Fine-spatial Paleoecological Investigations Towards Reconstructing Late Holocene Environmental Change, Landscape Evolution, and Farming Activity in Barrees, Beara Peninsula, Southwestern Ireland

Anette Overland[1,*] and Michael O'Connell[1]

Abstract - Long-term environmental change and human impact have been reconstructed at fine spatial and temporal resolutions in an archaeologically rich, and floristically interesting, part of southwestern Ireland, namely the Beara peninsula, County Cork. Detailed pollen and macrofossil analyses, and radiocarbon dating have been carried out on several short peat monoliths, and on a peat core and a lake core from small basins. Landscape evolution, vegetation dynamics, and farming activity from the end of the Neolithic (*c.* 2500 B.C.) to the present day, i.e., the period of greatest human impact in southwestern Ireland, have been reconstructed. While significant opening-up of the landscape began relatively early in the Bronze Age (between *c.* 2400–2100 B.C.), the main woodland clearances took place in the later Bronze Age (beginning *c.* 1400 B.C. and continuing into the Iron Age, i.e., to *c.* 400 B.C.). In the mid- and later Iron Age, there was considerable fine-scale spatial variation, with activity being concentrated mainly in the uplands (at *c.* 200 m asl) and at lower elevations. Radiocarbon dating and pollen evidence show that the linear stone-wall system, now partly obscured by shallow peat, was laid out towards the end of the Iron Age (*c.* A.D. 400) in the context of a largely open landscape. While the initial foci of bog growth appear to relate to the late Neolithic/beginning of the Bronze Age, widespread development of blanket bog was essentially a phenomenon of the late 1st/early 2nd millennium A.D. It was probably favoured by wetter and cooler conditions during the Little Ice Age. Detailed records are presented for the filmy ferns, *Hymenophyllum tunbrigense, H. wilsonii*, and *Trichomanes speciosum*, and also *Myrica* and *Ulex*, both shrubs with pronounced, oceanic distribution patterns.

Introduction

The potential of pollen analysis as a tool for paleoenvironmental reconstruction has long been recognised. Initially used as a tool for reconstructing woodland dynamics during the post-glacial (e.g., Erdtman 1924; L. von Post in 1916, reported by Fries 1967; Jessen 1949), the technique has, in the meantime, been refined in most respects including methods of sample preparation, range of palynomorphs identified, improved certainty in the identification of critical palynomorphs, and data interpretation, so that not only woodland history but also farming activity and the role of factors such as climate change can be reconstructed with a degree of completeness and certainty never envisaged by the original practitioners. The main strength of the technique is the ability to generate a continuous or near-continuous record provided that continuous, or at least close-interval, sampling is carried out. It can also provide evidence of fine-scale spatial variation in the natural/semi-natural vegetation (this may include not only woodland, but also bog and heath communities), and farming impact. A prerequisite for such fine-scale studies is the availability of suitable basins of deposition with deposits that enable local as distinct from regional records to be obtained. Such deposits may take a variety of forms including peats that have accumulated in small hollows including kettle holes, mor humus deposits that have accumulated within woodland contexts, soils with good pollen preservation, such as where sealed as a result of spread of bog, and small bogs and lakes (e.g., Behre and Kučan 1995, Odgaard 1994, Waller and Schofield 2007). The reconstructions reported here derive from several deposit types and are complemented by results from parallel archaeological excavation and survey.

Theoretical studies show that to obtain very localised records, basins with small diameter (100 m and preferably less) are required (Sugita 1994, 2007). Empirical data, especially those derived from situations where human impact is known or at least can be accurately estimated from archaeological/historical evidence (cf. Berglund 1998, Molloy and O'Connell 1995), further indicate not only the critical importance of small basin size but also other factors such as filtering effects of carr vegetation that often fringes bogs and lakes and potential over-representation of pollen derived from plants growing at the sampling site (cf. Bunting 2003, Tauber 1965). The latter can be particularly critical in the case of mires that give rise to pollen that are largely indistinguishable from pollen that derive from plants growing on mineral soils, e.g., Poaceae, Cyperaceae, and Ericoids (see below). Local conditions, including topography and climate—especially wind speeds and prevailing wind direction—also have an important bearing on pollen dispersal and hence pollen records. In the investigations presented here, particular attention is paid to the local contexts of the sampling locations, and the most important caveats regarding the interpretations are indicated and taken cognizance of in the reconstructions.

[1]Palaeoenvironmental Research Unit, Department of Botany, National University of Ireland - Galway, Galway, Ireland.
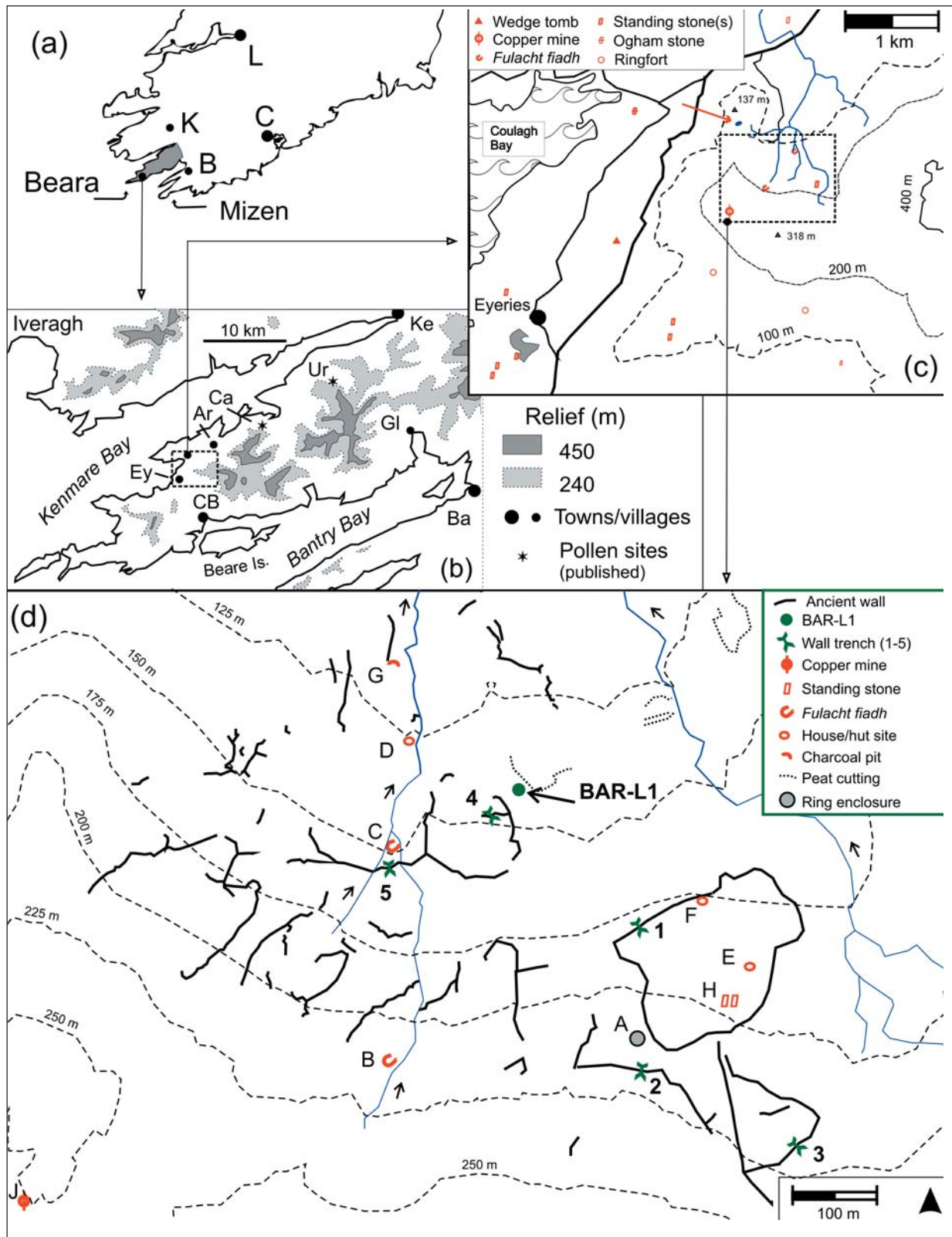*Corresponding author - anette.overland@nuigalway.ie.

Figure 1. Maps at various scales showing location and main features of the study area. (a) Map of southern Ireland—the Beara peninsula is shaded and centers of population (B = Bantry, C = Cork, K = Killarney, L = Limerick) are indicated; (b) Detail of southwestern Ireland centered on the Beara peninsula—towns (Ba = Bantry, CB = Castletown Bere, Ke = Kenmare), villages (Ar = Ardgroom, Ey = Eyeries, Gl = Glengarriff), pollen sites (Ca = Cashelkeelty, Ur = Uragh Wood) and relief are shown; (c) The study area and immediate surrounds—roads, contours, the main archaeological field monuments and village of Eyeries are shown. An arrow points to Loch Beag; and (d) Detailed map of the study area showing pollen sampling sites and archaeological features including stone field walls as recorded during archaeological survey.

The present investigations were undertaken, in the first instance, to provide an environmental context for archaeological survey and excavation in the under-explored and mainly upland landscape that lies between Ardgroom and Castletownbare on the Beara peninsula, hereafter referred to as Beara (Fig. 1). As in southwestern Ireland generally, it is usually assumed that prehistoric activity was concentrated in the Bronze Age rather than the Neolithic or Iron Age, not only because of the high frequency of monuments and features datable to the Bronze Age (e.g., wedge tombs, stone circles, standing stones, and *fulachta fiadh*, i.e., burnt mounds; O'Brien 2000, in press; Power 1992), but also due to the paleoecological evidence from Cashelkeelty and the wider Cork/Kerry region (see below).

The paleoecological investigations are spatially circumscribed in that they relate specifically to the partially peat-covered landscape of Barrees, a townland between Ardgroom and Eyeries (Fig. 1). The northeast/southwest grain of the landscape originated in the Hercynian (Armorican) uplift of late Paleozoic age that resulted in tight folding and exposure of erosion-resistant Old Red Sandstone of the Upper Devonian that forms the mountain ranges in this part of Ireland. The Hercynian folding also resulted in metalliferous deposits of copper, manganese, and barites in southwest Cork that formed the basis of Bronze Age and subsequent copper mining (Callaghan and Forsythe 2000; O'Brien 1996, 2004; Pracht 1997). Late Devonian and Carboniferous sandstone, limestone, and shale survive mainly in restricted coastal areas (MacCarthy 2007a, b; Pracht 1997) where relatively fertile, brown podzols occur. These contrast with the skeletal soils and peaty podzols derived from the nutrient-poor sandstones and overlying drift. These areas support mainly rough pastures, heaths, and peatlands (Conry and Ryan 1963), which characterize the landscape under investigation here. Though lying well within the eastern limits of the Killarney-Killumney ice-sheet (last glaciation), glacial deposits are generally thin and patchy, and derive largely from local bedrock, which has a major influence on soil types.

As regards previous paleoenvironmental investigations from the region, those by Lynch (1981) at Cashelkeely (Fig. 1b), 9 km to the north of Barrees, are the most detailed and relevant. The pollen profile, Cashelkeelty I, from a small peat basin near the main stone circle (Bronze Age), spans the interval 7000 B.C. to recent times (dates quoted as B.C. or A.D. are calibrated/calendar years). Human impact begins in the Bronze Age (shortly before 2000 B.C.) and is maintained until the late Iron Age, when what has come to be regarded as the Late Iron Age Lull, i.e., a period of reduced activity in the early centuries of the first millennium A.D. (cf. Molloy and O'Connell 2004), is recorded. In the historical period, there is evidence for sustained activity that was maintained until recent times. Local initiation of peat growth at *c.* A.D. 900 provides a *terminus ante quem* for a pre-bog stone wall at the site.

A profile from a small hollow (8 x 15 m) in Uragh Wood, near L. Inchiquin, some 9 km northeast of Barrees, records local woodland dynamics starting at *c.* 1400 B.C. (Fig. 1b; Little et al. 1996). The first and short-lived disturbance was recorded at about the B.C./A.D. transition. Shortly after this (*c.* A.D. 300), pine became locally extinct. A major disturbance phase involving clearance of oak occurred at about A.D. 1700. Little et al. (1996) suggest that soil podzolization took place some centuries prior to this.

A synthesis of research in the Killarney area and new pollen diagrams are provided by Mitchell and Cooney (2004), while Mighall and co-workers have carried out paleoecological investigations on the Mizen peninsula (Mighall and Lageard 1999; Mighall et al. 2000, 2007), the main region for Bronze Age mining in Ireland (O'Brien 2003).

