*Archaeologia Cambrensis* 162 (2013), 275–307

# Pollen analysis at Craig y Dullfan and Banc Wernwgan and other recent palaeoenvironmental studies in Wales

By Astrid E. Caseldine[1]

*The palaeoenvironmental evidence from two pollen sites, Craig y Dullfan and Banc Wernwgan, investigated as part of the Prehistoric Funerary and Ritual Sites Project, is presented. The investigations provide a chronologically controlled record of vegetation change and human activity that can be related to the construction of funerary and ritual monuments in the two areas. The record from Craig y Dullfan extends into the recent past while that from Banc Wernwgan provides further information about Mesolithic and Early Neolithic vegetation change on Mynydd Du. The palaeoenvironmental evidence recovered from recently excavated funerary and ritual monuments is also considered.*

The palaeoenvironmental investigations at Craig y Dullfan and Banc Wernwgan arose from a pan-Wales survey of prehistoric funerary and ritual monuments undertaken by the four Welsh Archaeological Trusts. Factors that could have influenced the location of funerary and ritual monuments during the Neolithic and Bronze Age range from physical landscape phenomena to wider cosmological considerations. One important element in any consideration of the landscape when the monuments were constructed is the nature of the vegetation cover that existed at the time and the possible impact of anthropogenic activity upon it. An integral part of the Prehistoric Funerary and Ritual Sites Project during the survey work was to consider the environmental potential of the monuments recorded, including the presence of peat deposits in the local vicinity. Following this, it was decided that a limited number of palaeoenvironmental investigations would be undertaken as part of the project.

The investigations at Craig y Dullfan and Banc Wernwgan were carried out in close proximity to complexes of prehistoric sites but independently of archaeological excavation. Craig y Dullfan lies close to the border between Powys and Ceredigion and close to Nant y Moch reservoir at Plynlimon (Fig. 1) and Banc Wernwgan lies on the northern slopes of Mynydd Du, (the Black Mountain), Carmarthenshire (Fig. 4). A third investigation, at Waun Llanfair in the uplands above Llanfairfechan in North Wales, was an integrated palaeoenvironmental and archaeological study involving the analysis of pollen from peat deposits in the area as well as the analysis of pollen, plant macrofossils and charcoal from excavations carried out at several cairns, burnt mounds and walls. The results of this landscape study will be presented elsewhere.

Following on from the initial survey, a number of excavations of funerary and ritual monuments were also carried out during which environmental sampling was undertaken and the results from some of these investigations, namely Pant y Butler (Murphy and Murphy 2013), Fan (Schlee 2013), Fan Foel (Hughes and Murphy 2013), and Llanelwedd (Britnell 2013) are also presented in this volume and briefly considered here, along with the results from other site studies.

**Methods**

Samples were prepared following standard procedures (Moore *et al.* 1991). Identification was by comparison with modern reference material and by reference to pollen identification atlases including Moore *et al*. (1991). *Lycopodium* spores were added as a marker and to enable charcoal concentrations to be calculated (Stockmarr 1971). A sum of 300 total land pollen (TLP) grains was counted where concentrations were sufficiently high but where concentrations were low the count was based on a

minimum of 300 *Lycopodium* spores. Pollen diagrams were prepared using TILIA[2] and TGView.[3] Pollen nomenclature is modified from Moore *et al.* (1991) following Bennett (1994; Bennett *et al.* 1994). Aquatics and spores are expressed as a percentage of TLP plus the group itself. Microscopic charcoal is expressed as charcoal concentration values in both diagrams. Selected fungal spores were counted for Craig y Dullfan and are expressed as a percentage of total land pollen. In addition the pollen sievings were examined and 'macro' charcoal and plant macrofossil remains recorded. The 'macro' charcoal and other charred remains are included in the Craig y Dullfan diagrams, whilst reference is made to the plant macrofossils in the lithostratigraphic descriptions for both sites. Stratigraphically constrained cluster analysis using CONISS (Grimm 2004) was used to aid zonation.

Radiocarbon samples were taken from each column, the results of which are included in the pollen diagrams. Full details of the dates of which are given below. The calibrated dates given in the text give the full age range rounded out to 10 years and quoted as cal. BC or cal. AD (2-sigma, 95.4% probability). Ages of undated zone boundaries and vegetation changes have been interpolated from adjacent pairs of dates using linear interpolation.

## CRAIG Y DULLFAN POLLEN EVIDENCE

The site investigated lies close to the Powys (Montgomeryshire)–Ceredigion border and the wider area includes sites surveyed both by Dyfed Archaeological Trust (Cook 2006) and Clwyd-Powys Archaeological Trust (Jones *et al*. 2004) (Fig. 1). Previous palaeoenvironmental studies in the Nant y Moch area include diagrams from near the summit of Plynlimon (Moore 1968; Moore and Chater 1969; Smith and Taylor 1969; Taylor 1973) but this work was undertaken at a time when radiocarbon dating was less widely available. The main aim of this investigation, therefore, was to provide an environmental context for the monuments in the Nant-y-Moch area, specifically the cairn at Craig y Dullfan, by producing chronologically controlled pollen diagrams. The site at Craig y Dullfan was also chosen because of its different topographical location, in a valley rather than close to a summit, and because a small amount of palaeoenvironmental work had been carried out in conjunction with excavations at Aber Camddwr II (Marshall and Murphy 1991). The latter site (now reconstructed by the edge of Nant-y-Moch reservoir) originally lay approximately 2.7 kilometres to the south-west, in what was formerly the Afon Camddwr valley but was later flooded by the reservoir. It was hoped that this work could also be placed in a wider environmental context and chronological framework through the investigations at Craig y Dullfan.

### Location of Craig y Dullfan and archaeological evidence in the surrounding area

The study involves the investigation of two mire sites, CYD1 (SN 77226 88678) and CYD2 (SN 77154 88815), close to Craig y Dullfan cairn (SN 77114 88759) which is situated on a terrace overlooking Nant y Moch reservoir at the southern end of the Afon Hengwm valley and the eastern end of the Afon Llechwedd-mawr valley (Fig.1). Approximately 1 kilometre to the north-east the Afon Hyddgen joins the Afon Hengwm valley.

The round barrow site itself is on a rock knoll and appears to consist of two adjoining cairns. The southern ring cairn is about 6m in diameter within a largely turf covered outer bank, which is particularly clear along the south-eastern edge of the structure. The interior area is level and filled with loose stone. A possible conjoined cairn lies immediately to the north-east. The cairns have been robbed to construct a ruinous drystone shelter and modern marker cairn, supposedly erected to commemorate a wedding, on the northern cairn. The site has also been interpreted as a single, larger funerary cairn. Blanket peat and peaty soils cover much of the valley and extend to within 20m of the cairn. Pollen site CYD1 lies on a slightly

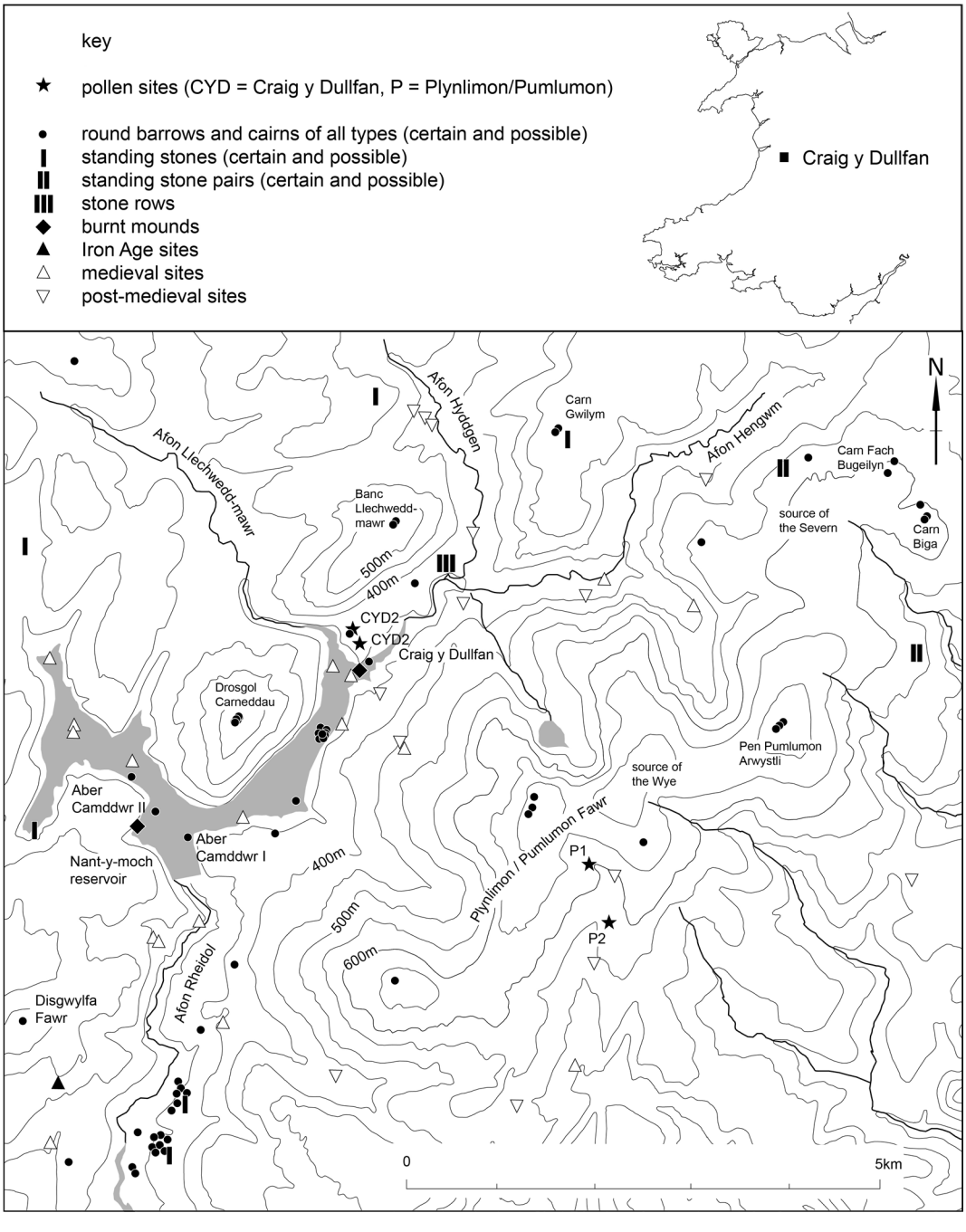


Fig. 1. Location of Craig y Dullfan pollen sites.

lower terrace approximately 150m to the south-east of the cairn at an altitude of 365m, while CYD2 lies approximately 50m to the north-east at 376m.

Barrow cemeteries occur on most of the surrounding summits including Banc Llechwedd-mawr mountain, Carn Gwilym, Carn Biga, Pen Pumlumon Arwystli, Pumlumon Fawr and Drosgol Carneddau, as well as a barrow cemetery now drowned beneath the waters of the reservoir. Individual cairns in the area include cairns at Carn Fach Bugeilyn and Craig Eglwys (Y Garn), whilst on a south-east alignment from Craig y Dullfan, and at a similar altitude, is a cairn at Nant Maesnant Fach. A number of other cairns lie on a similar alignment further down the Rheidol valley. The excavated sites of Aber Camddwr I (Hogg 1977) and II (Marshall and Murphy 1991) lie further to the west and are now submerged beneath the reservoir, although Aber Camddwr II has been reconstructed at the edge. The round barrow at Disgwylfa Fawr, at an altitude of *c.* 507m, has also been excavated (Green 1987).

Other archaeological sites in the area include Banc Llechwedd-mawr stone row and a burnt mound. Evidence of earlier human activity in the area is indicated by flintworking floor sites, possibly of Mesolithic or Neolithic date, but these are submerged beneath the reservoir. Evidence of later activity in the area includes an Iron Age hillfort on Disgwylfa Fawr and a number of deserted rural settlements indicating medieval and post-medieval activity in the area.

**Sampling at Craig y Dullfan**

At both sites the dominant vegetation was *Molinia caerulea*. Other taxa present included *Juncus* spp., *Galium saxatile*, *Potentilla erecta*, *Vaccinium myrtilus*, *Erica tetralix*, *Polygala vulgaris* and *Sphagnum* and *Polytrichum* species of mosses. Sampling sites were selected following probing of the peat to determine the depth. Pits were excavated and peat columns removed using monolith tins. The lithostratigraphies are as follows:

*Craig y Dullfan 1*

***0–12cm*** Modern root mat. ***12–33cm*** Dark brown humified fibrous peat with *Eriophorum vaginatum* remains and *Sphagnum* moss. Humified wood and leaves *c.* 20cm. Charcoal present throughout. Charred *Calluna vulgaris* remains, *Erica tetralix* leaves and moss. ***33–83cm*** Dark brown humified peat with relatively unhumified *Eriophorum* remains. *Calluna* remains and *Erica tetralix* seeds. *Potentilla* sp. seed and *Carex* spp. nutlets. Charred *Erica* tetralix leaves. Charcoal present *c.* 76–85cm. Minerogenic material *c.* 80–81cm and trace of minerogenic material *c.* 76cm. ***83–106cm*** Humified wood peat with twigs and bark present. *Betula* spp. wood 83–85cm and 105–106cm Monocotyledonous remains with *Carex* spp. nutlets and *Juncus* spp. seeds and *Eriophorum*. Charcoal present. ***106–131cm*** More humified amorphous peat with wood and monocotyledonous remains. *Betula* spp. wood 109–110cm and 123–124cm. *Carex* sp. nutlets and *Juncus* spp. seeds present. Trace of minerogenic material *c.* 110–111cm and becoming more minerogenic at base. Charcoal present.

*Craig y Dullfan 2*

***0–19cm*** Unhumified *Sphagnum* peat. ***19–41.5cm*** Unhumified *Sphagnum* peat with monocotyledon remains. ***41.5–102cm*** Humified fibrous peat with *Eriophorum vaginatum* remains and *Sphagnum*. *Betula* spp. wood present at 100cm. *Carex* spp. nutlet present and *Juncus* spp. seeds. Charcoal present throughout. Occasional traces of minerogenic material *c.* 44cm, 50cm, 64cm, 84cm and 92cm. ***102–123cm*** More humified less fibrous peat. *Juncus* spp. seeds frequent *c.* 120–123cm. *Betula* spp. wood *c.* 100–107cm. Frequent wood charcoal present including large fragments. Charred *Calluna* flower head. Band of small stones *c.* 105–107cm. ***123–126cm*** Silty humified peat. *Sphagnum* moss leaves present. *Juncus* spp. seeds frequent. Charcoal present including large fragments *c.* 124cm.

**Craig y Dullfan pollen zone characteristics and interpretation**

The pollen zones identified at the two sites are summarised below and shown Figures 2–3. A correlation between the zones identified in Craig y Dullfan 1 and Craig y Dullfan 2 is given in Table 1.

*Craig y Dullfan 1*

CYD1.1 ***Radiocarbon dates in years BP*** 129–130cm 4060±60. ***Characteristics*** AP values *c.* 50% TLP with *Alnus* dominant. Poaceae *c.* 25%TLP and Cyperaceae *c.* 20% TLP. Herb pollen scarce. ***Interpretation*** Grasses and sedges locally. Woodland comprising alder, birch, oak and hazel. Little human activity. ***Estimated calibrated zone duration*** *c.* 2870–2460 cal. BC.

