CONTENTS

# A PALYNOLOGICAL ANALYSIS OF A PEAT CORE FROM THE KINLOCH GLEN, ISLE OF RHUM

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## INTRODUCTION

This study is based on a four metre core obtained by Sue Bellamy in 1984 from a bog 1750m inland of the excavation sites in the Kinloch Glen (NG 386002). The bog is situated on gently shelving sandstone having a dominant vegetation of *Calluna vulgaris*, *Eriophorum vaginatum* and *Sphagnum* spp. (in June 1987). The basal deposits were a dark peat with woody fragments of *Betula* or *Alnus* overlain by a light coloured peat, about 3m deep. This was topped by a layer of recent, undecomposed plant material. The bottom 8770 ± 90 BP (HAR-6608).

## LABORATORY TECHNIQUES

Samples for analysis were taken at .05m intervals and prepared following the method of Faegri and Iversen (1975). After acetolysis the samples were sieved using a 10um mesh and an ultrasonic agitator to remove silica and other mineral matter. The slides were examined using a Zeiss binocular microscope at a magnification of x450. An oil immersion lens was used for detailed identifications (x1000). The two principal sources of reference used for pollen identification were Erdtman *et al.*,

(1961) and Moore & Webb (1978). The whole area under the 16mm coverslip was examined on each slide by traversing the area in strips equal in width to the field of view.

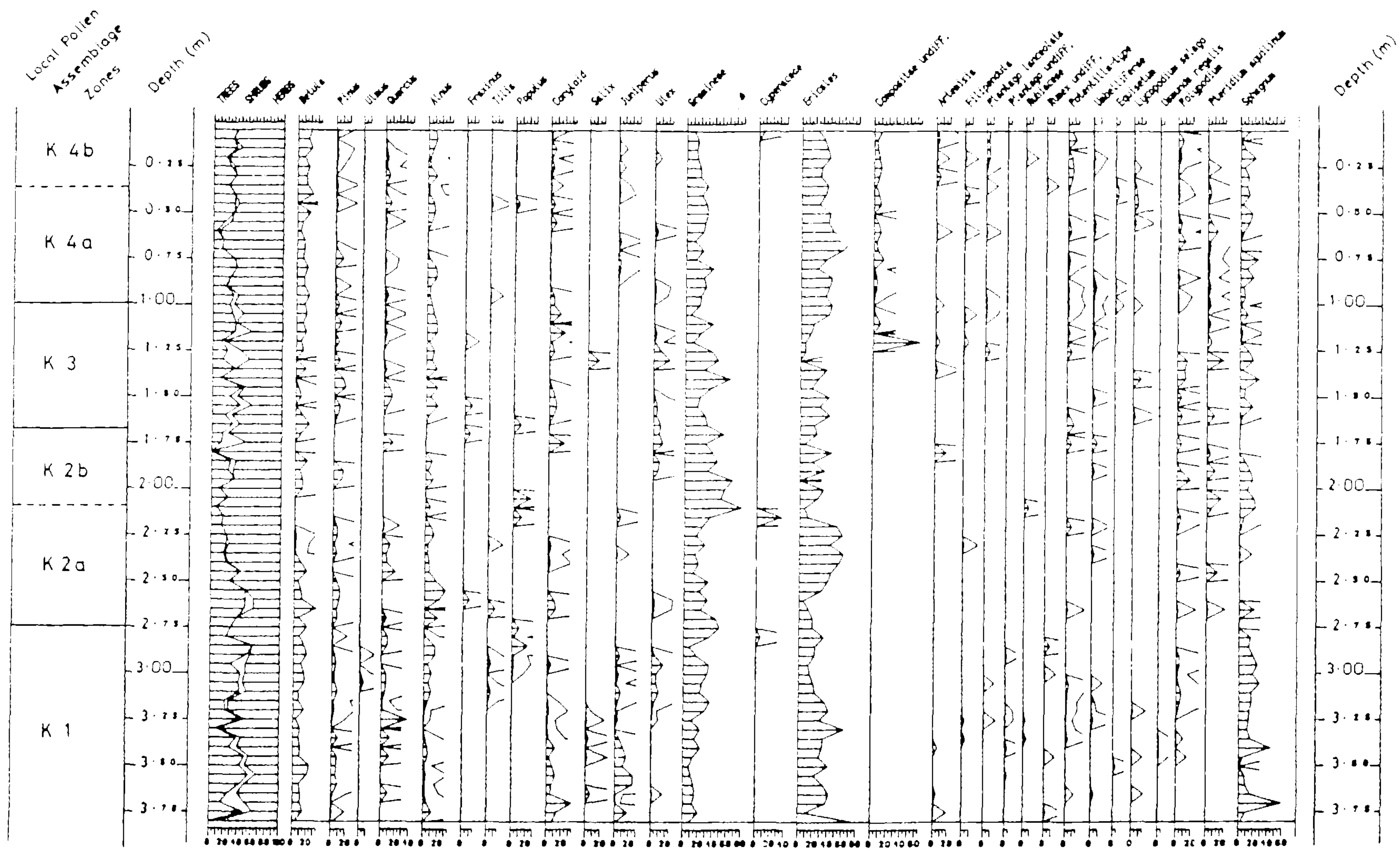
## PRESENTATION OF RESULTS

The pollen counts were calculated as percentages of total terrestrial pollen and drawn up to produce the pollen diagram (Ill 103 ). A total land pollen sum was chosen as the basis for calculation because in some instances there were no AP grains identified. Counts of aquatic taxa are excluded from the pollen sum as they represent only the local aquatic environment. Proportions of tree, shrubs and herbs, were calculated as percentages of total pollen ard spores to produce a summary pollen curve. Only levels where the pollen sum exceeded 50 pollen grains were included in the pollen diagram.

## INTERPRETATION OF RESULTS

The diagram was divided into four local pollen assemblage zones (PAZ), two of which are divided into sub-zones. Dating of this core is based on the tentative assumption of a steady peat accumulation rate, the basal radiocarbon date, and comparison with assemblages from other cores from N.W. Scotland.

### Zone 1 3.80-2.80m *Betula*-Ericaceae PAZ 8770+90-7500




Pollen sum = total land plant pollen: taxa outside sum as percent sum + taxon

Exaggeration of open curve is x10.

ILL 103 : The Kinloch Glen core. Pollen count

This is the basal zone of dark brown peat. The radiocarbon date for the lowest 0.20m (4.00-3.80m) was 8770+90 BP (HAR-6608).

Of the tree species Betula is the most important, with a small amount of B. nana, a dwarf birch native to mountainous areas of Britain, Scandinavia, Siberia and the Arctic circle today, here taken to represent open, cold conditions. Pinus pollen here may be derived by wind transport from the Scottish mainland. Quercus begins to appear after B. nana declines, suggesting a more temperate climate although its peak at 3.25m, may be due to washing of pollen onto the bog by increased surface drainage. Oak remains relatively unimportant after this peak. Alnus appears consistently in small quantities throughout the zone, and Acer, Abies and Picea occur intermittently. Abies and Picea may arise here from long distance transport. As they are not native to Britain it is likely that they are derived from earlier sediments.

Shrubs are dominated by Corylus and Juniperus in alternating peaks. Juniperus indicates base-rich soil conditions and tends to be usurped as shading from taller trees increased, and by more acid soil conditions. Salix pollen occurs near the base of the core. This group includes many taxa with wide ecologic and geographic ranges. Ulex peaks in this zone; Lonicera and Frangula make their only appearances and Prunus occurs; these pollen taxa may all derive from northern temperate or cosmopolitan species

(Clapham _et al_. 1952).

_Gramineae_ persists at low levels but rises towards the top of this zone. _Ericaceae_ comprises the other main dominant of Zone 1; initially at very high frequencies (75% at 3.80m), it declines to a high, fluctuating level, and then falls as grass pollen increases in frequency. Many herbs occur sporadically including _Artemisia_ (possibly the late-glacial species _A. norvegica_), _Armeria_, _Helianthemum_, _Linaria_, _Plantago maritima_, _Polygonum_, _Rubiaceae_, _Euphorbiaceae_, _Potentilla_ and _Succisa_; _Umbelliferae_ and _Urtica_. The herb spectrum includes a large number of ruderals and late-glacial elements. _Plantago_., _Potentilla_ and _Urtica_ are commonly associated with disturbed ground. _Humulus_ pollen is difficult to distinguish from that of _Cannabis_ (Whittington _et al_ 1987) but it is the more likely here being a natural liana of alder woods (Godwin 1975).

_Sphagnum_ occurs in very high frequencies near the base of the core (57% at 3.70m) and the presence of spores of the liverwort _Odontoschisma sphagnae_ which grows in the _Spahgnum_ spore capsule indicates that _Sphagnum_ was the major peat forming plant. Other _Pteridophytes_ are relatively unimportant; the most common being _Polypodium_. This occurs in woodland, but spores are more easily distributed in open environments.

The low AP (arboreal pollen) values in Zone 1 indicate fairly open conditions. This may be due to human impact or it may, as suggested for this time on Skye and Lewis, be due to climate (eg. Birks 1973). It is not possible to distinguish between the effects of these two factors in pollen data of this type. The vegetation was mainly grassland, with scattered birch in less exposed areas. Heather and [illegible]per dominate an important scrub component possibly indi[illegible] [illegible]ntinental climate. Strongly competitive ruderal gras[illegible] [illegible]est some disturbance although no charcoal was rec[illegible] [illegible]rom the pollen preparations.

<u>Zone 2a 2.75-2.15m *Alnus*-Ericaceae PAZ 7500-5000BP.</u>

The boundary of this zone is marked by a change in colour, but not texture, of the deposit to a lighter brown at 2.75m. There is an increase in *Betula*, but more importantly, in *Alnus* which reaches its highest frequences here - (30%).

A fall in Gramineae is matched by a simultaneous rise in Ericaceae. There is a complete decline in all shrub species, with only *Corylus* and *Juniperus* appearing at one or two levels. The proportion of AP : NAP (non-arboreal pollen) rises initially, but falls to a fairly steady lower level of around 25%. There is a decline in herbaceous taxa in mid-zone, co[illegible]responding with a large peak of Ericaceous taxa. Following this, *Centaurea* appears in significant quantites. Common in both late-glacial and anthropogeneous floras (Godwin 1975), *Centaurea* is rare in Scotland today and often associated with cultivation of rye. It may have been a native late-glacial relic. *Plantago*, *Potentilla* and _Umbelliferae_ also occur, which support the possibility of human disturbance. _Potentilla_ is a pollen-type including a range of plants of wide tolerance of pH often associated with declining AP frequencies.

Pteridophyta and aquatic taxa decline throughout this zone, which is characterised by low TAP frequencies. The decline of _Sphagnum_ is associated with drier conditions of a post-glacial warm period, and subsequent out-shading by expansion of alder.

Zone 2a vegetation is dominated by an Ericaceous scrub and alder is an important element, probably in damper, more sheltered areas or as a successional species of drying bogland. The indications of human presence show that human activity continued on Rhum through the time not represented in the Kinloch Excavations. Indeed it is unlikely that Rhum would not have been occupied during this period when climate was at its most favourable.

Zone 2b 2.10-1.75m Gramineae-Pteridophyte PAZ 5000-2000 BP.

The general trend of low TAP is continued but the relative proportions of AP : NAP fluctate more, reaching zero at 1.83m. Within this sub-zone is a total decline of trees and shrubs. _Betula_ alone recovers in mid-zone, although _Pinus_ and _Pinus_ reappear in smaller quantitites. _Ulex_ survives and peaks near the top of the zone, and at two consecutive levels, _Prunus_ makes its most significant appearance before vanishing totally.

There is a rise in Gramineae corresponding to the decline in arboreal taxa and Ericaceae. *Centaurea* peaks, but *Potentilla* is the only other herb of any significance. Others do occur, but only sporadically. *Sanguisorba* and Umbelliferae are the most important; the former occurs on limestone on Canna today, but has a wide pH tolerance so could survive in the more acid environment of Rhum. Spores are more frequent at this level, with rising *Sphagnum*, *Pteridium* and *Polypodium*. Aquatics are at their highest levels here also, possibly indicating a wetter bog surface.

This total decline of AP is of considerable importance in the context of the demonstrated activity of the people of Rhum. It suggests widespread forest clearance and its replacement by grassland, probably associated with the introduction of grazing animals and possibly correlated with the second phase of occupation at the Farm Fields excavation sites.

Zone 3 1.70-1.05m Betula-Alnus-Corylus PAZ 2000-1000 BP.

The boundary is marked by a rise in AP, sustained at higher, but fluctuating levels. The rise consists mainly of increases in *Betula* and *Alnus*, although *Quercus* and *Pinus* are again of some importance. *Acer*, *Fraxinus* and *Populus* are recorded only sporadically.

Shrubs show a general increase; *Corylus* and *Ulex* being the most dominant, but *Ilex* also occurs. A fall in Gramineae is matched by a rise in Ericaceae but not to previous high frequencies. *Centaurea* and *Artemisia* (probably a different species, associated with disturbance here, from the late-glacial species of Zone 1) are present but *Plantago* is missing for much of the lower part of this zone. Other herb species identified include *Convolvulus*, *Euphorbia*, *Filipendula*, *Knautia*, *Malvaceae*, *Polygonum* and *Umbelliferae*. *Teucrium* occurs on Rhum today but is known to be highly susceptible to sheep grazing on Canna, and is commoner in wet calcareous environments.

Pollen of *Linum usitatissimum*, the cultivated flax, was found in this zone. Flax pollen is believed to be disseminated only very locally to the parent plant suggesting that the cultivation was nearby. The distance of the sampling site from likely suitable areas, however, suggests that the single flax pollen grain was possibly derived from long distance transport. Pollen of flax was also found in the on site samples by Moffat (mf).

The zone suggests an incomplete recovery of forest with wetter bog surfaces and possibly wetter climatic conditions indicated by rises in alder and *Sphagnum*, and a fall in Ericaceae.

Zone 4a 1.00-0.40m Compositae-Betula-Ericaceae PAZ

The beginning of this zone is identified by a fall in AP and a recovery of Ericaceae, together with appearance of Compositae.

*Betula* continues to dominate the tree taxa; there is a fall in *Pinus* and in *Quercus* after an initial peak. *Alnus* remains a secondary dominant, but does not appear initially. A scatter of pollen from other tree taxa occurs which may be derived from more distant sources.

*Juniperus* reappears, and remains at low levels throughout the rest of the core. *Corylus* declines in importance; *Ulex* appears in two samples. Gramineae fall to lower levels but persist to the top of the zone. Ericaceae show a large initial rise, and *Centaurea*, *Euphorbiaceae*, *Filipendula*, *Malvaceae*, *Umbelliferae* and *Potentilla* make up the herb spectrum. Spores remain relatively important - *Pteridium*, *Polypodium* and, initially, *Lycopodium*, and the ubiquitous *Sphagnum*. Aquatics are dominated by *Myriophyllum*.

Continued disturbance and relatively intensive land use is implied in this zone; probably by sheep grazing which is thought to have been an important part of the economy at this time (Love 1983). Historical evidence suggests the continuous occupation of Rhum throughout this period.

The importance of Ericaceae reflects the natural, and possibly man-induced podsolization process to which all British soils have been subjected, due to deteriorating climate after the post-glacial thermal optimum. It also reflects the recent history of intensive landuse on Rhum - primarily grazing by sheep. Moorland removal of sheep have been replaced by restocking with deer and it may also be suppressed by competition. Nymphaea is the only aquatic present. It occurs in acidic waters possibly colonizing bog pools formed in old peat cuttings. AP : NAP rises again to about 25%.

SUMMARY

Woodland was never fully developed throughout the Flandrian across the bottom of the Kinloch Glen on Rhum. Possibly many of the open areas were not available for tree colonisation due to the early development of bog. Woodland reached its maximum extent at 2.60m depth in the peat core where AP attains 63% of total pollen. Ericaceae and Gramineae were the dominant taxa throughout. Birch and alder were the most frequent trees but pollen data suggest that pine and oak may have occurred locally. Hazel, juniper and whin occurred in favourable locations within a matrix of grass heath.

Compositae, plantain and Potentilla assume greater importance near the surface presumably as agricultural activity was intensified. The domination of grassland over woodland may have been due to a combination of a harsh environment, podsolization of soils , unfavourable topography and extensive influence of man, both temporally and spatially. Trees will grow on Rhum today, however, so climate cannot be the sole determining factor.

FURTHER STUDY

Two further pilot studies were carried out as part of the investigation of the Kinloch Glen peat core; an attempt to apply the Kontron Digital Image Processing System to aid in the identification of fossil pollen, and the application of DNA characterisation techniques to the stratigraphic study of the peat.

USE OF KONTRON DIGITAL IMAGE PROCESSING SYSTEM (K.I.P.S.) FOR POLLEN ANALYSIS

The aims of the pilot study were

- to analyse prepared slides using KIPS as an alternative to the optical microscope.
- to obtain enlarged images and photographs.
- to attempt to automate the pollen searching process.

The Kontron Image Processing System was devised for use in cytology, particularly in the identification of anomalies in cell division. The equipment consists of an automated scanning stage under a normal binocular microscope; the stage has an 8-slide capacity. The monitor can be programmed to set up a 'meander', a series of squares covering the area to be studied; the squares are contiguous, but not overlapping, thus ensuring no duplication or omission of any field of view. Co-ordinates of fields of view can be stored, and later recalled for image processing. At e[illegible] field of vision, two autofocus routines, operating on x, y, and z axes, focus on the most prominant object. This is also manually adjustable.

The IPM (Image Processing Module) is programmed to enhance contrast between feature and background; this appears to 'lift' the feature out of the screen. The feature can be enlarged (x4) up to three times, and photographed at any stage. After each enlargement there is a 'stilling' process of image integration, which removes noise and movement introduced by camera; and a filter process to eliminate the effect caused by enlargement of the individual squares of which the video screen consists. A calibrated scale of any size can be added (to the original video field) and new features photographed.

Several focal planes of an object of some depth can be combined to form one linear picture containing all elements of the object in focus. An infinite number of planes can be used, thus reducing a 3D object to 2D without losing any detail of resolution.