A valuable critique of the evidence from archaeological and historical sources relating to the period from the arrival of the Normans in Ireland (A.D. 1169) to the end of the Gaelic lordship by the O'Sullivan Beare (the Gaelic chieftain clan of Beara) in the early 17th century has recently been published (Breen 2005). Much of the field evidence and the historical sources relate, however, to the coastal parts and so, while providing useful background information, are of limited direct relevance (cf. also Dickson 2005). The identification of a large number of upland hut sites (age uncertain, probably medieval) on Beara is interesting in that it shows that today's marginal landscapes were extensively used in the past (Breen 2005:51). In the context of the present study, the idea that medieval landscapes under Gaelic control were not enclosed is also noteworthy (Duffy 2007), and Breen (2005:110–112) argues that this was also true for Beara. In addition to the above archaeological/historical research, accounts of life and landscape left by travellers to this once remote part of Ireland provide additional insights, but environmental information is limited (Durell and Kelly 2000).

The present paper, with its focus on the later Holocene, i.e., Bronze Age to modern times, provides insights into the development of what might be regarded as a marginal or liminal landscape in the regional contexts of Beara, and indeed western Ireland generally. The focus is on local woodland dynamics, land-use, and the development of the present-day, peat-covered landscape that largely obscures a network of stone walls that pre-date the earliest Ordnance Survey (OS) maps of the early 1840s. It constitutes the first such detailed, fine-scale paleoecological study for southwestern Ireland.

Description of the Study Area

The study area lies in a relatively sheltered, northwest-facing valley (elevation *c.* 100–250 m asl), on the lower western slopes of the Miskish Mountains (locally these reach 318 m asl; maximum 621 m asl) and 2 km from Coulagh Bay to the west (Fig. 1c–d). Present-day farming is concentrated in the lowlands. The first detailed Ordnance Survey map (OS 6-inch 1:10,560 scale map; surveyed 1842) shows a field pattern very similar to that of today, i.e., more or less confined to the valley floor, to the east of Loch Beag. Part of the present-day valley floor supports semi-open patches of Atlantic oak woodlands (Blechno-Quercetum petraeae scapanietosum; Fig. 2), i.e. the typical fern and bryophyte-rich sessile oak woodlands on acidic soils of western Ireland and Britain (Cross 2006, Kelly 1981). This woodland is not shown on the various editions of the 6-inch OS maps, and there are no old trees present today. Woodland appears not to have been a feature of the landscape at the time of the early surveys, i.e., the 1840s and later. *Quercus petraea* is the main tall-canopy tree today and *Betula pubescens* and *Ilex aquifolium* are common (plant nomenclature follows Stace [1997] for vascular plants, Smith [1978] for mosses and Watson [1981] for liverworts). Other common and typical plants include the filmy fern *Hymenophyllum tunbrigense* and liverworts such as *Scapania* spp. and *Saccogyna viticulosa* (cf. Plate II in Cross 2006). This open woodland lies mostly at or below 100 m asl, but patchy outliers extend to *c.* 150 m elevation (Fig. 2).

Ulex europaeus forms a band of open shrubby vegetation *c.* 10–20 m wide where the open woodland ceases. Above this, there are rough pastures, wet heath, and blanket bog (Fig. 2). Rushes (*Juncus effusus, J. acutiflorus, J. articulatus,* and *J. squarrosus*) dominate the rough pastures. *Molinia caerulea* tussocks are prominent on shallow peat, whereas *Sphagnum* spp., *Molinia*, *Nardus stricta*, and *Potentilla erecta* are common on deeper peat. Other common acidophilous species include *Anagallis tenella, Carex flacca, C. binervis, Drosera rotundifolia, Erica tetralix*, *Galium saxatile*, and *Pedicularis sylvatica.* Species with restricted distribution in Ireland include *Anthemis nobilis, Euphorbia hyberna, Pinguicula grandiflora* (also *P. lusitanica* and *P. vulgaris*), and *Ulex gallii.* The ferns *Hymenophyllum wilsonii* and *Blechnum spicant* occur in the more upland parts of the study area within heathy vegetation where local topography and aspect combine to give some shade and shelter from the prevailing southwesterlies and direct radiation. Associated species

Figure 2. View towards the main area of archaeological survey and excavation from a low hill at the northeast side of Loch Beag (the lake is partly visible in foreground). Heath dominates in the foreground, followed by pastures and *Q. petraea* woodland, and beyond these heath, rough pasture and blanket bog, where the short monoliths and the long core, BAR-L1, were taken. The area of main archaeological interest is enclosed by an ellipse (photograph: October 15, 2004).

include the leafy liverwort *Scapania gracilis* and mosses such as *Hypnum jutlandicum, Hylocomium splendens, Pseudoscleropodium purum, Sphagnum palustre, S. capillifolium,* and *S. subnitens.*

The pronounced oceanic climate is an important factor influencing species distribution at both regional and local levels, and has undoubtedly also influenced general landscape character, especially as regards blanket bog and heath development. The climate is characterised by mild winters with little frost or snow. January air temperature is 7 °C (mean daily) and 4.5 °C (mean daily minimum), while the July mean reaches only 15.5 °C and mean daily maximum is 18 °C. Rainfall is high (*c.* 1600 mm per annum) and frequent (*c.* 200 wet days, i.e., days with ≥1 mm precipitation). Winds are predominantly from the southwest and so are generally warm and rain-bearing. Average wind speed is relatively high (6 m sec^{-1}) (temperatures and precipitation refer to the periods 1931–1960 and 1941–1960, respectively; temperatures quoted are reduced to mean sea level; Rohan 1975).

The study area harbours a variety of archaeological features including a Bronze Age copper mine, *fulachta fiadh* (burnt mounds), hut sites and enclosures of various sizes, as well as a network of ancient stone walls, many of which are partially obscured by shallow peat (Fig. 1; details in O'Brien, in press). A particular focus of the present investigations was to establish a chronology for these walls, the environmental context in which they were built, and especially the land-use patterns associated with their construction and use.

Methods

The paleoecological research was greatly facilitated by the possibility of collecting a series of short monoliths from trenches freshly cut in the course of archaeological excavations. As peat thickness in the vicinity of the walls is generally not much more than 50 cm (and often less), the records obtained from these sources are relatively short and generally extend back to no more than about two millennia.

The short records from monoliths BAR1 to BAR5 are complemented by two longer records from a peat core and a lake core, respectively. The former, referred to as BAR-L1, was taken from relatively deep peat that accumulated in a small basin (*c.* 40 m diameter) within the area of prime archaeological interest (further details regarding cores and monoliths and sampling in the field are given in Table 1; photographs and additional details are in Overland and O'Connell, in press). Lying at *c.* 140 m asl, it is the lowest sampling site apart from Loch Beag, and is about 350 m distant from the

woodland remnants near the bottom of the valley. The uppermost meter of peat had been cut from half of the basin. In the cutover part, a substantial oak trunk was exposed by peat cutters, and a timber layer was encountered in the non-cutover part at *c.* 90 cm from the intact surface during trial coring. Sampling was carried out on the intact bog surface at a point where the peat was thickest as determined by a gouge corer.

The lake record is based mainly on core BEG1 taken from Loch Beag (literally Small Lake; lake unnamed in the OS maps). This lake lies in a small closed basin that is sheltered from the prevailing southwesterlies by high ground but open to the valley and the area of main archaeological interest to the northeast (Figs. 1, 2; further details in Overland 2007). The results from Loch Beag, while briefly considered here, will be described more fully elsewhere.

In the case of the short monoliths (BAR1–BAR5), depths were noted with respect to the mineral ground, i.e., positive depths indicate depths below mineral ground, while negative depths indicate height above the mineral ground/peat interface. In BAR-L1, depths were noted with respect to the present-day bog surface. In the case of the Loch Beag cores, depths are with respect to the surface of the coring platform that was supported by, and flush with, the semi-floating scraw (corresponds approximately to the lake-water surface).

Close-interval sub-sampling was carried out as follows. Samples of 1 cm^3 and 1 cm thick were taken at equal intervals where this was practical (BAR-L1; BEG1), or at irregular intervals as to avoid sampling over layer boundaries (BAR1 and BAR3). Samples were prepared for pollen analysis using standard procedures including HF treatment to remove mineral matter (Fægri and Iversen 1989). A known number of *Lycopodium* spores was added to each sample at the beginning of the preparation procedure to facilitate estimation of pollen concentration. Samples were mounted in glycerol, and counted under phase contrast using a Leica DM LB2 microscope fitted with a phase contrast Planapo 63/1.4 objective that gave a magnification of 788. In general, at least 1000 pollen (excluding bog taxa) were counted per sample. Pollen and spore identification followed mainly Fægri and Iversen (1989). Other authorities consulted include Moore et al. (1991), Beug (2004), and Reille (1992, 1995). Cereal-type pollen were distinguished following the criteria in Beug (2004; see Behre [2007] for overview on evaluation of cereal pollen). During counting, large Poaceae pollen with a large pore and annulus, i.e., fulfilling the criteria given by Beug for cereal-type pollen, were categorised according to size as follows (length of longest axis of grain

cited): 40–44 μm, 45–49 μm, and ≥50 μm. In addition, *Secale* pollen were distinguished. Spores of the filmy ferns were distinguished as follows: large size (62–74 μm) and distinctive polymorphic echinae enable *Hymenophyllum wilsonii* to be separated with confidence from the much smaller spores of *H. tunbrigense* (40–48 μm; measurements according to Page [1997], which, presumably, relate to untreated spores) and *T. speciosum*. Features such as the shape of the spore, and the distribution and shape of the sculptural elements enable *Trichomanes* to be distinguished from *H. tunbrigense*. The former is rounder and hence more regular in outline

with trilete markings that extend almost to the circumference. The surface texture consists mainly of low, verrucae-like projections and well-spaced, long (*c.* 2 μm), narrow, pointed projections that are often inclined by several degrees and also curved. In outline, *H. tunbrigense* tends to be more triangular than round and has a long, pronounced trilete marking. The sculpture consists of many echinae-like projections (*c.* 2 μm long), close to being isosceles triangular in shape (i.e., broad base) and lacking the heterogeneity of shape and size seen in *H. wilsonii*; in surface view, the base of many of the projections appear elongated.

Table 1. Details of sampling at Barrees and summary of the main analyses carried out.

Core/monolith and analyses*	Latitude and longitude	Additional details relating to sample location and sampling
Short monoliths		
BAR1 Alt: 182 m Pollen (20) ^{14}C (10)$^{\alpha}$	51°42'25.2"N, 9°55'03.2"W	From T1 at NW side of the main wall enclosure. Monolith included mineral soil and overlying peat taken c. 60 cm from edge of stone wall (uphill side). All of overlying peat sampled. An additional small monolith, BAR1(2)—a 6-cm thick slice of brown organic-rich sandy/silty soil—was taken from beneath a large stone that formed part of the foundation of the wall
BAR2 Alt: 220 m Pollen (2) ^{14}C (2)	51°42'19.7"N, 9°55'02.8"W	Uphill of BAR1 and near round enclosure, A. Basal peat (c. 20 cm) from beside the wall sampled.
BAR3 Alt: 218 m Pollen (12) ^{14}C (3)	51°42'17.0"N, 9°54'53.0"W	Monolith consisting of mineral soil and basal peat removed from uphill side of a substantial stone wall. Uppermost c. 50 cm of peat not sampled.
BAR4 Alt: 150 m Pollen (1) ^{14}C (1)	51°42'29.3"N, 9°55'12.4"W	Short monolith consisting of peat taken from beside a stone wall situated above the small basin (53 m to the SE) where BAR-L1 was taken. Note: an additional ^{14}C date was obtained subsequently by W. O'Brien.
BAR5 Alt: 155 m Pollen (2) ^{14}C (3)	51°42'27.2"N, 9°55'18.7"W	T5, at approximately the same altitude as T4, was cut through a low wall. BAR5-1, consisting of peat, was taken from beside the wall (downslope side). BAR5-2 consisted of mineral soil beneath a large stone of the wall.
Bog core		
BAR-L1 Alt: 140 m Pollen (51) ^{14}C (9)	51°42'30.4"N, 9°55'10.6"W	Core from a small hollow 65 m to the N.E. of BAR4 and below large enclosure (BAR1). Uppermost 40 cm removed as a monolith. Remaining peat sampled in a 10 cm diameter plastic pipe; basal mineral soil recovered. Monolith+core (referred to as core BAR-L1) was 266 cm long.
Lake core		
BEG1 Alt: 103 m Pollen (175) ^{14}C (17)	51°42'4.3"N, 9°55'32.5"W	Parallel, overlapping cores, BEG1 and BEG2, were taken beneath a scraw that has recently developed as a result of rapid lake-infilling. Open water occupies an area of c. 50 x 30 m; Loch Beag was probably double this size for much of the Holocene.

*Alt = altitude; numbers of pollen and ^{14}C samples are given in parentheses; T = Trench $^{\alpha}$ BAR1; ^{14}C samples as follows:
    5 samples for AMS dating (mainly *Juncus* seed and some fine charcoal fragments. The sample, BAR1-3, was too small to be dated; another sample (BAR1-7) was submitted for conventional dating.
    3 samples consisting of 1-cm thick peat slices for conventional dating.
    1 sample from a pre-wall context for AMS dating, i.e., *Juncus* seed extracted from the mineral soil preserved beneath the stone wall.
    1 sample consisting of *Salix* charcoal from a mineral soil context beneath a stone presumed to have been displaced in antiquity from the wall.