CYD1.2 ***Radiocarbon dates in years BP*** 120cm 3980±60. ***Characteristics*** Marked increase in AP, mainly *Betula*. *Alnus* declines and *Corylus avellana* type increases. Decline in Poaceae and Cyperaceae. Charcoal levels low. ***Interpretation*** Development of local birch fen woodland. Largely wooded landscape. Period of limited human activity continues. Low level of fire activity. ***Estimated calibrated zone duration*** *c.* 2870–2460 cal. BC to *c.* 2490–2460 cal. BC.

CYD1.3 ***Characteristics*** Fall in *Betula* values and increase in *Alnus*, *Quercus* and *Corylus avellana* type. Later decline in *Alnus* and *Corylus*. Increase in Poaceae and herb taxa including *Plantago*, *Rumex* and *Potentilla* type and *Pteridium* spores. Slight increase in charcoal. ***Interpretation*** Overall decline in woodland. Decrease in local birch woodland followed later by reduction in alder woods. Oak woodland little affected. Slight increase in hazel may indicate increased flowering or colonisation by hazel scrub. Clearance of hazel later. Increase in human activity. Herb taxa indicate pastoralism. Slight increase in fire activity. Activity at Disgwylfa Fawr. ***Estimated calibrated zone duration*** cal. 2490–2460 cal. BC to *c.* 2200–2040 cal. BC.

CYD1.4 ***Radiocarbon dates in years BP*** 104–106cm 3700±60. ***Characteristics*** Decline in AP followed by brief recovery. Increase in Poaceae. Initial rise in Cyperaceae then decline. Herb taxa present. Continuous representation of *Calluna*. Charcoal values low. ***Interpretation*** Further clearance and regeneration. Activity affecting oak an hazel woodland and, to a lesser extent, alder woodland. Birch woodland slightly affected. Pastoral activity continues. Increase in heather communities. ***Estimated calibrated zone duration*** *c.* 2200–2040 cal. BC to *c.* 1740–1640 cal. BC.

CYD1.5 ***Characteristics*** Fluctuations in AP but overall slight decline. Further increase in Poaceae pollen. *Potentilla* type pollen increases later in zone. Charcoal frequent. ***Interpretation*** Continued clearance activity affecting local birch woodland and alder and oak woods in the area. Pastoral activity. Marked increase in fire activity including local burning. Secondary cremation Disgwyllfa Fawr. Activity at Aber Camddwr II. ***Estimated calibrated zone duration*** *c.* 1740–1640 cal. BC to *c.* 1220–1120 cal. BC.

CYD1.6 ***Radiocarbon dates in years BP*** 33–35cm 2400±60; 62–64cm 2820±60. ***Characteristics*** AP values generally less than *c.* 40%.Cyperaceae pollen peaks mid-zone reaching *c.* 45%. Herb pollen frequent including *Artemisia* and Chenopodiaceae. Higher levels of *Plantago*, *Potentilla* type and *Pteridium*. Cereal type pollen present. Charcoal scarce until end of zone. ***Interpretation*** Further clearance of woodland and expansion in pastoral activity. Some evidence for cereal cultivation and mixed farming during the later Bronze Age. Possibly slightly reduced activity leading into the early Iron Age. Marked reduction in fire activity until end of zone. Activity at Aber Camddwr II. ***Estimated calibrated zone duration*** *c.* 1220–1120 cal. BC to *c.* 770–380 cal. BC.

CYD1.7 ***Radiocarbon dates in years BP*** 17–18cm 630±70. ***Characteristics*** Fluctuations in AP, notably *Betula*. *Calluna* increases then declines. Poaceae values fluctuate. Herb pollen less frequent.

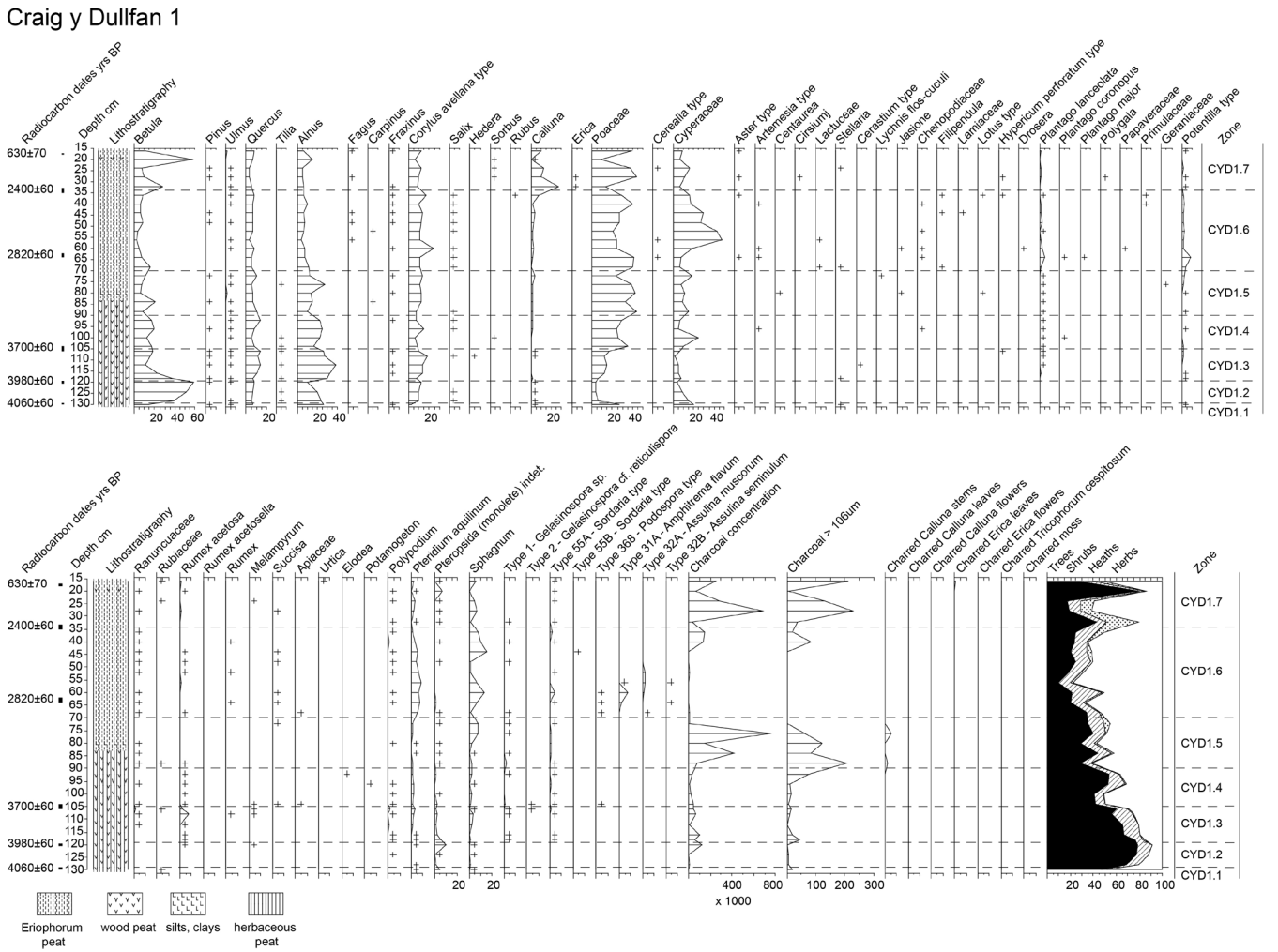


Fig. 2. Craig y Dullfan 1 percentage pollen diagram.

***Interpretation*** Regeneration followed by clearance during the Late Iron Age/Roman period. Regeneration during the early medieval period followed by clearance in medieval times. Evidence of burning, including locally. ***Estimated calibrated zone duration*** *c.* 770–380 cal. BC to *c.* cal. AD 1420–1450.

*Craig y Dullfan 2*

CYD2.1 ***Radiocarbon dates in years BP*** 114–116cm 4320±60; 121–122cm 4650±60. ***Characteristics*** AP values *c.* 45–65% TLP. Poaceae values decline from *c.* 45% to *c.* 25–30% TLP. Herb pollen present including *Plantago lanceolata* and especially *Potentilla* type. Charcoal frequent. ***Interpretation*** Relatively open environment in immediate area. Oak and alder woodlands with some elm and pine as well as birch and hazel woods in surrounding region. Small-scale clearance. Evidence of pastoral activity. Evidence of burning, including locally. ***Estimated calibrated zone duration*** *c.* 3640–3520 cal. BC to *c.* 2860–2630 cal. BC.

CYD2.2 ***Radiocarbon dates in years BP*** 71–72cm 3390±50. ***Characteristics*** AP values high, *c.* 70% TLP. Poaceae values decrease. Increase in *Calluna*. Low level of herb pollen including *Potentilla* type and Ranunculaceae. Cereal-type pollen present. ***Interpretation*** Series of impacts on woodland in the region affecting different woodland communities. Expansion in heather communities. Pastoral activity and possible cereal cultivation. Several fire events. Activity at Disgwylfa Fawr. ***Estimated calibrated zone duration*** 2860–2630 cal. BC to *c.* 1610–1520 cal. BC.

CYD2.3 ***Characteristics*** Sharp fall in AP followed by recovery to *c.* 55% TLP later in zone. Increase in Cyperaceae pollen then decline. Herb taxa present in noticeable amounts, especially *Plantago lanceolata*. ***Interpretation*** Marked impact on woodland involving clearance of oak, elm, alder, birch and to a lesser extent hazel woodland followed by reduced activity and some regeneration during the Iron Age. Further minor clearance and regeneration. Pastoral activity. Evidence of burning. Secondary cremation Disgwylfa Fawr. Activity at Aber Camddwr II. ***Estimated calibrated zone duration*** *c.* 1610–1520 cal. BC to *c.* cal. AD 70 to *c.* cal. AD 70–130.

CYD2.4 ***Radiocarbon dates in years BP*** 44cm 1490±40. ***Characteristics*** AP values similar to previously. Increase in *Calluna*. Reduction in herb taxa. ***Interpretation*** Further decline in woodland followed by regeneration. Local burning and expansion of heather dominated communities. ***Estimated calibrated zone duration*** *c.* cal. AD 70–130 to *c.* cal. AD 1520–1640.

CYD2.5a ***Radiocarbon dates in years BP*** 40cm 120±40. ***Characteristics*** AP values low but *Pinus* and *Ulmus* relatively well represented. *Calluna* values fall. Poaceae values high. *Plantago lanceolata* frequent. *Rumex* spp. noticeable. Cereal type pollen present. ***Interpretation*** Renewed afforestation including pine. Pastoralism and upland cultivation at end of zone. ***Estimated calibrated zone duration*** *c.* cal. AD 1520–1640 to *c.* cal. AD 1890–1910.

CYD2.5b ***Characteristics*** Increase in AP, mainly attributable to *Pinus*. Poaceae values high. Cereal type pollen present in noticeable amounts. ***Interpretation*** Further increase in afforestation, notably conifer plantations. Upland cultivation. ***Estimated calibrated zone duration*** *c.* cal. AD 1890–1910 to present.

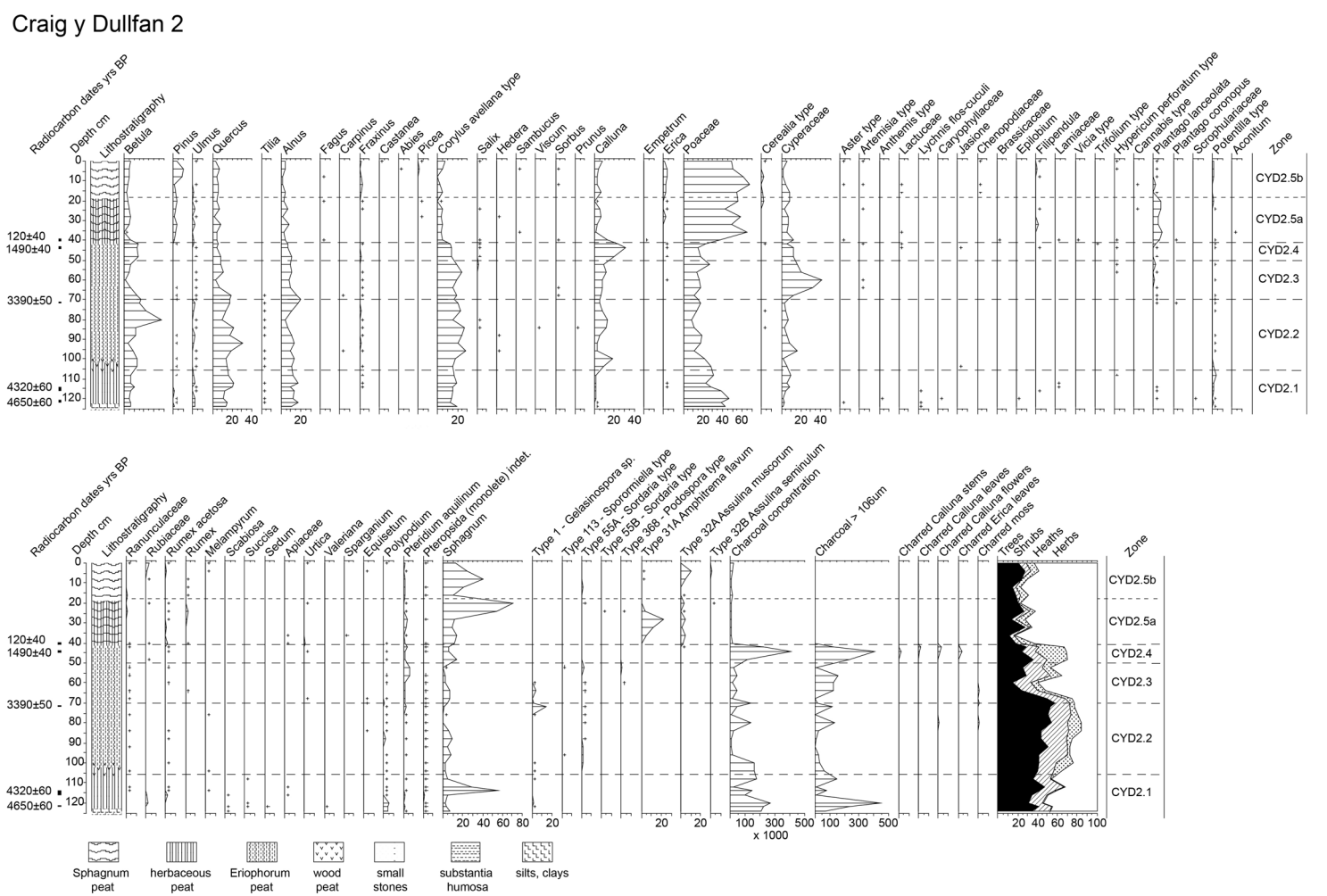


Fig. 3. Craig y Dullfan 2 percentage pollen diagram.

