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# Palaeoecological investigation of a submerged forest, Berneray, North Uist
# Interim Report

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JUNE 2017

# Palaeoecological Investigation of a submerged forest at Berneray, North Uist: Interim Report June 2017

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## 1. Introduction

The discovery of an area of exposed peat containing macroscopic remains of remnant woodland (submerged forest) by members of the local community at Berneray, North Uist (Figure 1, Plate 1) provided an opportunity to conduct a palaeoecological investigation of probable prehistoric woodland in the Western Isles. Remains of macroscopic wood remains have previously been recorded in the Western Isles (e.g. Fossitt, 1996) and while palynological investigations have been undertaken on intertidal peats in this region (e.g. Edwards et al., 2005) this is the first multi-proxy palaeoecological investigation to incorporate the recording and sampling of submerged forest remains with pollen, waterlogged plant remains and stratigraphic study.

**Plate 1 – Exposed peat and submerged forest remains at Berneray, North Uist (scale: knife is 0.3m in length).**

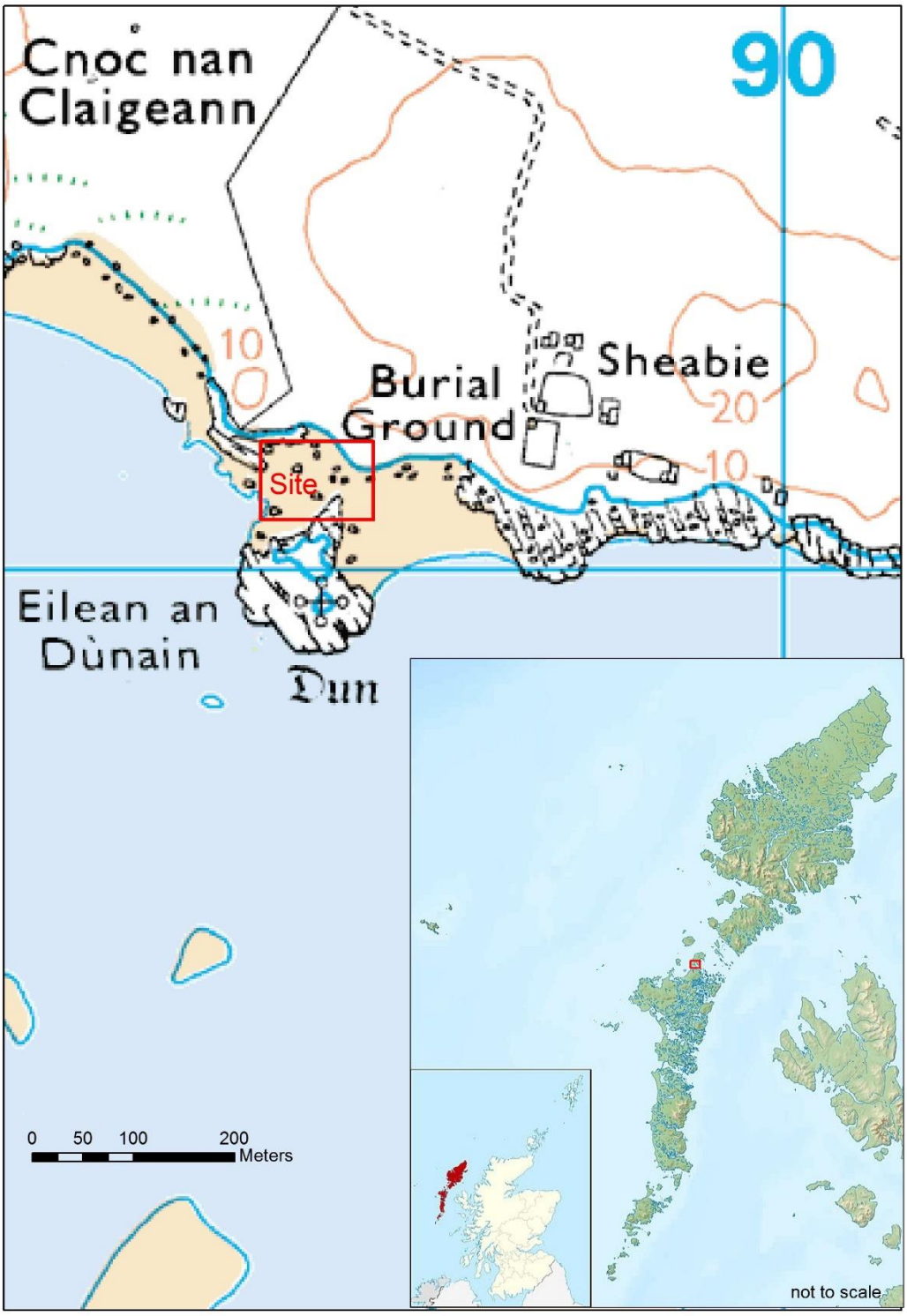




Figure 1. Site location. 1:5,000@ A4

## 2. Methods

The submerged forest at Berneray was visited on the 7th May 2016 by the author, colleagues from SCAPE as part of the Scottish Coastal Heritage at Risk Project and volunteers from Access Archaeology and the local community to undertake sampling and recording of the peat exposure and macroscopic wood remains.

### 2.1. Stratigraphic investigation

An auger survey was conducted across the exposed area of intertidal peat with volunteers using a manual gouge auger in order to investigate the thickness of the exposed peat surface and the depth of the stratigraphic sequence (Plate 2). At each auger point (AP) the type and depth of sediments was recorded, together with the presence of any visible plant macrofossils such as macroscopic wood remains and monocotyledon plant fragments. At each AP the gouge auger was driven as far as possible through the sedimentary sequence until it became stuck in the basal silts. The position of each AP was recorded using a Leica Viva dGNSS.

**Plate 2 – Volunteers and SCAPE staff recording the intertidal peat exposure**

### 2.2. Wood remains recording

All trees were recorded using a specially designed Tree and Intertidal Peat Recording Form. This has been used by the author working when with volunteers on other submerged forest sites in the UK

such as Pett Level, Sussex (Timpany et al, 2017). The recording form is used to detail information such as categorising the remains as trunk/stump/root/branch remains, dimensions of tree remains, evidence of branching, oak/non-oak tree remains and degree of preservation. A wood identification sample of c.2cm$^3$ was taken from the outer part of each recorded tree during recording; incorporating where possible bark and sapwood boundary in order to identify the tree remains as close to, species level as possible during laboratory work. All tree remain locations and OD height were recorded using a Leica Viva dGNSS. For trunks and roots/branches, a survey point was taken at each end of the tree remain, while for stumps a survey point was taken at the centre.