Selected non-pollen palynomorphs (NPP) including fungal spores, *Erica tetralix* seed epidermis fragments, and microscopic charcoal (>30 μm; here referred to as micro-charcoal) were also counted.

The pollen data are expressed as percentages based on a total terrestrial pollen sum (TTP) and also as concentrations (grains cm^{-3}). Taxa excluded from the pollen sum include bog taxa, corroded and unknown grains (generally few), charcoal, and NPP including fungal spores. The percentage representation of these taxa was calculated relative to TTP and the sum of taxa pertaining to the component in question. Pollen assemblage zone (PAZ) boundaries were drawn where major changes occur in the percentage curves as determined by visual inspection.

The matter retained in the 100-μm sieves after KOH treatment of the pollen samples was checked for macrofossils, and semi-quantitative estimates— rare (+), occasional (1), frequent (2), and abundant (3)—of macrofossils, macro-charcoal, and mineral matter were made. In addition, macrofossil analysis was carried out on samples with a volume of *c.* 35 cm^3 to get material suitable for AMS ^{14}C dating. The material retained in a 125-μm mesh sieve was scanned for macrofossils and other entities using a Leica MZ125 stereomicroscope. Bulk peat samples were also submitted for conventional ^{14}C dating (BAR1 and BAR3). Ash content, i.e., the amount of mineral matter present, was determined by burning dried samples to constant weight for six hours in Ni crucibles at 550 °C.

Results and Interpretation—Short Monoliths

Pollen diagrams relating to the short monoliths are presented in Figures 3–7. Conventions followed in these and the other pollen diagrams include (a) curves/histograms with a magnified x-axis are not in-filled, (b) a closed circle is used to emphasize presence where values are small and hence may go unnoticed, and (c) a "+" indicates a record made by scanning after pollen counting was completed. Macro-fossil and other data are also presented within the pollen diagrams.

In the short monoliths, where the focus was on mineral soils and the overlying peat, interpretation of the pollen data is not straightforward because of the complexities of the processes involved in the incorporation and preservation of pollen in mineral soils (cf. Dimbleby 1985, Havinga 1971, O'Connell 1986). Complications may arise from the presence of residual older pollen in soils, the probability of vertical movement of pollen within the profile, and differential preservation of corrosion-resistant pollen and spores (especially fern spores). The local soils are acidic and podzolised (iron pan noted only

in BAR3) and so poor preservation is not regarded as seriously distorting the results.

As regards pollen source area, soil samples reflect largely the local vegetation at and near the sampling site. As peat begins to accumulate and expand laterally, the non-bog pollen increasingly reflect regional vegetation change.

In presenting pollen data from peat profiles, it is usual practice to exclude bog taxa so as to avoid distortion of curves due to over-representation of locally produced pollen. On the other hand, bog taxa are best included in the pollen sum in the case of spectra relating to the mineral soils (since what is reflected is mainly the local environment which is normally also of greatest interest). The use of different pollen sums in the same pollen diagram is not, however, practical, and so a pollen sum based on TTP that excludes bog taxa has been used. It should be borne in mind that bog taxa are also influenced by grazing (Bleasdale and Sheehy Skeffington 1992). This fact is particularly relevant in this instance as the largely peat-covered uplands were probably always used for grazing, even if to varying degrees.

The ^{14}C dates for the short monoliths and the peat core are presented in **Supplementary Tables S1 and S2** (available online at http://dx.doi.org/ 10.1656/J080427.s1 and http://dx.doi.org/10.1656/ J080427.s2, respectively; additional details in Overland and O'Connell, in press). The dates have been calibrated using Calib ver. 5.0.1 and the IntCal04 calibration curve (Reimer et al. 2004).

Estimating age in the case of short peat monoliths presents a particular challenge. In addition to ^{14}C dates that give unlikely ages or have a large error value (see below), age construction is complicated by the unpredictability of peat accumulation, particularly at the initial stages of peat growth. In general, peat accumulation is expected to be initially relatively slow and then increase when conditions become more favorable for bog plants, as organic matter and soil wetness increase and decomposition rates decline with increased wetness. The results from the various profiles are now considered and local environmental change reconstructed for each site.

BAR1 (Trench 1)

At the point along the trench across the wall of the large enclosure where the monolith BAR1 was taken, there was a localised depression of *c.* 12 cm in the mineral soil surface (Fig. 3). This depression may be the imprint of a stone that was used in wall construction. It was filled with grey-brown silt that had a considerable organic component (see below).

Stratigraphy. The main stratigraphic features are as follows (Fig. 4). The basal mineral soil, on which the wall was built, was low in organics (layer 1). Layer 2 (0 to -21 cm) consisted of sandy silt with con-
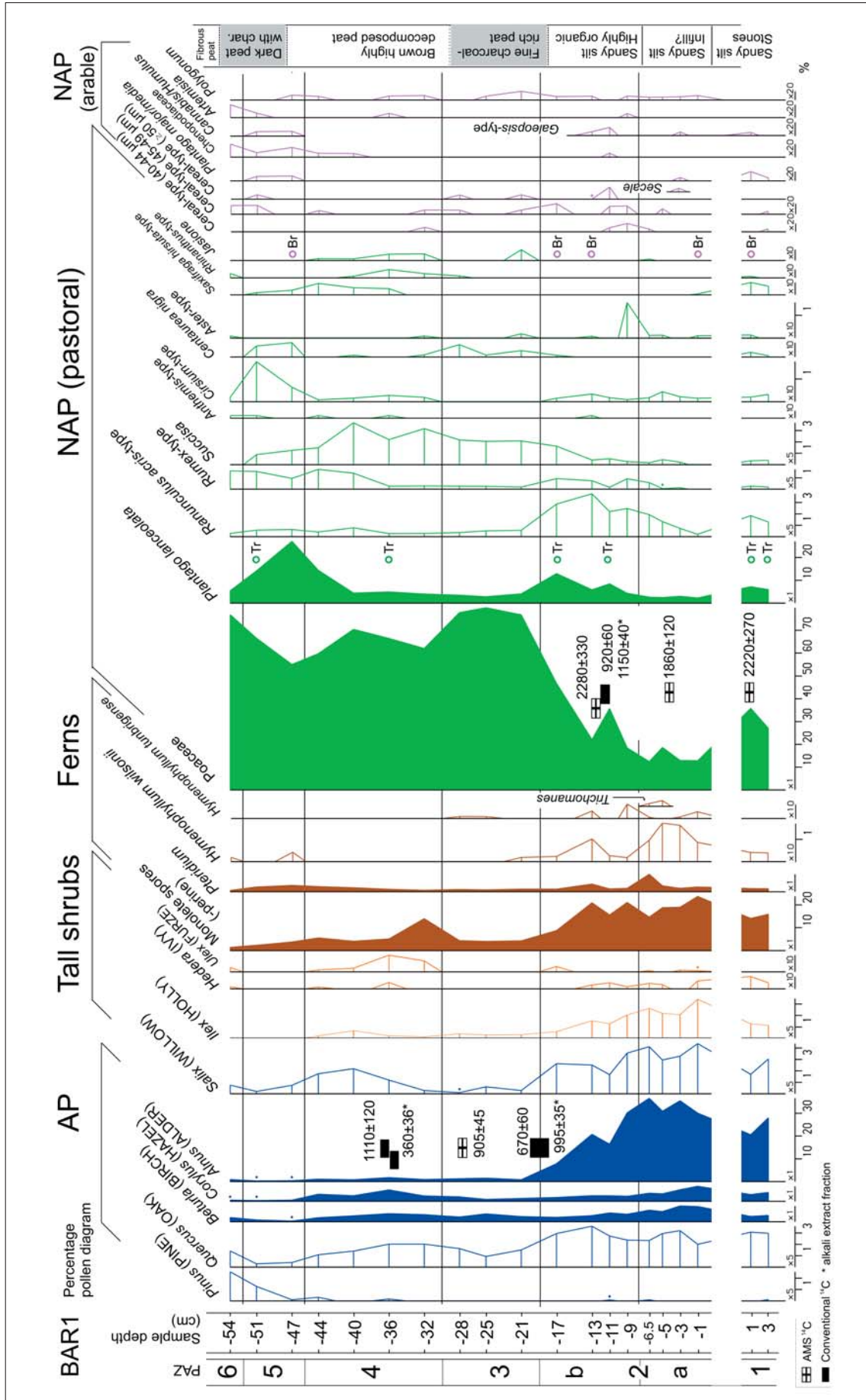
Figure 3. Profile BAR1: percentage pollen diagram (AP and NAP). Abbreviations: Tr = *Trifolium repens*, Br = Brassicaceae spp. (values <1% and mainly <0.2%).
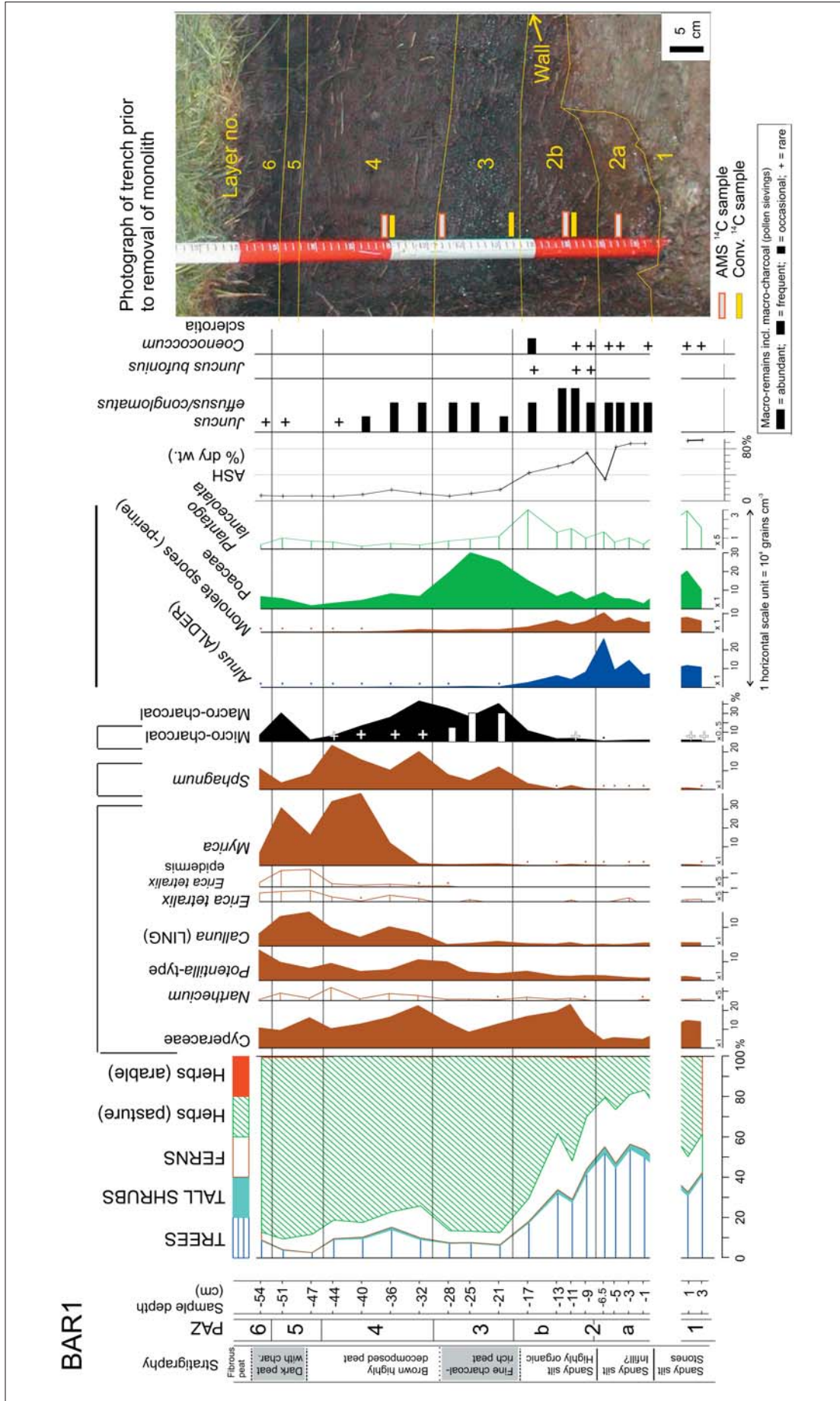
Figure 4. Profile BAR1: composite percentage and bog taxa pollen curves, micro- and macro-charcoal, selected pollen concentration curves, ash values, macrofossils, and photograph of part of Trench 1. The ranging rod marks the position where the monolith was taken. Position of samples taken for ^{14}C dating is indicated. Macro-charcoal is indicated by histograms and "+" using the same abundance scale as that used for the macrofossils. The *Juncus* records consist of seed.
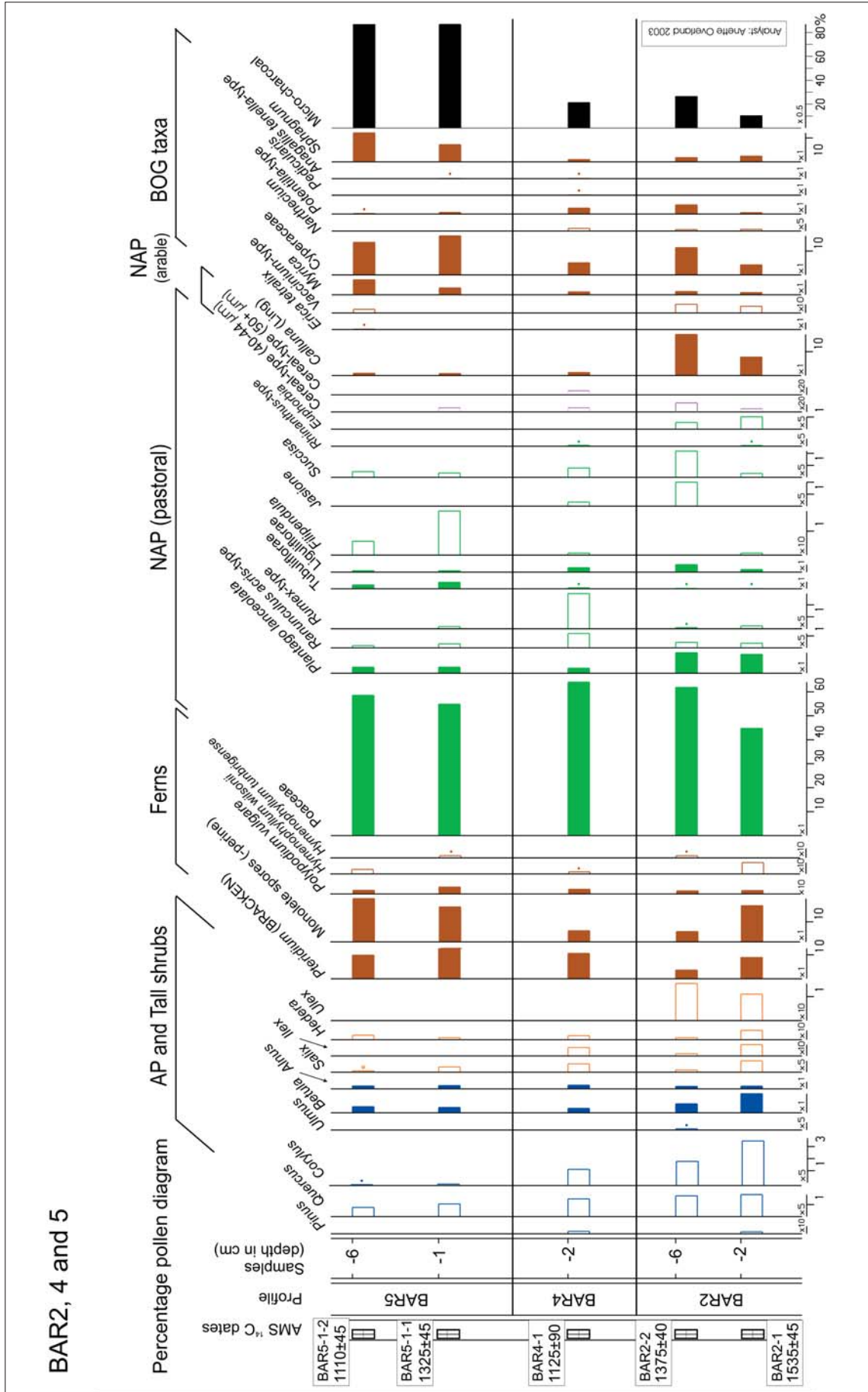
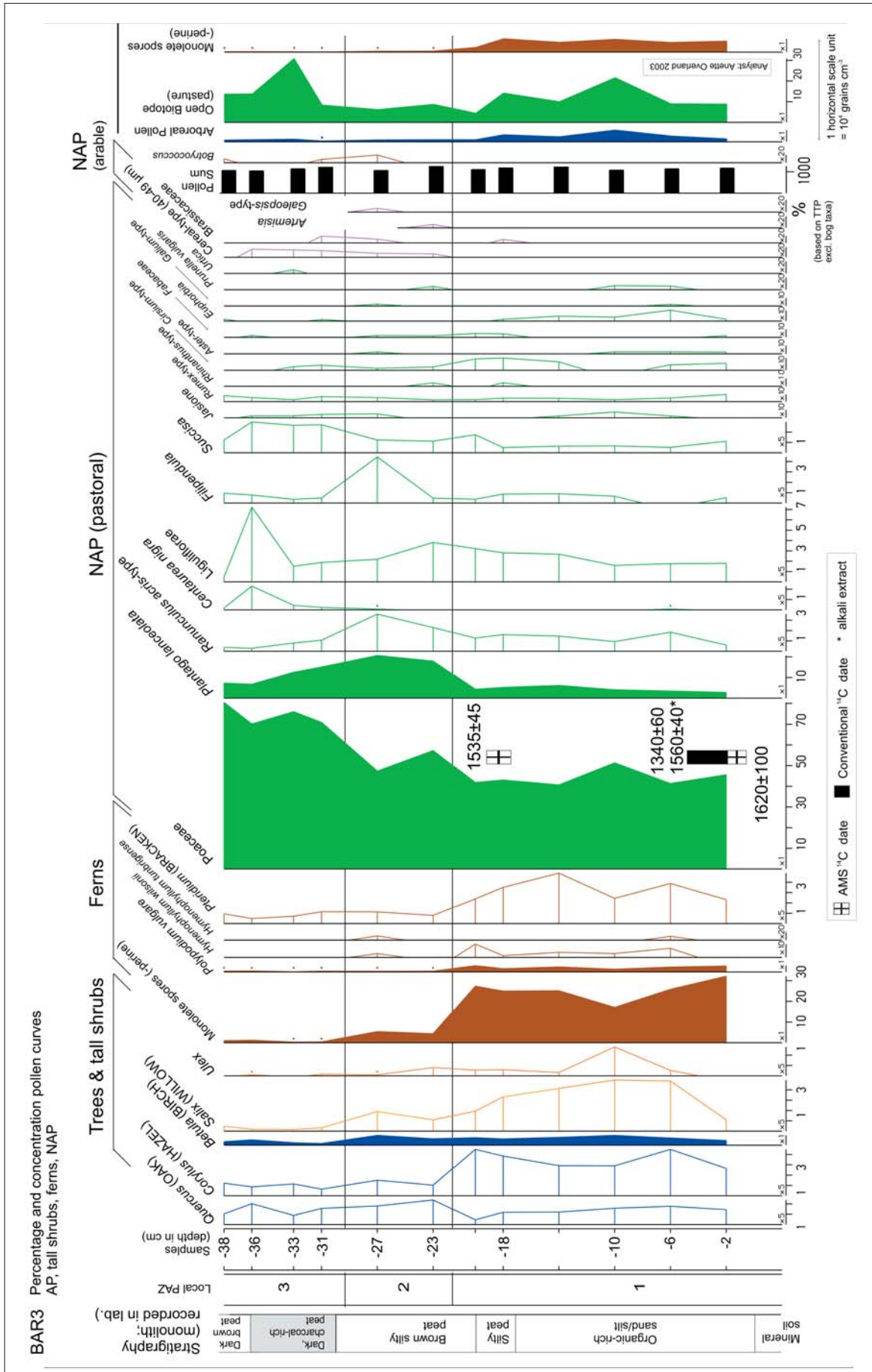Figure 5. Percentage pollen spectra from BAR2, BAR4, and BAR5.