**Interpretation and discussion of the Craig y Dullfan results**

*Neolithic vegetation change and land use*

The evidence from the two sites provides a record of environmental change in the area over approximately the last 5500 years. Although the two pollen sites are within 200m of each other they reveal slightly different vegetation and land use histories, reflecting differences in the local mire vegetation, depositional environment and pollen source area. The earliest record is from CYD2, the site nearest to the cairn. *Juncus* seeds in the basal minerogenic organic deposits reflect the increasingly wet conditions as peat began to develop. A radiocarbon date of 3640–3130 cal. BC (Beta-186678: 4650±60 BP) from these basal deposits suggests the pollen record in CYD2, zone CYD2.1, commenced after the 'elm decline', an event dated to *c.* 4000 cal. BC and widely recognised in north-west Europe. This event has been attributed to the effects of disease but its spread was possibly aided by anthropogenic activity and other factors such as climate may also have contributed (Rackham 1980; Girling 1988; Peglar 1993; Peglar and Birks 1993; Parker *et al.* 2002; Batchelor *et al.* 2014). *Ulmus* values are relatively well represented in the lowest levels but this probably represents a recovery in elm populations in the region following the elm decline, both of which are discernible in Moore's diagram from Plynlimon (Moore 1968; Moore and Chater 1969).

A relatively open grassland environment is indicated in the immediate area of the site by high Poaceae values but mixed deciduous woodland comprising oak, elm, lime, alder and pine is suggested in the surrounding region, as well as birch and hazel. Spores of the fern *Polypodium* also indicate the presence of

Table 1. Correlation of Craig y Dullfan 1 and Craig y Dullfan 2 pollen zones.

| Craig y Dullfan 1 | Craig y Dullfan 2 | Interpretation summary |
|---|---|---|
| | CYD2.5b | Recent afforestation. Pastoral activity. |
| | CYD2.5a | Post-medieval period. Renewed afforestation. Pastoral activity. |
| CYD1.7 | CYD2.4 | Late Iron Age/Roman period to end of medieval period. Further decline in woodland followed by some woodland regeration during early medieval period. |
| | CYD2.3 | Woodland regeneration during Iron Age. |
| CYD1.6 | | Further clearance. Cereal cultivation and mixed farming during later Bronze Age.<br>Reduction in activity in early Iron Age.<br>Further activity at Aber Camddwr II. |
| CYD1.5 | | Middle Bronze Age clearance activity. Fire activity including local burning of vegetation.<br>Secondary cremation at Disgwylfa Fawr. Construction of Aber Camddwr II. |
| CYD1.4 | CYD2.2 | Further clearance and regeneration. Pastoral activity. |
| CYD1.3 | | Beaker period/Early Bronze Age. Decline in woodland. Increase in human activity. Slight increase in fire activity. Disgwylfa Fawr round barrow constructed. |
| CYD1.2 | | Late Neolithic. Relatively wooded landscape. Local birch woodland. Low level of human activity. |
| CYD1.1 | CYD2.1 | Neolithic. Small-scale human activity. Pastoral activity. Evidence of local fire activity. |

woodland in the vicinity, whilst high microscopic charcoal values and larger charcoal fragments observable in the stratigraphy provide evidence of burning of woodland in the local area, perhaps suggesting the area of the site was already a focus of interest in the Neolithic. The high charcoal values coincide with small fluctuations in arboreal pollen of *Quercus*, *Alnus* and *Corylus* which suggests that oak, hazel and alder woodlands may have been affected. Throughout this period low levels of herb taxa, including *Plantago lanceolata*, *Potentilla* type, *Lychnis flos-cuculi*, Rubiaceae and *Succisa*, are present and suggest grazing of stock by Neolithic pastoralists, although in general there is a lack of archaeological evidence in the area as a whole for this period. *Pteridium* spores suggest colonization of cleared land by bracken following abandonment, or increased representation of the fern understorey as a result of the removal of woodland and opening of the canopy. At this time it has been postulated that Neolithic clearance, burning and grazing on the lightly wooded summits of mid Wales, including Plynlimon, would have contributed to an increase in soil moisture and the development of blanket peat where the topography was suitable (Moore 1972; 1993a; 1993b).

By the time of a decline in *Ulmus c.* 3270–2700 cal. BC (Beta-199872: 4320±60 BP) charcoal values are much reduced, perhaps indicating that the decline in elm was the result of disease rather than human activity. Multiple declines in *Ulmus* have been observed at a number of sites in Wales (e.g. Moore 1968; Smith and Cloutman 1988). A slight increase in *Quercus*, *Corylus* and *Betula* may represent an expansion of these species into areas formerly occupied by elm, before *Ulmus* itself shows a recovery during a brief phase of woodland regeneration. This in turn is followed by a decline in arboreal pollen generally and an increase in Poaceae pollen at the end of zone CYD2.1, suggesting renewed impact on the woodland in the region. This view is supported by an increase in charcoal which could be related to clearance activity, although it could also be from other fire events such as domestic fires or natural fires caused by lightning strikes. However, a band of small stones suggests disturbance of the vegetation cover and erosion in the local area. *Potentilla* type pollen is well represented and may indicate pastoral activity or local mire vegetation. The end of this phase is also recorded in the basal level, zone CYD1.1, from CYD1 and is dated to *c.* 2870–2460 cal. BC (Beta-186677: 4060±60 BP). Overall impact on the woodland in the region appears to have been small-scale during this period.

From *c.* 2870–2460 cal. BC (Beta-186677: 4060±60 BP) onwards the development of local birch carr woodland in the valley is demonstrated by the presence of *Betula* wood in the stratigraphies at both sites and at CYD1 *Betula* values increase to over 55% TLP. Although birch is a good pollen producer, representation declines over a relatively short distance. Hence the filtering effect of local birch woodland in zone CYD1.2 is probably responsible for lower values for other arboreal taxa, notably *Quercus* and *Corylus*, compared with zone CYD2.2 where there is a smaller increase in *Betula* values and less of a decline in other other arboreal taxa at the beginning of the zone. However, *Alnus* values are marginally higher, at least initially in zone CYD1.3, possibly suggesting the closer proximity of alder woodland, perhaps growing alongside the Afon Llechwedd-mawr and Afon Hengwm. That woodland was widespread at this time is suggested by wood remains recorded towards the base of another peat profile further up the Hengwm valley. An increase in *Calluna*, reflected in the diagram from CYD2, suggests deteriorating soil conditions and the spread of blanket peat and heather communities in the area. This period, perhaps lasting *c.* 100 years, appears to be one of reduced activity in the local area but microscopic charcoal recorded at the beginning of zone CYD2.2 could indicate anthropogenic activity in the wider region and minerogenic material in the peat could indicate soil disturbance.

*Bronze Age–Early Iron Age vegetation change and land use*

From the beginning of the Bronze Age changes in the woodland composition of the area are evident, at least some of which are probably attributable to human activity as well as natural vegetation changes. A

sharp decline in *Betula* values at the beginning of zone CYD1.3, dated to *c.* 2840–2290 cal. BC (Beta-199871: 3980±60 BP), is accompanied by increased representation of *Alnus* and *Quercus* pollen, which may reflect the reduced filtering effect of local birch at the site or an expansion of these species into areas formerly occupied by birch in the local area. A slight increase in *Corylus* may also indicate an extension in hazel woodland or increased flowering. However, overall there appears to be a steady decline in arboreal pollen until *c.* 2290–1920 cal. BC (Beta-199870: 3700±60 BP), when there is a more marked impact. At the same time the presence of *Plantago lanceolata*, *Rumex* spp. and *Potentilla* type supports the evidence for clearance and indicates pastoral activity, which would also have helped to suppress tree growth. Further evidence for local grazing activity is provided by the occasional *Sordaria* ascospore (Type 55). These fungal spores can be indicative of dung, although they are also found in decaying vegetation and are indicative of mesotrophic vegetation (Van Geel 1978; Van Geel *et al.* 1981; 2003; Buurman *et al.* 1995). Small peaks in charcoal indicate burning but whether this is from deliberate attempts at vegetation management to increase browse, domestic fires, fires from funerary pyres or other ritual activity or natural fires is uncertain.

Although relatively high arboreal pollen values are maintained in the record from zone CYD2.2 during this period, there are similar changes in the composition of the woodland represented. A decline in *Betula* is accompanied by an increase in *Corylus* and *Quercus* pollen. This is followed by a decline in *Coylus* then *Quercus* and *Alnus* pollen mid zone CYD2.2. *Betula* and *Corylus* increase suggesting that clearance of oak and alder woodland was replaced by birch and hazel. Traces of minerogenic material indicate some soil disturbance and erosion. There then follows a decline in *Corylus* pollen which may suggest the clearance of hazel scrub as well as oak and alder woodland, but a local expansion in birch woodland around this time may have taken place close to CYD2 and artificially depressed the values for *Quercus*, *Alnus* and *Corylus*. A small peak in charcoal again indicates fire activity in the area and there is some evidence, charred moss and a charred *Calluna* flower to indicate local burning. This might have been accidental or reflect deliberate attempts at vegetation management by the use of fire to increase browse for which there is possible evidence elsewhere in Wales during the Bronze Age (Caseldine and Barrow 1998).

A renewed expansion in oak, alder and hazel woodland occurs at the end of zone CYD2.2. However, the latter coincides with a decline in *Betula* which may, at least partially, account for the change in pollen representation. Pastoral indicators such as *Plantago lanceolata*, *Potentilla* type, Ranunculaceae and *Rumex* spp. are present but scarce, but *Sordaria* spores may also indicate the continuation of grazing activity in the area. Occasional cereal type pollen could hint at cultivation in the area but could equally be from wild grasses (Dickson 1988). The end of zone CYD2.2 corresponds with zone CYD1.4 where, in contrast to CYD2.2 there is much stronger evidence for pastoral activity, following on from that also evident in zone CYD1.3. A distinct increase in Poaceae pollen is accompanied by herbaceous taxa, including *Plantago lanceolata*, indicative of grassland. However after a clearance phase, a brief regeneration phase involving hazel, alder, oak and birch is evident at the end of zone CYD1.4. The differences in pollen representation between the two sites probably reflect the influence of local vegetation and pollen source areas.

There is evidence for further clearance and an expansion in the open landscape dated to soon after *c.* 1880–1530 cal. BC (Beta 211079: 3390±50 BP) zone CYD2.3. These changes are also discernible at CYD1 and a more detailed record of events is available from CYD1 than CYD2. At CYD1 fluctuating arboreal values, but with a decreasing trend, during zone CYD1.5 and the beginning of zone CYD1.6 continue until shortly after *c.* 1190–830 cal. BC (Beta-22226: 2820±60 BP) and suggest a series of impacts separated by minor regeneration episodes. Initially the pollen changes are accompanied by high charcoal values and a small peak in *Gelasinospora* (Type 1) fungal spores could also reflect burning, although it might simply indicate drier conditions (van Geel 1978). The presence of charred *Calluna* stems indicates that at least some of the charcoal is attributable to local fires and heather burning, possibly

including burning of the bog surface. The presence of a burnt mound nearby might also account for some of the charcoal. This burning phase during the middle Bronze Age might also be associated with activity at the cairn site.

Further evidence for disturbance of the vegetation and soils in the local area is the presence of a small band of minerogenic material in the peat at CYD1 during this period. Pastoral indicators are present throughout this period with an increase in *Potentilla* type followed by an increase in *Plantago lanceolata*. *Pteridium aquilinum* spores also increase around this time and suggest either abandonment of land or possibly a change in the stock being grazed. Whereas cattle will tend to trample bracken, thereby impeding its growth, sheep will tend to avoid it, hence permitting it to spread. The presence of *Sordaria* and *Podospora* fungal spores, both of which may be associated with animal dung, provides further evidence for grazing activity which would have helped prevent woodland regeneration. Although the evidence tends to indicate pastoral activity, the occurrence of cereal type pollen may indicate mixed farming in the area, perhaps cultivation on the lower slopes of the valleys.

The resolution of the diagram from CYD2 for this period is much poorer than that from CYD1 due to slower peat growth, but it does indicate a period of extensive clearance of woodland from shortly after 1830–1530 cal. BC (Beta-211079: 3390±50 BP) until the end of the late Bronze Age/beginning of the early Iron Age. As well as a reduction in other tree species, *Tilia* pollen disappears from the pollen record, estimated *c.* 1440–1410 cal. BC (3150 BP), indicating the removal of lime woods in the wider region. This date is also similar to that recorded at Carneddau (Walker 1993) for the same event. Pastoral indicators and fungal spores indicative of dung are present, although less well represented than at CYD1. A slight trace of minerogenic material indicates some soil erosion during this period. An increase in Cyperaceae pollen, evident at both sites, at this time coincides with an expansion in *Eriophorum* peat locally and possibly blanket peat generally. Following this, woodland appears to show some recovery in the area, though in a largely open landscape, during the early Iron Age. The increase in local Cyperaceae pollen previously might, however, have artificially depressed the arboreal values.

The evidence from Craig y Dullfan suggesting extensive woodland clearance during the Bronze Age, is not dissimilar to that from the wider region as well as other parts of Wales. To the north, at Llyn Glaslyn, increased clearance has been dated to *c.* 1890–1770 cal. BC (*c.* 3500 BP) (Cronin *et al.* 1993), while at Bryniau Pica, on the watershed between Teifi Pools and the Claerwen Reservoir, extensive clearance has been dated to *c.* 1420–1310 cal. BC (*c.* 3100 BP) and a series of burning horizons have been recorded (Buckley 2000; Buckley and Walker 2001). At Cwmystwyth peat initiation has been dated to *c.* 1890–1770 cal. BC (*c.* 3500 BP) and human activity considered to be a contributory factor (Mighall and Chambers 1993). Two episodes of clearance activity have been identified from peat deposits close to the prehistoric complex at Cefn Gwernffrwd and dated to *c.* 2120–1960 cal. BC to *c.* 1750–1660 cal. BC (*c.* 3650–3400 BP), or slightly earlier, and *c.* 1420–1310 cal. BC to *c.* 1000–910 cal. BC (*c.* 3000–2800 BP) (Chambers 1983) and a date of *c.* 1670–1620 cal. BC (*c.* 3350 BP) was obtained for clearance activity from peats near cairns at Carneddau, near Carno (Walker 1993).

Elsewhere, such as on the Black Mountain, carbonised remains of *Calluna vulgaris* and *Erica tetralix* in peat deposits at Waun-Fignen-Felen indicate heath-burning was widespread in the area *c.* 2290–2200 cal. BC to *c.* 810–790 cal. BC (*c.* 3800–2600 BP), possibly reflecting deliberate attempts at management, and together with *Plantago lanceolata* pollen and *Pteridium* spores reflect human pressure on the landscape (Smith and Cloutman 1988). Slightly further south, at Mynydd y Drum, birch carr gave way to a more open local environment comprising heaths, sedges and grasses *c.* 3020–2910 cal. BC (*c.* 4350 BP) which was followed by a series of human impacts during the Bronze Age, with the most dramatic *c.* 1890–1770 cal. BC to *c*. 1620–1530 cal. BC (*c.* 3500–3300 BP) (Chambers *et al.* 1990). Whereas heath burning may have been a deliberate attempt at land management to increase browse or the result of natural fires, it has

been suggested that charred heather remains from the ground surfaces at the summital cairn sites of Fan Foel, Corn-du and Pen-y-fan might indicate ritual fires (Caseldine and Griffiths 2013a).