<u>Application to The Peat Core</u>

An attempt was made to automate pollen searching by asking the computer to eliminate from any given field of vision those particles above or below a given size, and below a given sphericity. The sizes selected were 10-100um, and the circularity index scale was from 0.5 to 1u (1u = total perfect circle). The sizes chosen were assumed to cover the range of British pollen species. However, there was considerable difficulty in developing the programme because the computer was unable to distinguish between pollen grains and other matter when these were in contact with each other in any given focal plane. The size range chosen was also too large, because this included most of the other organic matter on the slide.

A final attempt was made to distinguish grains by an area-perimeter ratio - it was assumed that relatively 'solid' structured grains would have a low ratio compared with degenerate fibrous material. This failed for the same reasons as above. The main problem with automating analysis was the fact that the size and shape range of pollen was too great, and problems ensued relating to damaged grains, or naturally split ones, e.g. *Juniperus*.

## Cesar

This is a new software package which is becoming available for KIPS. It was developed for cytology screening of cancer cells, but is adaptable for any cell-like shape (i.e. almost any shape).

This enables the computer to 'learn' about 18 characteristics, including shape, size and surface pattern of the target object;

locate these on slides, and store their co-ordinates for recall. It would thus be possible for KIPS to 'identify' and count a large number of individual species of pollen grains, providing that suitable parameters to distinguish between closely related species, could be communicated to it.

ATTEMPT TO EXTRACT DNA FROM PEAT FIBRE

The composition of DNA from cell nuclei is genus and species specific. The aims of this study were to extract and examine DNA from samples of peat, to characterize the peat deposit and help confirm the composition of past peat forming vegetation.

All living cells able to divide contain a nucleus which is comprised mainly of deoxyribosenucleic acid (DNA), which encodes the genetic information of the cell and the whole plant. Every plant species has a characteristic composition of DNA, by which that genus, and species, may be recognised.

The technique of extracting and modifying plant DNA is now being widely used in many laboratories for 'genetic engineering' to obtain high-yielding, disease-resistant plants. Similar techniques could be used to identify vegetation debris and observe any differences from present day strains, provided that the DNA has been preserved intact.

The essential features of the simplest form of the procedure are:

i) extract the DNA separated from non relevant material.

ii) place it in an agarose or similar gel and electrophoretically separate its components according to charge and density.

iii) strain to detect the various bands of separated DNA.

The test substance, e.g. extract from the peat core, could be separated alongside DNA extracted from fresh heather, birch, alder, etc. A comparison of the bands indicates any homology between known control samples and the test material from core fibre.

There are more select ve procedures in which a DNA probe or extract of the ntrol material, labelled with a radio-isotope, is applied to the test sample. If there is homology between the DNA components, the probe will bind to the bands of the test sample. The amount of binding indicates the degree of DNA similarity.

Pilot test for DNA extraction

As a first step to test the feasibility of the idea, an attempt was made to extract DNA from a sample of the peat core. Unfortunately, there are two immediate limitations to DNA analysis of peat :

1) in the examination of Lindow Man recovered from a peat bog,

the acidity and tannins had completely denatured proteins, including DNA (Stead *et al.* 1986), and provided the conditions for preservation.

2) The presence of bacteria and other soil microflora, which contain DNA, would seriously contaminate any plant DNA.

To examine for contamination by bacteria, 16 samples of the peat at different depths were taken using a sterile spatula, dispersed in sterile distilled water, and plated out on nutrient agar in duplicate. Tubes with distilled water shaken with the spatula were negative controls. One set of plates was incubated at 37°C; the other at room temperature, about 21°C. Plates incubated at 37°C showed occasional colonies after 3 days. Those kept at room temperature showed fairly heavy growth of bacteria and fungi, indicating significant contamination by modern organisms at all depths.

Thus the samples were unsuitable for extraction of plant DNA. There were two possible approaches :

1. Prepare probes of the micro-organism DNA to determine similarity with any DNA extracted. This is a complex long-term procedure, and probably valueless.

2. Wash the fibres with large amounts of sterile water and filter off all bacteria and small debris.

To examine 2), one small sample of large fibres was vigorously shaken six times, each with 25ml sterile distilled water, and the fibres separated by retention on the surface of a coarse millipore filter.

The bacterial count was greatly reduced; the final wash fluid showed no bacterial growth. However, fibres laid out on the agar grew some bacteria along their length. This indicated that some bacteria were strongly bound to the peat fibre, and would contaminate any DNA extracted.

It is still to be resolved whether any plant DNA could be extracted from the peat fibre but it seems unlikely due to the acidity of the deposit.

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ENVIRONMENTAL ANALYSES OF SAMPLES FROM TRENCH AM AND A BLANKET PEAT REMNANT, FARM FIELDS EXCAVATIONS KINLOCH, ISLE OF RHUM.

Kevin J Edwards and Ken R Hirons

During the course of excavations in trench AM, a peat-like organic deposit was discovered sealed beneath slopewash. At the request of the excavators the deposit was sampled for its pollen content. The amount of identifiable pollen was meagre and in an attempt to extract as much environmental information as possible the opportunity was taken to assess the material for its charcoal and insect content. The deposit contained fragments of lithic material and a small piece of pottery. The preliminary examination of a small remnant of near-by blanket peat was also undertaken.

Trench AM is located 6 m east of the western wall of the principal excavation field at grid reference NM 404 999. The ground surface here is on an incline with the watercourse running NW to SE through the trench (to the north of the sample spot) and the southern limit of the slopewash deposit lying south of the trench. The organic material was found in the southern portion of the trench and the stratigraphy at the sampling point is described in table 43.

A monolith of material was collected and returned to the laboratory for analysis. An adjacent sample of the peaty material (8 cm in thickness) submitted for radiocarbon determination to the University of Glasgow laboratory gave a result of 4260± 70 (GU-2106).

The peaty material was sub-sampled for palynological analysis and received standard pretreatments based on NaOH, acetolysis and HF (Faegri and Iversen 1975). All samples were volumetrically prepared by displacement and tablets of Lycopodium annotinum were added to allow estimates of palynomorph concentration (Stockmarr 1971). Pollen and microscopic charcoal preparations were mounted in silicone oil of 12500cSt viscosity. Five duplicate slides per sample level were examined but the scarcity of pollen, its poor condition and the obfuscating charcoal prevented routine pollen counts and it was only feasible to record numbers of pollen grains and spores. Charcoal microfragments greater than 151 um in area were counted and estimates of concentration were made. The pollen and charcoal data are presented in table 44.
Further sub-samples of material were subjected to paraffin flotation (Coope 1985), in order to concentrate insect remains. No remains were found but small fragments of Sphagnum were present.

The remaining peaty material was passed through a 1mm seive. A large number of charcoal fragments were found of which charred hazel-nut shells (Corylus avellana) were readily identifiable. In addition there were 29 fragments of lithic material and a single sherd of coarse pottery.

The organic material would appear to be similar to a highly humified peat with very little indication of the peat forming vegetation (which included Sphagnum) remaining. There was a high content of both macroscopic (mainly hazel) and microscopic charcoal.

The radiocarbon date obtained from the organic material was 4260+70 bp (GU-2106), which, suggests a neolithic rather than mesolithic age for the deposit. This date might also be consistent with the coarseware find (unknown at the time of submission for dating) which appears to be similar to sherds found in the neolithic contexts of the main excavation area. Also, the dated material underlies the supposed slopewash deposit and is not dissimilar to the date of 3945± 60 bp (GU-2041) for a wood sample at the base of the slopewash material in trench AG. The date must, though, be viewed with caution. If the peaty material from trench AM does contain intrusive organic material (eg. older eroded peat or charcoal transported from upslope/upstream) then the date (as could also be the case for the trench AG sample) will precede the date of slopewash by an unknown period. Likewise, the possible mixture of organic materials means that any C-14 determinations could post-date local mesolithic activity.

The low quantities of pollen (table 44) cannot reliably be

| Depth (m) | Description of Deposits |
| --- | --- |
| Surface | Grass dominant flora |
| 0.00-0.30 | Organic ploughsoil, some angular stones up to 0.05 m diameter |
| 0.30-0.50 | Rotted, rounded sandstone pebbles in matrix of sandy mineral soil |
| 0.50-0.57 | Black peat-like deposit with visible fragments of charcoal and bloodstone |
| 0.57-0.70+ | Large, slightly rounded cobbles |

Table 43 Trench AM: stratigraphy at the sampling point

| Taxon (no. of grains/spores) | Depth (metres from base of deposit) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.00–0.01 | 0.01–0.02 | 0.02–0.03 | 0.03–0.04 | 0.04–0.05 | 0.05–0.06 | 0.06–0.07 |
| Pinus (pine) | | | 1 | 1 | | 1 | |
| Ulmus (elm) | 2 | | 2 | | | | |
| Alnus (alder) | 3 | 3 | 3 | 1 | | 5 | 2 |
| Coryloid (hazel/myrtle) | 1 | 2 | | | 1 | 1 | |
| Salix (willow) | | | 1 | | | | |
| Gramineae (grasses) | 1 | 1 | 1 | | | 2 | |
| Cyperaceae (sedges) | | 1 | 7 | | | 7 | |
| Plantago (plantain) | | 1 | 2 | | | | |
| Rumex (sorrel) | | 1 | 1 | | | | |
| Rosaceae (rose family) | | | 1 | | | | |
| Indeterminate Pollen | 3 | 9 | 21 | 4 | 2 | 21 | 6 |
| Filicales (fern) | 5 | 4 | 8 | 6 | 3 | 12 | 1 |
| Polypodium (polypody) | | | | | | 1 | |
| Charcoal ($mm^2/cm^3 \times 10^3$) | 32.8 | 22.2 | 51.2 | 29.8 | 36.2 | 12.8 | 18.5 |

Table 44 Trench AM : Pollen and charcoal counts

assessed for environmental purposes and this would especially be the case if the deposit was subject to the processes of contamination conjectured above, since the microfossil content would be similarly affected. the samples are dominated by Alnus and Cyperaceae pollen, both of which are indicative of wet conditions. The resistant spores of Filicales are frequently differentially preserved in pollen preparations but they do indicate the local presence of fern species. All of the pollen and spore types are present in detailed analyses from both the Farm Fields soil samples (Moffat mf) and the raised beach deposit to the west of the excavation (Hirons and Edwards mfa). The ubiquity of the taxa from trench AM in many different age levels in the raised beach profile, precludes a realistic assessment of either deposit age or the existence of contamination but the presence of Alnus suggests a post 6500BP date for the final accumulation at the site.

Upslope of trench AM, there is an area of denuded blanket peat which has been eroded by drainage waters and agricultural activity (see III 104). A small remnant of peat 98 m north-east of trench AM was cored and the maximum peat depth recoverable in the chamber of the Russian corer (Jowsey 1966) was found to be 1.13 m. The deposit consisted of a humified fibrous peat. A basal sample and two from higher in the profile were taken and processed for pollen analysis. The results are shown in table 45.

The basal sample has much higher Alnus, Coryloid and Filicales values than those higher in the profile wheras the reverse is the case for Gramineae and *Calluna*. The decline in woodland taxa at the raised beach site is dated at around 3950 BP. It is not certain that this date would apply to the decline in *Alnus* and Coryloid in the blanket peat but it is possible that the event is analogous. The basal sample also contains more *Quercus* pollen than is found in the raised beach profile. These findings suggest that prior to the period of woodland reduction indicated in the blanket peat samples, the soil conditions upslope of the Farm Fields were drier and able to support some oak with alder-hazel woodland, although this was probably open with an understorey of herbs and ferns. After the woodland decline an acid-heath replaced the woodland here rather than the acid-grassland around the damper raised beach site.

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| Taxon (% total land pollen) | Depth (metres from top of deposit) 0.64-0.65 | 0.87-0.88 | 1.12-1.13 |
|---|---|---|---|
| Betula (birch) | 2.10 | 3.50 | 16.70 |
| Pinus (pine) | 0.50 | 0.50 | 0.50 |
| Ulmus (elm) | 0.50 | | |
| Quercus (oak) | 0.50 | 2.90 | 7.70 |
| Alnus (alder) | 0.90 | 3.20 | 19.90 |
| Coryloid (hazel/myrtle) | 0.50 | 4.30 | 19.00 |
| Gramineae (grasses) | 29.40 | 57.90 | 20.80 |
| Cyperaceae (sedges) | 20.90 | 6.90 | 9.20 |
| Calluna (heather) | 25.10 | 2.60 | 0.90 |
| Erica-type (heath) | 5.50 | 0.60 | |
| Filipendula (meadowsweet) | 0.50 | 0.50 | |
| Plantago lanceolata (ribwort plantain) | 1.70 | 7.50 | |
| Potentilla (tormentil, etc.) | 3.40 | 5.20 | 3.90 |
| Sphagnum (bog mosses) | 11.00 | 22.90 | 1.50 |
| Filicales (ferns) | | 0.50 | 22.90 |
| Pteridium (bracken) | 0.50 | 0.60 | 3.70 |
| AP | 4.30 | 10.10 | 45.20 |
| Shrub | 0.50 | 4.90 | 19.30 |
| Ericaceae | 32.80 | 4.90 | 1.20 |
| Herbs | 62.40 | 80.10 | 34.30 |
| Pollen (no. of grains) | 235 | 347 | 336 |

Table 45 RH 3 : Pollen count

# POLLEN AND CHARCOAL ANALSES FROM THE FARM FIELDS SITE, KINLOCH, ISLE OF RHUM

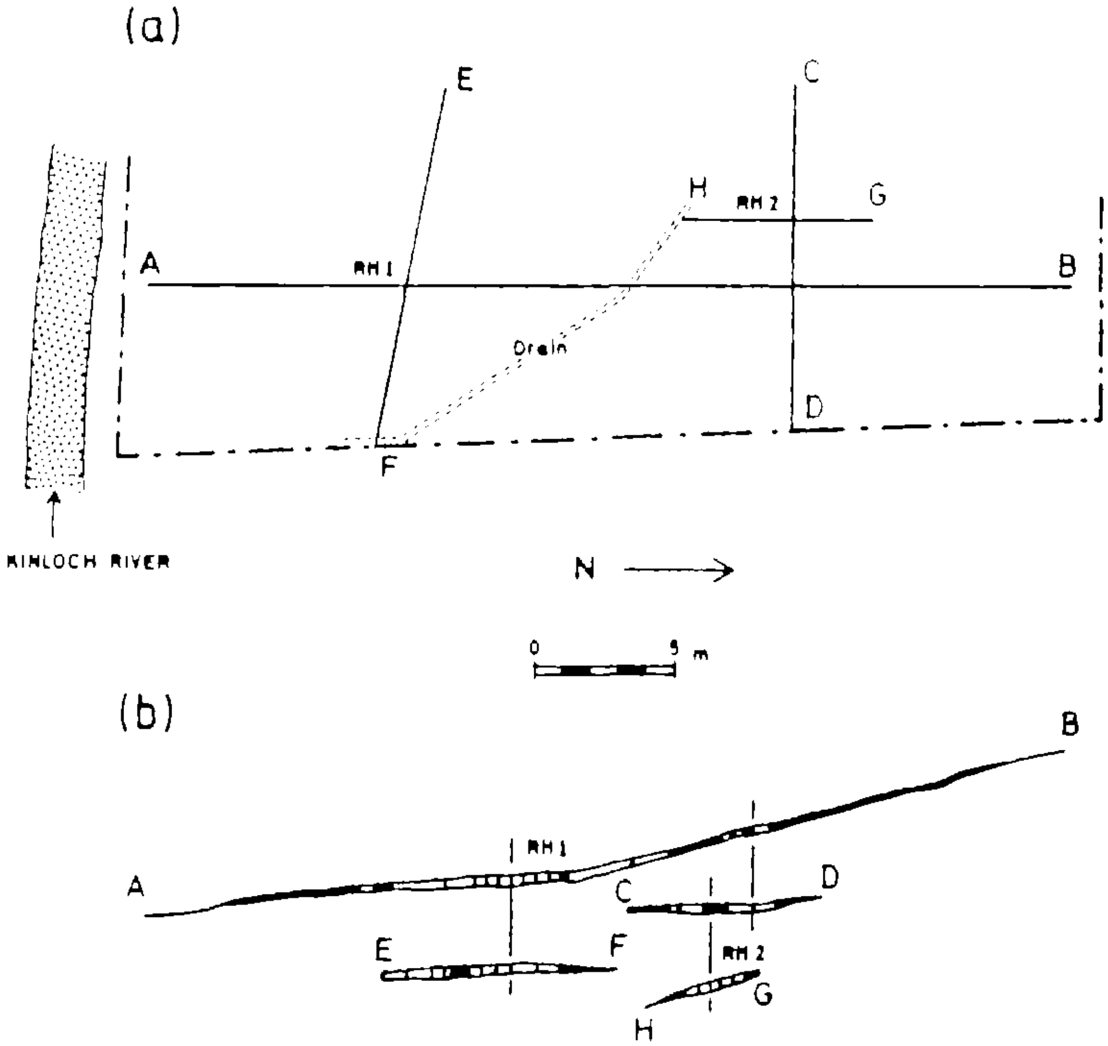
Ken R Hirons and Kevin J Edwards

The organic deposits near the Farm Fields excavation site (Moffat mf, Edwards & Hirons mf), provide only 'snapshots' of their respective environmental contexts. A promising locality for providing a long-term record of environmental events at the Farm Fields was that of the raised beach area to the west. At a distance of some 200 m from the excavations, a peat deposit began forming at around 7800 radiocarbon years BP and its investigation forms the basis of this report.

## METHODS

### The Site and Field Sampling

The sampling site is a soligenous mire found on estuarine clays first investigated by Dr Donald Sutherland. The aim was to find the transition from marine-clay to terrestrial peat and so provide a date for the retreat of the sea after the main postglacial transgression. Sutherland's site (designated site Rh1, Ill 104 ) was surveyed by us as part of an upslope transect (Ill 105 ) carried out in order to define the shape of the hillslope and the basin of accumulation. A sample monolith was collected from the deepest point on the transect at an altitude




ILL 105 : (a) Plan showing transect lines of the core sites RH 1 and RH 2. (b) Transect lines showing peat depths. NB. 2·5 x vertical exaggeration.

of 9.9 m local OD. The base of this profile is located close to the maximum height of the postglacial transgression. The stratigraphy is shown in table 46.