### 2.3. Test pit sampling

A Test Pit of 1m x 1m x 0.5m was dug into the thickest area of peat recorded through the auger survey; the location and dimension of which was surveyed and recorded using a Leica Viva dGNSS. The Test Pit allowed for the stratigraphic relationship between the tree remains and the peat to be investigated. A monolith tin (0.5m x 0.2m x 0.1m) was taken through the peat and underlying sediments, which could be sub-sampled for pollen (and non-pollen palynomorph), waterlogged plant remains and radiocarbon dating samples. Bulk samples of 10L were taken contiguously through the sequence at intervals of c.10cms for the recovery of any cultural materials (e.g. lithics), insects and additional waterlogged plant remains (cf. Smith *et al,* 2000). A section drawing was produced, showing the location of the monolith and wood remains within the section.

### 2.4. Wood identification

Wood identification samples were taken from each of the recorded trees during the fieldwork. For identification, wood samples were thin sliced along the radial, tangential and transverse sections using a razor blade and then bleached before being mounted on a slide in silicone oil and examined under a microscope at x100 and x400 when required. Wood sections were identified using features described by Schweingruber (1978, 1990). The differentiation of willow (*Salix*) from poplar (*Populus*) was made using key features described by Schweingruber, including the presence of heterogeneous rays in willow compared to the homogeneous rays in poplar. If this differentiation cannot be made it is identified as Salicaceae. Initial wood identification was undertaken as part of a training exercise with volunteers from the Access Archaeology Group (Plate 3).


**Plate 3 – Wood identifications with Access Archaeology volunteers in North Uist.**

### 2.5. Waterlogged Plant Remains analysis

For the analysis, five 1L sub-samples were measured out using the displacement method, where the displacement of water is used to measure the volume of material, where 1L of water is poured into a measuring jug and then material added until the water rises to 2L, thus giving 1L volume of material in the sample. All of the bulk samples were sub-sampled prior to being processed for finds and insects. Once measured out, the sub-samples were washed through a small stack of sieves with 1mm and 300µm meshes. The remains were sorted and identified using a binocular microscope, at magnification of x10, and x40 where needed. Identifications were confirmed using modern reference material held in the collection at Orkney College UHI and seed atlases including Berggren (1981) and Cappers et al (2006).