*Later Iron Age–Present vegetation change and land use*

The later record from both sites is compressed, apart from the most recent period at CYD2, but distinct vegetation changes can be assigned to broad periods. An increase in *Betula* dated to 760–390 cal. BC (Beta-222225: 2400±60 BP) at the beginning of CYD1.7 suggests some local birch regeneration during the Iron Age, whilst a later decline in arboreal pollen may demonstrate renewed clearance during the Late Iron Age–Roman period. This in turn is followed by a further regeneration episode probably dating to the early medieval period, again principally involving birch, before renewed clearance during the medieval period. Decayed wood in the stratigraphy indicates local woodland. The decline, particularly affecting birch and alder, is dated to cal. AD 1260–1430 (Beta 223797: 630±70 BP). This date agrees well with the historical record, although any correlations must be treated with caution. In 1280 Edward I sent orders that all woodland should be cleared in Cardiganshire so that it might not harbour thieves or rebels and the pollen site does lie not far from a track which may have ancient origins. Equally, in the wider region, the founding of Strata Florida Abbey in 1164 and the establishment of extensive upland sheep ranches by the Cistercians may have contributed to woodland clearance and certainly may have helped to prevent the re-establishment of woodland.

The pollen record indicates the continuation of pastoral farming in the local area during both the Late Iron Age/Roman and medieval clearance episodes. An expansion in heather communities during the Iron Age is followed by a decline and high charcoal values during the late Roman and beginning of the early medieval period and the later, medieval clearance episode indicate burning. A charred *Erica* leaf confirms local burning during the later clearance episode. Whether this was an attempt at deliberate land management is uncertain. Above this, the peats were considered to be disturbed and the pollen record unreliable.

The record from CYD2 is similar to that from CYD1 with evidence of woodland regeneration during the Iron Age but with only minor fluctuations in the arboreal record until a marked decline probably equivalent to that recorded at CYD1 and dated to cal. AD 1260–1430 (Beta 223797: 630±70 BP). The differences may be at least partly attributable to the constant representation of birch woodland at CYD2 during the late Roman and early medieval period. Prior to this, slight declines in oak and hazel suggest clearance in the wider area during the late Iron Age–Roman period. The expansion in birch may reflect abandonment of land following the withdrawal of the Romans from Wales. At the same time an increase in *Calluna* pollen indicates an expansion in heather communities in the area. As in the record from CYD1, high charcoal levels indicate local burning and charred *Calluna* and *Erica* macrofossil remains provide confirmation of this, but again whether this reflects a deliberate management strategy or simply natural fires is unclear. Pastoral farming is again indicated by *Plantago lanceolata* pollen, whilst a cereal type pollen grain may indicate cultivation.

Above this a change in the stratigraphy from a well-humified peat to a fresh *Sphagnum* peat at CYD2 marks a change to wetter conditions. This is also indicated by an increase in the testate amoeba *Amphitrema flavum* which is indicative of wet conditions, whilst higher in the stratigraphy relatively dry conditions are suggested by a decline in *Amphitrema* and increase in *Assulina muscorum* (Charman *et al.* 2000). A date of cal. AD 1670–1950 (Beta-235896: 120±40 BP) dates the beginning of this renewed peat growth and the latter may relate to a period of cooling known as the 'Little Ice Age', conventionally known as lasting from the sixteenth to nineteenth centuries. However, it is possible there may be a hiatus in the peat record prior to this renewed peat growth.

Following the renewed peat growth at CYD2, high Poaceae and low arboreal values reflect a landscape similar to that of today. However, compared with previously, changes in the composition of the woodland

are evident. There is less evidence of oak, alder, birch and hazel woodland but high *Pinus* values indicate the planting of coniferous woodland, while an increase later in the record may indicate twentieth-century forestry plantations. The appearance of *Picea* pollen reflects the introduction of spruce, possibly during the eighteenth century. Frequent *Plantago lanceolata* indicates pastoral activity, whilst low *Calluna* levels indicate a reduction in heather communities as a result of high grazing levels. The appearance of cereal type pollen does, however, indicate the expansion of cereal cultivation into the uplands as a result of economic pressures, at least partly attributable to the Napoleonic wars.

There is no archaeological evidence for Iron Age or Roman occupation in the immediate area of Craig y Dullfan, although Iron Age settlements occur in the wider region, including a hillfort on Disgwylfa Fawr. However, the pollen evidence does suggest continued use of the uplands for pastoral activity. In contrast a number of medieval and post-medieval deserted rural settlements confirm a high level of activity in the area during the more recent past, as do the presence of former mines.

**Anthropogenic activity in the Nant y Moch area during the Bronze Age**

Prior to the Bronze Age, archaeological evidence for human activity in the area is limited to flintworking floors of possible Mesolithic or Neolithic date, but the pollen and charcoal evidence from Craig y Dullfan and Plynlimon (Moore 1968; 1993; Moore and Chater 1969) indicate activity by Neolithic peoples, principally pastoral, already taking place in the area. In contrast Bronze Age cairns on the surrounding summits above Craig y Dullfan and in the wider region, as well as those on the lower slopes of the valleys, demonstrate widespread human activity in the area. Standing stones, stone rows, burnt mounds and finds of arrowheads provide further evidence.

The cairn site at Craig y Dullfan is unexcavated but the cairns of Aber Camddwr I and Aber Camddwr II, less than 3 kilometres to the south-west, have been excavated, initially by Hogg (1977) with further excavations at Aber Camddwr II by Murphy (Marshall and Murphy 1991). Slightly further away, the Disgwylfa Fawr round barrow, approximately 10.5 kilometres to the south-west, was excavated in 1937 by Forde (Forde 1938; 1939a; 1939b; Green 1987). At the latter site no environmental work was undertaken but two wooden 'dug-outs' preserved in the National Museum of Wales have since been radiocarbon dated (Green 1987). The large dug-out was at the base of the mound in 'primary' position and the wood, identified as oak, gave a date of 2570–2130 cal. BC (HAR-2187: 3860±70 BP), but this was considered to be at least 20 years older than the felling date of the tree. The date does, however, broadly agree with the first phase of possible Bronze Age clearance activity evident at Craig y Dullfan.

The smaller dug-out was considered to be a secondary cremation, which was confirmed by a radiocarbon date of 1770–1410 cal. BC (HAR-2677: 3300±80 BP) from a sample taken from directly below the bark. This date coincides with a period of further clearance, pastoral activity and burning at CYD1 and a period of extensive clearance recorded at CYD2. It is also during this period that the cairn at Aber Camddwr II was constructed.

The site at Aber Camddwr II comprised a circular, kerbed cairn, cairn annexe, several orthostats, some set in charcoal-filled pits, other charcoal-filled pits and numerous stakeholes (Murphy 1991). In addition a spread of stones interpreted as a ruined field wall was traced to within around 200m of the cairn. A radiocarbon date of 1600–1300 cal. BC (CAR 997: 3210±70 BP) from the fill of pit 16 from beneath the annexe was considered to act as a *terminus post quem* for the construction of the cairn and the annexe. A pollen sample from a buried soil found beneath one of the larger kerb stones indicated the monument was constructed in an open grassland environment but with oak woodland and hazel scrub in the vicinity of the site (Caseldine 1991). In addition alder may have been growing in the valley along the edge of the Afon Camddwr. Birch appeared to be a minor component of the woodland but, as the evidence from Craig y Dullfan demonstrates, it was a more significant presence in the wider area and fluctuations in the *Betula*

curve during zone CYD1.5 may, perhaps, reflect human activity at this time. Birch was also represented in the charcoal assemblage from pit 16 along with blackthorn and hazel, although oak dominated and around this time high microscopic charcoal values are recorded at Craig y Dullfan some of which could be derived from funeral pyres or fires associated with ritual or domestic activity, as well as natural fires or fires associated with land management.

Radiocarbon dates of 1410–1010 cal. BC (CAR995: 2980±70 BP) and 1290–900 cal. BC (CAR 996: 2900±70 BP) from pits at the site indicate continued activity and this was interpreted as a change from sepulchral to ceremonial activity (Murphy 1991). These dates correlate with a period of continued clearance at CYD2 and renewed clearance following regeneration lasting until *c.* 1190–830 cal. BC (Beta 222226: 2820±60 BP) at CYD1. At the latter site charcoal values are minimal at this time, whereas at CYD2 there is possibly stronger evidence for fires and, again, it is possible that some of the charcoal could derive from fires associated with funerary or ceremonial practices in the wider region. Charcoal identified from these pits and others, as well as a burnt layer, at Aber Camddwr II (Caseldine 1991) and pits associated with a child burial at Aber Camddwr I (Seddon 1977) comprised oak, alder, birch, hazel and hawthorn/rowan type. The charcoal results from the two sites are therefore in agreement with the pollen evidence from Craig y Dullfan, which confirms the availability of these species in the area.

The herb taxa from the buried soil from Aber Camddwr II indicate pastoral activity but occasional cereal type and *Artemisia* pollen grains suggest there may have been some limited cultivation in the local area. Although there is some possible evidence for cereal cultivation slightly earlier at CYD2, the evidence from CYD1 suggests increased agricultural activity commencing at the beginning of zone CYD1.6, prior to *c.* 1190–830 cal. BC (Beta 222226: 2820±60 BP). As well as increases in *Plantago lanceolata* and *Potentilla* type pollen, suggesting an intensification or expansion of pastoral activity, the presence of cereal type pollen accompanied by weeds indicative of cultivation such as *Artemisia* and Chenopodiaceae suggests some cultivation and mixed farming.

**The place of the Craig y Dullfan round cairn in the landscape**

The decision to construct a cairn at Craig y Dullfan may owe much to its location on a terrace overlooking the confluence of the Afon Llechwedd-mawr and the Afon Hengwm. Although from the site there are limited views towards many of the summital cairns in the area, there is a commanding view down the Nant y Moch valley and the cairns now submerged beneath the reservoir and Nant Maesnant Fach round barrow by the side of it. Beyond this, but not visible from Craig y Dullfan, a series of cairns on a similar alignment continues down the Rheidol valley. There are also good views towards the other valleys and perhaps most important may have been its position in relation to routeways through the mountains and the visibility of these routes.

Today, the site lies close to a path which disappears to the south into Nant y Moch reservoir but previously this led down to stepping stones and fords, enabling access across the two rivers. To the north the path joins a bridleway which leads in one direction into the Afon Llechwedd–mawr valley and in the other along the side of Banc Llechwedd-mawr, avoiding the boggy ground before crossing the river and dividing into three routes, one heading north along the Afon Hyddgen valley, another to the east along the Afon Hengwm valley and a third to the south, down the eastern side of what is today the reservoir. Hence a combination of a meeting of routes, its proximity to crossing-points across the rivers, its slightly elevated position giving good views down the valleys and a dry site avoiding the valley mires could all have contributed to the attractiveness of the site and resulted in it being a focus of activity.

These routeways through the upland valleys would have linked with the lowland river valleys such as, in this case, the Rheidol, providing through-routes for communication between the coast and the mountains inland. It has been argued that Neolithic and Early Bronze Age sites are associated with distinct landforms

and *loci* in the north Ceredigion lowland valleys, including valley-junctions (Driver 2008). It has also been suggested by Timberlake (2001), in relation to Bronze Age mining in north Ceredigion, that standing stones and burial monuments might have marked routeways, possibly related to prospecting, linking the coast with the uplands.

At Craig y Dullfan there is evidence for activity in the area from the Neolithic onwards, with increasing evidence for clearance from around the time of the round barrow at Disgwylfa Fawr. It is possible the cairns at Craig y Dullfan were constructed during the period when there is the strongest evidence for human activity and extensive clearance in the area, but this can only be confirmed by excavation, and an earlier date is possible. The reason why the cairns were constructed must also remain open to speculation. Whether they represent monuments to people who died whilst on a journey through the mountains, perhaps even prospecting, or whether the individuals were deliberately brought to Craig y Dullfan for burial, remains elusive. Given the location, the site may well have served as a meeting place and the presence of conjoined cairns suggests the site may have been of significance for some time.

## BANC WERNWGAN POLLEN EVIDENCE

The site at Banc Wernwgan was chosen principally to investigate the environmental conditions associated with funerary and ritual monuments at the south western end of the Black Mountain (Mynydd Du) range (Cook *et al.* 2003) (Fig. 4). The site was also at a lower altitude than other investigations that had taken place on the Black Mountain, namely Waun-Fignen-Felen (Cloutman 1983; Smith and Cloutman 1988; Barton *et al.* 1995), Pen Rhiw-wen (Cloutman 1983) and Fan Foel (Caseldine and Griffiths 2013a) and therefore would provide comparative data. Although the investigation was primarily concerned with the Bronze Age environment, the sequence also covers the Neolithic and Mesolithic periods and provides significant information about the vegetation changes and human impact in the area during the periods prior to the Bronze Age.

### Location of Banc Wernwgan and archaeological evidence in the surrounding area

The location of the pollen site (SN69103 18246) at an altitude of *c.* 360 m is close to a swallow hole on the northern side of a small peat filled glaciated valley on the western flanks of Mynydd Du. In the local area, around 185–225m to the north west is a cairnfield comprising six possible round barrows forming a rough line trending NE–SW while further to the north lies a possible ring barrow. Lying *c.* 280m to the south west is a recumbent stone, possibly a fallen standing stone, used as a boundary marker between Llandeilo Fawr Rural and Llangadog parishes. On the other side of the peat filled valley lies the Tair Carn Uchaf barrow cemetery *c.* 780–1000m to the south-south-east. In the wider summital area lie the cairns at Tair Carn Isaf to the south-west and Carn Pen y Clogau and Carn Pen-rhiw-ddu to the east with the cairn at Fan Foel (Hughes and Murphy 2013) *c.* 13.6 kilometres to the north east. Although there is an absence of Mesolithic and Neolithic archaeological evidence in the immediate area there is considerable Mesolithic evidence in the Waun-Fignen-Felen area *c.* 13.3 kilometres to the east.