The immediate environment of the site is rough grazing dominated by Juncus but former cultivation ridges attest to a more varied history of agriculture. Above the field the land rises sharply and the sandstone slopes are dominated by Calluna vulgaris and Molinia caerulea. There is a coniferous shelter-belt to the east of the site and hedgerows containing Crataegus monogyna and Salix spp.

Laboratory Analysis and presentation of results.

Loss-on-ignition determinations were made on contiguous 1 cm thick samples which were dried at 110 C for 12 hours and ignited at 550 C for 8 hours. The results are calculated as percentage dry weight and they are plotted in Ill 106.

Samples for pollen and microscopic charcoal analyses were processed by standard NaOH, acetolysis and HF techniques prior to mounting in silicone oil (Faegri & Iversen 1975). All samples were volumetrically prepared by displacement and tablets of Lycopodium annotinum added in order that palynomorph concentrations could be estimated (Stockmarr 1962). The pollen sum aimed at was 500 determinable land pollen grains which was not attained for all levels ( e.g. between 1.03-1.17 m and in the

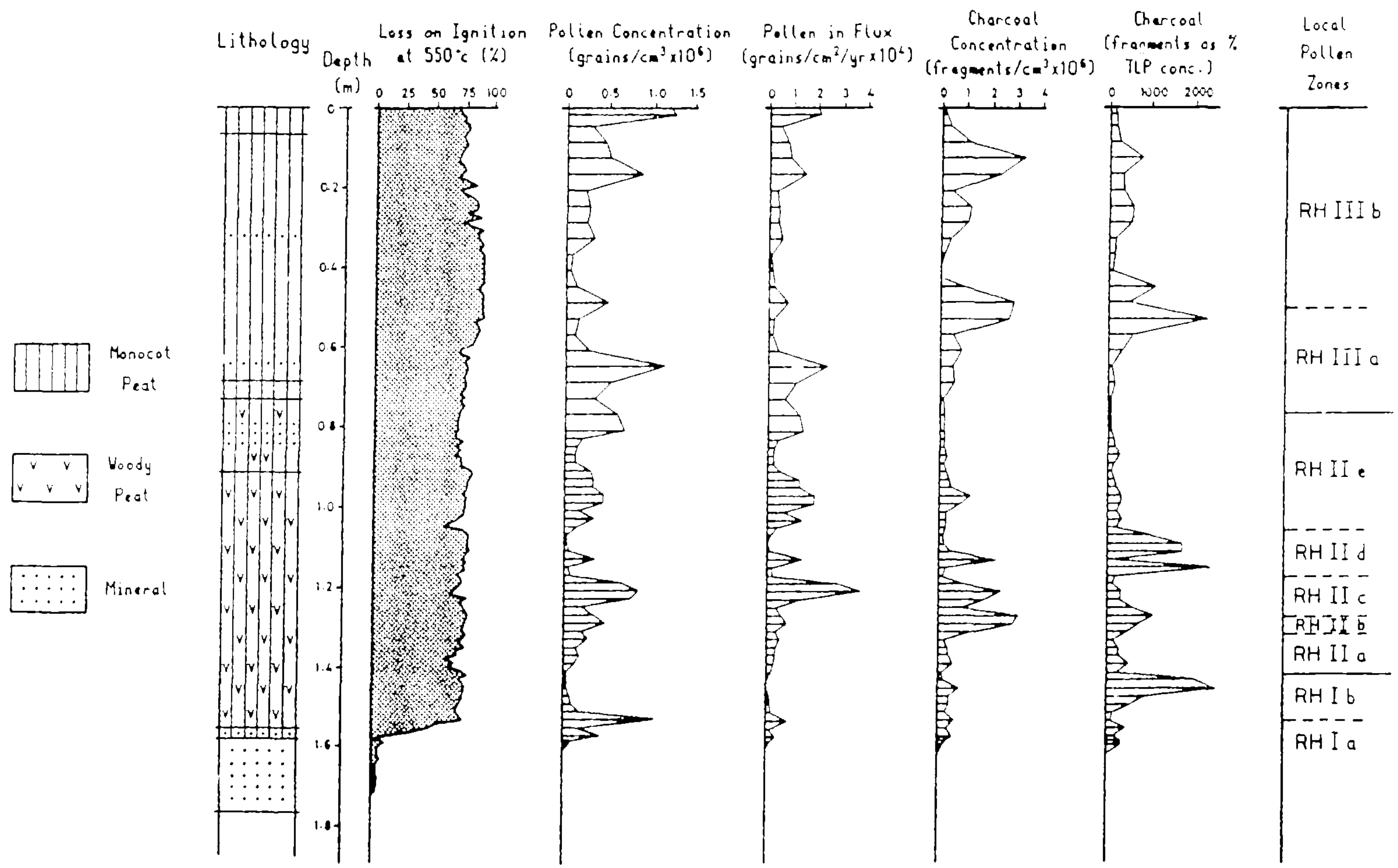
| | | | |
|---|---|---|---|
| 0.00–0.07 | m | Dark brown, fibrous, unhumified peat with grass/sedge fragments, some coarse sand-fine grit. |
| 0.07–0.67 | m | Dark brown-black humified peat with fibres and grass/sedge fragments. Some mineral 0.26–0.27m. Mica platelets visible 0.60–0.62m. |
| 0.67–0.73 | m | Less humified light brown wood-sedge peat with some silt particles. |
| 0.73–0.80 | m | Light brown sedge-wood peat, some mineral content 0.77–0.80m. |
| 0.80–1.51 | m | Brown wood peat with fibres and sedge component. |
| 1.51–1.55 | m | Sandy peat, sand increasing with depth, roots and rhizomes of _Phragmites_ and _Equisetum_ present. Some sandstone grit and mica present. |
| 1.55–1.70 | m | Silty clay with _Equisetum_ rhizomes, roots and mica present and sandstone chips up to 0.01m in size. Clay blue but with red mottling due to rotting sandstone stones. |

Table 46 Core RH 1 : stratigraphy

basal clays which were barren of pollen). The pollen data are presented as a percentage of the total land pollen sum with pollen and spores outside the sum calculated as sum + taxon. The pollen diagram (III 105 ) is divided into local pollen assemblage zones (RhI-RhIII) some of which are further subdivided into subzones. Full concentration data are not given here but a curve for total pollen concentrations is presented in III 10[illegible] . The counts for microscopic charcoal are based on fragments greater than 151 um in size. Curves for charcoal concentration and the total pollen to charcoal ratio (Swain 1973) are also presented in III 106 .

Five samples were used for the C-14 dating of site RhI. Four samples were taken from the pollen monolith and a fifth came from the same sample hole at the base of the peat (Sutherland mf). Dating was carried out on 2 cm or, in the case of the uppermost sample where the peat had less organic content, 3 cm slices of peat by The University of Glasgow Radiocarbon Dating Laboratory. A chronology of sedimentation may be proposed by plotting the available C-14 dates (table 47) against depth and interpolating between mean quoted sample ages. Illustration shows such a time-depth curve which has been completed by assuming a date of 0 years bp for the surface and assuming the date taken from the basal 2 cm of peat by Sutherland corresponds to the basal 2 cm of peat in the sample monolith.

The time-depth curve has been used to convert pollen




ILL 106 : RH1. Environmental data

concentrations into total pollen accumulation rates or pollen influx in illustration 107.

RESULTS

The stratigraphy recorded at sample site Rh1 is given in table 46.

Pollen zone Rh1 (1.57-1.41 m, 8400-6500 BP)

This zone preceeds the rise in alder pollen. It is characterized by a peak of Cyperaceae (sedge) rising from 12% to the highest sedge pollen frequencies in the profile (71%) before declining by the end of the zone. Two subzones are defined:

Subzone Rh1a (1.57-1.53 m, 8400-7500 BP)

This subzone is characterised by increasing Coryloid (cf. hazel) and Cyperaceae percentages, falling Gramineae (grass) and Compositae values and Ranunculaceae, *Thalictrum*, *Lycopodium selago* and *Empetrum* are present. Other herb pollen types include *Koenigia islandica*, *Caryophyllaceae*, *Saxifrageaceae*, *Artemisia*, *Cruciferae*, *Plantago coronopus* and P. *maritima*, and *Selliaginella selliaginoides* spores. Some of these taxa indicate the presence of plant communities which may reflect the proximity of the sea (e.g., Caryophyllaceae, *Plantago maritima*, Compositae). Others are characteristic of late- or early postglacial open environments (e.g., *Artemisia*, *Koenigia islandica*, *Thalictrum*, *Empetrum*, *Lycopodium selago* ). This subzone suggests the establishment of open hazel scrub with an understorey of horsetails, ferns and sedges and with tall-herb communities including *Filipendula*, *Rumex acetosa* and Umbelliferae. *Betula* (birch) and *Pinus* (pine) may have been present on the island at the time but were probably not local to the Farm Fields. The closing of the hazel canopy appears to have supressed the flowering of Compositae, *Thalictrum*, *Lycopodium selago* and *Empetrum*. Charcoal is low in concentration and percentage terms.

Subzone RhIb (1.53-1.41 m, 7500-6500 BP)

Coryloid and Cyperaceae pollen are dominant and *Filipendula*, *Filicales* and *Equisetum* increase. *Osmunda* spores are present from near the start of this subzone and *Pteridium* (bracken) becomes important in the latter part. Open hazel scrub with an understorey of sedges, *Filipendula*, *Melampyrum*, *Rumex*, ferns and *Equisetum* spp. dominated this long period. The increased frequencies of *Potentilla* and *Succisa*, the appearance of *Calluna* (heather) pollen suggest the establishment of dwarf-shrub heaths on the drier sandstone soils near the site.

Microscopic charcoal fragments are present throughout the analysed profile but are low in concentration in zone RhI. Local anthropogenic activity may be indicated by the peak of *Rumex acetosa*-type pollen in KIb and the increased frequencies of several pollen types which may, arguably, support a suggestion of local burning; *Pteridium aquilinum*, *Potentilla* and *Melampyrum*. In combination these lines of evidence suggest that the vegetation of the mire surface was disturbed by fire at times in this zone and that this disturbance could have contributed to the establishment of Alnus (alder) in the next zone (McVean 1956a). It is not possible to attribute this disturbance to either anthropogenic or natural fires on the data presented here.

Pollen zone RhII (1.41-0.74 m, 6500-3950 BP)

This zone starts at the rise in Alnus pollen and ends just after Alnus and Coryloid pollen begin major declines and grass pollen increases. The zone is divided into five subzones on the basis of major fluctuations in Alnus pollen frequencies.

Subzone RhIIa (1.41-1.31 m, 6500-5950 BP)

An initial Salix (willow) pollen peak declines (50-<1%) as Alnus frequencies increase and ferns expand. There is less Potentilla, Melampyrum and Cyperaceae pollen than in the previous zone. Sphagnum and sedges were replaced by local stands of willow which were in turn, replaced by Alnus. There is a loss-on-ignition peak at 1.40 m which suggests a period of erosion resulting in the flushing of mineral material onto the mire. McVean (1956b, 327) has shown that Alnus glutinosa is a pioneer species capable of colonising a wide range of wet habitats as they become available and would not normally be involved in a simple Salix-Alnus hydroseral sucession. Alnus was clearly immigrating to an area already suited to its colonisation.

Coryloid pollen frequencies were not affected by the Salix-Alnus

| Lab no. | Radiocarbon yrs. BP 1 sd. | Depth (m) |
|---|---|---|
| GU-2062 | 7800 ± 75 | 1.55–1.57 |
| GU-2108 | 6430 ± 80 | 1.39–1.41 |
| GU-2107 | 5300 ± 60 | 1.19–1.21 |
| GU-2110 | 4680 ± 70 | 0.89–0.91 |
| GU-2108 | 3340 ± 80 | 0.59–0.62 |

Table 47 Core RH1 : radiocarbon determinations

sucession, although its concentration declined briefly at the lower zone boundary. This might indicate that _Corylus avellana_ was the species concerned here as the alternative _Myrica gale_ would probably have been influenced by the local changes on the bog surface had it been present. The scarcity of _Myrica_ on Rhum at the present time is notable (eg. McVean & Ratcliffe 1962, Ratcliffe 1977).

Subzone RhIIb (1.31-1.27 m, 5950-5700 BP)

*This subzone is characterised by greatly reduced* _Alnus_ *and* Coryloid and increased _Pteridium_ and Gramineae values. These changes indicate a reduced tree cover both on the damp alder-fern woodland suggested for wet areas of the mire and on the drier surrounding slopes which may have supported hazel. The change to grasses and bracken and further reduced _Sphagnum_ and _Equisetum_ indicates a continued drying of the local mire surfaces. Charcoal concentrations and percentages are higher in RhIIb and the start of RhIIc than in RhIIa.

The pollen changes and increased frequency of charcoal in this subzone suggest the decline of woodland may be associated with an increased incidence of fire.

Subzone RhIIc (1.27-1.17 m, 5700-5250 BP)

_Alnus_ and _Coryloid_ pollen frequencies recover in this subzone and a gradual decline of grasses and bracken takes place. _Potentilla_ pollen values are low and _Melampyrum_ is absent, _Sphagnum_ remains low and *Polypodium* rises. These changes suggest that the mire surface was still fairly dry but there is also loss-on-ignition evidence for the washing of mineral onto the surface of the site. This is the period of maximum *Pinus* pollen frequencies and corresponds to the expansion of *Pinus* onto drier aerated bog surfaces on Skye (Williams 1976). *Alnus* and *Corylus* expanded to regain their former habitats, suggesting open woodland as in subzone RhIIa. Grass and sedges maintain a major presence and a range of herbs is present. *Fraxinus* pollen has its first appearance. Pollen frequencies of *Filipendula* and *Osmunda* are low perhaps indicating that they were unable to regain their former prominence in the regenerating woodland.

Subzone RhIId (1.17-1.03 m, 5250-4950 BP)

In this subzone *Alnus* pollen frequencies are reduced and those of sedges increase. *Filipendula* pollen and *Equisetum*, *Osmunda* and *Sphagnum* spores increase. *Potentilla*, Ranunculaceae and *Melampyrum* all expand and *Pteridium* has a peak. There is some evidence that charcoal production increased, certainly in relation to pollen. This coupled with the possibility that *Pteridium*, some species of *Potentilla* and *Melampyrum*, may increase in response to fire, could indicate the disturbance of vegetation arising from burning.

In the first part of the subzone increased *Sphagnum*, *Equisetum*, and Cyperaceae all suggest a wetter mire surface. In the latter part of the subzone a similar succession of pollen-types to that found in RhIIa takes place. *Sphagnum* and *Cyperaceae* were replaced by *Salix*, again coinciding with an increase in mineral content of the peat, indicated by loss-on-ignition decreasing from 75-80% to 60 %. This change was followed by the decline of *Salix* and the re-expansion of *Alnus* with ferns. In RhIIa similar changes were interpreted as resulting from drying of the mire and the expansion of *Alnus* was interpreted as resulting from the invasion of *Salix* by arriving *Alnus* populations.

The expansions of *Osmunda* and *Filipendula* are interesting as both are resistant to salt-spray and this might indicate that an increased incidence of gales contributed to the pattern of events. The start of this subzone (c. 5200 BP) dates to around the time of the elm decline when climatic shifts have been suggested for north-western Scotland (Pennington *et al.* 1972; Williams 1976) possibly involving increased precipitation resulting fr[illegible] southward displacement of the polar front (Magny 1982).

Subzone RhIIe (1.03-0.74 m, 4950-3950 BP)

This subzone has a recovery of *Alnus* and Coryloid pollen to their highest frequencies in the diagram. Lower frequencies of ferns, herbs of open ground and herb taxa possibly local to the mire surface, for example, *Filipendula* and *Osmunda*, suggest that this was the period of most closed tree vegetation at the site.

Evidence for possible human impact begins at the time of a mid-subzone increase in mineral matter. _Plantago lanceolata_ and _Potentilla_-type pollen start a slow increase while _Filipendula_ and _Osmunda_ values begin to decline. There is also the beginning of a shift towards higher grass pollen frequencies. The composition of the tree pollen assemblage begins to include such open habitat taxa as _Ilex_, _Fraxinus_ and _Sorbus_, and _Lonicera_ is present. At the end of the subzone _Betula_ expands to reach its highest frequency in the profile.

_Subzone RhIII (0.74-0 m, 3950-present)_

This zone starts as _Alnus_ begins to decline and is close to the start of reductions in Filicales and Coryloid frequencies. Grass pollen frequencies rise significantly at the start of the phase. _Potentilla_, _Betula_ and Ericaceae undiff. pollen is better represented and _Filipendula_, _Pteridium_, _Osmunda_ and _Salix_ are less frequent. Two subzones are defined; RhIIIa is a transitional zone where _Alnus_ and Coryloid are declining and RhIIIb after the decline has taken place.