## 3. Results

### 3.1. Stratigraphy and Radiocarbon Dating

The stratigraphy of the exposed peat sequence together with the radiocarbon dating information is provided in Table 1, while a detailed description of the stratigraphy is presented for the Monolith sequence given in Figure 2. Full details of the radiocarbon dates are shown in Table 2.

| Unit | Sediment | Date | Interpretation |
|---|---|---|---|
| VI | Dark brown fine to medium sandy PEAT with macroscopic wood remains. | Top: 3645-3389 cal BC<br><br>Bottom: 3766-3642 cal BC | Terrestrial woodland period. |
| V | Greyish brown fine to medium SAND with bands of very dark brown peat. | | Sand blow period with phases of soil stabilisation and vegetation growth. |
| IV | Black peaty SILT | Top: 4494-4358 cal BC | Infilling freshwater pool. |
| III | Very dark brown organic SILT | | Freshwater pool. |
| II | Very dark greyish brown organic SILT | | Freshwater pool. |
| I | Brown silty CLAY with medium to coarse sand and angular to sub-angular gravel inclusions | | Glacial till. |

**Table 1 – Stratigraphic sequence for Berneray, North Uist.**

The stratigraphic sequence shows a progression from probable open (till, Unit I) post glacial landscape to the formation of an open freshwater pool, which became gradually infilled by vegetation, signalled by an increased organic content (colour change from brown to black; Units II to IV) during the Late Mesolithic period at 4494-4358 cal BC. There is then a period of sand blow from the Late Mesolithic to the Early Neolithic, which may indicate increased storminess. Phases of stabilisation are observed through bands of peat within this layer (Unit V) signalling a vegetated ground surface. The development of wood peat (Unit VI) above this sand layer indicates the end of the previous period of instability with the growth of woodland at 3766-3642 cal BC. This woodland continued to be present during the Early Neolithic to 3645-3389 cal BC where the sequence ends. It is likely that woodland may have continued beyond this period but that the stratigraphic record has been eroded by the tide. No overlying sediments were recorded and therefore the date of submergence for this area by rising sea level is unknown.

**Figure 2 Berneray, North Uist, Monolith 1 Stratigraphy**

1-13cm dark brown (10YR 3/3) fine to medium sandy PEAT with occasional macroscopic wood fragments. dk 3; st 0; el 1; dry 3-4; str homogenous; sh very sharp; hum 4.

13-35cm greyish brown (10YR 5/2) fine to medium SAND with bands of very dark brown peat (10YR 2/2). dk 1; st 4; el 0; drys 4; str heterogenous; sh very sharp; hum 4.

35-43cm black (10YR 2/1) peaty SILT. dk 4; st 0; el 1; dry 3-4; str homogenous; sh very gradual; hum 4.

43-44cm very dark brown (10YR 2/2) organic SILT. dk 3; st 0; el 1; dry 3-4; str homogenous; sh very gradual; hum 4.

44-47cm very dark greyish brown (10YR 3/2) organic SILT. dk 3; st 1; el 1; dry 3-4; str homogenous; sh sharp; hum 4.

47-50cm brown (10YR 4/3) silty CLAY with medium to coarse sand and sub-angular to angular gravel inclusions. dk 3; st 0; el 0; dry 4; str homogenous; sh sharp; hum 4.


**Sediment Description Key:** degree of darkness (dk), degree of stratification (st), degree of elasticity (el), degree of dryness (dry), Structure (str), sharpness of boundary (sh), humicity (hum).

Radiocarbon dating sample location.

| Laboratory Number | Sample depth (cm) | Material and Context | Radiocarbon Age (BP) | $\delta^{13}C$ (‰) | Calibrated date (95% confidence) |
|---|---|---|---|---|---|
| SUERC-73452 | 2 | Peat from the top of the submerged forest peat. | 4782±32 | -28.2 ‰ | 3645-3389 cal BC |
| SUERC-73451 | 12 | Peat from the base of the submerged forest peat. Overlying windblown sand deposit. | 4912±32 | -28.8 ‰ | 3766-3642 cal BC |
| SUERC-73450 | 36 | Organic silt from the top layer of the infilling pool sediment. Below windblown sand deposit. | 5602±32 | -28.3 ‰ | 4494-4358 cal BC |

**Table 2 – Radiocarbon Dating results from Monolith sample.**

### 3.2. Wood Identifications

Two arboreal taxa were identified from the tree remain samples and show a probable wet woodland of birch (*Betula*) and willow (Figure 3). The wood recording sheets indicate that the tree remains largely consist of roots, while one possible stump was also observed (dashed circle on sketch plan).