Figure 6. Profile BAR3: percentage pollen diagram (excluding bog taxa) and concentration curves for selected composite taxa.
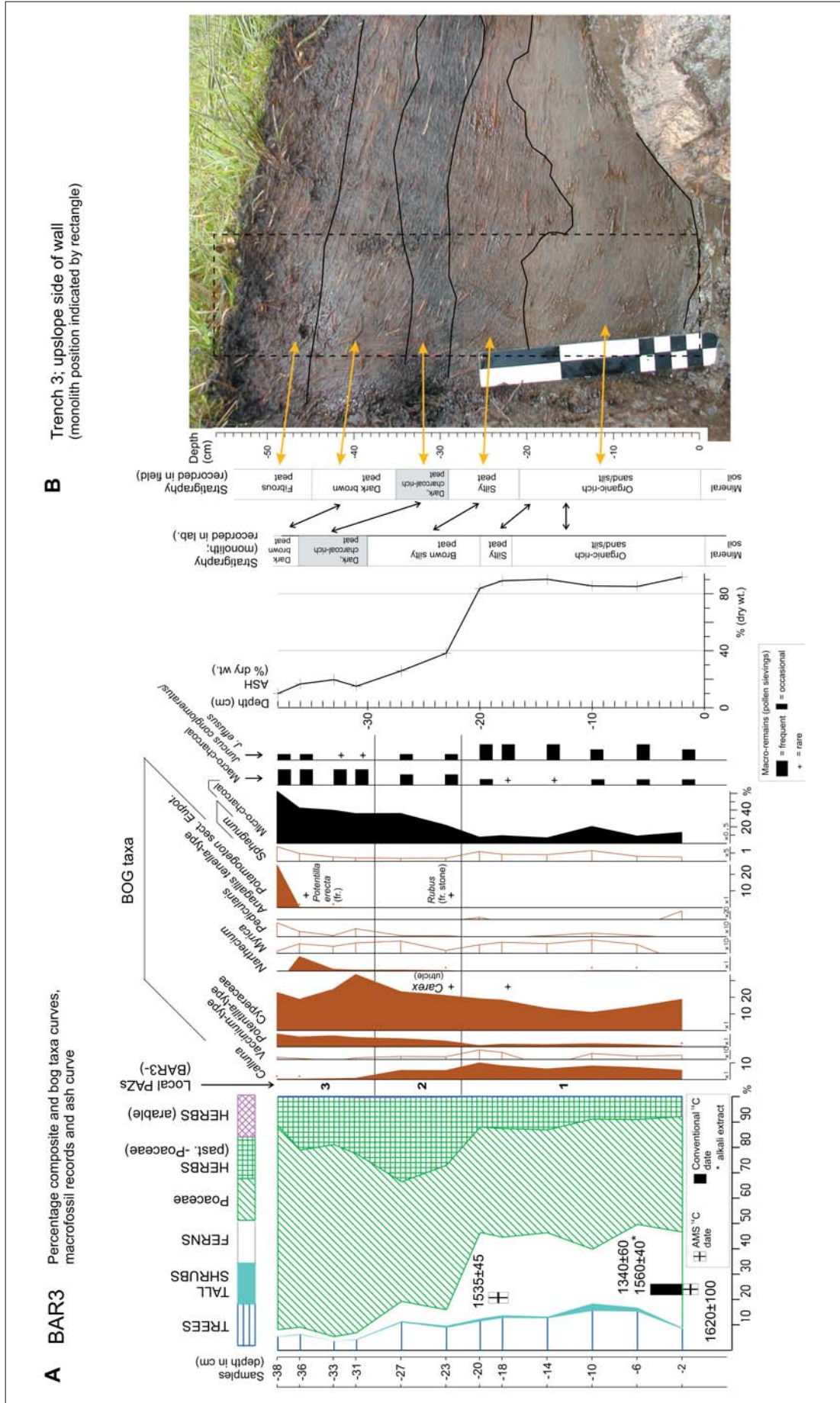
Figure 7. A. Profile BAR3: composite and bog taxa percentage pollen curves, micro- and macro-charcoal records, macrofossil records, ash curve, and stratigraphy as recorded in the laboratory. B. Photograph of Trench 3 immediately prior to removal of monolith and stratigraphy as recorded in the field. Note: the vertical scale is compressed compared with A.

siderable organic content; sublayer 2b was more organic-rich and darker. This layer was overlain by peat as follows: a fine, dark, charcoal-rich peat that formed a distinctive layer (layer 3, -21 to -31 cm); highly decomposed brown peat with abundant fine roots (layer 4, -31 to -50 cm); dark, relatively charcoal-rich peat with many roots including woody roots (layer 5, -50 to -58 cm); and a highly fibrous peat that formed the rooting zone of present-day vegetation (layer 6, -58 to -63 cm).

Chronology. The results of the ^{14}C dating are plotted in Figure 8. The age/depth curve (Fig. 8) gives what is regarded as the most probable age/depth relationship based on the available evidence that includes not only ^{14}C dates but also lithological and pollen analytical features. It is assumed that the accumulation rate is low at the base of the profile, and that once organic matter began to build up, the accumulation rate increased, an assumption supported by the ^{14}C data.

The AMS ^{14}C date based on *Juncus* seed from mineral soil beneath the wall (2220 ± 270 B.P.) has

a very large error; the date is regarded as broadly indicative of an age in the end of the first millennium B.C. (1σ probability range is 743 B.C.–A.D. 53). The AMS ^{14}C date, 975 ± 35 B.P., derived from *Salix* charcoal beneath a fallen stone, appears acceptable. It suggests that peat growth had not commenced before *c.* A.D. 1100, and wall construction had taken place before this, and possibly considerably earlier.