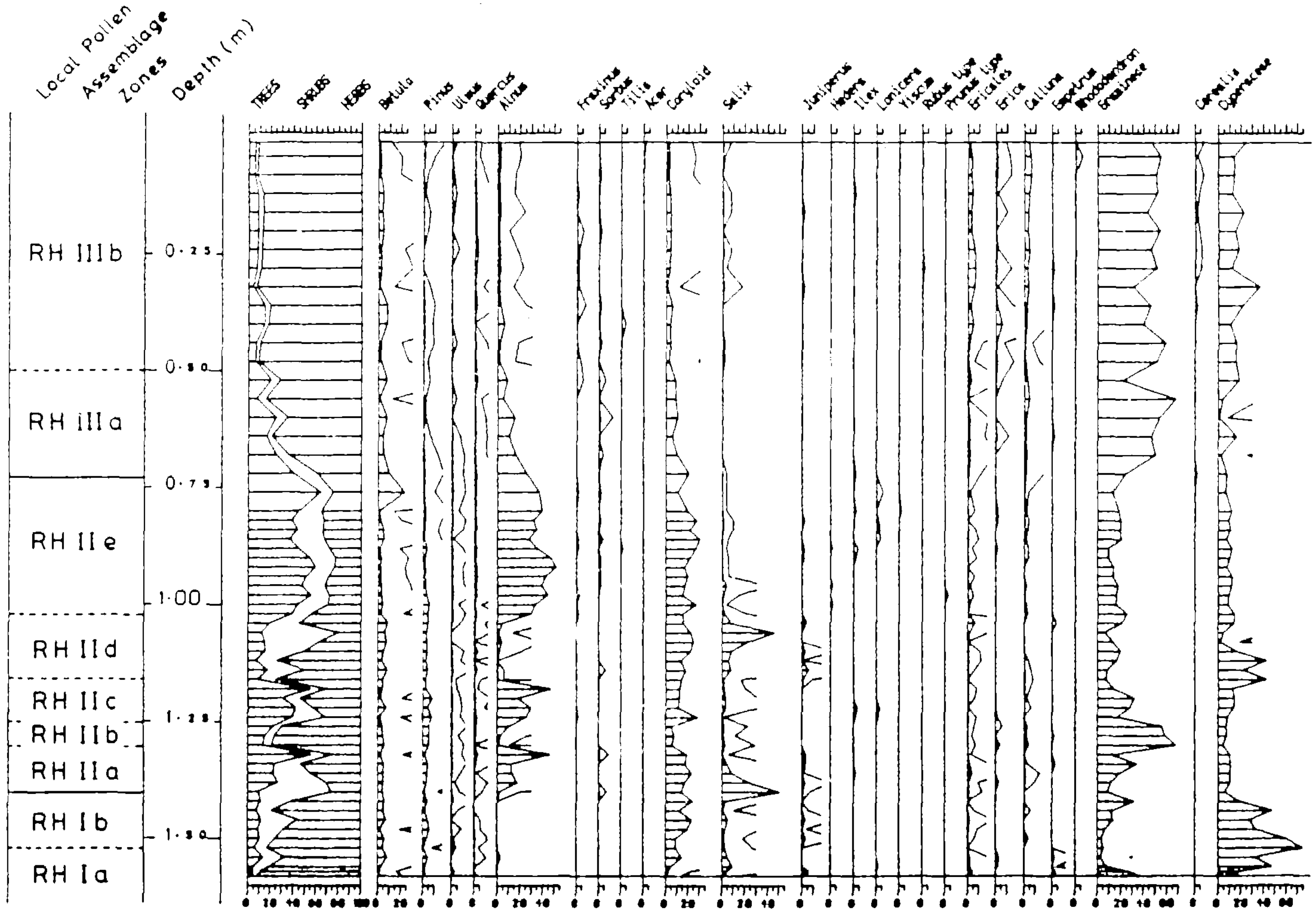
_Subzone RhIIIa (0.74-0.50 cm, 3950-2800 BP)_

This subzone is defined by falling _Alnus_ and Coryloid pollen frequencies which are replaced by grass and to a lesser extent sedge pollen. _Potentilla_ is slightly increased over the previous zone. These changes suggest a decline in the alder woodland and tall-herb communities previously dominating the mire surface, and the hazel on surrounding drier soils. This is reflected by a change in the peat between 0.67-0.73 m where the wood content decreases. *Calluna* and *Succisa* pollen expand suggesting the replacement of *Corylus* on drier slopes by the spread of heath vegetation. *Betula* and *Sorbus* pollen are present in high frequencies, both possibly expanding as pioneer taxa on drier cleared areas left open by the removal of hazel. One cereal-type pollen grain was found at the start of RhIIIa. In combination with the increased frequencies of *Plantago lanceolata*, *P. media* and increased charcoal frequencies, clearance for agriculture is suggested. The start of this subzone also coincides with a decline in *Pinus*. This decline is approximately coeval with the regional pine decline at c. 4000 BP and it is often interpreted elsewhere as a being caused by either man and/or climate (Bennett 1984).

Subzone RhIIIb (0.50-0 m, 2800-present)

This subzone has the lowest frequencies of tree pollen, Coryloid pollen and fern spores. These are replaced by pollen of heaths, grasses, sedges and *Potentilla*. This suggests the development of base-poor grassland perhaps similar to that on the site at present. The reduced mineral content of the peat in the first half of the subzone shows that local soils had reached an equilibrium after the decline of alder and hazel.

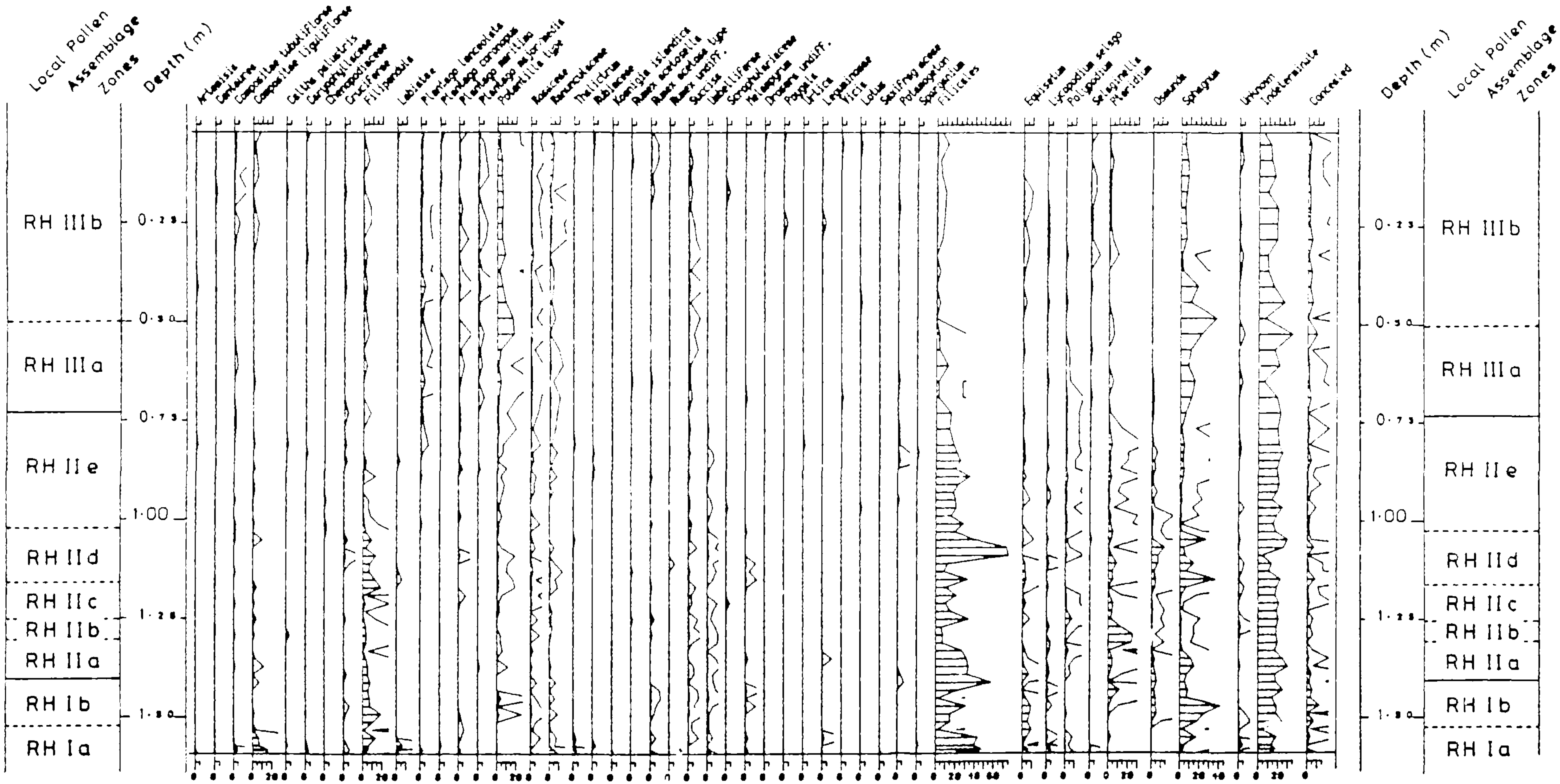
Cereal-type pollen forms a continuous curve in the latter half of this zone and the presence of pollen of ruderal taxa (eg, Compositae, *Artemisia*, Ranunculaceae and *Rumex acetosa*), suggests




Pollen sum = total land plant pollen: taxa outside sum as percent sum + taxon

Exaggeration of open curve is x10.

ILL108: RH 1. Percentage pollen diagram



ILL 108 (contd) RH 1. Percentage pollen diagram

Pollen sum = total land plant pollen: taxa outside sum as percent sum + taxon. Exaggeration of open curve is x10.

that this was the period of most intensive cultivation. Starting around 0.28 m (the beginning of a continuous cereal curve and dated to c. 1500 BP) this period coincides with increased mineral input to the peat. This probably represents the consequences of soil instability resulting from agricultural activity directly upslope of the pollen site. Local recent cultivation is evidenced by the lazy beds at the site itself. The increase in Fraxinus pollen probably relates to the expansion of Fraxinus after local vegetation had become more open.

It has been shown above that there is pollen evidence of possible Mesolithic activity at Farm Fields at least between c. 5950-5700 BP. Before this time pollen evidence for the impact of man is difficult to distinguish from the general background pollen of early postglacial open and exposed habitats. A combination of herb pollen types from plants which may respond to fire, and charcoal evidence, suggests that fire was an important ecological factor and may have contributed to conditions leading to the expansi n of Alnus at 6500 BP. Whether such fire was deliberate and associated with the mesolithic inhabitants of Rhum or whether it was accidental or the result of lightning strikes is unknown.

The first appearance of Plantago lanceolata (ribwort plantain) occurs at 100 cm depth and is dated to 4900 BP. This suggests that Rhum was inhabited at the time although the occupants' impact on the alder woodland was minimal. The start of the first sustained hillwash event recorded by mineral inwash at Rh1 was at 0.90 m depth and dated to c. 4700 BP. At 0.80 m (4200 BP) the *P. lanceolata* curve becomes continuous suggesting that man's impact, possibly associated with grazing activities, spread to the drier slopes above Rh1 first causing some washing of mineral onto the mire and that several hundred years elapsed before direct impact started on the mire itself. The major accelerated impact on the mire started at the begining of zone RhIIIa at c. 3900BP. There is a suggestion of local arable cultivation after clearance of alder and hazel, charcoal becomes more frequent and a general change to open conditions is apparent. This takes the form of local sedge-grassland with plantains, Ranunculaceae and Compositae and expansion of heaths with *Succisa* and *Potentilla*.

Environmental disturbances in the neolithic may be examined in the light of radiocarbon dates associated with colluvial slopewash deposits in the excavation area (III ). Wood from beneath colluvium in trench AG was dated to 3945± 60 BP (GU-2041), while peaty organic material beneath colluvium in trench AM was dated to 4260 ± 70 BP GU-2106). The interpretation of these dates requires some caution (Edwards & Hirons mf) but they may provide the earliest dates for upslope erosion for their respective sampling sites. The evidence for neolithic impact at the pollen profile site to the west of Farm Fields is consistent with the dates.

The suggestion of anthropogenic impact from the pollen record at

Rh1 in the time between 7500 and 4900 when no settlement evidence is evident in the excavation is not necessarily anomolous. The raised beach area is effectively off-site with regard to the excavated area; its pollen record thus reflects different influences though the pollen catchment areas of the pollen and archaeological sites may well overlap. The environmental record is predominantly local and indicates anthropogenic and other factors which are similarly local. Nevertheless, the profile does show vegetational changes consistant with human impact during the mesolithic, neolithic and later periods and they would also appear to demonstrate disturbances which have yet to be accounted for in the archaeological record of the area.

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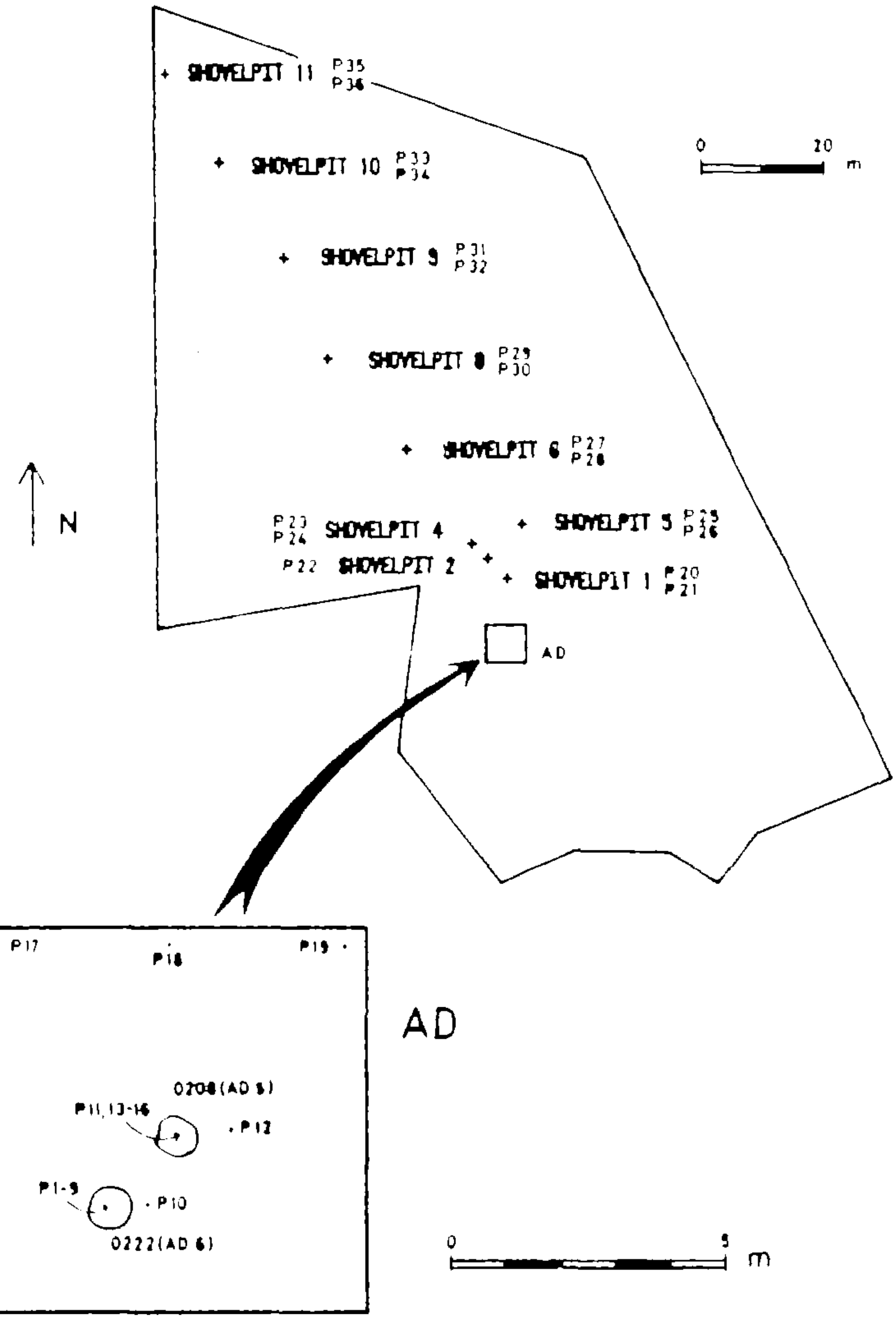
CHEMICAL ANALYSIS OF SOIL SAMPLES FROM THE FARM FIELDS EXCAVATION, KINLOCH, ISLE OF RHUM.

Ken R Hirons and Kevin J Edwards

## INTRODUCTION

The analysis of phosphates, organic matter and trace elements in soils associated with archaeological excavation takes place primarily to assist in the interpretation of human activity. This works on the premise that the disposal of domestic rubbish and human and animal waste products over a sufficient period of time, may lead to the enhancement of certain chemical elements in the soil. The analysis of soil phosphates is the most common soil chemistry test to be used in archaeological contexts, particularly in an effort to assess the spatial extent, intensity or type of activity (Provan 1971, Proudfoot 1976, Edwards et al. 1983). An assessment of soil organic content may indicate the presence of burning, biological residues or the accumulation of soil organic matter (cf. Hamond 1983)and, although less useful, trace element determinations have been used for similar purposes (Sokoloff and Carter 1952, Cook and Heizer 1965, Hamond 1983).

This report presents chemical data from 36 samples submitted by the excavators in 1985. The principal aim of the investigation was to compare soil phosphate concentrations in samples from excavation trench AD with phosphate levels along a transect in




ILL 109 : Location of sampling points for chemical analysis across the excavation site the same field (Ill 109 ). The opportunity was also taken to assess the samples for organic matter and limited trace element content.

## Sampling procedures

The soils in the excavation field have been assessed (Davidson 1984) as comprising a topsoil of sandy loam (0-24 cm in sample trench 080856) underlain by stony loamy sand (24-58 cm) and a stony sand/gravel layer (58-116+ cm). The stony horizons are interpreted as being of glacial/fluvio-glacial origin. The topsoil is now a cultivation horizon and the prehistoric soil may have been a peaty gley (with podzols occurring in better drained areas). Davidson suggests that cultivation may have resulted in the loss of an earlier peat layer.

Details of soil sample locations are shown in Ill 109 and table 48. Within the constraints of the sampling programme, it was the aim of the excavators to obtain data showing both horizontal and vertical variations in chemical content. Samples P1 to P19 relate to trench AD and two of its pits (AD 5 and AD 6). Samples P20 to P36 were obtained from 9 shovel pits spaced at a maximum interval of 23 m along a transect running north-west of trench AD (Ill 109 ). In each shovel pit (except P22), samples were collected from the surface of the subsoil (i.e. from immediately below the visible cultivation horizon) and from the same depth again within the subsoil. A working hypothesis was that the transect samples would provide 'background' levels for the chemical composition of the soils in the proximity of the excavations.