### Sampling at Banc Wernwgan

Samples were taken from a peat section close to the swallow hole using monolith tins. The lithostratigraphy is as follows:

***0–16cm*** Humified peat containing charred *Calluna* and monocotyledon remains. *Sphagnum* and other moss leaves were present as well as *Eriophorum* sclerenchymatous spindles, *Juncus* seeds, *Erica* remains

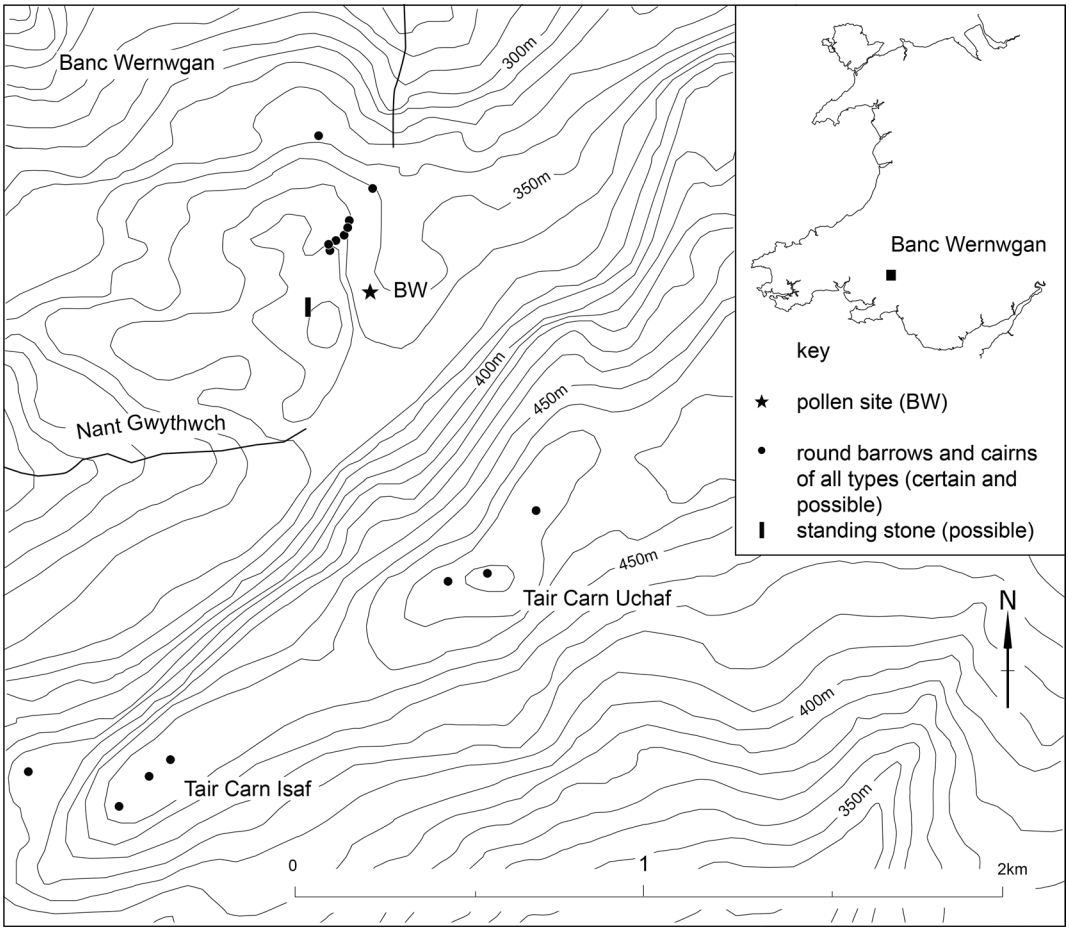


Fig. 4. Location of Banc Wernwgan pollen site.

and charcoal. ***16–40cm*** Herbacaeous peat with *Calluna* remains *Erica* seeds. Charred *Calluna*, *Sphagnum* leaves, *Juncus* seeds present. ***40–221cm*** *Sphagnum-Eriophorum-Calluna* peat. *Calluna* seeds, charred *Calluna*, charcoal and *Sphagnum* leaves. ***221–247cm*** Monocotyledon remains. *Calluna* and charcoal present. ***247–251cm*** Black amorphous (mor-like) peat with charcoal and mineral particles, greasy feel. Fine monocotyledon remains, charcoal and frequent *Juncus* seeds. ***251–258cm*** Black amorphous (mor-like) peat with clay. Fine monocotyledon remains, charcoal and frequent *Juncus* seeds. ***258–267cm*** Organic clay with fine monocotyledon remains, wood, charcoal, abundant *Juncus* seeds. ***267–271cm*** Organic clay with fine monocotyledon remains, wood, abundant *Juncus* seeds. ***271–273cm*** Clay. *Juncus* seeds and charcoal.

**Banc Wernwgan pollen zone characteristics and interpretation**

The following pollen zones identified at Banc Wernwgan are summarised below and shown in Figure 5.

BW1 ***Characteristics*** Herbaceous pollen >70% TLP, largely Poaceae, Cyperaceae, Asteraceae and Caryophyllaceae. Arboreal pollen mainly *Betula* and *Pinus*. *Corylus*, *Quercus*, *Juniperus* and *Salix* present as well as *Empetrum.* ***Interpretation*** Relatively open environment with grasses, sedges and other open ground taxa with some birch woodland. Crowberry and juniper also represented. Possibly incorporation of some later pollen. ***Estimated calibrated zone duration*** ?

BW2 ***Characteristics*** Arboreal pollen values, particularly *Betula*, increase sharply to > 65% TLP. *Corylus* and *Quercus* also increase. *Ulmus* and *Alnus* present. Cyperaceae and Poaceae values decline. Marked decrease in other herb taxa. Increase in Pteropsida (monolete) indet. ***Interpretation*** Expansion in birch woodland and decline in open ground in the local area. Increase in oak and hazel woodland and presence of elm and alder. Increase in ferns. ***Estimated calibrated zone duration*** ?

BW3 ***Characteristics*** Initially sharp increase in *Corylus* and *Quercus* pollen accompanied by decline in *Betula* pollen then *Corylu*s also begins to decline. Increase in Pteropsida (monolete) indet. spores. Poaceae values fall then increase. Charcoal present. ***Interpretation*** Decline in birch woodland and expansion in hazel and oak woodland followed by slight decrease in hazel woodland. Further increase in ferns. ***Estimated calibrated zone duration*** ? – *c.* 5310–5220 cal. BC.

BW4 ***Radiocarbon dates in years BP*** 248cm 6030±60. Decline in *Corylus* and increase in Poaceae. *Quercus* and *Betula* also decline and *Ulmu*s, *Alnus* and *Pinus* increase. Charcoal values increase sharply. ***Interpretation*** Decline in hazel woodland and expansion of grassland. Expansion of elm, alder and possibly pine while oak declines. Slight increase in birch woodland followed by decline. Increase in charcoal suggests fire activity. ***Estimated calibrated zone duration*** *c.* 5310–5220 cal. BC to *c.* 4910–4800 cal. BC.

BW5 ***Radiocarbon dates in years BP*** 248cm 6030±60. ***Characteristics*** *Alnus* values increase. *Quercus* and *Corylus* values fluctuate and are lower. *Ulmus* values also fluctuate slightly but relatively high. *Tilia* and *Fraxinu*s are present. Poaceae values increase. Cyperaceae values increase then decline. *Calluna* increases. Charcoal frequent. ***Interpretation*** Increase in alder woodland. Decrease in hazel and oak woodland. Expansion of grassland and heather and sedge communities. Fire activity. ***Estimated calibrated zone duration*** *c.* 4910–4800 cal. BC to *c.* 4330–4230 cal. BC.

BW6 ***Radiocarbon dates in years BP*** 198–200cm 5090±60; 221cm 5330±70. ***Characteristics*** Decline in Poaceae and increase in *Calluna* and Cyperaceae pollen. Sharp increase in *Sphagnum* spores. Further fluctuations in arboreal pollen including minor declines in *Ulmus*. Small peaks in *Fraxinus* pollen. *Plantago lanceolata* present. Charcoal values high. ***Interpretation*** Expansion in heather, sedge and Sphagnum moss communities locally and decline in grassland. Changes in woodland communities. Opening up of woodland canopy. Grazing activity. Continued fire activity. ***Estimated calibrated zone duration*** *c.* 4330–4230 cal. BC to *c.* 4040–3710 cal. BC.

BW7 ***Radiocarbon dates in years BP*** 162–163cm 4790±70; 198–200cm 5090±60. ***Characteristics*** *Ulmus* values decline then recover slightly before further decline. *Quercus*, *Alnus* and *Corylus* values fluctuate. *Calluna* declines while *Cyperaceae* increase mid zone. Poaceae values fluctuate. Herb pollen increases, particularly *Plantago lanceolata*.*Sphagnum* spores abundant. Small peak then charcoal values low. ***Interpretation*** Decline in elm and small-scale impact on woodland. Increase in anthropogenic indicators, notably ribwort plantain suggesting grazing activity. Decrease in heather communities and increase in sedges. Fire activity low apart from initially. ***Estimated calibrated zone duration*** *c.* 4040–3710 cal. BC to *c.* 3640–3520 cal. BC.

BW8 ***Radiocarbon dates in years BP*** 83–84cm 4160±60. ***Characteristics*** *Quercus* and *Alnus* values fluctuate but relatively constant until slight decline towards end of zone. *Ulmus* increases


Fig. 5. Banc Wernwgan percentage pollen diagram.

then declines mid zone. *Betula* increases mid zone. *Fraxinus* present consistently. *Corylus* increases slightly. *Calluna* values higher and Poaceae values lower. *Plantago lanceolata* present sporadically. Charcoal values low until late in zone. ***Interpretation*** Relatively low level of small-scale clearance activity. Expansion in hazel and birch woodland. Decline in alder and oak woodland later in zone. Expansion in heather communities. Grazing activity. Generally low level of fire activity until late zone. Pre-barrow activity at Fan Foel. ?Construction of Fan Foel round barrow. ***Estimated calibrated zone duration*** *c.* 3640–3520 cal. BC to 2210–2140 cal. BC.

BW9 ***Characteristics*** Continued decline in arboreal pollen but values fluctuate. *Tilia* less frequent. *Plantago lanceolata* consistently represented.*Pteridium* values high throughout zone. Poaceae and charcoal values gradually increase. Increase in Cyperaceae. ***Interpretation*** Further impact on woodland. Expansion in pastoral activity indicated by increase in ribwort plantain. Bracken also increases. Expansion in grass and sedge communities. Evidence of fire activity increases; ?construction of Fan Foel round barrow. ***Estimated calibrated zone duration*** *c.* 2210–2140 cal. BC to *c.* 1530–1280 cal. BC.

BW10 ***Radiocarbon dates in years BP*** 27–28cm 3160±50. ***Characteristics*** Decline in arboreal pollen but values fluctuate. *Plantago lanceolata* values increase. *Calluna* and Poaceae increase as do charcoal values. ***Interpretation*** Increased impact on woodland. Further expansion in pastoral activity and heather and grassland communities. Increase in fire activity; ?land management; ?activity at Banc Wernwgan possible round barrows. ***Estimated calibrated zone duration*** *c.* 1530–1280 cal. BC to *c.* 840–800 cal. BC.

**Interpretation and discussion of the Banc Wernwgan results**

*Mesolithic vegetation change and land use*

The basal pollen levels from Banc Wernwgan appear to indicate a compressed vegetation record when compared with a number of other sites in the wider region but give some indication of the vegetation changes taking place from the end of the Loch Lomond stadial and during the early Holocene. The earliest pollen evidence (zone BW1), from the basal clay deposit, is dominated by Poaceae, Cyperaceae and herbaceous taxa including *Aster* type and *Anthemis* type, suggesting a relatively open environment dominated by grasses and sedges and other open ground taxa. *Empetrum* pollen indicates the presence of heath but is much less frequent than at Waun-Fignen-Felen WFF/6 (Barton *et al*. 1995). At another Waun-Fignen-Felen site, GØØ, dates of 10,430–9,400 cal. BC (CAR-692: 10,180±110 BP ) and 9120–8290 cal. BC (CAR-691: 9340±110 BP ) (Smith and Cloutman 1988) bracket the *Empetrum* phase. The difference in *Empetrum* representation could indicate local vegetation differences and more heathland on the summit. Another possibility is that there is a hiatus in the diagram and the *Empetrum* phase is missing.

Although there is a trace of *Juniperus* pollen at both Banc Wernwgan and Waun-Fignen-Felen WFF/6 (Barton *et al.* 1995) there is no *Juniperus* maximum such as that recorded at Craig-y-Fro (Walker 2007a) and Craig Cerrig-gleisiad (Walker 2007b) in the Fforest Fawr area or Traeth Mawr, Mynydd Illtyd (Walker 2007c). This may indicate juniper scrub was absent or limited in the area or *Juniperus* pollen may be under-represented as the grain is more fragile than many pollen types and indeterminate pollen was relatively frequent at both sites. There is, however, some evidence for birch and pine woodland. The presence of *Quercus* pollen may indicate incorporation of later pollen into the deposit.

A marked rise in *Betula* pollen (zone BW2) signifies an amelioration in climate and increasing colonisation by birch woodland along with a marked reduction in open ground in the area. A slight increase in *Corylus* and *Quercus* pollen also indicates a gradual expansion in hazel and oak woodland but could indicate a very slow accumulation rate or some mixing of pollen from higher levels. *Betula* values reach over 50% TLP at Banc Wernwgan (altitude *c.* 360m) compared with a maximum of just over 30% TLP

at Waun-Fignen-Felen WFF/6 (Barton *et al.* 1995), at an altitude *c*. 485m, where dwarf-shrub taxa and herbaceous taxa make up most of the remainder, possibly suggesting open birch woodland with grassland and heathland on the summit and rather more closed woodland at a lower altitude. The stratigraphic position of flint artefacts at WFF/6 suggests Early Mesolithic occupation at this time. Charcoal evidence indicating fire activity is slight at this time at Banc Wernwgan.

A further change in woodland in the area (zone BW3) is suggested by an increase in *Corylus* and *Quercus* pollen indicating replacement of birch woodland by hazel and oak woodland, although birch remains an element of the woodland. Pteropsida (monolete) indeterminate spores indicate ferns were a significant element of the ground cover at this time. Elsewhere in south Wales, namely Llanilid in the Vale of Glamorgan, the expansion in birch woodland is dated to *c.* 9050 cal. BC) with the expansion in hazel around 300 years later (Walker *et al.* 2003). At Waun-Fignen-Felen the decline in *Betula* and increase in *Corylus* was dated at two sites to *c*. 8620–8480 cal. BC (*c.* 9300 BP) and *c.* 7050–6830 cal. BC (*c.* 8000 BP), the former from the centre of the basin and the latter from a ridge to the north-east (Smith and Cloutman 1988). It was suggested that the latter date may represent a later, local expansion of hazel while the former represents a regional hazel expansion. At Pen Rhiw-wen it was also suggested that the pre-peat vegetation was hazel scrub (Cloutman 1983) and open hazel woodland on the Brecon Beacons, including Corn-du and Pen-y-fan (Chambers 1982; Chambers and Lageard 1997).

At other sites such as Craig y Fro (Walker 2007a) there is a clear delay before an expansion in oak whilst this is not the case at Banc Wernwgan, reflecting either the resolution of the diagram and a very slow accumulation rate, some mixing of pollen from a higher level in the pre-peat minerogenic soil, or a discontinuity in the record. At Craig y Fro (Walker 2007a) it was suggested that mixed woodland was established within 500 years of the arrival of hazel with oak and pine on the hillsides and elm on the valley floors more sheltered localities. The record from Craig Cerrig-gleisiad (Walker 2007b) is similar to that from Craig y Fro.

Following the initial increase in hazel woodland at the beginning of zone BW3 it then declines and continues to decline during zone BW4 accompanied by a decline in oak woodland and increase in grassland and accompanied by a sharp increase in microscopic charcoal, suggesting that fire may have played a role in the changes taking place. At the same time *Ulmus* followed by *Alnus* and *Pinus* values increase indicating an increasingly diverse woodland. The changes during zone BW4 coincide with a change from a minerogenic soil to a black amorphous peaty mud deposit containing frequent *Juncus* seeds as well as charcoal. The black peaty mud deposit rich in charcoal is similar to the 'mor' deposit recorded at Waun-Fignen-Felen (Smith and Cloutman 1988; Barton *et al.* 1995*). Juncus* seeds in this and preceding mineral soil indicate damp conditions but aquatic taxa are rare. This is followed by a fine herbaceous peat also rich in charcoal in the transition to ombrogenous peat. As at Waun-Fignen-Felen it seems likely that the high density of microscopic charcoal enhanced the impervious nature of the deposits and contributed to ombrogenous peat development. The charcoal may indicate deliberate burning of vegetation by Mesolithic people in the area rather than natural fires.