The lowermost AMS ^{14}C date from the monolith, 1860 ± 120 B.P., is from mid-layer 2a. This layer is regarded as infill in the depression left after removal of a stone for wall construction. It follows that the infill accumulated after wall construction and prior to peat growth. The 1σ probability range for this date is A.D. 21–325. Wall construction seems to have taken place sometime during the first three centuries A.D., after which the process of infilling the depression commenced.

The two ^{14}C samples from the lower part of layer 2b indicate very different ages. The AMS ^{14}C date 2280 ± 330 B.P. has a very large error margin and so
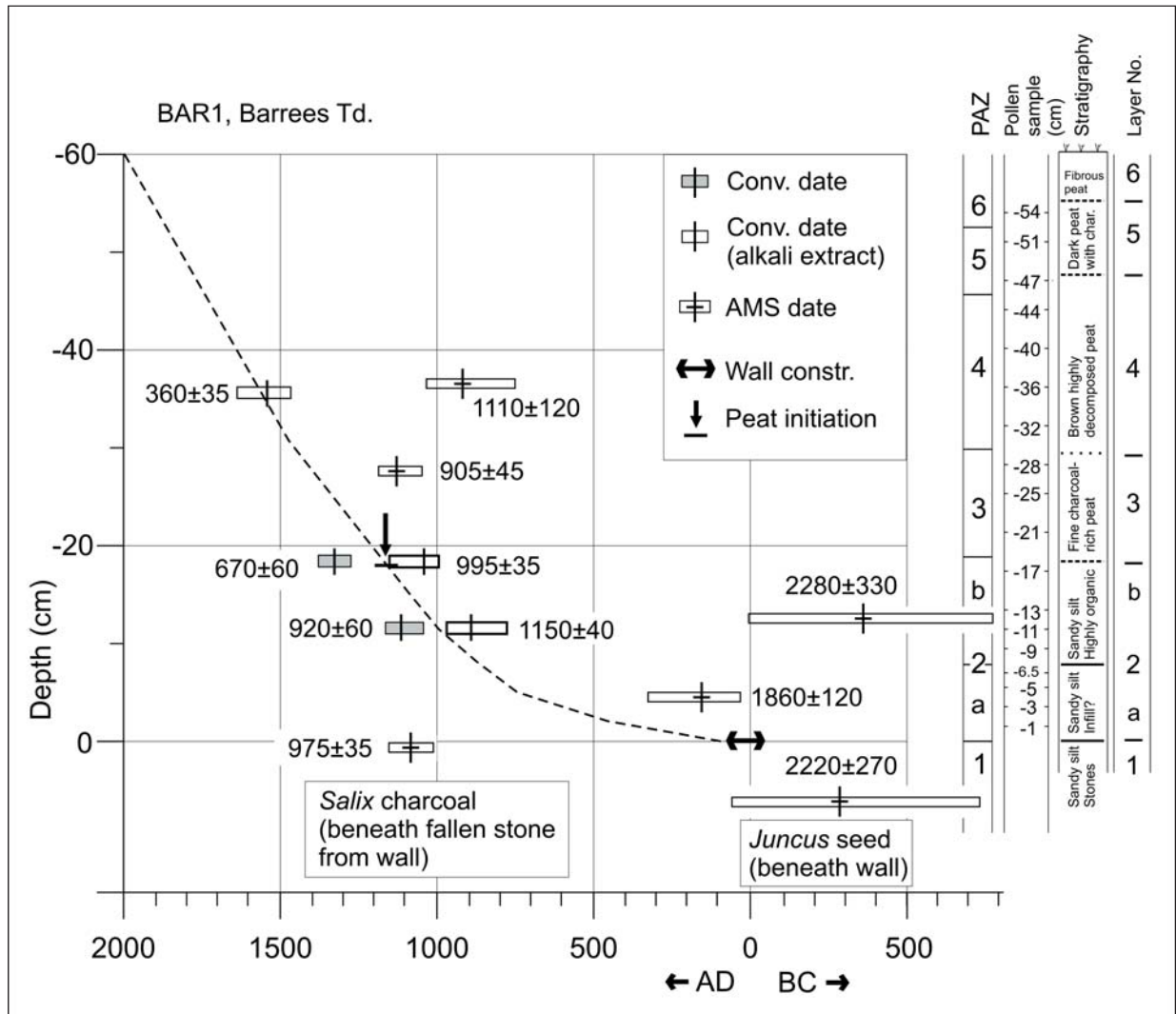

Figure 8. Proposed age/depth relationship for BAR1 is shown by the dashed line. The calibrated 1σ age range (width of rectangle) and the median probability (vertical line) for each ^{14}C date are indicated.

is of little use. As regards the lower sample for which conventional ^{14}C dates are available, the alkali extract gave the older date (1150 ± 40 B.P.; 920 ± 60 B.P. for the humin fraction). The situation is similar in the case in the sample immediately above. The dates for the humin fractions are probably too young due to root penetration. The dates *c.* A.D. 1000 and A.D. 1150 are suggested as appropriate for the depths in question (-12.5 and -19 cm, respectively). This estimate takes into account the AMS ^{14}C date for the *Salix* charcoal and likely sedimentation patterns.

The AMS ^{14}C date 905 ± 45 B.P. from the top of the charcoal-rich layer (layer 3) appears to be too old if the dating outlined above is correct (2 mm year^{-1} accumulation rate would be required, which is unrealistic given the peat composition). It is therefore dismissed, as is the AMS ^{14}C date 1110 ± 120 B.P. from layer 4, which is also regarded as too old.

As regards the uppermost conventional ^{14}C date, the ^{14}C content in the humin component was in excess of 100%, i.e., post-modern, and hence is discounted. The alkali extract, on the other hand, gave what appears to be an acceptable date (360 ± 35 B.P., i.e., *c.* A.D. 1550) on the basis of overall sedimentation patterns and given that the secondary rise of *Pinus* (18th century phenomenon) first registers at -51 cm (Fig. 3).

Paleoenvironmental reconstruction (Figs. 3 and 4)

Zone BAR1-1; pre-wall pollen spectra (1 and 3 cm; end of 1st millennium B.C.). These spectra are from the mineral soil that was sealed as a result of wall construction. They reflect vegetation and land use locally in the years (possibly decades) prior to wall construction. Relatively species-rich grassland dominated in which grasses, *P. lanceolata*, various Asteraceae species, and other herbs played an important role. Sedges and rushes (*Juncus* seed frequent) were also important, but other bog/heath plants (e.g., *Calluna*, *Erica* spp., *Sphagnum*) were poorly represented. Alder was common in the vicinity of the site, and oak, hazel, birch, willow, and holly were probably also common in the immediate vicinity (arboreal pollen (AP) is at 41% and 31% in the lower and upper spectra, respectively).

In general, the pollen and macrofossil evidence indicates that, at or in the vicinity of the site, the landscape was relatively open, but trees and especially alder were common, and there was little or no bog/heath development.

Zone BAR 1-2; -1 to -17 cm (c. A.D. 1–1150). This zone is subdivided into subzones BAR1-2a and BAR1-2b, which, in turn, relate to the lithological layers with corresponding numbers (see above). It is assumed that layer 2a—infill of a depression left by a stone used in wall construction—began to form

shortly after wall construction in the early centuries A.D. (probably towards the end of the first century A.D. if contemporaneous with the nearby circular enclosure, i.e., Site A), and layer 2b, which also has a high mineral content, presumably formed prior to local peat initiation. The age-depth model suggests that subzone BAR1-2b spans the interval *c.* A.D. 850–1150 (Fig. 8).

Pollen assemblage subzone BAR1-2a (-1 to -6.5 cm) is rather similar to BAR1-1, i.e., the pre-wall mineral soil spectra. *Alnus*, however, is more strongly represented, and *P. lanceolata* and especially Poaceae have lower values. Occasional cereal-type pollen were recorded, including a *Secale*-type pollen at -3 cm (Fig. 3).

Vegetation and land use were broadly similar to that which pertained during pre-wall construction. Grasslands, though, were not as important as before, there was cereal growing (but minimal), and relatively species-rich, alder-dominated woodlands were important. Holly and the filmy ferns, *H. tunbrigense* and especially *H. wilsonii*, were common, and six spores of *T. speciosum* (Killarney fern) were recorded (Fig. 3).

The subzone BAR1-2b (-9 to -17 cm) is transitional between BAR1-2a and BAR1-3 in that the percentage and concentration values for *Alnus* and Poaceae change substantially, the former decreasing and the latter increasing (Figs. 3 and 4). This shift in representation suggests replacement of alder-dominated woody vegetation by grassland. A high diversity of non-arboreal pollen (NAP) suggests species-rich grasslands that presumably served as pasture. Cereal-type pollen achieve their highest representation in the profile (max. 0.5% in -11 cm), and there are also records for plants associated with disturbed ground, trampling, and arable farming (cf. *Galeopsis*-type, Brassicaceae, and *Polygonum,* which includes occasional grains of *P. aviculare* and *P. bistorta*-type pollen). These features suggest disturbance, including arable farming, at or in the general vicinity of the site.

The high Cyperaceae representation suggests wet, sedge-rich grasslands with *Potentilla erecta* (the most likely source of the *Potentilla*-type pollen) and possibly *Narthecium. Juncus* seed (mainly *J. effusus/conglomeratus* and also *J. bufonius*; Fig. 4) are well represented, which suggests that the local pastures were rushy and wet.

The decline in AP as the subzone ends is most likely the result of increased farming pressure that is also manifested in increased micro-charcoal representation. An increase in *Sphagnum* suggests local initiation of bog. The age-depth model suggests that peat initiation at the site started in the early 2nd millennium A.D.

Zone BAR1-3; -21 to -28 cm (c. A.D. 1150–1450). This PAZ relates to layer 3, i.e., the dark, charcoal-rich layer that formed the basal peaty deposits. The zone is dominated by Poaceae (achieves 80%), AP is very low (*c.* 7%), and there is an increase in *Sphagnum* and *Potentilla*-type (presumably *P. erecta*, a species of acid soils and tolerant of burning), but Ericoids are poorly represented. Both micro- and macro-charcoal representation is high. These features suggest a period of intensive land-use with grass-dominated vegetation on shallow peaty soils in which acidophiles such as *Succisa* were well represented. Interestingly, *Centaurea nigra* (Knapweed) is also consistently recorded. This plant is a grassland species that is favored by meadowing and infrequent burning (Grime et al. 2007). Within the Irish context, it is recognised as a diagnostic species of meadow communities (cf. Centaurio-Cynosuretum association; White and Doyle 1982). The evidence for cereal cultivation is weaker than in subzone BAR1-2b (occasional cereal-type pollen and few pollen of weeds associated with arable activity).

The age-depth model suggests that this phase of intensive, mainly pastoral-based farming activity ended shortly before A.D. 1500. The decline may be connected with increasingly unfavorable conditions as the climatic downturn associated with the Little Ice Age became more pronounced. The adverse effects of the Elizabethan wars of the late 16th century (also inheritance disputes within the local O'Sullivan Beare clan) were probably much more serious and are known to have impinged greatly on farming in southwestern Ireland (Feehan 2003:84–85).

Zone BAR1-4; -32 to -44 cm (c. A.D. 1450–1750). Compared with the previous zone, this zone shows a small increase in *Corylus* and *Salix* and a decline of *c.* 10% points in Poaceae. The main change, however, is an increase in bog/heath taxa such as *Calluna*, *Erica tetralix*, and especially *Myrica*, which attains 38% (based on TTP+bog taxa). These changes, and in particular the expansion of *Myrica,* may have been facilitated by increased availability of suitable habitat as a result of bog expansion and a reduction in farming activity that led to less firing of the vegetation. *Ulex* (pollen not differentiated to specific level) is recorded throughout and is best represented in the two lowermost spectra (Fig. 3). The decline in grazing pressure at the beginning of the zone may have favoured the spread of furze, i.e., *U. europaeus* and *U. gallii*, both of which are common at local and regional levels today (see Discussion).

Zones BAR1-5 and 6; -47 to -54 cm (c. A.D. 1750–mid 1900). The secondary rise in *Pinus*, reflecting pine planting in the wider region, is recorded at -51 cm while other AP curves are at their lowest for the profile. The peak in *P. lanceolata* (27%) at the base of the zone suggests that plantain grew locally, presumably in a grassland context, and in considerable abundance. Ericoids were important at least locally (cf. *Calluna* and *E. tetralix;* pollen and epidermal fragments of *E. tetralix* seed well represented; Fig. 4). Cereal-type pollen are few but, on the other hand, pollen of arable weeds and disturbed habitats achieve highest representation (though still modest; Fig. 3).