**Methods of Analysis**

Samples were dried at 110 C for 24 hrs and sieved through a 2 mm mesh. For phosphorus determination, samples were ignited for 1 hour at 550 C and digested for 1 hour in 1N HCl to extract organic and inorganic phases (Andersen 1976). The extract was filtered, made up to 100 ml and total phosphorus was determined by the phospho-molybdate method of Murphy & Riley (1962). Every fourth sample was repeated and cross-batch replicates were included for an estimate of overall between - and within - batch precision.

Initial estimates of organic matter content were made using low temperature loss on ignition (8 hrs at 400 C). More acceptable estimates were sought using the oxidisable organic carbon method of Walkley & Black (1934). Again every fourth sample was duplicated. Values of total organic matter (%OM) were calculated from the oxidisable organic carbon data using a correction factor of 1.724 (Hesse 1971, Finlayson 1975).

Measures of total manganese (Mn), zinc (Zn), calcium (Ca), magnesium (Mg) and copper (Cu) were made by atomic absorption spectrophotometry on a Perkin-Elmer 306 AAB after sample

| Sample No. | |
|---|---|
| P1 | bottom centre of emptied 0222 [AD 6] |
| P2 | bottom E. side of emptied 0222 [AD 6] |
| P3 | 0.05m up E. side of emptied 0222 [AD 6] |
| P4 | 0.10m .. .. .. .. .. .. .. |
| P5 | 0.15m .. .. .. .. .. .. .. |
| P6 | 0.20m .. .. .. .. .. .. .. |
| P7 | 0.25m .. .. .. .. .. .. .. |
| P8 | 0.30m .. .. .. .. .. .. .. |
| P9 | 0.35m up (top edge) E. side of emptied 0222 [AD 6] |
| P10 | subsoil surface, 0.50m E. of E. side of emptied 0222 [AD 6] |
| P11 | bottom centre of emptied 0208 [AD 1] |
| P12 | subsoil surface, 0.50m E. of emptied 0208 [AD 1] |
| P13 | top edge, E. side of emptied 0208 [AD 1] |
| P14 | 0.20m down E. side of emptied 0208 [AD 1] |
| P15 | 0.30m .. .. .. .. .. .. .. |
| P16 | bottom E. side of emptied 0208 [AD 1] |
| P17 | NW corner trench AD, subsoil surface |
| P18 | 3.00m E. of NW corner trench AD, subsoil surface |
| P19 | NE corner trench AD, subsoil surface |
| P20, P21 | shovelpit 1 0730/[illegible]810 |
| P22 | .. 2 [illegible] |
| P23, 24 | .. 4 [illegible] |
| P25, 26 | .. 5 0480/[illegible]020 |
| P27, 28 | .. 6 0530/[illegible]170 |
| P29, 30 | .. 8 0370/[illegible] |
| P31, 32 | .. 9 [illegible] |
| P33, 34 | .. 10 0150/[illegible]740 |
| P35, 36 | .. 11 0020/[illegible]040 |

Table 48 Description of the sampling points for chemical analysis across the excavation site

digestion by the acid-pressure decomposition method of Bernas (1978). The Cu content was below the limits of detection in all samples.

**Results**

Results of total phosphorus and organic matter determinations are given in table 49. The overall precision of the method in terms of laboratory precision (using the values for replicates) and of background (shovel pit) vertical and horizontal variability, using replicates from different soil levels (subsoil and subsoil surface) and from closely spaced pits 1, 2 and 4, was estimated by the method of Vermeulen (1953). These, and estimates of confidence intervals (following Chambers 1964) are shown in table 50. The data suggest that differences greater than 250 ppm (90% significance) or 350ppm (95%) are likely to be significantly different given laboratory imprecision. Background soil vertical and horizontal variability suggests that only differences between samples which exceed 550 ppm (90%) or 800 ppm (95%) are likely to be meaningful for the purposes of identifying artificial enhancement. Variability of less than this could be expected by varying depth of sampling in the soil. For estimated total organic matter determinations, precisions are given in table 51. Horizontal variability is greater than vertical variations for organic matter.

1) The shovelpit samples used to assess possible background

| Sample No. | Total Phosphorous ppm. | Oxidisable Organic Carbon % | Est. Total Organic Matter | Loss on Ignition % |
|---|---|---|---|---|
| P1 | 528 | 3.1 | 5.3 | 10.9 |
| P2 | 700 | 7.0 | 12.1 | 17.8 |
| P3 | 550 | 2.9 | 5.0 | 8.2 |
| P4 | 640<br>560 ] 600 | 4.9<br>4.9 ] 4.9 | 8.5<br>8.5 ] 8.5 | 12.5 |
| P5 | 720 | 2.1 | 3.6 | 6.2 |
| P6 | 700<br>720 ] 710 | 2.4 | 4.1 | 10.6 |
| P7 | 516<br>652 ] 584 | 2.5 | 4.3 | 8.5 |
| P8 | 710<br>3.6 ] 3.5 | 3.4<br>6.2 ] 6.1 | 5.9 | 8.4 |
| P9 | 820<br>950 ] 885 | 2.8 | 4.8 | 10.4 |
| P10 | 1370 | 8.6 | 14.8 | 22.3 |
| P11 | 690 | 4.1 | 7.1 | 11.9 |
| P12 | 456<br>2.2 ] 2.2 | 2.1<br>3.8 ] 3.7 | 3.6 | 4.9 |
| P13 | 520<br>664 ] 592 | 3.1 | 5.3 | 7.1 |
| P14 | 360 | 2.3 | 4.0 | 4.8 |
| P15 | 480 | 3.0 | 5.2 | 9.0 |
| P16 | 590<br>740 ] 665 | 3.0 | 5.2 | 8.0 |
| P17 | 650 | 3.2 | 5.5 | 7.5 |
| P18 | 650<br>500 ] 575 | 6.5<br>7.8 ] 7.2 | 11.2<br>13.5 ] 12.4 | 17.5 |
| P19 | 870<br>750 ] 810 | 4.7 | 8.1 | 14.4 |
| P20 | 390 | 2.8 | 4.8 | 8.9 |
| P21 | 264<br>168 ] 216 | 2.8 | 4.8 | 10.6 |

Table 49 Chemical analysis across the excavation site : total phosphate and organic matter determinations

| Sample No. | Total Phosphorous ppm. | Oxidisable Organic Carbon % | Est. Total Organic Matter | Loss on Ignition % |
|---|---|---|---|---|
| P22 | 344 | 4.7, 4.7 ] 4.7 | 8.1, 8.1 ] 8.1 | 17.7 |
| P23 | 360 | 5.7 | 9.8 | 21.7 |
| P24 | 432, 440 ] 436 | 1.3 | 2.2 | 6.1 |
| P25 | 136, 136 ] 136 | 4.3 | 7.4 | 18.6 |
| P26 | 660 | 4.3, 4.1 ] 4.2 | 7.4, 7.1 ] 7.2 | 14.1 |
| P27 | 204, 212, 204 ] 207 | 3.6 | 6.2 | 13.2 |
| P28 | 280 | 2.8 | 4.8 | 12.5 |
| P29 | 340, 350 ] 345 | 3.0 | 5.2 | 9.9 |
| P30 | 456 | 3.0, 3.5 ] 3.3 | 5.2, 6.0 ] 5.7 | 13.4 |
| P31 | 456, 388, 336 ] 392 | 2.3 | 4.0 | 8.6 |
| P32 | 560, 450, 520 ] 510 | 2.8 | 4.8 | 11.6 |
| P33 | 356, 372, 284 ] 337 | 3.9 | 6.7 | 12.1 |
| P34 | 300 | 2.9 | 5.0 | 12.2 |
| P35 | 260, 272 ] 266 | 1.9 | 3.3 | 8.5 |
| P36 | 420, 400 ] 410 | 3.0, 2.7 ] 2.9 | 5.2, 4.7 ] 5.0 | 11.9 |

| | Precision | Difference likely to be significant 90% confidence | 95% confidence |
|---|---|---|---|
| Laboratory variation | ± 0.6 | ± 2.6 | ± 3.8 |
| Background vertical variation | ± 2.0 | ± 8.4 | ± 12.4 |
| Background horizontal variation | ± 3.4 | ± 13.9 | ± 20.5 |

Table 50 Chemical analysis across the excavation site : total phosphate determination, estimate of variability ( ppm P )

| | Precision | Difference likely to be significant 90% confidence | 95% confidence |
|---|---|---|---|
| Laboratory variation | ± 60 | ± 250 | ± 350 |
| Background vertical variation | ± 135 | ± 550 | ± 800 |
| Background horizontal variation | ± 120 | ± 500 | ± 750 |

Table 51 Chemical analysis across the excavation site : total organic matter determination, estimate of variability ( % om )

levels of P from the Kinloch field vary in concentration between 136 and 660 ppm P (both shovelpit 5). There is a general tendency for samples from within the subsoil to have P values exceeding those at the surface of the subsoils (ranges; 216-660 ppm for subsoils and 136-3?3 ppm for subsoil surface). This pattern holds for all but shovelpit 1 but is never significant even at 90% confidence level. Illustration 110 shows frequency histograms of the phosphorus determinations : 2a) from the surface of the subsoil and 2b) from within the subsoil. The slight difference in values is apparent from the histograms. There is no apparent spatial trend in P concentrations within the transect samples.

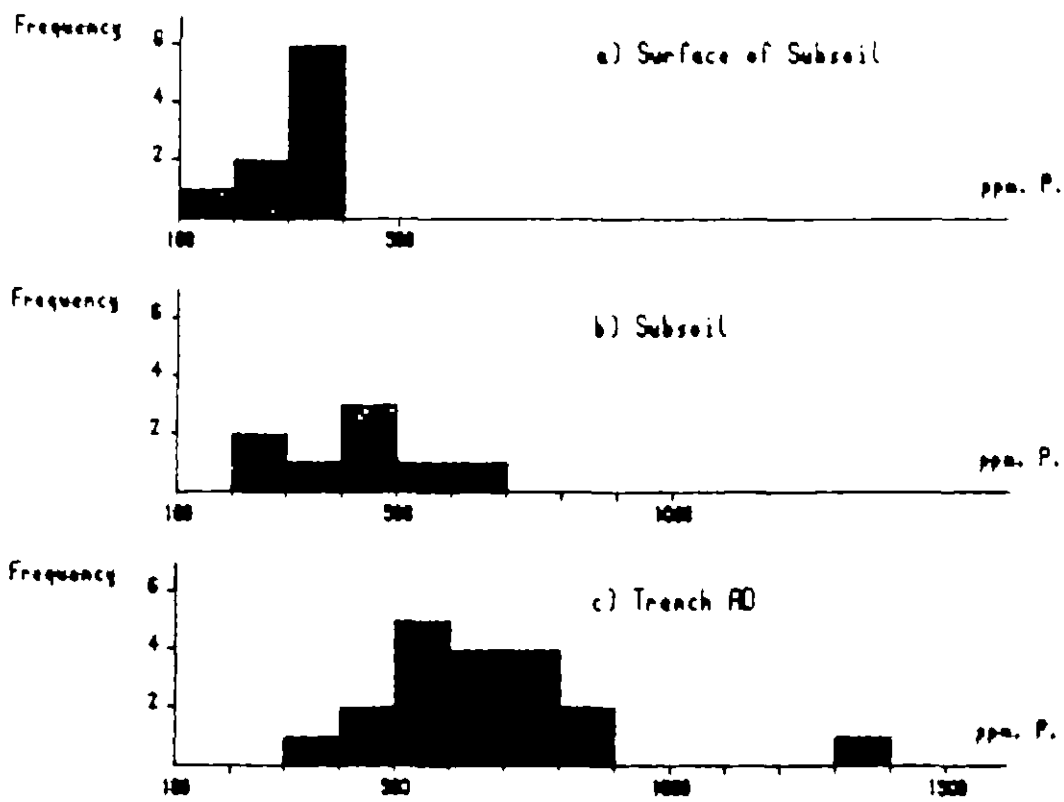
2) Phosphate samples from the subsoil surfaces in trench AD (P10, P12, P17-19) range in concentrtion between 446ppm and 1370ppm. P10, P17 and P19 are all significantly higher in P than shovelpit samples at the 90% probability level. Illustration 110 shows a histogram of all samples from trench AD including those from the two pits.

3) Vertical phosphate variability within the two pits AD208 and AD222 showed no consistent trend or any layers with significantly enhanced P levels. The two samples with highest concentrations occur at the top of AD222 (P9) and at P10 close by. A students t-test of differences between means for samples of unequal variance was used to compare the background samples (X = 356 ppm P, s = + 124) with samples from trench AD (X = 665 ppm P, s = + 211). This gave a t obs of 5.27 which is significant at p 0.01 given d.f. =

3). Thus, assuming both sample sets to be normally distributed, which seems reasonable on inspection of Ill 109, the samples from AD have significantly higher P concentrations than the background samples.

4) There is some tendency for organic matter to increase downslope in the surface and subsoil samples of the background transect. The lack of consistent vertical variation is not unexpected given that samples came from beneath the cultivated surface horizon. Maximum organic matter values of 8.1% and 9.8% are lower down the field (pits 2 and 4) whilst the lowest value is at pit 11 at the top of the field. Pit 1 has low values but is on the knoll with trench AD. Some organic matter values within trench AD tend to be high; P10 = 14.8% (highest value) and P18 = 12.4%. However, background variation is large and AD values other than the two aforementioned fall within the background range.
Organic matter profiles from pits AD5 and AD6 show no clear patterning, although P2 at 12.1% from the base of AD6 is significantly higher than samples overlying it and its near neighbour P1.

5) An extended discussion of the trace element analyses is beyond the remit for this study. The data in table 52 are included for interest. Such bases as Ca and Mg are highly susceptible to leaching processes, Ca and Mn values may be enhanced by the disintegration of bone in acid soils while Zn and




ILL 110 : Chemical analysis across the site. Frequency distributions for phosphate determinations

Cu are concentrated in shellfish and the viscera of such wildlife as fish, animals and birds (cf. Hamond 1985). A more comprehensive study of the chemistry of soils at the site would be of interest.

Phosphate concentrations from several samples taken from trench AD at Kinloch Farm field were found to be significantly higher than background levels determined from shovelpits within the excavation field. It is unlikely that this concentration has been caused by lateral translocation of topsoil as AD is situated on a slight knoll which has presumably been a sediment shedding rather than receiving site. The enhancement is more likely to be due to an accumulation of human/animal derived phosphates related to a period of localised activity. However, the enhancement is not great, being of the order of 300 ppmP (X for background samples 356 ppm and for trench AD samples 665 ppm). The enhancement observed could be explained by P accumulation from animal corralling and human waste due to proximity to the bothy over a period of time and could well be modern. Phosphate values from pits AD5 and AD6 show no enhancement over values from the rest of trench AD. The two highest P concentrations are from the subsoil surface at the top of AD6 and at nearby P10.

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**REPORT ON POLLEN AND ANCILLARY ANALYSES IN SUPPORT OF THE EXCAVATIONS AT KINLOCH, RHUM 1984, 1985, 1986**

B MOFFAT

## Introduction

This report presents the results of the analysis of pollen and plant macro-remains from on-site deposits in support of the excavations at Kinloch, Farm Fields, Rhum in 1984, '85 and '86. The study comprised three parts:

1) Samples taken from excavated contexts in or adjacent to archaeological features to aid in the definition and interpretation of the features.

2) Samples taken from material attached to pottery.

3) Pollen analyses from a peat monolith collected from the infill of a watercourse that once crossed part of the site. This sampling point was the site closest to the excavations where stratified deposits could be found. 'Loss on ignition' and aluminium content of the infill were determined. A radiocarbon date was obtained from a buried soil below the base of the deposit.

Samples were collected from carefully cleaned faces or by scraping from the potsherd in question. The monolith was collected by hammering a metal monolith tin into the cleaned face of the trench. Sub sampling for pollen was then carried out in the laboratory.

Preparation for pollen analysis was by a modification of the concentration techniques of Faegri and Iversen (1975). This included sieving, deflocculation with KOH, acetolysation and removal of mineral silicates with HF. Finally, the samples were stained with safarin and mounted in glycerine for examination under the microscope.

'Loss on ignition' was measured on samples from the monolith as an estimate of organic content. Aluminium values were determined by atomic absorption spectrophotometry as an index of active soil erosion. The determinations were carried out by Dr. Michael Penny in the Department of Forestry and Natural Resources, University of Edinburgh.

**Sample Descriptions**

In all, seventy-one samples were collected for palynological examination as part of this study. These were numbered consecutively and are described in the concordance below along with an assessment of their archaeological period, brief description, the radiocarbon age (if determined) and a finds number where appropriate.

Samples were collected from the following groups;

1. Samples from the fill of mesolithic pits.

2. Sample from neolithic context AD7.

3. Scrapings from neolithic potsherds.

4. Samples from artificial dumps within the peaty fill of the watercourse.

5. A series of samples taken from the peaty fill of the watercourse including a monolith taken through the deposit.

**CONCORDANCE OF SAMPLES**

**1. Samples from the fill of Mesolithic pits.**

*a) Context AD6, Samples from fill of post pipe within AD0222.*

1.AD0209:

Pit AD0222. Base of post pipe at edge of woody part of core. Peaty soil.

2.AD0209:

Woody part of core at base of post pipe. Partly humified wood with three pieces identified as Betula spp.

3. AD0225:

Organic 'pellet' in lowest fill of AD0222.

4. AD0225:

Lowest fill of AD0222, peaty soil from body of deposit.

8. AD0159:

Upper part of post-pipe fill. Peaty soil with comminuted charcoal abundant.

11. AD0225:

Sub-sample of lowest fill of AD 0222; matrix of fibrous peat with Eriophorum spp. remains.

*b) Context AG122*

6. AG121:

Fill of pit AG0121. Stems of Calluna , some charred, included in greasy, black peaty fill.

7825+65BP GU-2039

7. AG122:

Sample from fill of pit AG0122.