As well as the Early Mesolithic flint artefacts at Waun-Fignen-Felen (WFF/6) which were stratigraphically contemporary with the birch phase (Barton *et al.* 1995), a number of other Mesolithic occupation sites have been recorded at the peat-mineral interface at Waun-Fignen-Felen and have yielded both earlier and later Mesolithic flints (Berridge 1980; Barton *et al.* 1995), leading to the suggestion there was repeated use of the site as a 'persistent place'. The lithic scatters suggest visits of short duration with the site acting as a focus for hunting activity. Initially the suggestion was put forward at Waun-Fignen-Felen that the relatively open conditions with birch woodland may have resulted from Mesolithic activity prior to *c.* 7050–6830 cal. BC (*c.* 8000 BP) (Smith and Cloutman 1988), although other explanations were also offered, whereas Barton *et al.* (1995) argued that there was no compelling evidence for human

involvement prior to *c.* 7050–6830 cal. BC (*c.* 8000 BP) in the decline of birch and hazel woodland. They considered that the area was never very densely wooded and that it would have been unnecessary to open up the cover. A more broken cover would have favoured hunting, and suggest that people were clearly operating in the area well before such changes occurred. Charcoal was scarce during the *Betula* phase (zone BW2) at Banc Wernwgan but increases slightly during zone BW3 and increases markedly during zone BW4, suggesting fire may have been a factor in the decline in birch and hazel, particularly hazel, at least locally. Estimated dates for zone BW4 are *c.* 5310–5220 cal. BC to *c.* 4910–4800 cal. BC.

At the end of zone BW4 charcoal values increase significantly, immediately prior to an increase in *Alnus* and it is possible that fire activity may have favoured the spread of alder into the local area. The increase in *Alnus* pollen at the beginning of BW5 is dated to 5210–4770 cal. BC (Beta-199866: 6030±60 BP). Dates for the rise in alder at Waun-Fignen-Felen range from *c.* 6430–6370 cal. BC to *c.* 5220–5070 cal. BC (*c.* 7500 BP to 6200 BP) and were interpreted as reflecting establishment of alder in the basin area earlier than on the surrounding higher, drier ground (Smith and Cloutman 1988). The alder record from the centre of the basin may represent a regional pollen signal (Barton *et al.* 1995) as may the initial rise during BW3 at Banc Wernwgan with the later, more marked, rise reflecting alder spreading into the local area. The date from Banc Wernwgan dates the end of the rise rather than the beginning and is therefore broadly in keeping with the Waun-Fignen-Felen dates.

Also following the very high charcoal values at the end of zone BW4 is a slight increase in *Calluna*, the latter suggesting an expansion in heather communities and increasing soil acidity at the beginning of zone BW5. An increase in Cyperaceae pollen followed by an increase in *Sphagnum* spores demonstrates the development of sedge and *Sphagnum* moss communities. *Juncus* seeds indicate the presence of rushes locally. Throughout zone BW5 charcoal values remain high indicating burning in the area. Smith and Cloutman (1988) have argued that Mesolithic activity at Waun-Fignen-Felen may have been responsible for the presence of charcoal and appearance of heaths during the period *c.* 7050–6830 cal. BC to *c.* 4940–4840 cal. BC (*c.* 8000–6000 BP).

Hazel shows an overall decline throughout zone BW5 although values fluctuate. Oscillations in the *Quercus* and *Alnus* curves occur and together with the high charcoal levels may reflect changes in the woodland composition as a result of fire activity as well as grazing activity, changes in the soils or hydrological changes. Poaceae pollen values are high suggesting grassland locally and *Succisa* pollen during zone BW4 and at the beginning of zone BW5 is also indicative of grassland. The occurrence of cerealia type pollen towards the end of zone BW5 is almost certainly attributable to certain wild grasses such as *Glyceria* species.

The area of the swallow hole at Banc Wernwgan may already have proved attractive as a source of water for grazing animals such as deer and it is possible that fire may have been deliberately used by Mesolithic populations in the area to manipulate the vegetation to increase browse and aid hunting.

*The elm decline and Neolithic vegetation change and land use*

The following pollen record reflects the vegetation changes taking place immediately prior to the primary ‘elm decline’, an event traditionally associated with the beginning of the Neolithic and the establishment of farming communities, and the changes afterwards. Although there is a lack of archaeological evidence for Neolithic activity the pollen record clearly demonstrates human activity in the area.

An expansion in *Sphagnum*, Cyperaceae and *Calluna* at the beginning of zone BW6 is dated to 4330–3990 cal. BC (Beta-199865: 5330±70 BP) and marks the establishment of ombrogenous bog locally, while changes in arboreal pollen indicate changes in the woodland composition in the area. A minor fluctuation in *Ulmus* also occurs at this time followed by a further slight fall, though *Ulmus* pollen levels remain relatively high. These slight changes may suggest some sort of impact on elm in the wider area,

perhaps the result of disease or human activity while fluctuations in *Quercus*, *Alnus* and *Corylus* curves may indicate local vegetation competition and/or human interference with the vegetation. *Tilia* is present, possibly indicating an expansion of lime in the area. Small peaks in *Fraxinus*, a light-demanding species, may also reflect opening of the woodland canopy as may the appearance of *Plantago lanceolata,* which suggests grazing activity by either wild or domestic animals. Of note is the continued presence of high levels of charcoal suggesting that burning of vegetation was continuing in the area, possibly by Mesolithic communities rather than as a result of natural fires.

Following the slight fall, *Ulmus* values remain relatively constant until towards the end of zone BW6 when they again increase slightly. However they then show a marked decline at the beginning of zone BW7. The beginning of this decline is dated to 4040–3710 cal. BC (Beta-199864: 5090±60 BP) and the decline probably represents the classical primary 'elm decline', a broadly synchronous event occurring across the British Isles. Both this date and that of the earlier decline lie within the range of dates for the 'elm decline' recorded in a review of 139 dated sites (Parker *et al.* 2002). They also lie within the range of dates for the primary 'elm decline' recorded at Waun-Fignen-Felen, where it is suggested that the variation in dates and representation may indicate local events (Smith and Cloutman 1988).

The cause of the 'elm decline' has been the subject of much debate and a number of hypotheses put forward including disease, human interference, climate, vegetation competition and soil deterioration, all of which may have contributed, to a greater or lesser extent, to the decline of elm (Parker *et al.* 2002; Batchelor *et al.* 2014). Recent studies in the Thames valley provide further support for a multi-causal hypothesis with evidence for human activity and soil deterioration as well as disease (Batchelor *et al.* 2014). Given the evidence for fire activity, grazing activity and possibly clearance activity affecting oak, alder and hazel during zone BW5 leading up to the decline in elm at the beginning of zone BW6, it seems likely that human activity, as well as disease, played a role in the decline in elm in the area. An expansion in *Calluna* also suggests a deterioration in soils and expansion in blanket peat and heathland.

Changes in the pollen curves for *Quercus*, *Corylus*, *Alnus* and *Ulmu*s during zone BW7 may indicate human interference with the woodland and clearance and regeneration episodes during the earlier Neolithic. Peaks in Poaceae along with herb taxa such as *Plantago lanceolata* and *Ranunculus* may represent an expansion in grassland in cleared areas and livestock grazing. *Plantago lanceolata* values remain relatively high until *c*. 3700–3370 cal. BC (Beta-224977: 4790±70 BP) after which representation is reduced, possibly suggesting a reduction in activity. This period of reduced activity (zone BW8) during the mid-late Neolithic is also reflected in other vegetation changes, including initially an increase in hazel and alder woodlands followed by an expansion in oak woodland (*c.* 148cm), then an expansion in birch woodland (*c.* 120cm) and recovery in elm (*c.* 108cm). Fluctuations in the *Quercus* and *Alnus* curves broadly mirror each other, suggesting colonisation of areas formerly occupied by the other. The recovery in elm is followed by a further decline in elm with a minimum estimated shortly before 2890–2580 cal. BC (Beta-224976: 4160±60 BP). An *Alnus* minimum also occurs around this time while an increase in *Quercus* and *Corylus* suggests an expansion of oak and hazel into areas formerly occupied by elm and alder. This episode appears to be relatively short lived before a further recovery in elm which lasts until a decline estimated *c.* 2200–2040 cal. BC (*c.* 731 BP). A further decline in the elm curve was also recorded at sites at Waun-Fignen-Felen with dates varying between *c.* 2290–2200 cal. BC to *c.* 2620–2490 cal. BC (*c.* 3800 to 4050 BP).

*Bronze Age vegetation change and land use*

The remaining record reflects the vegetation changes taking place in the area from the end of the Neolithic to the late Bronze Age/early Iron Age and it is during this period that the funerary and ritual monuments were constructed. A marked decline in *Quercus* and a fall in *Corylus* values, is dated to 2890–2580

cal. BC (Beta-224976: 4160±60 BP), suggesting clearance of oak and hazel woodland, although a renewed increase in *Corylus* suggests this was short-lived before invasion by hazel scrub. At the same time charcoal values increase suggesting an increase in fire activity in the area. *Quercus* values continue to show an overall decline in oak woodland in the area but it is not until the beginning of zone BW9, estimated *c.* 2210–2140 cal. BC, that *Plantago lanceolata* is consistently present and *Pteridium* also increases, suggesting a greater level of pastoral activity in the area. At Waun-Fignen-Felen the increase in *Plantago lanceolata* is dated to *c.* 2620–2490 cal. BC to *c*. 2200–2130 cal. BC (*c.* 4050–3750 BP) (Smith and Cloutman 1988), slightly earlier than at Banc Wernwgan, perhaps indicating/reflecting the spread of pastoral activity from the summital areas to lower slopes during the early Bronze Age. An increased human impact on the environment is suggested from *c.* 1530–1280 cal. BC (Beta-211074: 3160±50 BP) at the beginning of zone BW10 when a there is a distinct increase in representation of *Plantago lanceolata* , suggesting a further expansion in livestock grazing, as well as a continued decline in *Quercus*, *Alnus* and *Corylus.* Although there is a slight increase in *Betula* initially, suggesting there was possibly some colonisation of cleared areas, *Betula* then also declines. Again this may indicate increasing impact at the moorland/woodland interface. In addition an increase in *Calluna* followed by a marked increase in charcoal concentrations and then another increase in *Calluna* may indicate some attempt at land management to increase browse using fire in the local area. This increased representation of activity may also be associated with activity at the possible round barrows at Banc Wernwgan, though they could be earlier in date. The increase in charcoal evident from *c.* 2890–2580 cal. BC (Beta-224976: 4160±60 BP) onwards may also reflect human activity in the area, including activity associated with the round barrows in the area, including Tair Carn Uchaf barrow cemetery on the other side of the valley.

Comparison of the evidence from Banc Wernwgan with that from the excavation of a round barrow at Fan Foel (Caseldine and Griffiths 2013) *c.* 13.6 kilometres to the north-east suggests that the rise in *Plantago lanceolata* pollen, signifying an increase in pastoral and anthropogenic activity estimated *c.* 2210–2140 cal. BC, along with the increase in microscopic charcoal is in keeping with the date of 2460–2140 cal. BC for burning and pre-barrow activity. Hence by the time of the cremation burials dated to 2140–1915 cal. BC and 2135–1895 cal. BC and later activity to 1975–1750 and 1945–1740 cal. BC Bronze Age pastoral activity was well established in the area. The environment at this time was dominated by heather, grass and sedge communities on the summits with some hazel and birch woodland as well as at lower altitudes such as in the Banc Wernwgan area.

Elsewhere in the wider area of the Brecon Beacons and Fforest Fawr there is evidence of Bronze Age impact on the upland environment. The cairns at Corn-du and Pen-y-fan were constructed at a similar time to Fan Foel, again in an open environment dominated by grass, heather and *Sphagnum* moss communities but with some upland hazel woodland, which declines from this time onwards (Chambers and Lageard 1997). At Mynydd y Drum a series of human impacts were recorded during the Bronze Age and the pollen evidence from beneath the cairns suggested a landscape dominated by heath or hazel scrub (Chambers *et al.* 1990).

Overall, the evidence from Banc Wernwgan suggests that when the Bronze Age barrows were constructed in the surrounding area the immediate environment was one of grass and heather communities with open hazel and birch woodland giving way to mixed oak woodland on the lower slopes. There is evidence from *c.* 2210–2140 cal. BC when there is increased representation of *Plantago lanceolata*, or perhaps slightly earlier, when there is evidence for increased fire activity, for significant human impact on the environment, while a more marked impact occurs from *c.* 1530–1280 cal. BC (Beta-211074: 3160±50 BP), possibly related to activity at Banc Wernwgan round barrows, or they could be earlier in date. A gradual decline in oak suggests clearance of upland oak woods at the interface with moorland while fire was possibly used to manage the heather communities and increase browse. It is estimated the record ends *c.* 840–800 cal BC.

## RÉSUMÉ OF OTHER RECENT PALAEOENVIRONMENTAL EVIDENCE FROM PREHISTORIC FUNERARY AND RITUAL SITES IN WALES

In addition to the investigations discussed above, a number of other palaeoenvironmental investigations associated with excavations of funerary and ritual monuments have been undertaken in recent years, most of which were follow-up studies to the initial Prehistoric Funerary and Ritual Project survey work and some of which are reported in this volume at Pan y Butler, Fan, Fan Foel, and Llanelwedd, as noted above. These studies were concerned with attempting to elucidate the nature of the local environment and whether there was evidence for human activity associated with the monuments. Of note is the possible evidence from Fan Foel round barrow (Caseldine and Griffiths 2013a) and Pant y Butler round barrows (Caseldine 2013a) for the use of *Filipendula* as a floral tribute during the Bronze Age, a use which has also been suggested elsewhere in Britain. As well as pollen evidence providing information about the local environment at these sites and Fan round barrow (Caseldine 2013b), soil micromorphology also demonstrated the impact of human activity, trampling and burning, on the local soils prior to barrow construction at Fan Foel (Macphail 2013). There was also some evidence for cereal cultivation, namely wheat, during the Neolithic and Bronze Age from Fan round barrow (Foster *et al.* 2013), although the evidence was extremely scarce, and the cultivation of barley from the Bronze Age cairn sites at Llanelwedd (Caseldine, Griffiths and Bale 2013).

Other recent palaeoenvironmental studies concerned with funerary and ritual sites include investigations at Corndon Hill round barrow (Britnell *et al.* 2008) where pollen evidence suggested the barrow was located in a grassland upland environment with open hazel woodland with some ash and alder. Charcoal from the site indicated fire activity pre-barrow construction and radiocarbon dates indicated more than one fire episode. Because of the altitude, as at Fan Foel (Hughes and Murphy 1913), any fire might have attracted attention from some distance away in the wider area, though whether this would have influenced the builders of the barrow is entirely speculative.

Vegetation changes similar to those recorded at Fan Foel (Caseldine and Griffiths 1913), were also found at Blaen Hepste, near Ystradfellte, in southern Breconshire, where a change from open hazel woodland to a heather-grass dominated landscape occurred prior to construction of the cairn (Caseldine, Griffiths and Bale 2014). There is therefore a consistent picture of clearance of upland hazel woodland, fire activity and the developmentt of grass-heath communities in the uplands of Wales prior to the establishment of funerary and ritual monuments.