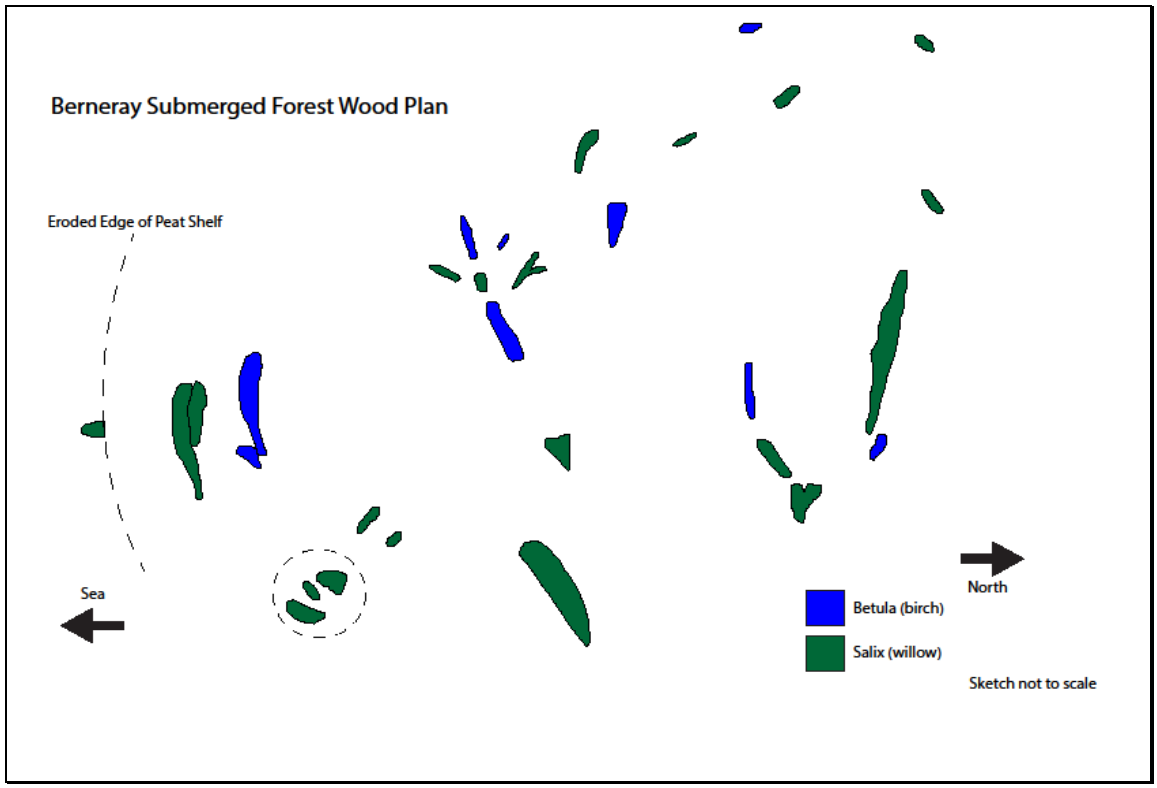


**Figure 3 – Wood identification results presented on submerged forest sketch plan (by Elinor Graham)**

### 3.3. Waterlogged Plant Remains (Emma Aitken)

The results of the waterlogged plant remains analysis are provided in Table 3, with samples taken from the wood peat layer (Unit VI) to the organic silt layer (Unit IV). All of the samples contained sparse quantities of plant remains, with the wood peat layer having the greatest recovery; this is likely a reflection of the minerogenic nature of the sampled sediments. Preservation of remains was poor to moderate with seeds showing evidence of breakage and degradation meaning that positive identification to species level has not been possible.

The only seeds recovered from the organic silt layer were from rushes with both probable soft rush (cf. *Juncus effusus*) and probable compact rush (cf. *Juncus conglomeratus*) present indicating wet ground. A small number of plant remains were recovered from the overlying sand layer, including damp/wet ground and grassland indicators, possible soft rush, possible violets (cf. *Viola* sp.) and possible creeping buttercup (cf. *Ranunculus repens).* The majority of plant remains were recovered from the overlying wood peat, which contained a mixture of damp/wet ground taxa such as sedges (*Carex* sp.) probable buttercups (cf. *Ranunculus* sp.) and cinquefoils (*Potentilla* sp.), together with a small number of woodland indicators such as possible birch (cf. *Betula* sp.) seeds. Unfortunately, the birch seeds were broken and so could not be identified to species level.