*c) Context BA3 mesolithic pits.*

BA0048 dated to 7850±50 BP GU-2145.

80. BA0021:

Fine black soil from within shallow depression. Much burnt amorphous material and small angular stones.

*d) Context BA4/5 fill of master hollow BA0110.*

64-68. BA0106:

Pit fills from from shallow depression under master context 110. Samples taken from beneath slab stones that lie set in pit.

*e) Context BA8 mesolithic fill of hollow BA0110.*

69-70. BA0108:

Samples of pit fill from set of shallow depressions recorded under master context BA0110, samples taken from below slab.

*f) Context BA9 mesolithic fills from master hollow BA0110.*

58. BA0091:

Fine black soil from within shallow depression. Much burnt amorphous material and small pebbles.

59. BA0093:

Fine black soil from within shallow depression. Much burnt amorphous material and small pebbles.

**2. Sample from Neolithic context AD7.**

8. AD0153:

Taken from layer sealing pit A1 and from beneath large slab stone. Subsided silty material.

**3. Scrapings from Neolithic Potsherds**

*a) Samples collected from the ploughsoil context AG0271.*

16. AG0271:

Residues encrusted on pot sherds. Sherd 10.

17. AG0271:

Residues encrusted on pot sherds. Sherd 4.

18. AG0271:

Residues encrusted on pot sherds. Sherd 24.

19. AG0271:

Residues encrusted on pot sherds, context interpreted as modern contamination from field drain. Sherd 91.

20. AG0271:

Residues encrusted on pot sherds, context interpreted as modern contamination from field drain. Sherd 27.

21. AG0271:

Residues encrusted on pot sherds. Sherd 28.

22. AG0271:

Residues encrusted on pot sherds. Sherd 214.

29. AG0271

Residues encrusted on pot sherds. Sherd 13.

*b) Samples from modern field-drain disturbing the site.*

Context AG0181.

23. AG0127:

Residues encrusted on pot sherds. Fill of drain 181. Black fibrous soil. Sherd 38.

24. AG0127:

Residues encrusted on pot sherds. Fill of drain 181. Black fibrous soil. Sherd 42.

28. AG0127:

Fill of drain 181. Residues encrusted on pot sherds, context interpreted as modern contamination from field drain. Sherd 38.

*c) Samples from rock and gravel dumps in fill of watercourse.*

Context AG0128.

25. AG0128:

Residues encrusted on pot sherds. Top layer of peaty fill of watercourse (mixed wood/grass/sedge). Sherd 29.

26. AG0128:

Residues encrusted on pot sherds. Top layer of peaty fill of watercourse (mixed wood/grass/sedge). Sherd 1.

27. AG0128:

Residues encrusted on pot sherds. Top layer of peaty fill of watercourse (mixed wood/grass/sedge). Sherd 104.

**4. Samples from dumps within peaty fill of watercourse.**

*a) Samples from "Midden Dump"*

BA0077 comprised dumps of neolithic midden and brushwood in part of the watercourse (Samples 30-38). Radiocarbon determination 4080±60 BP GU-2148.

30-38. BA0077:

From "midden deposit" dumped in watercourse. Haswithin it charred brushwood (Alnus , Betula spp. and Corylus ). Near sherd in lens of woody peat, mainly Alnus .

*b) Samples from rock and stone dumps. Context AG0128.*

5. AG0128:

From deep top layer of watercourse fill, stems of Calluna and fibrous peat. 7925±65 BP GU-2042

10. AG0128:

Sample of top layer in watercourse fill.

12. AG0128:

Boxed samples from E edge of AG0128 (12-15). Agglutinated peaty inclusion in basal sand.

13. AG0128:

Sample of basal sand in 0128.

14. AG0128:

Sand, peaty soil boundary overlying 12-13 in AG0128.

15. AG0128:

Peaty soil above 12-14 in 0128.

**5. Series of samples taken from the peaty fill of the watercourse.**

*BA0060 'spit' across the peat fill of the watercourse (Samples 37-41).*

37-41. BA0060:

Sample to characterise content of peat layer in gully of burn. Wood with macro-remains of cotton-grass, Eriophorum, and peaty detritus.

42-43. BC0028:

Gelatinous black mass smelling of resin, for a half-hour after exposure, in base of watercourse. Contains splinters of coniferous wood. Area highly disturbed by drains.

44-57. *Samples from monolith taken through fill of watercourse.*

## RESULTS

### Introduction

The results of the pollen analyses of on-site soil samples are tabulated (table 53). The tables give numbers of pollen counted with percentages of tree plus shrub, grass and sedge pollen, herb pollen, ericaceous and spore-bearing taxa.

Samples 11, 13, 18, 20, 21, 22, 27, 62, 64, 65 and 69-71 all proved to be barren of pollen. Full counts from samples 35, 38, 41, 61 and 68 provided only very few grains and these were also excluded from the pollen table. The pollen table shows samples calculated as percentages of the sum of pollen of dry land taxa with other pollen and spores represented as sum plus taxon.

There are no modern exotics in any of the pollen samples which would necessarily indicate modern contamination. However, the archaeological context of the samples shows that they were deposited as part of an 'open system' and as such they must have been subject to mixing of elements from different pollen accumulation sites. This is particularly true of the Monolith samples which will be discussed later. In general, however, slopewash has been suggested as the chief agency for infilling large parts of Trenches AG and AH and it is likely that overland flow has been active over most of the site bringing with it transported pollen. This pollen was possibly mainly pene-contemporaneous (ie. recently deposited pollen) but latterly, after peat formation, derived pollen also must be suspected.

More specifically, samples 19, 20, 23, 24, 25, 26, 27 and 28 all originate from either modern ploughsoil or from the top of the dump of rocks and other material in the watercourse (AG128), and the interpretation of this is problematical. Samples 42 and 43 must also be considered suspect on the basis that their localities were highly disturbed by field drains.

**Resume**

Context 1a: Samples 1-3 all contain birch pollen, unlike 4 and 6 and fewer ericas. There is no patterning evident evident in the samples from within AD6, and this suggests a fill of mixed provenance, as might be expected in a post hole fill.

Context 1b: The samples gave similar results to each other although 7 has slightly more alder pollen than 8.

Context 1c: Sample 60 has high Alnus pollen.

Context 1d: Samples 64 and 65 had no countable pollen.

Context 1e: All samples proved to have a very low pollen concentration.

| SAMPLE NO. | POLLEN SUM | Alnus | Salix | Coryloid | Betula | Quercus | Ulmus | Pinus | Ilex | Sambucus | Hedera | Prunus type | TREES & SHRUBS % OF POLLEN SUM | Gramineae | Cereal type | Cyperaceae | GRASSES & SEDGES % OF POLLEN SUM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 214 | 4 | 9 | 7 | 13 | 1 | | 1 | | | 1 | | 16.8 | 86 | | 52 | 64.5 |
| 2 | 272 | 11 | 5 | 11 | 102 | 2 | | 4 | 1 | 1 | 4 | 1 | 52.2 | 54 | | 8 | 22.8 |
| 3 | 198 | 7 | 6 | 8 | 29 | | | | 1 | 1 | 7 | | 29.8 | 48 | | 20 | 34.3 |
| 4 | 317 | 1 | 1 | 1 | 6 | 1 | | 1 | | | | | 3.5 | 73 | | 27 | 31.5 |
| 5 | 280 | 3 | 1 | 2 | 4 | | | 1 | | | 1 | | 4.3 | 31 | | 7 | 13.6 |
| 6 | 274 | 4 | 1 | 3 | 12 | 11 | 3 | 2 | 1 | 1 | 4 | | 15.3 | 65 | | 31 | 35.0 |
| 7 | 42 | 5 | | | 2 | | | | | | | | 16.7 | 9 | | 3 | 28.6 |
| 8 | 76 | 3 | | 1 | 2 | | | | 1 | | | | 9.2 | 9 | | | 11.8 |
| 9 | 218 | 11 | | 3 | 14 | 1 | 1 | | | | 3 | | 15.1 | 43 | | 11 | 24.8 |
| 10 | 56 | 5 | | | 4 | | | | | | | | 16.0 | 5 | | | 8.9 |
| 11 | nil | | | | | | | | | | | | | | | | |
| 12 | 242 | 4 | 1 | 3 | 15 | 1 | | 1 | 1 | 1 | 2 | | 12.0 | 45 | | 19 | 26.4 |
| 13 | nil | | | | | | | | | | | | | | | | |
| 14 | 412 | 23 | 2 | 5 | 41 | 2 | 1 | 1 | | 1 | 3 | | 19.2 | 97 | | 41 | 33.5 |
| 15 | 286 | 11 | 1 | 9 | 28 | 6 | 2 | | | 2 | | | 20.6 | 68 | | 22 | 31.5 |
| 16 | 20 | 2 | | 1 | 1 | | | | | | | | 20.0 | 2 | | 1 | 15.0 |
| 17 | 173 | 8 | | 4 | 3 | 1 | | | | | | | 9.2 | 23 | | 8 | 17.9 |
| 18 | nil | | | | | | | | | | | | | | | | |
| 19 | 234 | 14 | | 6 | 9 | 2 | | 2 | | | | | 14.1 | 52 | 9 | 9 | 29.9 |
| 20 | nil | | | | | | | | | | | | | | | | |
| 21 | nil | | | | | | | | | | | | | | | | |
| 22 | nil | | | | | | | | | | | | | | | | |
| 23 | 184 | 13 | | 8 | 5 | 1 | | 2 | | | | | 15.8 | 39 | 3 | 6 | 26.0 |
| 24 | 129 | 5 | | 2 | 3 | 1 | | 1 | | | | | 9.3 | 14 | | 8 | 17.1 |
| 25 | 42 | 2 | | 1 | 2 | | | | | | | | 11.9 | 6 | | 2 | 19.0 |
| 26 | 25 | 1 | | 1 | 1 | | | | | | | | 12.0 | 3 | | 1 | 16.0 |
| 27 | nil | | | | | | | | | | | | | | | | |

| SAMPLE NO. | Ranunculaceae | Cruciferae | Caryophyllaceae | Chenopodiaceae | Linum catharticum | Potentilla type | Filipendula | Umbelliferae | Rumex sect. Rumex | Rumex sect. Acetosa | Urtica dioica | Teucrium | Plantago lanceolata | Plantago major | Campanula type | Galium type | Succisa | Compositae lig. | Compositae tub. | Iris pseudacorus | HERBS % OF POLLEN SUM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | | 1 | | 1 | 2 | | | 1 | | | 1 | 2 | | | 1 | | 1 | 2 | 2 | 7.0 |
| 2 | 1 | | 1 | | 1 | 1 | 1 | | | 1 | 4 | 1 | 4 | 1 | | 3 | 1 | | | 4 | 8.8 |
| 3 | | | | 4 | | | | | 1 | | 25 | | 6 | 6 | | | | 1 | 1 | | 22.2 |
| 4 | | | | | 1 | 1 | | | | | | 1 | 1 | | | 2 | 1 | | | | 2.2 |
| 5 | 1 | 1 | 2 | | 5 | 5 | 1 | 1 | | 1 | | 3 | 2 | | | 5 | 1 | 1 | | | 10.4 |
| 6 | 2 | 2 | 7 | 1 | 1 | 3 | | 2 | 1 | 4 | 1 | 3 | 1 | 1 | | 3 | | 1 | 2 | | 12.8 |
| 7 | 1 | | | | | | | | | 1 | | | | | | | | 2 | | | 9.5 |
| 8 | | | | | | | | | | 1 | | 1 | | | | | | 1 | | | 3.9 |
| 9 | 2 | 1 | 2 | 1 | | 1 | | | | 1 | | | 2 | | | 6 | 2 | 1 | 1 | | 9.2 |
| 10 | 1 | | | | 1 | | | | | 1 | | 1 | | | | 3 | | | | | 12.5 |
| 11 | | | | | | | | | | | | | | | | | | | | | |
| 12 | 1 | | 3 | | 2 | 2 | 3 | | | 3 | | 3 | 2 | 1 | 4 | 4 | | 1 | | 1 | 12.4 |
| 13 | | | | | | | | | | | | | | | | | | | | | |
| 14 | 2 | 3 | 4 | 1 | 5 | 1 | 3 | 1 | 8 | 4 | | 1 | 3 | 1 | 3 | | | 2 | | | 10.2 |
| 15 | 1 | | | 1 | 1 | | | | 1 | 2 | 4 | 3 | 4 | 2 | 1 | 3 | | 2 | 3 | 1 | 10.1 |
| 16 | | | | | | | | | | 1 | 1 | | 1 | | | | | 1 | | | 20.0 |
| 17 | 3 | | | 2 | | 1 | 2 | | | 4 | 2 | 1 | 4 | | | 2 | 1 | 4 | 2 | | 16.1 |
| 18 | | | | | | | | | | | | | | | | | | | | | |
| 19 | 8 | | | 3 | | | 2 | | | 4 | 2 | 3 | 5 | | | 2 | 2 | 9 | 2 | | 17.9 |
| 20 | | | | | | | | | | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | | | | | | | | | |
| 22 | | | | | | | | | | | | | | | | | | | | | |
| 23 | 1 | | | 2 | | 1 | 13 | | | 1 | | | 4 | | | | | 2 | 4 | | 15.2 |
| 24 | 2 | | | 1 | | 1 | 8 | | 1 | 1 | | 1 | 1 | | | | | 1 | 3 | 1 | 14.7 |
| 25 | 1 | | | | | | | | | 1 | | | 1 | | | | | 1 | 2 | | 14.3 |
| 26 | | | | | | | | | | | | | 1 | 1 | | | | 3 | | | 20.0 |
| 27 | | | | | | | | | | | | | | | | | | | | | |

| SAMPLE NO. | Calluna | Ericales | ERICOID SHRUBS % OF POLLEN SUM | Polypodium vulgare | Equisetum | Osmunda | Pteridium | Blechnum spicant | Dryopteris filix-mas | Filicales | Sphagnum | SPORIFEROUS TAXA % OF POLLEN SUM | SAMPLE NO. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 21 | 4 | 11.7 | 5 | | | 3 | | | 25 | 6 | 18.2 | 1 |
| 2 | 37 | 7 | 16.2 | 43 | 2 | 4 | | 19 | 3 | 146 | | 79.8 | 2 |
| 3 | 21 | 6 | 13.6 | 7 | 14 | | 1 | 1 | 1 | 17 | | 20.7 | 3 |
| 4 | 145 | 54 | 62.8 | 8 | | 17 | | 8 | | 39 | | 23.0 | 4 |
| 5 | 176 | 25 | 71.8 | | 1 | | 25 | 5 | | 80 | 5 | 41.4 | 5 |
| 6 | 58 | 43 | 36.9 | 8 | | | 17 | 1 | 1 | 96 | 6 | 47.4 | 6 |
| 7 | 19 | | 45.2 | | 1 | | 5 | | | 38 | | 104.8 | 7 |
| 8 | 51 | 6 | 75.0 | 5 | | | | | | 20 | 19 | 57.9 | 8 |
| 9 | 89 | 22 | 50.9 | | | | 2 | 7 | 1 | 30 | | 18.3 | 9 |
| 10 | 31 | 4 | 62.5 | | | 8 | | | | 28 | | 64.3 | 10 |
| 11 | | | | | | | | | | | | | 11 |
| 12 | 87 | 32 | 49.2 | 2 | 5 | | | 8 | | 67 | 5 | 36.0 | 12 |
| 13 | | | | | | | | | | | | | 13 |
| 14 | 119 | 34 | 37.1 | 40 | 5 | 2 | 8 | 5 | 5 | 93 | | 38.3 | 14 |
| 15 | 79 | 29 | 37.8 | 5 | 5 | | | 1 | | 35 | 6 | 18.2 | 15 |
| 16 | 9 | | 45.0 | 2 | | | | 1 | | 4 | | 35.0 | 16 |
| 17 | 79 | 19 | 56.6 | 3 | | 1 | 5 | 1 | | 11 | 1 | 12.7 | 17 |
| 18 | | | | | | | | | | | | | 18 |
| 19 | 83 | 6 | 38.0 | 5 | | | 3 | 2 | | 21 | | 13.2 | 19 |
| 20 | | | | 2 | | | 1 | | | 5 | | | 20 |
| 21 | | | | 3 | | | | 1 | | 6 | | | 21 |
| 22 | | | | | | | | | | 1 | | | 22 |
| 23 | 61 | 18 | 42.9 | | 1 | 18 | 2 | | | 6 | 1 | 15.2 | 23 |
| 24 | 58 | 18 | 58.9 | 2 | 1 | 1 | | 1 | | 13 | 1 | 14.7 | 24 |
| 25 | 18 | 5 | 54.8 | 2 | | | | 2 | | 2 | | 14.3 | 25 |
| 26 | 11 | 2 | 52.0 | 2 | | | | | | 1 | | 12.0 | 26 |
| 27 | | | | | | | | | | | | | 27 |