Other recent studies included an investigation of potentially unusually large late Neolithic and early Bronze Age ring-ditches at Pentrehobin in Mold, Causeway Lane near Llanymynech, Powys, Collfryn to the north of Guilsfield, Dyers Hall Farm near Pool Quay, Powys, Sarn-y-bryn-caled to the south of Welshpool and Walton Court Farm in the Walton Basin, Radnorshire (Britnell and Jones 2012). Of these, after investigation and dating Collfryn was thought to be an Iron Age enclosed settlement, the evidence from Dyers Hall Farm was insufficient to draw any conclusions, Pentrehobin was thought to be a denuded round barrow and the remaining three sites all ring-ditches. Evidence from charred plant remains and charcoal was scarce but possibly indicated a contemporary environment comprising grassland with some secondary woodland (Caseldine, Griffiths and Bale 2012). The presence of open grassland with some mixed woodland nearby was also suggested by the limited evidence from Meusydd timber circles and ring ditch near Llanrhaeadr-ym-Mochnant, Powys (Caseldine and Griffiths 2009a). There was also, however, some possible evidence for the deliberate placement of plant material but rather than meadowsweet, as was the case at Pant y Butler (Murphy and Murphy 2013) and Fan Foel (Hughes and Murphy 2013) round barrows, in this instance the presence of relatively abundant *Sphagnum* spores from a humic layer associated with Beaker sherds in the central pit within the ring ditch possibly indicated the deliberate

placement of *Sphagnum* moss (Caseldine and Griffiths 2009a). As in the case of *Filipendula* pollen, there is evidence from other parts of Britain for the deliberate use of *Sphagnum* moss at other burial sites.

Apart from Walton Court Farm, charred plant remains have been examined from several other funerary and ritual sites in the Walton Basin including Womaston Neolithic causewayed enclosure (Caseldine and Griffiths 2009b), Hindwell cursus (Caseldine and Griffiths 2011a, b) and Hindwell double palisaded enclosure (Caseldine and Griffiths 2013b), following on from earlier work including Upper Ninepence putative round barrow and Hindwell palisaded enclosure (Gibson 1999). There was slight evidence for cereal cultivation in the area from Womaston but less than that from Upper Ninepence (Caseldine and Barrow 1999) and most of the evidence indicated grassland. Charcoal evidence from several sites, Hindwell cursus (Caseldine and Griffiths 2011b), Womaston (Caseldine and Griffiths 2009b) and Upper Ninepence (Johnson 1999) suggested that hazel woodland and scrub species such as hawthorn type and blackthorn were common in the area during the period *c*. 3950–2900 cal. BC, perhaps reflecting colonisation after earlier woodland clearance. In contrast oak is more frequent in assemblages dating from *c*. 3000–2500 cal. BC at Upper Ninepence (Johnson 1999), Hindwell double palisaded enclosure (Caseldine and Griffiths 2013b) and Hindwell enclosure (Gibson 1999). The increased representation of oak from these later sites could reflect a real increase in the availability of oak woodland in the area or perhaps simply reflect the different type of monument, although equally, the two are not mutually exclusive.

At Dyffryn Lane henge complex near Welshpool once more there is evidence for grassland as well as oak woodland and scrub (Caseldine and Griffiths 2010), while the first activity at the site is associated with a period of pit deposition involving the burial of Peterborough Ware and charred material including hazelnut shell (Caseldine and Griffiths 2010). In keeping with the evidence for grassland is evidence for livestock farming; residue analysis of the Peterborough sherds suggests the ware was used for dairying prior to its deposition (Gibson 2010).

In north Wales investigations included analysis of charred plant remains from Bryn Gwyn stone circle, Brynsiencyn, on Anglesey where a large pit within the stone circle yielded a few cereal grains though these were possibly later in date (Caseldine and Griffiths 2013c). However, hazel charcoal was recovered from a spread of charcoal-rich soil containing unurned cremated bone while hazel charcoal from a pit nearby and cremated bone from another pit nearby gave dates in the middle to late Neolithic and relate to the first phase of activity and erection of the stone circle and subsequent funerary activity. Hazel charcoal gave a date in the early second millennium BC and it is considered the associated stone represents a second phase of activity. Limited palaeoenvironmental investigations were carried out at Llanfechell standing stone site (Caseldine, Peck and Griffiths 2013). Only a small amount of wood charcoal was obtained from the standing stone pit and hazel charcoal gave a date of 4460 to 4330 cal. BC while Ericaceae charcoal from a small pit at the base of the standing stone pit gave a date of 740 to 390 cal. BC, indicating later disturbance.

The nature of the assemblage of charred plant remains from Cromlech Farm chambered tomb on Anglesey, together with an early medieval radiocarbon date, suggested that at least some of the remains were later intrusive material (Caseldine and Griffiths 2013e), although hazel charcoal from the site also gave a date compatible with Beaker pottery from the site (Caseldine and Griffiths 2013d). The charcoal suggested there may have been oak and hazel woodland in the vicinity of the site.

Overall, the evidence from the excavations is consistent with that from previous excavations. Although charred cereal evidence, reflecting arable farming, is quite widespread in Wales for the Bronze Age in most instances the evidence tends to be quite slight. Hence the evidence from Llanelwedd and Fan is a useful, if limited, addition to the record. The occurrence of charred grass remains at many of the sites is consistent with increased clearance activity and pastoral activity. Wood charcoal from the sites add to the extensive record for the Bronze Age in Wales and provides some evidence for the woodland available, in

particular providing evidence for areas such as the Walton Basin where there is a lack of pollen evidence and in others complementing pollen studies.

## CONCLUSIONS

In conclusion the evidence obtained from the pollen and archaeological sites investigated as part of the Prehistoric Funerary and Ritual Sites project has added to the palaeoenvironmental record for Wales, providing further information about the environment and human activity. The pollen evidence from Craig y Dullfan and Banc Wernwgan indicates increasing impact on the landscape during the Bronze Age. This is consistent with the widespread archaeological evidence for Bronze Age activity in the two areas. At Craig y Dullfan the beginning of a decline in woodland and low level of fire activity can be correlated with construction of the round barrow at Disgwylfa Fawr. A period of increased clearance activity and fire activity contemporary with activity at Aber Camddwr II may also be contemporary with construction of the cairn at Craig y Dullfan. It is proposed that the site may have been chosen because of its slightly elevated position giving good views of routes along the valleys, especially to the south and east, its dry position away from the valley mire, its proximity to river crossing-points and its focus as a meeting of routes. At Banc Wernwgan a decline in woodland and increase in fire activity may be contemporary with the period of pre-barrow activity at Fan Foel. Construction of the round barrow at Fan Foel may also relate to this period or the following period of increased activity. The possible round barrows at Banc Wernwgan may also relate to this period or a later expansion in pastoral and fire activity. The pollen record from Banc Wernwgan also provides evidence of Mesolithic and early Neolithic activity.

As well as the evidence from Craig y Dullfan and Banc Wernwgan, other recent pollen investigations also suggest increasing clearance activity during the Bronze Age and possibly the use of fire to manage the upland grass-heath vegetation communities to increase graze. There is evidence for fire activity at several sites prior to barrow construction and there is also evidence for soil acidification and the development of heathland in the uplands. At other sites the occurrence of charred grass remains is consistent with increased clearance activity and pastoral activity. Charcoal evidence provides additional information about the woodland communities. Finally, the possible evidence for use of *Filipendula* as a floral tribute and the possible deliberate placement of *Sphagnum* moss along with Beaker sherds suggests that funerary and ritual practises in Wales involving plant material were similar to those in other parts of Britain, notably Scotland.

## RADIOCARBON DATING

The following radiocarbon dates were obtained from Beta Analytic Inc. in Florida. The radiocarbon determinations were calibrated using Oxcal version 4.2 (Bronk-Ramsey 1995) and the dataset for terrestrial samples IntCal13 (Reimer *et al.* 2013).

### CRAIG Y DULLFAN 1

**Beta-223797**
*Sample depth*: 17–18cm
*Radiocarbon age BP*: 630±70
*Calibrated date at 2 sigma*: cal. AD 1260–1430 (95.4%)

**Beta-222225**
*Sample depth*: 33–35cm
*Radiocarbon age BP*: 2400±60
*Calibrated date at 2 sigma*: 760–680 cal. BC (17.8%) and 680–390 cal. BC (77.6%)

**Beta-222226**
*Sample depth*: 62–64cm
*Radiocarbon age BP*: 2820±60
*Calibrated date at 2 sigma*: 1190–1180 cal. BC (0.5%), cal. BC 1160–1140 cal. BC (0.8%) and 1130–830 cal. BC (94.1%)

**Beta-199870**
*Sample depth*: 104–106cm
*Radiocarbon age BP*: 3700±60
*Calibrated date at 2 sigma*: cal. BC 2290–2240, cal. BC (3.9%) and 2240–1920 cal. BC (91.5%)

**Beta-199871**
*Sample depth*: 119.5–120.5cm
*Radiocarbon age BP*: 3980±60
*Calibrated date at 2 sigma*: 2840–2810 cal. BC (1.4%), cal. BC 2670–2290 and cal. BC (94.0%)

**Beta-186677**
*Sample depth*: 128.5–130.5cm
*Radiocarbon age BP*: 4060±60
*Calibrated date at 2 sigma*: 2870–2800 cal. BC (13.6%) and 2780–2460 cal. BC (81.8%)

CRAIG Y DULLFAN 2

**Beta-235896**
*Sample depth*: 40–41cm
*Radiocarbon age BP*: 120±40
*Calibrated date at 2 sigma*: cal. AD 1670–1780 (36.1%) and cal. AD 1800–1950 (59.3%)

**Beta-211078**
*Sample depth*: 43.5–44.5cm
*Radiocarbon age BP*: 1490±40
*Calibrated date at 2 sigma*: cal. AD 430–500 (13.1%) and cal. AD 530–650 (82.3%)

**Beta-211079**
*Sample depth*: 71–72cm
*Radiocarbon age BP*: 3390±50
*Calibrated date at 2 sigma*: 1880–1840 cal. BC (4.7%), 1820–1790 cal. BC (2.3%), 1790–1590 cal. BC (82.2%) and 1590–1530 cal. BC (6.2%)

**Beta-199872**
*Sample depth*: 114–116cm
*Radiocarbon age BP*: 4320±60
*Calibrated date at 2 sigma*: 3270–3240 cal. BC (1.1%), 3110–2860 cal. BC (91.4%), 2810–2750 cal. BC (2.5%), 2720–2700 cal. BC (0.3%)

**Beta-186678**
*Sample depth*: 120.5–122.5cm
*Radiocarbon age BP*: 4650±60
*Calibrated date at 2 sigma*: cal. BC 3640–3550 cal. BC (11.6%), 3540–3330 cal. BC (81.4%), 3220–3190 cal. BC (1.4%), and 3160–3130 cal. BC (1.0%)

BANC WERNWGAN

**Beta-211074**
*Sample depth*: 27–28cm
*Radiocarbon age BP*: 3160±50
1530–1280 cal. BC (95.4%)

**Beta-224976**
*Sample depth*: 83–84cm
*Radiocarbon age BP*: 4160±60
2890–2580 cal. BC (95.4%)

**Beta-224977**
*Sample depth*: 162–163cm
*Radiocarbon age BP*: 4790±70
3700–3490 cal. BC (77.2%) and 3470–3370 cal. BC (18.2%)

**Beta-199864**
*Sample depth*: 198–200cm
*Radiocarbon age BP*: 5090±60
4040–4020 cal. BC (0.3%), 4000–3750 cal. BC (92.2%) and 3750–3710 cal. BC (2.9%)

**Beta-199865**
*Sample depth*: 220.5–221.5cm
*Radiocarbon age BP*: 5330±70
4330–4030 cal. BC (91.3%) and 4030–3990 cal. BC (4.1%)

**Beta-199866**
*Sample depth*: 247.5–248.5cm
*Radiocarbon age BP*: 6030±60
5210–5170 cal. BC (2.3%) and 5080–4770 cal. BC (93.1%)

ACKNOWLEDGEMENTS

I would like to thank Catherine Griffiths for preparing pollen samples and assisting with plant macrofossil work and Denise Druce for preparing pollen samples and some initial counting of Banc Wernwgan pollen samples. Assistance with fieldwork at Craig y Dullfan was provided by Professor Mike Walker, Ian Grant and Catherine Griffiths and at Banc Wernwgan by Catherine Griffiths and David Griffiths. Thanks are also due to Nigel Jones and Nikki Cook for providing funerary and ritual site data and Bill Britnell for the location map illustrations.

NOTES

1. School of Archaeology, History & Anthropology, University of Wales Trinity St David, Lampeter, Ceredigion, SA48 7ED.
2. TILIA: E. C. Grimm, 1991–93, Springfield, Illinois State Museum, Research and Collections Center.
3. TGView, version 2.0.2*:* E. C. Grimm, 2004, Springfield, Illinois State Museum, Research and Collections Center.

BIBLIOGRAPHY

Barton, R. N. E., Berridge, P., Walker, M. J. C. and Bevins, R. E., 1995. 'Persistent places in the Mesolithic landscape: an example from the Black Mountain uplands of South Wales', *Proceedings of the Prehistoric Society* 61, 81–116.

Batchelor, C. R., Branch, N. P., Allison, P. A. Bishop, B., Brown, A. D., Elias, S., Green, C. P. and Young, D. S., 2014. 'The timing and causes of the Neolithic elm decline: new evidence from the Lower Thames Valley (London, UK)', *Environmental Archaeology* 19, 263–90.

Bennett, K. D., 1994. *Annotated catalogue of pollen and pteridophyte spore types of the British Isles* (Department of Plant Sciences, University of Cambridge).

Bennett, K. D., Whittington, G. and Edwards, K. J., 1994. 'Recent plant nomenclatural changes and pollen morphology in the British Isles', *Quaternary Newsletter* 73, 1–6.

Berridge, P. J., 1980. 'Waun-Fignen-Felen', *Archaeology in Wales* 20, 19–20.

Britnell, W. J., 2013. 'Cairns, coneys and commoners on Llanelwedd Rocks, Radnorshire', *Archaeologia Cambrensis* 162, 147–273. [this volume]

Britnell, W. J., Caseldine, A. E. and Griffiths, C. J., 2008. 'Partial excavation of a round barrow on Corndon Hill in 2006', *Archaeology in Wales* 48, 17–25.

Britnell, W. J. and Jones, N. W., 2012. 'Large late Neolithic and early Bronze Age ring-ditches in Wales', *Archaeologia Cambrensis* 161, 165–98.

Bronk Ramsey, C., 1995. 'Radiocarbon calibration and analysis of stratigraphy: the oxcal program', *Radiocarbon* 37 (2), 425–30.

Buckley, S. L., 2000. 'Palaeoecological investigations of blanket peats in upland Mid-Wales', unpublished PhD thesis, University of Wales, Lampeter.

Buckley, S. L. and Walker, M. J. C., 2001. 'The Flandrian vegetation history of upland mid-Wales Bryniau Pica', in M. J. C. Walker and D. McCarroll (eds), *The Quaternary of West Wales: Field Guide* (London: Quaternary Research Association, London).

Buurman, J., van Geel, B. and van Reenen, G. B. A., 1995. 'Palaeoecological investigations of a Late Bronze Age watering-place at Bovenkarspel, the Netherlands', in G. F. W. Herngreen and L. van der Valk (eds), *Neogene and Quaternary Geology of North-West Europe, Mededelingen Rijks Geologische Dienst* 52, 249–70.

