	1	1	1	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1	–	–	–	6
Rhynchaenus quercus (L.)	1	–	–	–	2	2	1	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8
Rhynchaenus sp.	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
SCOLYTIDAE																										
Scolytus scolytus (F.)	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
Hylesinus crenatus (F.)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Acrantus vittatus (F.)	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Kissophagus hederae (Schm.)	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Ernoporus caucasicus Lind.	–	–	2	4	3	2	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13
Xyleborus dryographus (Ratz.)	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
INSECTA OTHER THAN COLEOPTERA																										
TRICHOPTERA (Caddis larvae)	1	–	–	–	1	1	2	–	–	2	–	8	–	–	–	2	–	–	–	–	–	–	–	1	–	18
HEMIPTERA (bugs)	–	–	–	–	–	–	1	1	–	2	–	–	–	–	–	–	2	4	1	–	–	3	–	2	–	16
HYMENOPTERA																										
Formicidae (ants)	1	–	–	2	3	2	–	–	–	–	1	–	–	–	–	–	1	–	1	–	–	–	–	–	–	11
Parasitica (parasitic wasps)	–	–	–	–	2	–	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	4
DIPTERA																										
Tipulidae (crane-flies)	1	–	–	1	–	–	1	3	–	7	2	–	–	–	2	–	3	–	–	–	–	–	–	2	–	22
Adult flies	–	–	–	–	–	–	–	–	2	1	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	5
fly larvae and puparia	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	–	2	–	4
ARACHNIDAE																										
Acari (Mites)	–	–	3	–	1	1	–	–	–	–	1	–	–	1	–	–	2	–	–	–	–	–	–	–	–	9
Aranea (Spiders)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	1	–	–	–	–	–	–	–	3

Table 1 (continued)

Table 2

Summary of environmental changes at West Heath Spa shown by the faunas

Depth (cm)	GROUND BEETLES	WATER BEETLES	ON WATER PLANTS	ON LAND PLANTS	DUNG BEETLES	FOREST BEETLES	DECAYED WOOD
0-5							
5-10							
10-15							
15-20				???	WHS 4		
20-25							
25-30							
30-35						SOME	
35-40			PRESENT			TREES	
40-45		POOLS					
45-50							
50-55	DAMP				WHS 3	SOME	
55-60	OPEN				PRESENT	TREES	
60-65	SOILS			PRESENT			
65-70							
70-75						HAZEL	
75-80		MUCH	SMALL			ASH	
80-85		SURFACE	AMOUNTS				
85-90		WATER,			WHS 2		
90-95		POOLS					
95-100							
100-105		SOME	SMALL	VERY		LIME FOREST	MANY
105-110		POOLS	AMOUNTS	LITTLE		WITH ELM,	ROTTING
110-115	SHADED	DAMP OR				OAK, HAZEL,	TREES
115-120	MULL	BOGGY			WHS 1	IVY, HOLLY,	
120-125	SOILS	AREAS	SCARCE			WILLOW, MAPLE	
125-130	PEBBLES		OR				
130-135			NONE			OAK	