Table 53 Environmental samples from the excavation site: results of pollen analysis

| SAMPLE NO. | POLLEN SUM | Alnus | Salix | Coryloid | Betula | Quercus | Ulmus | Pinus | Ilex | Sambucus | Hedera | Prunus type | TREES & SHRUBS % OF POLLEN SUM | Gramineae | Cereal type | Cyperaceae | GRASSES & SEDGES % OF POLLEN SUM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 28 | 214 | 24 | | 5 | 7 | | | | | | | | 16.8 | 38 | 5 | 19 | 29.0 |
| 29 | 82 | 6 | | | 2 | | | | | | | | 9.8 | 17 | 2 | 5 | 29.3 |
| 30 | 212 | 32 | 1 | 5 | 8 | 1 | | 1 | | | | | 22.6 | 21 | | 15 | 17.0 |
| 31 | 240 | 61 | 2 | 7 | 18 | 3 | | 3 | | 2 | 1 | | 40.4 | 33 | | 19 | 21.7 |
| 32 | 624 | 262 | 18 | 98 | 110 | 7 | 3 | 8 | | 6 | | | 82.1 | 27 | | 29 | 9.0 |
| 33 | 486 | 172 | | 61 | 82 | 6 | 2 | 6 | | 4 | | | 68.5 | 38 | | 24 | 12.8 |
| 34 | 702 | 306 | 13 | 32 | 17 | 7 | 1 | 11 | | 11 | | | 56.7 | 119 | | 82 | 28.6 |
| 35 | 11 | 2 | | 3 | 1 | | | | | | | | 54.5 | 2 | | | 18.2 |
| 36 | 4 | 1 | | | | | | | | | | | 25.0 | | | | |
| 37 | 117 | 28 | | 11 | 9 | 3 | | 2 | | 2 | | | 47.0 | 17 | | 6 | 19.7 |
| 38 | 182 | 18 | 3 | 15 | 11 | 3 | 1 | 5 | | 6 | | | 34.1 | 33 | | 15 | 26.4 |
| 39 | 244 | 32 | 3 | 4 | 15 | 1 | 1 | 2 | | 3 | | | 25.0 | 41 | | 29 | 28.7 |
| 40 | 86 | 5 | 1 | 5 | 4 | 2 | | 7 | | | | | 27.9 | 15 | | 3 | 20.9 |
| 41 | 12 | 1 | | 2 | 1 | | | | | | | | 33.3 | 1 | | 2 | 25.0 |
| 42 | 1800 | 362 | 37 | 172 | 231 | 16 | 2 | 792 | | | | | 89.6 | 48 | | 28 | 4.2 |
| 43 | 872 | 106 | 17 | 68 | 82 | 9 | | 492 | | | | | 88.7 | 22 | | 19 | 4.2 |
| 58 | 219 | 31 | 1 | 2 | 3 | | | 9 | | | | | 21.0 | 37 | | 14 | 23.3 |
| 59 | 179 | 19 | | 1 | 9 | | | 4 | | | | | 18.4 | 48 | | 12 | 33.5 |
| 60 | 311 | 136 | 1 | 4 | 25 | | | 6 | | | | | 55.3 | 21 | | 11 | 10.3 |
| 61 | 14 | | | | | | | | | | | | | | | | |
| 62 | nil | | | | | | | | | | | | | | | | |
| 63 | 214 | 24 | | 5 | 9 | 1 | | 2 | | | | | 19.2 | 68 | | 24 | 43.0 |
| 64 | nil | | | | | | | | | | | | | | | | |
| 65 | nil | | | | | | | | | | | | | | | | |
| 66 | 201 | 21 | | 2 | 8 | | | 3 | | | | | 15.9 | 68 | | 39 | 53.2 |
| 67 | 112 | 6 | | 3 | 2 | | | 12 | | | | | 20.5 | 24 | | 7 | 27.7 |
| 68 | 12 | 12 | | | | | | | | | | | 100.0 | | | | |
| 69-70 | nil | | | | | | | | | | | | | | | | |

| SAMPLE NO. | Ranunculaceae | Cruciferae | Caryophyllaceae | Chenopodiaceae | Linum catharticum | Potentilla type | Filipendula | Umbelliferae | Rumex sect. Rumex | Rumex sect. Acetosa | Epilobium type | Urtica dioica | Teucrium | Plantago lanceolata | Plantago major | Campanula type | Galium type | Succisa | Compositae lig. | Compositae tub. | Scrophulariaceae | Plantago maritima | Iris pseudacorus | HERBS % OF POLLEN SUM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 28 | 1 | | 1 | | | 2 | 19 | | 1 | 4 | | | | 6 | 1 | | 3 | 6 | | | | | | 20.6 |
| 29 | | | | | | 4 | 3 | | | 2 | | | | 8 | | | | 1 | 2 | | | | | 24.4 |
| 30 | 2 | | 2 | 2 | | 1 | 1 | 1 | 2 | 1 | | 3 | 1 | 13 | 2 | 1 | 4 | | 19 | 12 | | 5 | | 34.0 |
| 31 | | 1 | | 2 | | 2 | 1 | | 3 | 4 | | | 3 | 9 | 1 | | | | 3 | | | | | 12.1 |
| 32 | 1 | | | 1 | | 1 | | | | 2 | | 4 | | 8 | | | | | 5 | | | | | 3.5 |
| 33 | 1 | | | 4 | 1 | 2 | | | | 1 | | 2 | | 11 | | | 1 | | 7 | 1 | | | | 6.4 |
| 34 | | | | 2 | | 2 | | | 4 | 2 | | 1 | | 5 | 1 | | 4 | 2 | 8 | 3 | | | | 4.8 |
| 35 | | | | | | | | | | | | | | | | | | | 1 | | | | | 9.1 |
| 36 | | | | | | | | | | | | | | | | | | | | | | | | |
| 37 | | | | 1 | | | | | 1 | 1 | | 1 | 1 | 4 | | | | | 5 | 2 | | | | 13.7 |
| 38 | 1 | | 1 | | | 2 | 2 | 1 | 3 | 4 | | 3 | | 4 | | | | 1 | 2 | | | | | 13.2 |
| 39 | | 1 | | | | | | | 6 | 4 | | 23 | 2 | 11 | | | | 1 | 8 | 2 | | | | 23.8 |
| 40 | | | | 3 | | | | | 1 | 2 | | | | | | | | | 2 | | | | | 9.3 |
| 41 | | | | | | | | | | | | | | | | | | | 2 | | | | | 16.7 |
| 42 | 2 | | | 2 | | 1 | | | 7 | | | 5 | | 5 | | | | | 16 | | | | | 2.1 |
| 43 | | | | 1 | | | | | 7 | | | 2 | | 2 | 3 | | | | 7 | 5 | | | | 2.8 |
| 58 | 1 | 1 | 1 | 1 | | | | 1 | 1 | 1 | | | | 8 | 1 | | | 1 | 2 | 2 | | | | 9.6 |
| 59 | | 1 | 1 | | | | | | | | | | | 16 | | | | | 5 | 1 | | | | 13.4 |
| 60 | | 1 | | | | | | | 31 | | 14 | | | | | | | | 2 | | 1 | | | 11.3 |
| 61 | | | | | | | | | | | | | | | | | | | | | | | | |
| 62 | | | | | | | | | | | | | | | | | | | | | | | | |
| 63 | | 1 | | | | | 1 | | 6 | | | | | | | | 1 | | 13 | | | | | 10.3 |
| 64 | | | | | | | | | | | | | | | | | | | | | | | | |
| 65 | | | | | | | | | | | | | | | | | | | | | | | | |
| 66 | | 2 | 1 | | | | 3 | | 5 | | | | | 9 | 2 | | | | 3 | 4 | | | | 14.4 |
| 67 | | 1 | | | | | | 1 | 1 | | | 1 | | 1 | | | 1 | | 1 | | | | | 6.3 |
| 68 | | | | | | | | | | | | | | | | | | | | | | | | |
| 69-70 | | | | | | | | | | | | | | | | | | | | | | | | |

| SAMPLE NO. | Calluna | Ericales | Empetrum | ERICOID SHRUBS % OF POLLEN | Polypodium vulgare | Equisetum | Osmunda | Pteridium | Blechnum spicant | Dryopteris filix-mas | Filicales | Sphagnum | SPORIFEROUS TAXA % OF POLLEN SUM | SAMPLE NO. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 28 | 61 | 11 | | 33.6 | 2 | | 5 | 6 | | | 5 | | 8.4 | 28 |
| 29 | 28 | 2 | | 36.6 | 1 | | 2 | | | | 6 | | 11.0 | 29 |
| 30 | 34 | 22 | | 26.4 | 18 | | 1 | 3 | | 3 | 16 | 7 | 22.6 | 30 |
| 31 | 47 | 15 | | 25.8 | 3 | | | 5 | | | 22 | 6 | 15.0 | 31 |
| 32 | 30 | 3 | 1 | 5.4 | 8 | 16 | | 1 | | | 40 | 7 | 11.5 | 32 |
| 33 | 41 | 19 | | 12.3 | 5 | 2 | | 7 | | | 19 | 5 | 7.8 | 33 |
| 34 | 48 | 21 | | 9.8 | 31 | 24 | | 8 | | | 32 | 7 | 14.5 | 34 |
| 35 | 2 | | | 18.7 | | | | | | | 12 | | 109.0 | 35 |
| 36 | 3 | | | 75.0 | | | | | | 1 | 1 | | 50.0 | 36 |
| 37 | 21 | 2 | | 19.7 | 5 | | 1 | | | | 5 | 8 | 16.2 | 37 |
| 38 | 36 | 12 | | 26.4 | 2 | | 2 | 3 | | | 6 | 1 | 7.7 | 38 |
| 39 | 41 | 14 | | 22.5 | 7 | | | 8 | | | 6 | | 8.6 | 39 |
| 40 | 30 | 6 | | 41.9 | 8 | | 3 | 5 | | | 13 | 19 | 55.8 | 40 |
| 41 | 3 | | | 25.0 | 1 | | 1 | 1 | | | 12 | 5 | 167.0 | 41 |
| 42 | 48 | 23 | | 4.1 | 114 | 8 | | | | | 40 | | 9.0 | 42 |
| 43 | 36 | 6 | | 4.3 | 16 | | | | | | 32 | | 4.8 | 43 |
| 58 | 88 | 13 | | 46.1 | 2 | | | 1 | | | 4 | 22 | 13.2 | 58 |
| 59 | 42 | 20 | | 34.6 | 3 | | | | | | 5 | | 4.5 | 59 |
| 60 | 60 | 12 | | 23.2 | 2 | | 1 | | | | 11 | 5 | 6.1 | 60 |
| 61 | | | | | | | | | | | | | | 61 |
| 62 | | | | | | | | | | | | | | 62 |
| 63 | 51 | 8 | | 27.6 | 5 | 2 | | | | 1 | 2 | 4 | 6.5 | 63 |
| 64 | | | | | | | | | | | | | | 64 |
| 65 | | | | | | | | | | | | | | 65 |
| 66 | 30 | 3 | | 16.4 | 5 | 1 | | 1 | | 1 | 12 | 2 | 10.9 | 66 |
| 67 | 32 | 19 | | 45.5 | 14 | | | 7 | | 2 | 9 | 6 | 33.9 | 67 |
| 68 | | | | | | | | | | | | | | 68 |
| 69-70 | | | | | | | | | | | | | | 69-70 |

Table 53 (contd) Environmental samples from the excavation site: results of pollen analysis

Context 1f: Assemblages dominated by heathers, grasses and sedges.

Context 2: Sample 9 was dominated by heathers with some fern content.

Context 3a: Samples from potsherds collected from the ploughsoil. A fairly homogeneous group with a high Ericaceous content.

Context 3b: Scrapings from potsherds taken from the modern field-drains crossing the site. Again these form a homogenoeus group dominated by Ericaceae and Gramineae pollen.

Context 3c: Scrapings from potsherds taken from the rock and gravel dumps in the watercourse. Again very similar to 3a) and b).

Context 4a: Samples from peat within the "midden dump" material in the watercourse. These samples were taken to provide a background against which to compare the potsherd scrapings. They are somewhat different to the group three samples in having more tree pollen, mainly _Alnus_ but also some Coryloid and _Quercus_, and lower Ericaceous pollen.

Context 4b: Samples from peat within the rock and stone dumps in the watercourse. These samples have a high Ericaceous pollen content similar to those in group three.

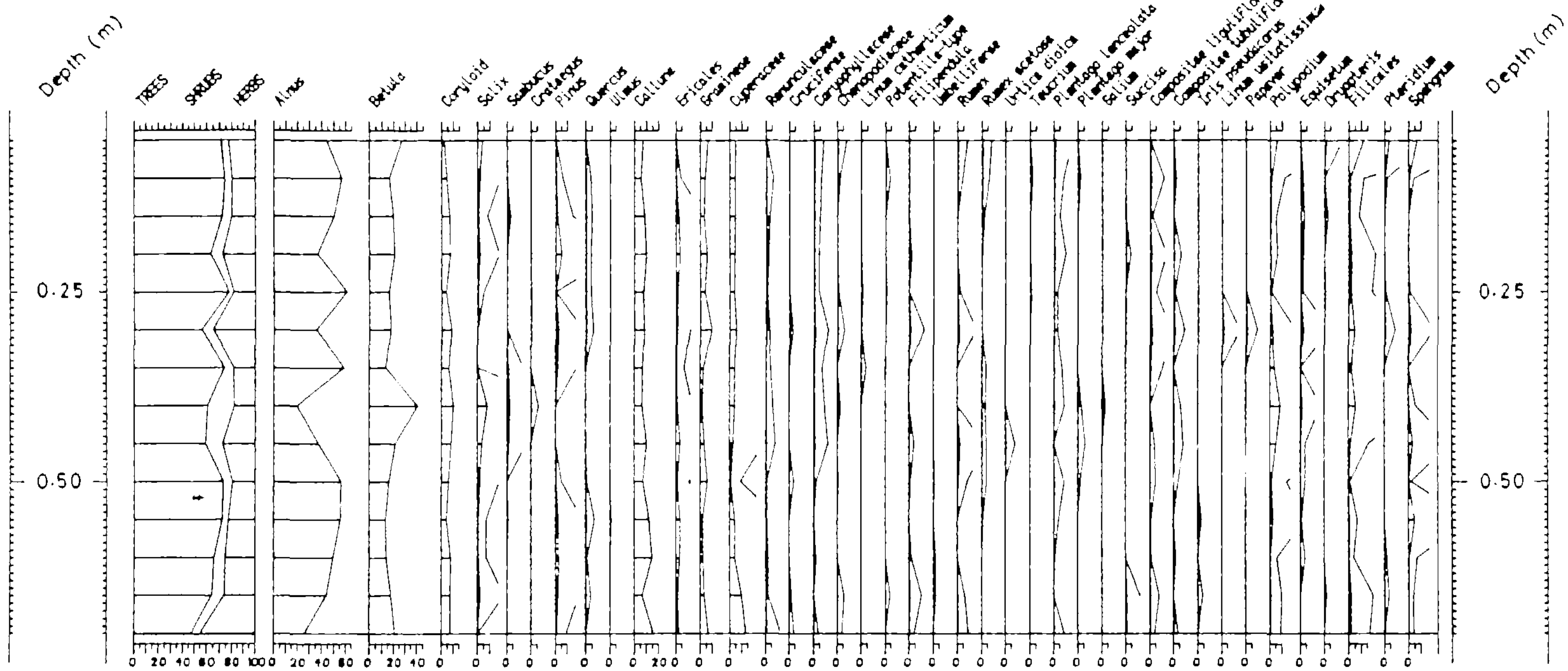
Context 5: Samples from the peaty fill of the watercourse. Samples have slightly more tree pollen and less Ericaceae than the group three-type. Samples 42 and 43 have very high pine pollen contents but are from a disturbed context.

**Discussion**

The results of the pollen analyses from the monolith through the watercourse crossing the site are presented in the form of a pollen diagram (Ill 111). The data are plotted against depth, calculated on the basis of total land pollen.

Sutherland (Chapter 12) has suggested that the channel was only active as a stream in late or immediate postglacial times and that an orderly accumulation of peat might have been possible. However, there are many problems inherent in attempting an investigation of such channel fills in a stratigraphic context; the assumed derivation of pollen and sediment from sources other than the immediate vicinity of the sampling site, and the likelihood of alluvial and colluvial episodes make it difficult to interpret the stratigraphy as a simple time series. Also the likelihood of hiatuses caused by sediment removal by flushing of the site during extreme events and possible sediment inversions by inwashing of eroded peat add to the uncertainties.

The pollen diagram shows a rather homogeneous pollen sequence dominated by <u>Alnus</u> which, at up to 80% was probably predominant



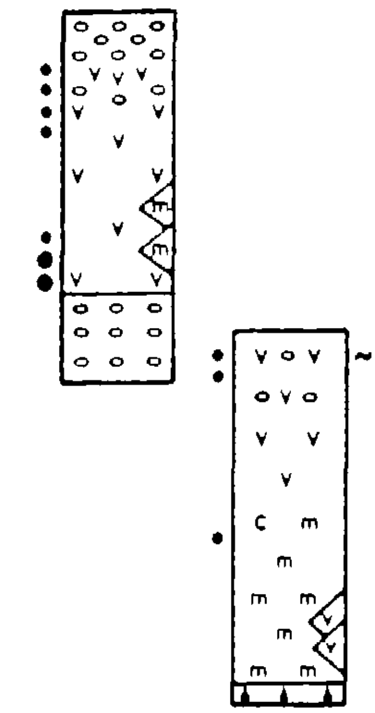
Pollen sum = total land plant pollen! taxa outside sum as percent sum + taxon
Exaggeration of open curve is x10.

ILL 111 : The watercourse monolith. Pollen count in the scrub around the wet flush. *Betula*, *Gramineae*, Coryloid and Cyperaceae are the other important taxa represented. *Salix* is present in some quantity but other trees are poorly represented. Many herb-pollen types were recorded throughout the profile. The only real trend apparent in the diagram is from slightly higher Cyperaceae and *Calluna* in lower parts of the diagram to slightly higher *Betula* and Gramineae in the upper parts of the profile. In the middle of the profile there is a phase with slightly higher *Salix* and *Betula* and a continuous *Sambucus* curve. The area near the burn was a wet flush with *Alnus* bushes rooted in it at various points. The plants contributing the birch pollen probably grew further up the slope where the soils would have been drier. The trend suggests slightly drier conditions in the period represented by the upper sediments presumably in response to the infilling of the channel.

The date of 7140±130 BP (GU-2211) from the buried soil below the base of the monolith precedes the date of the rise in *Alnus* pollen in the Rhum 1 monolith of 6430±80 BP (GU-2108). As *Alnus* pollen was found at the base of the watercourse monolith either we have local presence of *Alnus* at Farm Fields c. 500 years before the major expansion at the core site RH1, or a hiatus in sedimentation occurred between the soil sample date and the start of peat accumulation.