Macroscopic charcoal fragments were recovered from all sediment layers with the highest quantity from the organic silt layer (Unit IV) indicating some evidence for burning taking place in the area. However, it is unknown at this time whether this may signal human activity or natural burning events.

## 4. Discussion and Further Work

The work done to date at Berneray, North Uist has presented the first mapped area of submerged woodland in the Western Isles. The recorded stratigraphy and available radiocarbon dates shows this woodland developed following during the Early Neolithic period from 3766-3642 cal BC to at least 3645-3389 cal BC. Wood identifications from the submerged forest indicate this was a birch and willow woodland. The waterlogged plant remains recorded also demonstrate the presence of birch and suggest a wet/damp field layer vegetation of rushes, sedges, cinquefoils and buttercups. Although not present in the recovered waterlogged plant remains, hazel (*Corylus*) nutshell was observed in the peat during fieldwork, suggesting hazel trees were growing not too far from the recorded submerged forest site. Hazel pollen has been recorded in Neolithic levels on North Uist indicating that it did form a significant part of the woodland canopy (e.g. Edwards et al., 2001, 2005); however, it was likely

growing on areas of drier ground rather than in the wet birch-willow woodland recorded at Berneray. The presence of hazel nuts may also be dues to faunal transport into this woodland by animals such as voles and mice, together with being dropped by birds, which has been shown in submerged forests in the Severn Estuary (Timpany, in press).

The growth of woodland took place after a period of instability, possibly signalling increased storminess, lasting approximately 700 years (cal BC), where blown sand deposits accumulated at Berneray, punctuated by phases of stabilisation and vegetation growth. Plant remains from this sand layer are sparse but suggest when vegetation was able to form, damp/wet ground communities of rushes, violets and buttercups were present.

Prior to the windblown sand accumulation, the stratigraphy (organic silts) indicates the presence of a freshwater pool at Berneray that gradually became infilled around 4494-4358 cal BC through invading vegetation, changing sediment colour suggesting an increase in organic content. Plant remains from the upper part of the silts (Unit IV) show the presence of wet/damp ground vegetation of rushes that were likely to have been colonising the water body and present around the edge. The presence of macroscopic wood charcoal fragments within this period (Table 3) suggests some burning activity took place locally in the landscape but further work is required to attempt to see whether this represents natural or anthropogenic fire activity.

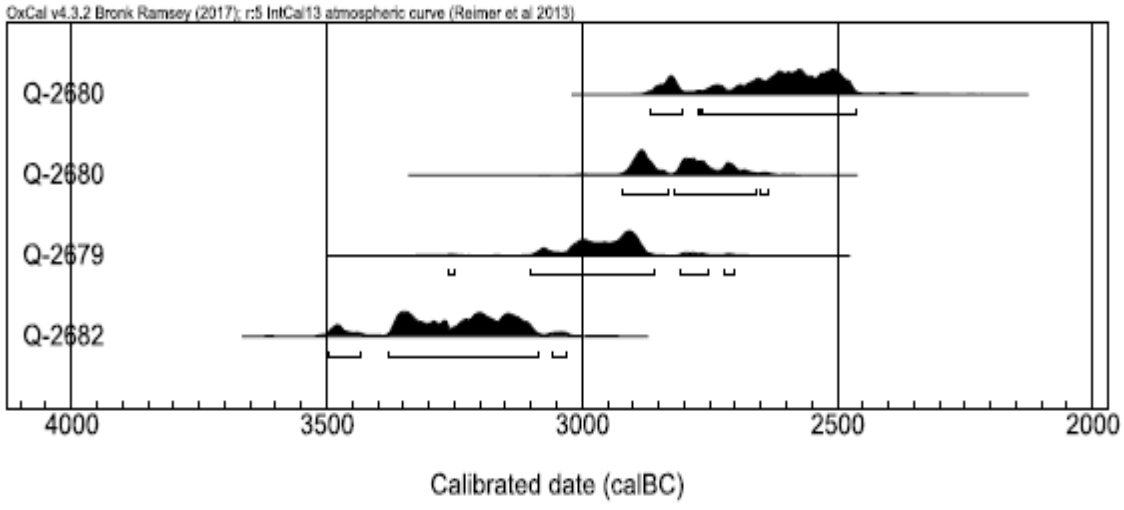


**Figure 4 –** Neolithic macroscopic wood dates from Uists and Benbecula (after Fossitt 1996). All dates used at 95% confidence level.