Carr, S. J., Coleman, C. G., Humpage, A. J. and Shakesby R. A. (eds), *The Quaternary of the Brecon Beacons: Field Guide* (London: Quaternary Research Association).

Caseldine, A. E., 1991. 'Aber Camddwr II: Appendix 4, Palaeoenvironmental evidence', in Marshall Murphy 1991, 65–9.

——2013a. 'Pollen evidence from Burial 3', in Murphy and Murphy 2013, 50–3. [this volume]

——2013b. 'Pollen evidence', in Schlee 2013, 94–9.

——2013c. 'Pollen', in Smith 2013, 67–9.

Caseldine, A. E. and Barrow, C. J., 1997. 'The plant macrofossil evidence from Pen-y-fan and Corn-du', in A. Gibson, 'Survey, excavation and palaeoenvironmental investigations on Pen-y-fan and Corn-du, Brecon Beacons, Powys, 1990–1992', *Studia Celtica* 31, 30–45.

——1999. 'The charred plant remains from Walton', in Gibson 1999, 141–50.

Caseldine, A. E. and Griffiths, C. J., 2009a. 'Charred plant remains, charcoal, and pollen analysis', in N. W. Jones, 'Meusydd timber circles and ring-ditch, Llanrhaedr-ym-Mochnant, Powys: excavation and survey, 2007', *Archaeologia Cambrensis* 158, 59–63.

——2009b. 'Charcoal and charred plant remains', in N. W. Jones, 'Womaston Neolithic causewayed enclosure, Powys: survey and excavation 2008', *Archaeologia Cambrensis* 158, 31–4.

——2010. 'Charred plant remains and charcoal', in Gibson 2010, 241–2.

——2011a. 'Charred plant remains', in Jones 2011, 16–19.

——2011b. 'Charcoal identification', in Jones 2011, 15–16.

——2013. 'Palaeoenvironmental evidence', in Hughes and Murphy 2013, 125–35.

——2013b. 'Charcoal Identifications from Hindwell Double-palisaded Enclosure', unpublished report prepared for Clwyd-Powys Archaeological Trust.

——2013c. 'Environmental evidence', in G. Smith, 'The Bryn Gwyn stone circle, Brynsiencyn, Anglesey', *Archaeology in Wales* 52, 32–3.

——2013d. 'Cromlech Farm – environmental evidence, wood charcoal', in Smith 2013, 63–4.

——2013e. 'Charred plant remains', in Smith 2013, 64–7.

Caseldine, A. E., Griffiths, C. J. and Bale, R. J., 2012. 'Charrred plant remains and charcoal identifications from trial excavations on large ring-ditches', in W. J Britnell and N. Jones, 'Large late Neolithic and early Bronze Age ring-ditches in Wales', *Archaeologia Cambrensis* 161, 183–9.

——2013. 'Charred plant remains and charcoal identifications', in Britnell 2013, 220–30.

——2014. 'The palaeoenvironmental evidence from Blaen Hepste Burial Cairn', in N. W. Jones, 'The Upper Hepste Valley: a Bronze Age and later landscape', *Brycheiniog* 45, 92–8.

Caseldine, A. E., Peck, I. A. and Griffiths, C. J., 2013. 'Llanfechell: – environmental analysis: the charred plant remains and charcoal', in Smith 2013, 51–76–78.

Chambers, F. M., 1982. 'Two radiocarbon-dated pollen diagrams from high-altitude blanket peats in South Wales', *Journal of Ecology* 70, 445–9.

——1983. 'The palaeoecological setting of Cefn Gwernffrwd – a prehistoric complex in Mid-Wales', *Proceedings of the Prehistoric Society* 49, 303–16.

—— (ed.) 1993. *Climate Change and Human Impact on the Landscape* (London: Chapman & Hall).

Chambers, F. M. and Lageard, J. G. A., 1997. 'Palaeoenvironmental analyses of peat samples from Pen-y-fan, Corn-du and Tommy Jones's Pillar, Brecon Beacons', in A. Gibson, 'Survey, excavation and palaeoenvironmental investigations on Pen-y-fan and Corn-du, Brecon Beacons, Powys, 1990–1992', *Studia Celtica* 31, 45–71.

Chambers, F. M., Lageard, J. G. A. and Elliot, L., 1990. 'Post glacial environmental history of the Mynydd y Drum opencast site', in P. Dorling, and F. M. Chambers, 'Field survey, excavation and pollen analysis at Mynydd y Drum, Ystradgynlais, Powys, 1983 and 1987', *Bulletin of the Board of Celtic Studies* 37, 234–45.

Charman, D. J., Hendon, D. and Woodland, W. A., 2000. *The identification of testate amoebae (Protozoa: rhizopoda) in peats,* QRA Technical Guide No. 9 (London: Quaternary Research Association).

Cloutman, E. 1983. 'Studies of the vegetational history of the Black Mountain Range, South Wales', unpublished PhD thesis, University of Wales.

Cook, N., 2006. 'Prehistoric Funerary and Ritual Sites Project: Ceredigion 2004–2006', unpublished report, Cambria Archaeology Report No. 2002/94.

Cook, N., Hughes, G., Page, N. and Ramsey, R., 2003. 'Prehistoric Funerary and Ritual Sites Project: east Carmarthenshire 2002–2003', unpublished report, Cambria Archaeology Report No. 2002/94.

Cronin, S. P., Lamb, H. F. and Whittington, R. J., 1993. 'Seismic reflection and sonar survey as an aid to the investigation of lake sediment stratigraphy: a case study from upland Wales', in J. McManus and R. W. Duck (eds), *Geomorphology and Sedimentology of Lakes and Reservoirs* (Hoboken: John Wiley & Sons), 181–203.

Dickson, C. A., 1988. 'Distinguishing cereal from wild grass pollen: some limitations', *Circaea* 5, 67–71.

Driver, T., 2008. 'Sacred mountains in a changing landscape: plough-levelled Neolithic and Bronze Age complexes along the north Ceredigion coastal valleys', in P. Rainbird (ed), *Monuments in the Landscape* (Stroud: Tempus), 54–65.

Forde, D. C., 1938a. 'Dysgwylfa Fawr barrow', Cardiganshire', *Cardiganshire Antiquarian Society Proceedings* 13, 72–3.

——1939a. 'Dysgwylfa Fawr barrow', *Cardiganshire, Antiquaries Journal* 19, 90–2.

——1939b. 'Dysgwylfa Fawr barrow', Cardiganshire, *Bulletin of the Board of Celtic Studies* 9, 188–9.

Foster, A., Foster, L., Walker, A. and Carrott, J., 2013. 'Charred plant remains', in Schlee 2013, 94–5.

Gibson, A., 1999. *The Walton Basin Project. Excavation and Survey in a Prehistoric Landscape 1993–7*, CBA Research Report 118 (York: Council for British Archaeology).

——2010. 'Excavation and survey at Dyffyn Lane henge complex, Powys, and a reconsideration of the dating of henges', *Proceedings of the Prehistoric Society* 76, 213–48.

Girling, M., 1988. 'The bark beetle *Scolytus scolytus* (Fabricius) and the possible role of elm disease in the early Neolithic', in M. Jones, *Archaeology and the Flora of the British Isles*, Oxford University Committee for Archaeology Monograph 14 (Oxford: Oxbow Books), 34–8.

Green, H. S., 1987. 'The Disgwylfa Fawr round barrow, Ceredigion, Dyfed', *Archaeologia Cambrensis* 136, 43–50.

Hogg, A. H. A., 1977. 'Two cairns at Aber Camddwr, near Ponterwyd, Cardiganshire', *Archaeologia Cambrensis* 126, 24–37.

Hughes, G. and Murphy, K., 1913. 'Fan Foel round barrow, Mynydd Du, South Wales: archaeological excavation and palaeoenvironmental analysis, 2002–04', *Archaeologia Cambrensis* 162, 105–46. [this volume]

Johnson, S., 1999. 'The Walton complex charcoal identifications', in Gibson, 1999, 150–3.

Jones, N. W., 2011. 'The Hindwell Cursus, Radnorshire: Excavation and Geophysical Survey 2011', unpublished report, Clwyd-Powys Trust Archaeological Report 1114.

Jones, N. W., Owen, W. J. and Gibson, A. M., 2004. 'Prehistoric Funerary and Ritual Sites: Montgomeryshire', unpublished report, Clwyd-Powys Archaeological Trust Report 609.

Macphail, R. I., 2013. 'Soil micromorphology', in Hughes and Murphy 2013, 135–7.

Marshall, E. C. and Murphy, K., 1991. 'The excavation of two Bronze Age cairns with associated standing stones in Dyfed: Parc Maen and Aber Camddwr II', *Archaeologia Cambrensis* 140, 28–75.

Mighall, T. and Chambers, F. M., 1993. 'The environmental impact of prehistoric mining at Copa Hill, Cwmystwyth, Wales', *The Holocene* 3, 260–4.

Moore, P. D., 1968. 'Human influence upon vegetational history in north Cardiganshire', *Nature* 217, 1006–9.

——1972. 'The initiation of peat formation and the development of peat deposits in mid-Wales', *Proceedings of the Fourth International Peat Congress: Helsinki*, 1, 89–100.

——1993a. 'The history of vegetation in Cardiganshire', in L. D. Jones (ed.), *Cardiganshire County History: From the earliest times to the coming of the Normans* (Cardiff: University of Wales Press), 26–41.

——1993b. 'The origin of blanket mire, revisited', in Chambers (ed.) 1993, 217–24.

Moore, P. D. and Chater, E. H., 1969. 'The changing vegetation of west-central Wales in the light of human history', *Journal of Ecology* 57, 361–79.

Moore, P. D., Webb, J. A. and Collinson, M. E., 1991. *Pollen Analysis*, 2nd edn (Oxford: Blackwell Scientific Publications).

Murphy, K., 1991. 'Aber Camddwr II, Trefeurig', in Marshall and Murphy 1991, 52–63.

Murphy, K. and Murphy, F., 2013. 'The excavation of two Bronze Age round barrows at Pant y Butler, Llangoedmor, Ceredigion, 2009–10', *Archaeologia Cambrensis* 162, 33–66. [this volume]

Parker, A. G., Goudie, A. S., Anderson, D. E., Robinson, M. A., Bonsall, C., 2002. 'A review of the mid-Holocene elm decline in the British Isles', *Progress in Physical Geography* 26, 1–45.

Peglar, S. M., 1993. 'The mid-Holocene Ulmus decline at Diss Mere, Norfolk, UK: a year-by-year pollen stratigraphy from annual laminations', *The Holocene* 3, 1–13.

Peglar, S. M. and Birks, H. J. B., 1993. 'The mid-Holocene *Ulmus* fall at Diss mere, south-east England – disease ad human impact', *Vegetation History and Archaeobotany* 2, 61–8.

Rackham, O., 1980. *Ancient Woodland* (London: Edward Arnold).

Reimer, P. J., Bard, E., Bayliss, A., Beck, J. W., Blackwell, P. G., Bronk Ramsey, C., Grootes, P. M., Guilderson, T. P., Haflidason, H., Hajdas, I., Hatte, C., Heaton, T. J., Hoffmann, D. L., Hogg, A. G., Hughen, K. A., Kaiser, K. F., Kromer, B., Manning, S. W., Niu, M., Reimer, R. W., Richards, D. A., Scott, E. M., Southon, J. R., Staff, R. A., Turney, C. S. M. and van der Plicht, J., 2013. 'IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years Cal BP', *Radiocarbon* 55(4), 1869–1887.

Schlee, D., 2013. 'The excavation of Fan round barrow, near Talsarn, Ceredigion, 2010–11', *Archaeologia Cambrensis* 162, 67–104. [this volume]

Seddon, B., 1977. 'Charcoal identification', in A. H. A. Hogg, 'Two cairns at Aber Camddwr, near Ponterwyd, Cardiganshire', *Archaeologia Cambrensis* 126, 31.

Smith, A. G. and Cloutman, E. W., 1988. 'Reconstruction of Holocene vegetational history in three dimensions at Waun-Fignen-Felen, an upland site in south Wales', *Philosophical Transactions of the Royal Society*, B322, 159–219.

Smith, G., 2013. 'Llanfechell: a prehistoric funerary and ritual landscape in north Anglesey', *Transactions of the Anglesey Antiquarian Society* 2013, 51–88.

Smith, R .T. and Taylor, J. A., 1969. 'The post-glacial development of vegetation and soils in northern Cardiganshire', *Transactions of the Institute of British Geographers* 48, 75–96.

Stockmarr, J., 1971. 'Tablets with spores used in absolute pollen analysis', *Pollen et Spores* 13, 615–21.

Taylor, J. A., 1973. 'Chronometers and chronicles: a study of palaeo-environments in west central Wales', *Progress in Geography* 5, 247–334.

Timberlake, S., 2001. 'Mining and prospection for metals in Early Bronze Age Britain – making claims within the archaeological landscape', in J. Bruck, (ed.) *Bronze Age Landscapes – Tradition and Transformation* (Oxford: Oxbow).

van Geel, B., 1978. 'A palaeoecological study of Holocene peat bog sections in Germany and the Netherlands', *Review of Palaeobotany and Palynology* 25, 1–120.

van Geel, B., Bohncke, S.J.P. and Dee, H., 1981. 'A palaeoecological study of an upper Late Glacial and Holocene sequence from 'De Bochert', The Netherlands', *Review of Palaeobotany and Palynology* 31, 367–448.

van Geel, B., Buurman, J., Brinkemper, O., Schlevis, J., Aptroot, A., van Reenen, G. and Hakbijl, T., 2003. 'Environmental reconstruction of a Roman period settlement site in Uitgeest (The Netherlands), with special reference to coprophilous fungi', *Journal of Archaeological Science* 30, 873–83.

Walker, M. J. C., 1993. 'Holocene (Flandrian) vegetation change and human activity in the Carneddau area of upland mid-Wales', in Chambers (ed.) 1993, 169–83.

——2007a. 'Craig y Fro: pollen stratigraphy and dating', in S. J. Carr, C. G. Coleman, A. J. Humpage, R. A. Shakesby (eds), *The Quaternary of the Brecon Beacons: Field Guide* (London: Quaternary Research Association), 128–9.

——2007b. 'Craig Cerrig-gleisiad: pollen stratigraphy and dating', in S. J. Carr, C. G. Coleman, A. J. Humpage, R. A. Shakesby (eds), *The Quaternary of the Brecon Beacons: Field Guide* (London: Quaternary Research Association), 142–4.

——2007c. 'Traeth Mawr: pollen stratigraphy and glacial chronology', in S. J. Carr, C. G. Coleman, A. J. Humpage, R. A. Shakesby (eds), *The Quaternary of the Brecon Beacons: Field Guide* (London: Quaternary Research Association), 146–58.

Walker, M. J. C., Coope, G. R., Sheldrick, C., Turney, C. S. M., Lowe, J. J., Blockley, S. P. E. and Harkness, D. D., 2003. 'Devensian Lateglacial environmental changes in Britain: a multi-proxy environmental record from Llanilid, South Wales, UK', *Quaternary Science Reviews* 22, 475–520.

*Published with the aid of a grant from Cadw – Welsh Government*