Ill 112 shows a stratigraphic column and sediment data from the watercourse monolith. The sediments are comprised of a *Molinia*

| Sample No. | Wt mg | Org % | Al ppm |
|---|---|---|---|
| 4/1 | 1426.0 | 10.2 | 257.0 |
| 4/2 | 1076.0 | 91.1 | 323.9 |
| 4/3 | 1122.0 | 90.4 | 337.3 |
| 4/4 | 1222.0 | 87.2 | 339.2 |
| 4/5 | 1195.0 | 80.2 | 356.5 |
| 4/6 | 993.0 | 90.3 | 407.4 |
| 5/1 | 866.0 | 23.8 | 412.8 |
| 5/2 | 913.0 | 44.8 | 478.6 |
| 5/3 | 468.0 | 92.5 | 711.5 |
| 5/4 | 1061.0 | 85.3 | 362.4 |
| 5/5 | 603.0 | 92.2 | 738.0 |
| 5/6 | 732.0 | 90.7 | 530.0 |
| 5/7 | 715.0 | 94.7 | 543.4 |
| 5/8 | 748.0 | 84.0 | 413.8 |



Boxes in position
Contents

- v — Woody Peat
- m — Molinia Peat
- c — Sedge Peat
- o — Stony Silts
- ▲ — Basal Silts
- • common — Charcoal
- ● abundant — Charcoal
- ~ Ova of sheep liver fluke (?)

ILL 112 : The watercourse monolith. Stratigraphic column and sediment characterisation data peat with woody inclusions, 30-cm in depth, overlain by a more woody peat of 30 cm depth. Between these layers there was a band of stony-silts around 25 cm in thickness. Stony silts again appear within the top 10 cm of the profile. A layer of brushwood is present within the lower peat stratum. The wood was identified as Alnus. The figures for organic matter and aluminium content outline the mineral layers in the profile; organic matter content being reduced where the layers occur. Aluminium follows this pattern being generally lower in the upper part of the monolith and declining where the mineral content of the sediment is higher. This suggests that the mineral content of the upper part of the monolith is lower in aluminium than the lower part perhaps indicating that the soils washing into the watercourse in the upper part of the sediment had been subject to more leaching of aluminium than those below.

*The Presence of Linum pollen (flaxes).*

Linum usitatissimum occurs as five grains at 30cm depth in the monolith. Linum pollen is large and not carried far by wind (eg. Gennard 1987, Hall *pers comm*) and under normal circumstances a find of its pollen would suggest cultivation of flax on or in the immediate vicinity of the site of discovery. The sediments in the watercourse are undoubtedly derived, though not necessarily from any great distance and it is most likely that flax cultivation took place within what is now the excavation field. The dating scheme suggested for the peat in the watercourse by the radiocarbon dates outlined above would indicate that the stones dump which overlies the finds of flax pollen dated to slightly before 4000 BP. It is of course possible that the date is influenced by redeposition of derived organic sediments but the secure dating of the slopewash suggests flax cultivation somewhere around the start of the second millennium BC. Jessen and Helbaek (1944) report the cultivation of flax in the neolithic of Britain and Godwin (1975) reports records of it as far north as the Lake District, flax has recently been reported from likely neolithic deposits in Kincardine, Deeside (Bond & Hunter 1987, 175).

Linum catharticum (purging flax), is a native annual characteristic of, but not confined to, calcareous grasslands. It is quite common in heathy grasslands on Rhum today. Linum catharticum possesses the fibrous and oleaginous properties of L. usitatissimum to a small degree but by any modern assessment it does not rival the properties of cultivated flax. Godwin (1975) reports finds of its pollen in association with Bronze Age and Early Iron Age cultivation. Linum catharticum was found in four samples assumed to be mesolithic (1, 2, 4, 8) and several neolithic (5, 10, 12, 14, 15, 33).

It is notable that all of the Neolithic contexts containing Linum pollen are associated with the watercourse. Samples 5 and 10 are from the rock dump; samples 12, 14 and 15 are from context AG0128; samples 30,31,32,33 and 34 are from the midden dump; and 38 is from the peat in the watercourse. Perhaps the watercourse was used as a retting pond for the flax. This was possibly in the neolithic but it is more likely that later, it took place after some of the upper sediments had been dug out of the flush. This might relate to the making up of the banks of the watercourse by the spreading of rubble, or to the laying down of a brushwood base, perhaps to consolidate the flush for use as a pond. Macro-remains of the cultivated flax Linum usitatissimum provide the best evidence of retting and without these the interpretation of these deposits must remain uncertain.

*The Littoral Element*

There is little evidence of an obligate littoral element in these pollen floras. However, many pollen taxa could represent plant species characteristic of local marine conditions. These include Caryophyllaceae, Chenopodiaceae, Rumex and Plantago maritima suggesting that the marine influence although strong has not been a predominant factor in the formation of the fossil assemblages.

*Tree Pollen*

Overall, there are significant differences in the amounts of tree pollen in the range of on-site samples investigated. Samples with low tree pollen counts include mesolithic samples from BA (58, 59, 66, 67) and both mesolithic and neolithic samples from AG and AD (5-7, 10, 12, 14 and pot encrustation samples 16-29). Samples with high tree pollen frequencies include BA 32-35 and BC 42 and 43 which are most likely neolithic or later. Off-site pollen analyses would tend to confirm that the period when tree and shrub vegetation was at its most prominent locally was after the time of mesolithic occupation excavated at Farm Fields. The pollen suggests a scrub woodland element with hazel and alder predominating. However there are in some samples with relatively high proportions of Betula (14.8 - 37.5% TLP in samples 2, 3, 32, 33) and in samples from the resinous mass in the burn-fill (samples 42 and 43) very high Pinus frequencies (44-48.2% TLP).

*Cultivars*

Only two undisputed cultivars have been identified amongst the pollen assemblages. Flax, which was found in the burn-fill and as discussed above, and cereal. The pollen of cereals occurred in four samples from on site (19, 23, 28 and 29), all of which were from potsherds. All four samples also contained higher proportions of Filipendula pollen than in samples from the sediment matrix (eg. group 4 samples) and these findings are interpreted as evidence of former pot contents (Moffat in press). It is difficult to place these samples in a wider context since all but sample 28 come from contexts with some contamination. However, given the finds of cereal-type pollen in the monolith from Farm Fields (Rh1, Hirons and Edwards mf ) it is possible that cultivation was practised close to the excavation site in the Neolithic after 4000 BP. There were numerous herb taxa present in the pollen record many of which might be equated with weeds. These fit in to an occasional and seasonal outbreak of weed growth; they are unremarkable and do not compliment any particular agrarian or crop system.

*Liver Fluke*

The ova of the sheep liverfluke *Fasciola hepatica* were found in a sample from the monolith, in three samples of woody peat from the midden deposit (32-34), and in sample 7 of woody peat from alongside the watercourse (36 in all). Although known as the sheep liver fluke this parasite has been recorded in most orders of animal but it is a major epizootic infestor associated with livestock particularly when kept at high densities in enclosed conditions. Repeated feeding upon infested grasslands leads to pervasive and severe infestation. The swampy burn side is an appropriate habitat for the wetland snail which is specifically required to complete the life cycle of the fluke and the boggy watercourse may well have encouraged congregations of livestock.

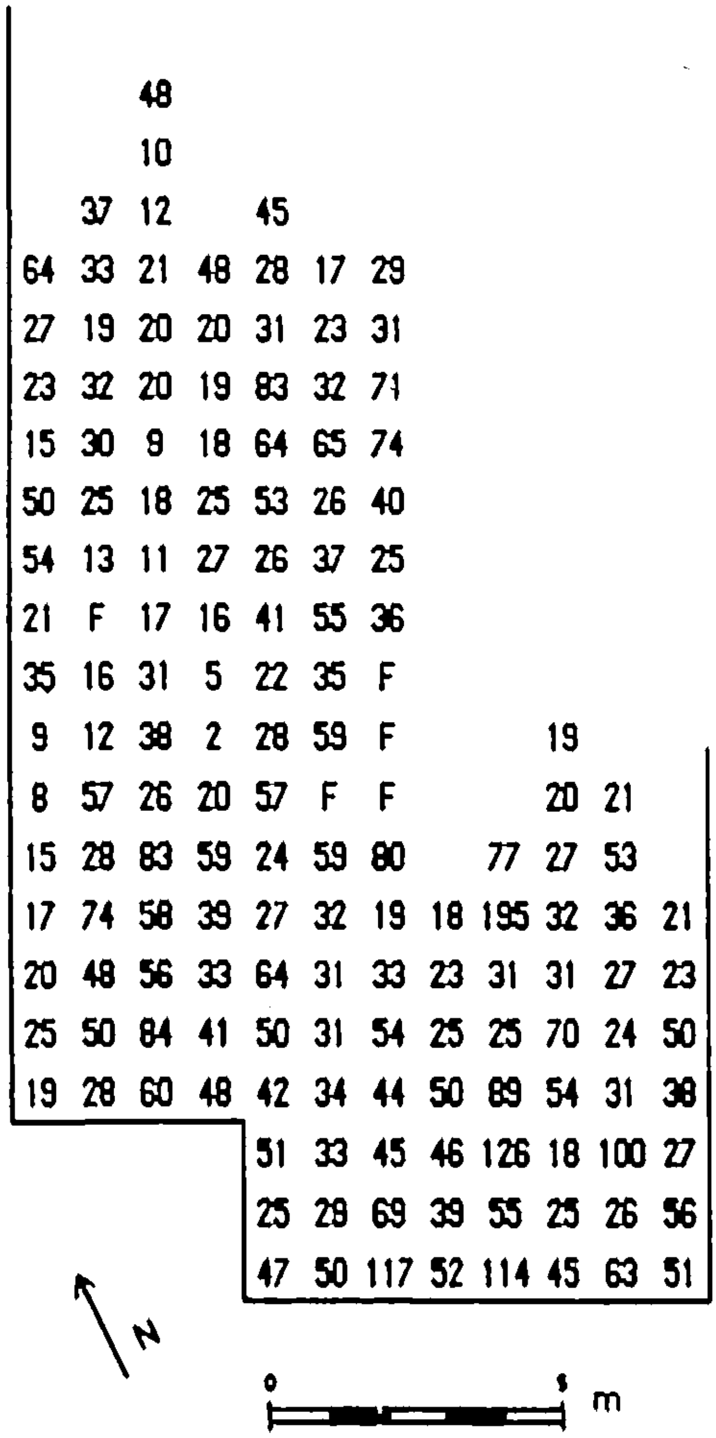
Ms. Fiona Guinness, Director of the Red Deer Project on Rhum writes -

"Rhum deer are quite often infested with Fasciola hepatica. During a period between 17.3.74 and 11.2.75, I collected 132 faecal samples from deer in our study area, 23 % of which had positive F. h. egg counts. Counts varied between 0 and 38. Egg counts from a sample of three deer kept here in an enclosure at higher density varied between 0 & 5.

From 53 of our study deer I was able to carry out post mortems this spring and, of those which still had intact livers, I found that 42 % of the livers were infested by one or more fluke - mostly very few - i.e. 1 - 4 fluke but one hind had 28....." (*pers. comm.*)

Fluke may have originated in the native red deer of Rhum or any livestock, watering and excreting at this swampy waters edge.

BRIAN MOFFAT, SHARP, 38 HAWTHORNVALE, EDINBURGH, EH6 4JN.




ILL 113: Trench BA. Surface magnetic susceptibility survey.
F = Feature fill removed

use over the centuries. The most extensive soil at the time of prehistoric occupation is likely to have been a peaty gley though a podzol may have occurred in the best drained situations, as in between seepage lines. The presence of a forest cover would also have improved drainage. Cultivation in recent historical times has resulted in the loss of the original peat layer and the production of a shallow stony mineral topsoil within which the bloodstone arifacts have been found.

**Summary of Geomorphological and Pedological Evolution of Area in Vicinity of Excavation Site**

| | |
|---|---|
| POST GLACIAL | Historic time: cultivation and mixing of upper horizon (layer I); loss of peat layer; lazy bed formation.<br>Flandrian transgression to 8m, occupation of site ?<br>Development of a peaty gley-podzol soil suite. |
| LOCH LOMOND ADVANCE | Corrie glaciers on Rhum; intensive periglacial processes; extensive spreads of solifluction (layer II). |
| LATE GLACIAL TRANSGRESSION | Transgression to 30m O.D.; formation of shoreline; reworking, resorting fluvio-glacial deposits and landforms below 30m. |

| Horizon | | A | B | B | C |
|---|---|---|---|---|---|
| Depth (m) | | 0.02-0.08 | 0.15-0.25 | 0.30-0.38 | 0.81-0.72 |
| % Loss on ignition | | 12.60 | 3.78 | 3.75 | 2.41 |
| % Sand U.S.D.A | | 61.6 | 80.6 | 82.9 | 83.6 |
| % Silt U.S.D.A | | 8.1 | 3.3 | 2.0 | 2.6 |
| % Sand int. | | 88.8 | 81.2 | 83.6 | 84.4 |
| % Silt int. | | 4.2 | 2.7 | 1.4 | 1.8 |
| % Clay int. | | 4.0 | 2.3 | 1.2 | 1.4 |
| Exchangeable Cations me/100g | Ca | nil. | nil. | nil. | nil. |
| | Mg | 0.43 | 0.10 | 0.08 | 0.08 |
| | Na | 0.18 | 0.08 | 0.08 | 0.11 |
| | K | 0.16 | 0.05 | 0.05 | 0.01 |
| | H | 18.2 | 3.31 | 1.80 | 2.00 |
| % Saturation | | 4.4 | 6.8 | 10.4 | 8.3 |
| pH | | 5.05 | 5.30 | 5.52 | 5.20 |
| % Carbon | | 6.01 | 1.53 | | |
| % Nitrogen | | 0.355 | 0.118 | | |
| Total $P_2O_5$ mg/100g | | 125.0 | 115.0 | 134.0 | 138.0 |
| Read. sol. $P_2O_5$ mg/100g | | 0.5 | 0.2 | 0.3 | 0.4 |

REMARKS

Exch. Ca very low throughout.
Exch. Mg low in B and C.
Soluble $P_2O_5$ very low throughout.

Table 61 Guirdil raised beach : soil analysis

These samples differ from the other feature fills in having comparatively spherical stones. These stones are also small and well sorted. The samples are similar to each other.

19, 20, 21. *BA90*

Samples 19 and 21 are moderately similar to each other, but 20 is slightly different. The stones in sample 19 are moderately spherical, while those in samples 20 and 21 are slightly more angular than the mean. The sphericity of 19 and 21 is very variable while that for 20 is much less so. Stones in all three samples are large and poorly sorted.

22, 23. *BA91*

These samples differ slightly from each other. Both contain stones which are less spherical than the mean, sample 23 very much so. Both have very variable sphericities. While the stones in sample 22 are smaller than the mean and moderately well sorted those in sample 23 are larger and moderately poorly sorted.

24, 25. *BA093*

These samples are very similar to each other. Both are slightly less spherical than the mean and contain stones which are slightly larger than the mean. The variability of both is slightly greater than the mean, for both criteria.

26, 27, 28. *BA094*

These samples differ from each other, 28 more so than 27 and 26. While 26 and 27 are less spherical than the mean and contain larger stones, 28 is more spherical and contains larger stones. This follows the trend established in other samples which shows that angular stones which are exotic to the parent material are also larger than the mean.

Flandrian (i.e. c.10,000 BP to the present). More general reviews of raised shorelines around Scotland (e.g. Sissons 1976) have provided maps that indicate the altitude attained by the sea at the peak of the Main Postglacial Transgression (i.e. c.6500-7000 BP). On Rhum, this figure has been put at c.8-9m O.D. It is important to note, however, that figures derived from such national diagrams are broadly related to Newlyn Datum, a mean-tide datum, whilst Rhum local datum, according to the 2nd Edition 1:10,560 maps, is a low-tide datum. (No resurvey of bench marks was carried out during production of the 1:10,000 maps on Rhum: the bench mark altitudes given on these maps are the 6-inch 2nd Edition values converted to metres). Admiralty Tide Tables indicate the tidal range in this area of the Inner Hebrides to be c.4m. Hence, on the altitude reached by the Main Postglacial Transgression on Rhum when related to local datum should be increased by c.2m to 10-11m local O.D.

*Local Shore-Forming Factors:*

In addition to the datum problem, the development and altitude of any particular shoreline feature is a function of local factors such as sediment supply, exposure, offshore profile and coastal profile (as well as regional factors such as isostasy and eustasy which alter the altitude of operation of marine processes over long time periods).

On Rhum, sediment supply to the coast today, as apparently during the whole of the Flandrian, is very low. This is indicated by the component of foreign erratics, is suggestive of glacial action playing some role in the origin of the sediment, though no striations were noted on any of the clasts. The poorly sorted nature of the sediment would also support a glacial origin but the roundness analysis implies that, compared to most tills, which mainly have a modal class of subangular material, this sediment has been subjected to rounding, presumably by fluvial or marine processes. The average clast form is not dissimilar to that found in tills although the c/a ration is relatively low implying selection of or modification to flatter clasts such as occurs on beaches or as a result of frost shattering. Considering all the available information it is concluded that the sediment underlying the archaeological site is a stone-rich glacial till that has been partly modified, probably by marine processes, producing increased roundness and flatness in the clasts.

The altitude of the sample pit is slightly above the level to which it may be inferred that the uppermost Flandrian sea reached. It is therefore thought unlikely that marine modification occurred during the Flandrian. It is more probable that such modification took place during the Late glacial marine regression from the marine limit (at c.35m local O.D.) at the head of Loch Scresort.

**Bloodstone Hill/Guirdil**

A detailed geomorphological map of Guirdil/Bloodstone Hill is shown (Ill 122). The following account focusses on the

## AGE CALCULATIONS

At the end of each five cycle period the sample count rates were converted to radiocarbon dates according to the standard treatment of Stuiver and Polach (1979). There is unfortunately no similarly rigorous approach to error analysis. In this laboratory the errors on (a) background, (b) modern standard and (c) the sample count rates, together with errors on (d) quenching, (e) fractionation and (f) replicate analysis all contributed to the final error in the age.

DR GORDON T COOK & DR EM SCOTT, SCOTTISH UNIVERSITIES RESEARCH AND REACTOR CENTRE, EAST KILBRIDE.