**Table 3 - Results from Waterlogged Plant Analysis for Berneray, North Uist**

| | | | | Test Pit 1 | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 00-06cm | 06-15cm | 15-25cm | 25-36cm | 36-43cm |
| | | | **Sediment Unit** | VI | VI | V | V | IV |
| **Habitat** | **Latin Name** | **Plant Part** | **Common Name** | | | | | |
| | ***Trees*** | | | | | | | |
| | wood fragments | wood | indet. | ++++ | ++++ | ++ | ++ | ++ |
| W, S, H, D | *c.f. Betula sp.* | seed | possible birch | 2 | - | - | - | - |
| | ***Herbs*** | | | | | | | |
| D, G, W, A | *c.f. Ranunculus sp.* | achene | possible buttercup | 1 | 2 | - | - | - |
| G, W, D | *c.f. Ranunculus repens* | achene | possible creeping buttercup | - | - | - | 2 | - |
| D, S, Z | *Potentilla sp.* | fruit | cinquefoils | 1 | - | - | - | - |
| W, S, Hd, G | *c.f. Viola sp.* | fruit (broken) | violet | - | - | 1 | 2 | - |
| D, W | *c.f. Juncus effusus* | fruit | possible soft-rush | 1 | - | - | 2 | 95 (total amount of both |
| D, W | *c.f. Juncus conglomeratus* | fruit | possible compact rush | - | - | - | - | *Juncus sp.* combined) |
| D, H, S, W | *c.f. Carex sp.* | nutlet | possible sedge sp. | 1 | - | - | - | - |
| D, H, W | *c.f. Carex canescens* | nutlet | possible white sedge | 1 | 2 | - | - | - |
| D, H, S, W | *Carex sp.* | broken nutlet fragments | sedge sp. | 3 | - | - | - | - |
| | Unknown Seeds | fragments | indeterminate | 4 | - | - | - | - |
| | *Fungal sclerotia* | | | ++++ | ++++ | ++++ | +++ | ++++ |
| | ***Charcoal*** | | | | | | | |
| | *wood charcoal* | wood fragments - 1mm | tbc | - | 5 | - | 3 | 40 |
| | | wood fragments - 300µm | tbc | - | 5 | - | 44 | 70 |

**Habitat key:**

A - arable land
Aq - Aquatic
C - coastal
D - damp/wet ground
G - grassland
H - heathland
Hd - hedgerow
S - scrubland
Sm - saltmarsh
W - woodland
Z - waste ground

**Abundance key:**

+ - rare (1-10)
++ - occasional (11-50)
+++ - common (51-100)
++++ - abundant (>100)

**Analyst: E. Aitken**

The acquired Early Neolithic dates for the intertidal peat and submerged forest of 3766-3642 cal BC to 3645-3389 cal BC compare well with birch and willow macroscopic subfossil wood remains dated by Fossitt (1996, 176) of Neolithic date from the Uists and Benbecula (Figure 4) suggesting that birch-willow woodland was common across this area during the Neolithic. The research from Beneray is adding to this picture.

The burning activity associated with Unit V dating to approximately 4494-4358 cal BC within the Late Mesolithic period is of interest given the increasing evidence for burning during the Mesolithic observed through palynological and microscopic charcoal studies in the Western Isles (e.g. Fossitt 1996; Ritchie et al*,* 2001; Edwards et al, 2000, 2005). While there is also archaeological evidence for the presence of Mesolithic populations in areas such as Harris (e.g. Gregory et al, 2005). Of particular relevance is the hypothesis put forward by Edwards et al (2005) that burning through human agency in the Mesolithic could have led to increased machair formation, especially given the windblown sand (Unit V) directly overlying the organic silt (Unit IV) containing the macroscopic wood charcoal.

The work undertaken to date has informed on the woodland character of the submerged forest at Berneray, together with providing some information on the field layer vegetation. The radiocarbon dates compare will with previous subfossil wood remains and suggest a broader presence of this woodland type across the Uists. While the stratigraphic sequence has demonstrated when this woodland formed and the changing previous environment including a long-term period of sandblow. Work will now look to add to this data through palynological study and further waterlogged plant remains analysis from the monolith sequence. This work will add to our knowledge of landscape change in Berneray during the mid-Holocene and possibly provide evidence for human activity, together with palaeoecological information of the vegetation communities present. This work will then be put into its wider context through comparison with other palaeoenvironmental studies from the Western Isles (e.g. Fossitt, 1996; Ritchie et al*,* 2001; Edwards et al, 2000, 2005).

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