Zone BAR1-5 corresponds with the period of greatest population pressure and highly intensive land-use that involved widespread potato cultivation. Here, as in other parts of western Ireland, potato cultivation was mainly in ridges. In the study area, cultivation ridges are generally below 160 m asl and there are no indications that the potato was cultivated at this relatively high elevation (*Solanum tuberosum* has poor pollen production and dispersal, and is seldom recorded in pollen profiles). Single *Cannabis/Humulus*-type pollen were recorded in the two spectra in zone BAR1-5, i.e., dating to the 19th century. *Humulus* (hop) and *Cannabis* (hemp) are regarded as introduced to Ireland (Preston et al. 2002, Webb et al. 1996), and both plants are rare in the present-day flora (Preston et al. 2002). Unfortunately, distinction of the pollen of these two species is difficult (it has not been attempted here), especially if occasional grains only are present (cf. Dörfler [1990] for a critical review of the history of *C. sativa* cultivation in Europe). The possibility that *C. sativa* is represented is quite likely, though local cultivation cannot be assumed given that single grains only were recorded. Production of hemp fibre in Britain and Ireland assumed considerable importance, particularly in the Napoleonic period (Edwards and Whittington 1990, Feehan 2003:164). Hemp cultivation, however, was never important in southwestern Ireland (Dickson 2005:205), which contrasts with parts of central and eastern Ireland, where there is pollen evidence for hemp growing in medieval times (Parkes and Mitchell 2000, Weir 1995).

In the uppermost spectrum there is increased Poaceae, and *P. lanceolata* declines further. This probably reflects changes in vegetation (both near the site and the study area in general) as the farming population and activity decline from the second half of the nineteenth century onwards.

BAR2 (Trench 2)

Two pollen samples are available from the basal peat of a short monolith taken beside what appears as a minor stone wall that was sectioned in Trench 2 (Table 1). As in the case of all walls investigated, this wall rested on mineral ground that, at the sampling point, was relatively level.

Stratigraphy. Four layers were distinguished. Layer 1 (0 to -4.5 cm) rested on organic-rich mineral soil. It consisted of highly decomposed (80%), dark brown/grey peat, with charcoal and considerable mineral matter, including small stones, fine sand, and silt. Layers 2 (-7.5 to -4.5 cm) and 3 (-16 to -7.5 cm) consisted of dark peat with charcoal, peat in the latter being less decomposed but darker due to higher charcoal content. Layer 4 (-16 to -55 cm) consisted of brown fibrous peat that constituted the rooting zone of the present-day, *Molinia*-dominated rough grassland.

Chronology and paleoenvironmental reconstruction. Two pollen spectra and AMS ^{14}C dates from the same levels within layers 1 and 2 are presented in Figure 5. The ^{14}C dates suggest that peat accumulation was initiated by the 5th century A.D., and the pollen spectra probably relate to the late 5th/early 6th and 7th centuries A.D., respectively.

The pollen data suggest a more or less completely open landscape, at least at the sampling site. AP decreases from 16% to 10%, which suggests that woody vegetation, initially scarce, declined further. *Betula* is best represented (8% and 4%), but given its high pollen productivity and dispersal capacity, birch was probably not important, at least locally. *Ulex*, on the other hand, is well represented, especially bearing in mind its poor dispersal properties. It is assumed that furze (probably both *U. gallii* and *U. europaeus*) grew locally. High *P. lanceolata* values (*c.* 8%), combined with high Poaceae, suggest that grasslands with much ribwort plantain were locally dominant. The upper spectrum, where *Calluna*, *Succisa*, and *Jasione* are well represented, suggests an increase in heathy vegetation in the vicinity of the site.

Indications of arable farming are weak. A few cereal-type pollen (3 in all; size range 40–44μm) were recorded. While classified as cereal-type pollen, derivation from non-cultivated grasses cannot be excluded (cf. Behre 2007, O'Connell 1987).

From a biogeographical/floristic viewpoint, the records for the filmy ferns, *H. wilsonii* and *H. tunbrigense*, and *Euphorbia* (presumably *E. hyberna*) are noteworthy.

BAR3 (Trench 3)

A short monolith BAR3 was removed from beside a substantial, well-constructed wall that runs more or less parallel to the local contours. The wall is close to the eastern, upper limit of well maintained and reasonably fertile grazing land (in view of the elevation) where *Molinia* tussocks on shallow peat form a conspicuous feature. Other typical species include *Juncus acutiflorus, J. squarrosus*, *Pinguicula* (probably both *P. grandiflora* and *P. vulgaris*), *Anagallis tenella*, and *Potentilla erecta.*

The short monolith that was investigated was removed on the uphill side of the wall where the

deposits were much thicker than on the downslope side. A description of the lithology, which showed substantial lateral variation, follows (cf. Fig. 7). The basal layer (above the stony mineral soil) consisted of a relatively thick colluvium (*c.* 20 cm). This stone-free, silt/clay layer is regarded as the result of downwash of fine mineral material from the relatively steeply rising ground upslope of the wall. Above this base was a silty peat layer that was overlain by dark, charcoal-enriched peat. This layer was followed by a fibrous peat that included the rooting zone. In all, there was 56 cm of peat; the pollen record relates to the lower part (-38 cm downwards).

Two AMS ^{14}C dates (mainly *Juncus* seed) and one conventional ^{14}C date are available from the lower part of the profile. The alkali-solvent fraction was also dated in the case of the latter (**Supplementary Table S1** available online at http://dx.doi.org/10.1656/J080427.s1). This fraction gave a considerably older date than that derived from the humin fraction. The alkali extract (conventional date) and the AMS ^{14}C date from a sample immediately beneath are, however, in agreement and so are accepted as a good indication of age. The base of the colluvium is regarded as dating to *c.* 1600 B.P., i.e., the 5th century A.D. Colluvium accumulation was probably connected with wall construction and associated farming. Downslope erosion appears to have led to relatively rapid accumulation of a mineral-rich deposit (*c.* 20 cm in about a century). The uppermost part of the pollen profile (zone BAR3-3) probably extends into the early part of the 2nd millennium A.D. Given the limited number of ^{14}C dates, the time intervals as given below should be regarded as broadly indicative only.

Palaeoenvironmental reconstruction

Zone BAR3-1; -2 to -20 cm (c. A.D. 400–600). This zone is dominated by monolete spores (fern spores without perine), Poaceae, Cyperaceae, and *Calluna* (Figs. 6 and 7). As the deposit arose mainly by soil erosion, it is likely that pollen within the eroding soil has made a considerable contribution. The high values for monolete spores is indicative of differential preservation of decay-resistant fern spores which should also be taken into account in the interpretation.

The low AP (9–16%) indicates open landscape though some trees/tall shrubs were probably still locally present. The consistent records of spores of the filmy fern, *H. wilsonii*, and also occasional records of *H. tunbrigense*, support the idea of local woodland, though the former species, which generally has wider tolerance, can be found today in favourable micro-habitats within the local heath communities (see Description of the Study Area).

Low shrubby vegetation included *Ulex*, which is presumably under-represented in the pollen

record. The relatively high values for *Calluna*, Cyperaceae, *P. lanceolata,* and high NAP diversity, as well as abundant *J. effusus/conglomeratus* seed, suggest a mixture of heath and wet grasslands. Cereal-type pollen were not recorded and pollen of weeds indicative of arable/disturbed ground are rare. Soil erosion may have had natural causes (severe rains, frosts, etc. occurring in the context of a sloping terrain), but overgrazing, leading to poaching of the soil and sparse vegetation cover, may also have contributed.

Zone BAR3-2, -23 and -27 cm (c. A.D. 600–900). A sharp change in several pollen curves registers in this zone. Monolete spores have greatly reduced representation, and there is an increase in Poaceae, *P. lanceolata,* Cyperaceae, and *Potentilla*-type. The lithostratigraphy also changes. Highly minerogenic deposits give way to brown, silty peat, and ash values are accordingly lower (Fig. 7).

Some of the changes in pollen representation, and especially the lower values for monolete spores, are explainable in terms of greatly reduced minerogenic soil erosion. The decline in AP is probably attributable to less woody vegetation at both local and regional levels. The exceptionally high *P. lanceolata* values (average: 19.3%) and the diverse herb pollen flora (cf. *Ranunculus,* Liguliflorae, and *Filipendula)* suggest species-rich grasslands with a decidedly acidic element (cf. *Potentilla*-type and *Succisa*). The *Calluna* and Cyperaceae pollen probably derive from bog vegetation at the sampling site (cf. *Carex* utricle at -23 cm) and also the surrounding area. A *Rubus* fruit stone at -23 cm suggests local presence of brambles, perhaps in association with the wall. A single cereal-type pollen grain (*Secale*) was recorded at this level. Rye cultivation is assumed, though not necessarily at this elevation, given that rye has good pollen dispersal.

Zone BAR3-3, -31 to -38 cm (A.D. 900–1300). In this zone, Poaceae and Cyperaceae dominate and AP representation does not exceed 6.4%. This representation suggests a more or less treeless landscape. The three lower spectra derive from a dark and charcoal-rich peat, which suggests frequent burning at and/or near the sampling site. The fires may be natural, but purposeful firing (also loss of peat through burning) cannot be excluded (see below). Substantial values for *P. lanceolata* and other NAP taxa, normally regarded as indicative of pastoral farming, suggest continued farming activity, though likely of a different character—probably less intensive—to that recorded in the previous zone. The bog taxa indicate distinctly wetter conditions (cf. *Narthecium* curve, high *Potamogeton* values in the uppermost spectrum, and also low

Calluna values; records also for the microscopic alga *Botryococcus*), which are somewhat unexpected given the evidence for burning. Burning, however, probably took place during dry spells as is usually the case today.

Occasional cereal-type grains (a *Secale* pollen at -31 cm; other cereal-type pollen were within the size range 40–49μm) are indicative of arable farming, but given the low representation and the infertile soils, the cereals may not have been growing locally. Interestingly, the limited macrofossil evidence relating to the medieval period for Cork and Kerry suggests that barley and oat were the main crops, while rye and wheat, though often recorded, were never abundant (Monk et al. 1998).

BAR4 (Trench 4)

The sample (10 cm of basal peat), taken from beside a large stone that rested at an angle against the small stones that constituted a well-defined wall, consisted of dark brown, highly decomposed peat with fine charcoal and mineral matter that included gravel and silt.

A 1-cm thick sample from -2 cm was prepared for pollen analysis and an AMS ^{14}C date, based mainly on fine charcoal and *Juncus* seed, was obtained from the same level. The ^{14}C date (1125 ± 90 B.P.) suggests that peat accumulation began in the mid-medieval period (*c.* A.D. 900; note: the age range is large, i.e. A.D. 781–994, 1σ range). There is also a ^{14}C date, 1610 ± 40 B.P., based on charcoal from a pre-wall context (A.D. 409–533, 1σ range; median age: A.D. 464; W. O'Brien, Department of Archaeology, Univeristy College Cork, Cork, Ireland, pers. comm.).

The pollen spectrum indicates a completely open landscape (AP only 7%; Fig. 5). Poaceae dominate, but interestingly, *P. lanceolata* is rather low. Some of the Poaceae pollen may derive from *Molinia,* a common grass of blanket bog and heath (cf. also *Succisa* and *Jasione*, both acidophiles).

Two cereal-type pollen (40–44 μm and ≥50 μm) were recorded, but other taxa indicative of arable activity are poorly represented. Arable farming cannot be excluded, but if part of the farming economy, it was not important locally.

BAR5 (Trench 5)

The sampling site BAR5 lies *c.* 35 m distant and uphill from a *fulacht fiadh* (Site C). The context of Trench 5 is a modest-sized, stone wall in shallow peat that runs diagonally downslope towards a small stream. The mineral ground on the downhill side was much higher than that on the uphill side, which was unexpected and not readily explainable. The basal peat and immediately underlying mineral soil in a crevice between stones on the uphill side

were sampled (BAR5-1). The sample included the mineral soil—mineral-rich (fine sand/silt), brown, highly decomposed peat (5 cm)—and a *c.* 1-cm thick layer of charcoal-rich, highly decomposed peat.

A large flat stone—part of the pre-bog wall—was removed, and the mineral-rich soil (mainly fine sand/silt, organic content low) under the stone was also sampled (BAR5-2). This is assumed to represent the pre-wall soil.

Samples as follows were prepared for pollen and AMS ^{14}C dating (mainly fine charcoal; a few *Juncus* seeds; **Supplementary Table S1** [available online at http://dx.doi.org/10.1656/J080427.s1]). From BAR5-1, pollen samples and sievings for AMS ^{14}C dates were prepared from 1-cm thick peat samples from -1 cm (BAR5-1-1), i.e., immediately above mineral ground, and from -6 cm (BAR5-1-2); from BAR5-2, an AMS ^{14}C date was obtained from material sieved from a 2-cm thick slice of mineral soil to obtain a *terminus post quem* for wall construction.

The ^{14}C dates (Fig. 5; **Supplementary Table S1** [available online at http://dx.doi.org/10.1656/J080427.s1]) suggest that wall construction at this site took place after *c.* A.D. 400 (1650 ± 60 B.P.), while peat growth commenced more than two centuries later (mid-7th/8th century), i.e., somewhat later than at BAR2, but probably earlier than BAR4.

The two pollen spectra indicate an open, treeless landscape as peat was initiated and began to accumulate. As at BAR4, *P. lanceolata* is rather poorly represented, but Poaceae and Cyperaceae values are high. This finding, and the relatively strong *Filipendula* representation, suggest that wet grassland prevailed locally.

Results and Interpretation – Bog Core, BAR-L1

The results for core BAR-L1 are presented as follows: an age/depth curve in Figure 9, and pollen diagrams, including macrofossil records and the results of ashing, in Figures 10–12. Details regarding ^{14}C dates are given in **Supplementary Table S2** (available online at http://dx.doi.org/10.1656/J080427.s2).

Stratigraphy

The main stratigraphical features of core BAR-L1 follow (details in Overland and O'Connell, in press). The basal peat was quite woody (261–140 cm). Dark peat, enriched with fine charcoal, was conspicuous between 140–136.5 cm and 133–113 cm; sand was obvious in ashed samples from the latter levels. Above 113 cm, the peat was paler brown and more or less wood-free. The most pronounced charcoal-rich layer (dark peat) was at 86.5–82.5 cm, and a fairly sharp transition to poorly decomposed fibrous peat

(rooting zone) occurred at 22 cm. A medium-sized stone (*c.* 5 cm) was recovered from *c.* 80 cm while digging out the core.

As regards mineral content, the basal sample from the organic-rich mineral soil has, as expected, a high ash value (77%; Fig. 12). Samples 248–244 cm also have elevated values (average: 11%), which presumably reflects input of mineral matter from the surrounding mineral soils (peat was presumably only occupying the deepest part of the basin at this time). From 144 cm upwards, ash values are substantially higher (13.4% vs. 5.7% in the interval 244–148 cm). Particularly elevated values were recorded between 68 and 41 cm (average: 22.5%; sand noted between 82.5–22 cm).

Chronology

The ^{14}C dates are consistent and in line with expectations and so have been accepted. To obtain single points for plotting the age-depth curve, the median probability of each ^{14}C date, as given by the calibration program Calib 5.0.1, was used. In constructing the age-depth curve, the depth 16 cm was assigned the date A.D. 1850 (2nd rise of *Pinus* well established), and the top of the core was regarded as dating to A.D. 2000. The age/depth relationship was obtained by fitting a curve using EXCEL, the add-in XlXtrFun.xll (Scott Allen Rauch, Advanced Systems Design and Development 1993–1999; www.xlxtrfun.com/XlXtrFun/XlXtrFun.htm) and, from this add-in, the function INTERPOLATE (linear). This procedure gives a curve that passed through each dated point and smooths out changes at either side of the points (Fig. 9).

Macrofossil data

Most of the sievings from the pollen samples yielded *Juncus* seed (seed with epidermal cells were identified as *J. conglomeratus/effusus*), especially in the lower part of the core (Fig. 12). Small woody remains (cf. *Betula*) were noted in several samples between 257 and 112 cm and from higher levels only in the interval 55–58 cm. Twigs were microscopically identified as *Betula* from 256, 245, 209, 195, 181, 167, and 55–58 cm (the last mentioned was a sample taken for AMS ^{14}C dating; otherwise, wood was noted during subsampling), and *Alnus* and *Fraxinus* twigs were recorded from 226 and 114 cm, respectively (Fig. 10). A sample from 105 cm, which was sieved to obtain macrofossils for ^{14}C AMS dating, yielded a variety of identifiable remains (detailed in description of zone BAR-L1-4 below; Fig. 12). Other interesting records include *Sphagnum* leaves (including *S. papillosum*) at 136, 112, 60, and 41 cm, leaves of the woodland moss *Thuidium tamariscinum* at 232 cm, and *Rubus* fruit stones at 224, 204, 144, 136, 112, and 105 cm (Figs. 10 and 12).

Paleoenvironmental reconstruction

The basin where core BAR-L1 was taken is small (*c.* 40 m diameter), and so the pollen profile is expected to be local in character. How local is difficult to say as there are potentially several influencing factors, especially filtering effects if a fringing carr community—usually involving alder, birch, and willow—was present. The various pollen components are also expected to reflect different source areas, the pollen of trees and tall shrubs being derived from a wider area than that of the herb component, which has more limited dispersal capacity. In general, it is likely that a profile such as BAR-L1 reflects predominantly the vegetation within a relatively small area with a radius not greatly exceeding 100 m.

Where bog and heath development in the overall landscape is of primary interest, the difficulty of determining whether the pollen of bog taxa derive mainly from the basin itself or the surrounding landscape is particularly acute. Poaceae pollen, for instance, which are normally regarded as indicative of grassland, may arise from mire grasses such as *Molinia*, which is a common species of blanket bogs. In comparable peat profiles from Brittany, van Zeist
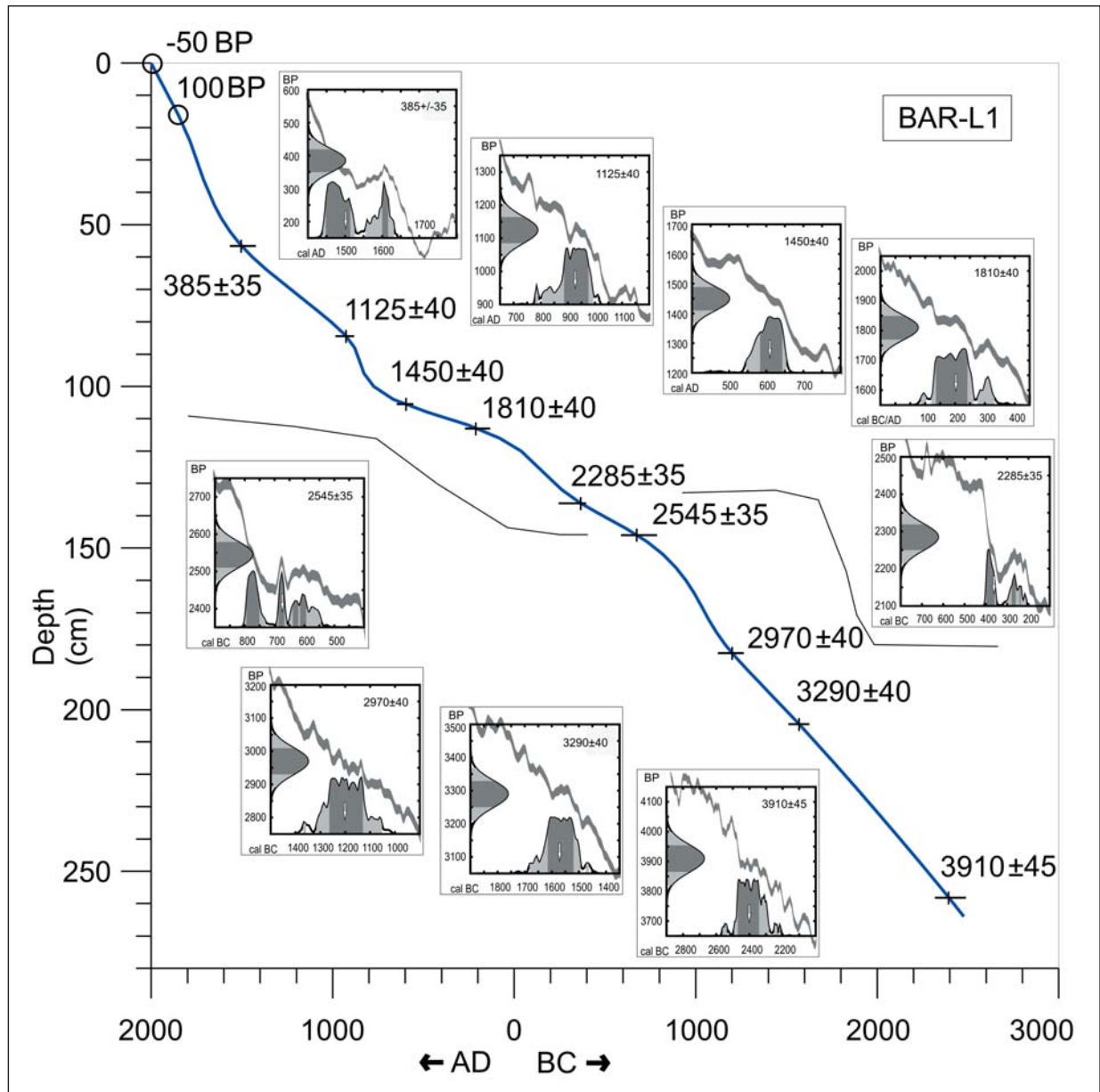

Figure 9. Age/depth curve for BAR-L1. Radiocarbon dates (horizontal line indicates 1σ range; vertical indicates median age) are plotted on an A.D./B.C. age scale. The point marked 100 B.P. is an estimated age based on the secondary rise in *Pinus*. The present surface is assigned the date -50 B.P. (A.D. 2000). Calibration curves (produced by Calib ver. 5.0.2) for each ^{14}C date are indicated as follows: the relevant part of the ^{14}C calibration curve, probability curves for the ^{14}C date, the calibrated date (shading indicates 1 and 2σ probability ranges), and the median probability (arrow) used to construct the age/depth curve.
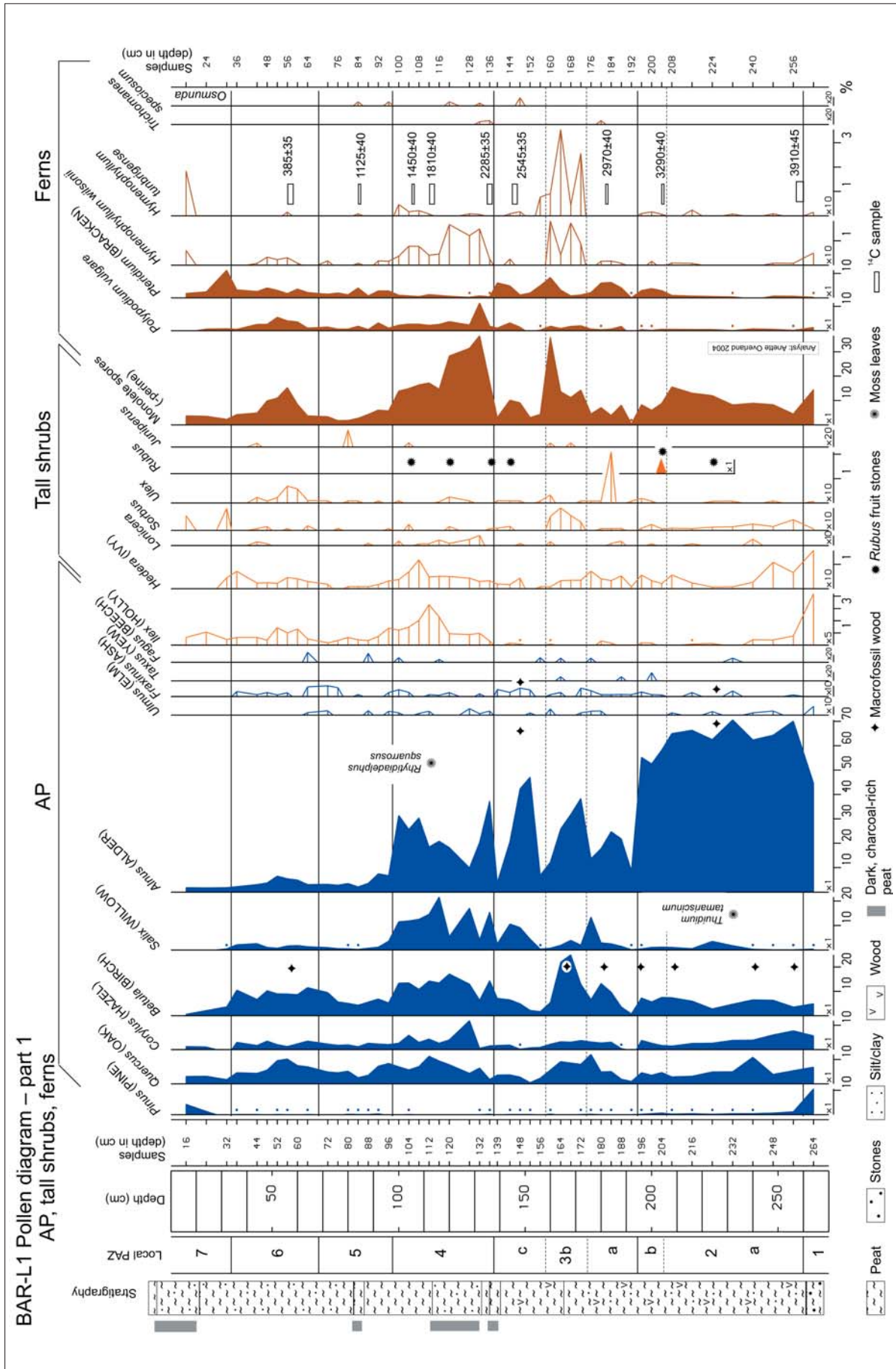
Figure 10. Profile BAR-L1: percentage pollen diagram from peat basin (AP, tall shrubs, and ferns) and macrofossil records.
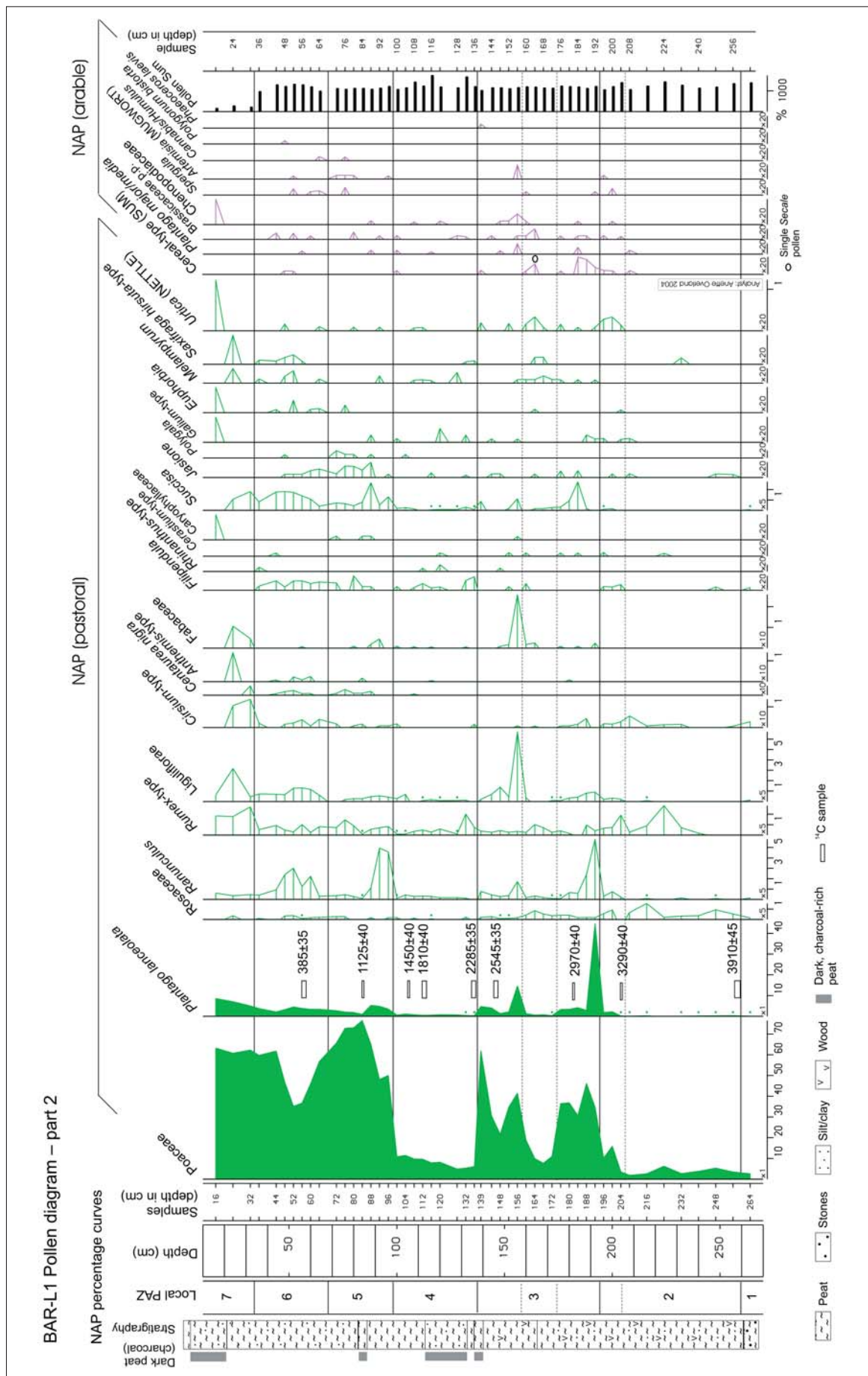
Figure 11. Profile BAR-L1: percentage pollen diagram from peat basin (NAP).
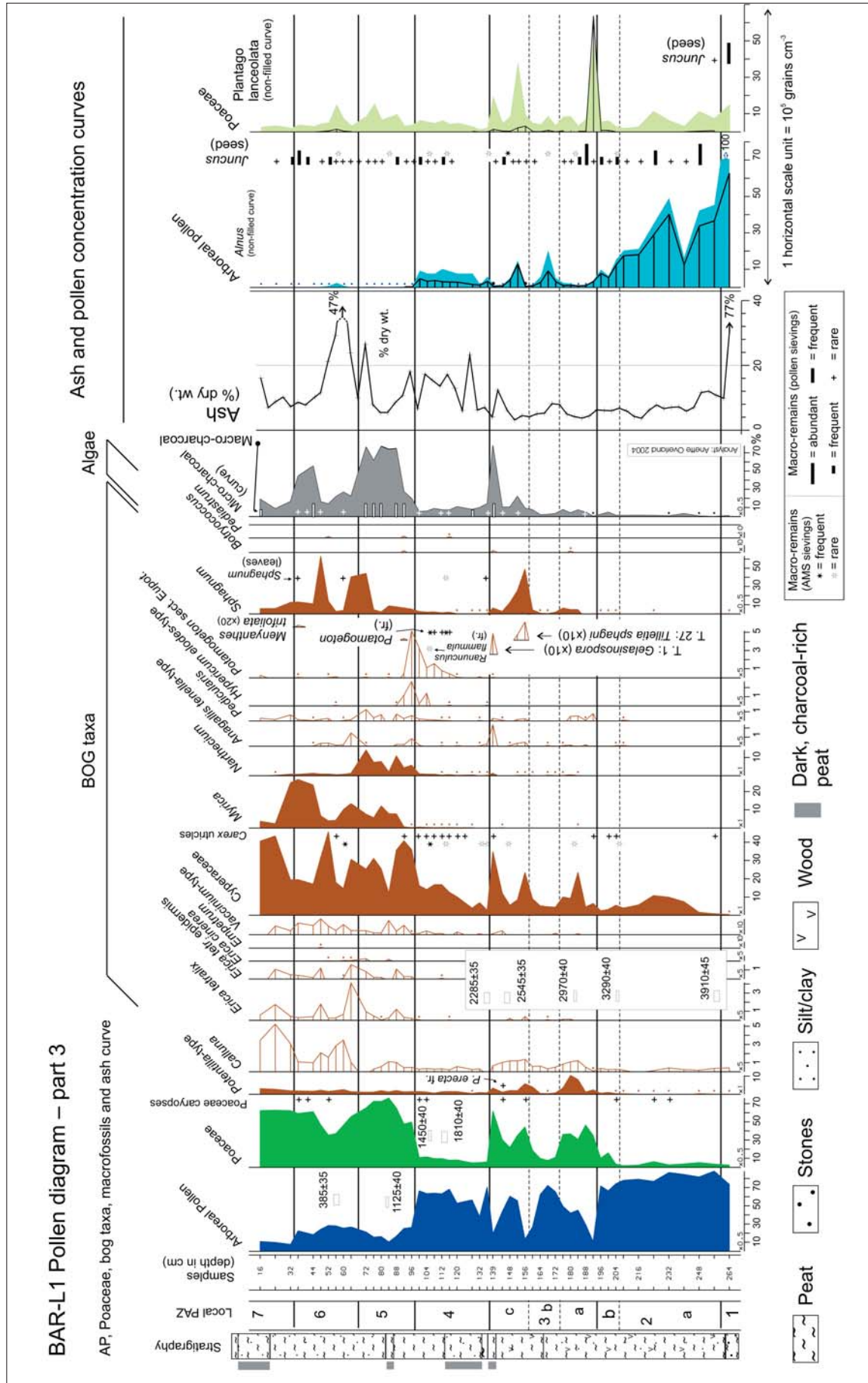
Figure 12. BAR-L1: percentage pollen diagram from peat basin (bog taxa), ash curve, selected pollen concentration curves, and macrofossil records.

(1964), for instance, estimated that as much as 50% of the Poaceae pollen derived from grasses growing on the bog. In such instances, *P. lanceolata* and other NAP taxa, especially the composites (Liguliflorae, Tubuliflorae) and some Fabaceae (e.g., *Trifolium*), are therefore important indicators in that these represent species that are more or less exclusively confined to grasslands on mineral ground.

Zone BAR-L1-1 (spectrum 264 cm; c. *2500 B.C.).* Arboreal pollen is at 74% and consists mainly of *Alnus* (45%; Fig. 10). This spectrum suggests a wooded landscape (cf. low values for farming indicators including *P. lanceolata*) at least about the basin. Alder was the dominant tree, and most of the other tall canopy trees—e.g., pine, oak, and hazel—though not abundant, were well represented, as was holly. The filmy ferns, *H. wilsonii* and *H. tunbrigense*, were presumably part of the fern-rich woodland flora (see also Discussion).

Zone BAR-L1-2 (spectra 256–196 cm; c. *2400–1400 B.C.).* The main feature is high representation of *Alnus* (average 63%). The decline in *Pinus* from 11% to 1% across the lower zone boundary is also noteworthy. Subzones 2a and 2b (the boundary between these subzones dates to shortly after 1600 B.C.) are recognised on the basis of somewhat lower *Alnus* values and an increase in several NAP curves, e.g., Poaceae, *Urtica*, and cereal-type, in subzone 2b (Figs. 10 and 11).

The decline in *Pinus* suggests that the pine population was greatly reduced at least in the vicinity of the site. In the lake profile, BEG1, *Pinus* is also in decline, but values of generally more than 10% persist until *c.* 1900 B.C., and the subsequent decline is slow and gradual (Fig. 13). High *Alnus* values indicate that alder was the dominant woodland tree, but oak, hazel, and birch also contributed to the local woodland composition.

The peat in this zone had considerable quantities of wood—mainly *Betula* twigs and *Alnus* at 226 cm (Fig. 10)—so it is assumed that both birch and alder grew on peat within the basin. In the lowermost sample from subzone 2b (204 cm), *Rubus* achieves 5.6% and local presence of *R. fruticosus* agg. is confirmed by a fruit stone in the sievings from the pollen sample. *Rubus* fruit stones were recorded in six samples in all—between 224 and 104 cm (Fig. 10)—which suggests that bramble was frequently present during this interval on or near the edge of the mire.

In the period *c.* 2400–1600 B.C. (subzone 2a) NAP, including *P. lanceolata*, have low representation. There appears to be little human activity, at least in the vicinity of the basin. Shortly after *c.* 1600 B.C., i.e. in the mid-Bronze age, there are several indicators of local human impact such as a marked increase in NAP—especially Poaceae, *P. lanceolata* (from 0.2% in subzone 2a to 2% in subzone 2b; average values cited), and cereal-type—and weeds

of disturbed habitats/arable crops are well represented (Fig. 11). Ash content is somewhat elevated (Fig. 12), probably due to erosion of mineral soil. The overall evidence clearly points to pastoral and arable farming in the vicinity of the basin.

Zone BAR-L1-3 (spectra 192–139 cm; c. *1400–400 B.C.).* In this zone, AP values are greatly reduced (mainly due to much lower *Alnus* representation), but oscillate considerably (hence three subzones of more or less equal duration), and NAP values are generally high, especially Poaceae and *P. lanceolata*.

Subzone 3a (*c.* 1400–1050 B.C.) reflects a particularly intensive phase of farming activity (cf. *P. lanceolata* peaks to 45%) and woodland clearance. *Alnus* declines from 55% to 9% as the subzone opens; this decline is presumed to be the result of clearance of alder-dominated woodlands. Large cereal-type pollen are well represented (seven, two, and three pollen in size categories 40–44, 44–49, and ≥50 μm, respectively), so it is assumed that these derive from cereals rather than non-cultivated grasses.

The bog pollen taxa (Fig. 12) suggest that the basin supported typical blanket bog vegetation for the first time (cf. Cyperaceae, *Sphagnum*, *Calluna*, *Pedicularis, Narthecium*, and *Anagallis tenella;* Fig. 12). The decline in ash content may be the result of a shift away from minerogenic to more ombrotrophic conditions on the mire. Heath/bog vegetation was not yet, however, important in the landscape as a whole (see Discussion).

In subzone 3b (1050–850 B.C.), AP recover and especially *Alnus, Betula*, and *Quercus*. These changes, combined with a sharp drop in NAP (e.g., *P. lanceolata* declines from an average of 12% in the previous subzone to 0.8%), indicate a decline in farming, at least in the vicinity of the site. In response, woodland regenerated strongly. The substantial representation of the filmy ferns, *H. tunbrigense* and *H. wilsonii*, and fern spores in general (also *Sorbus*, the pollen of which is poorly dispersed) suggests that woodland extended close to the margin of the basin during this time. In the upper part of the subzone, there are indications once again of increased farming activity (increase in Poaceae and *Pteridium*; occasional cereal-type pollen [including a single *Secale* pollen], Brassicaceae, and *Artemisia*). Overall, however, there appears to have been low levels of farming near the basin in the later Bronze Age.

In subzone 3c (850–400 B.C.), high representation of Poaceae and *P. lanceolata*, especially at the beginning and towards the end of the subzone which coincides with low AP values, suggests intensive farming in the vicinity of the basin. Farming was decidedly pastoral but had a minor arable component (cf. pollen of weeds of arable habitats and spores
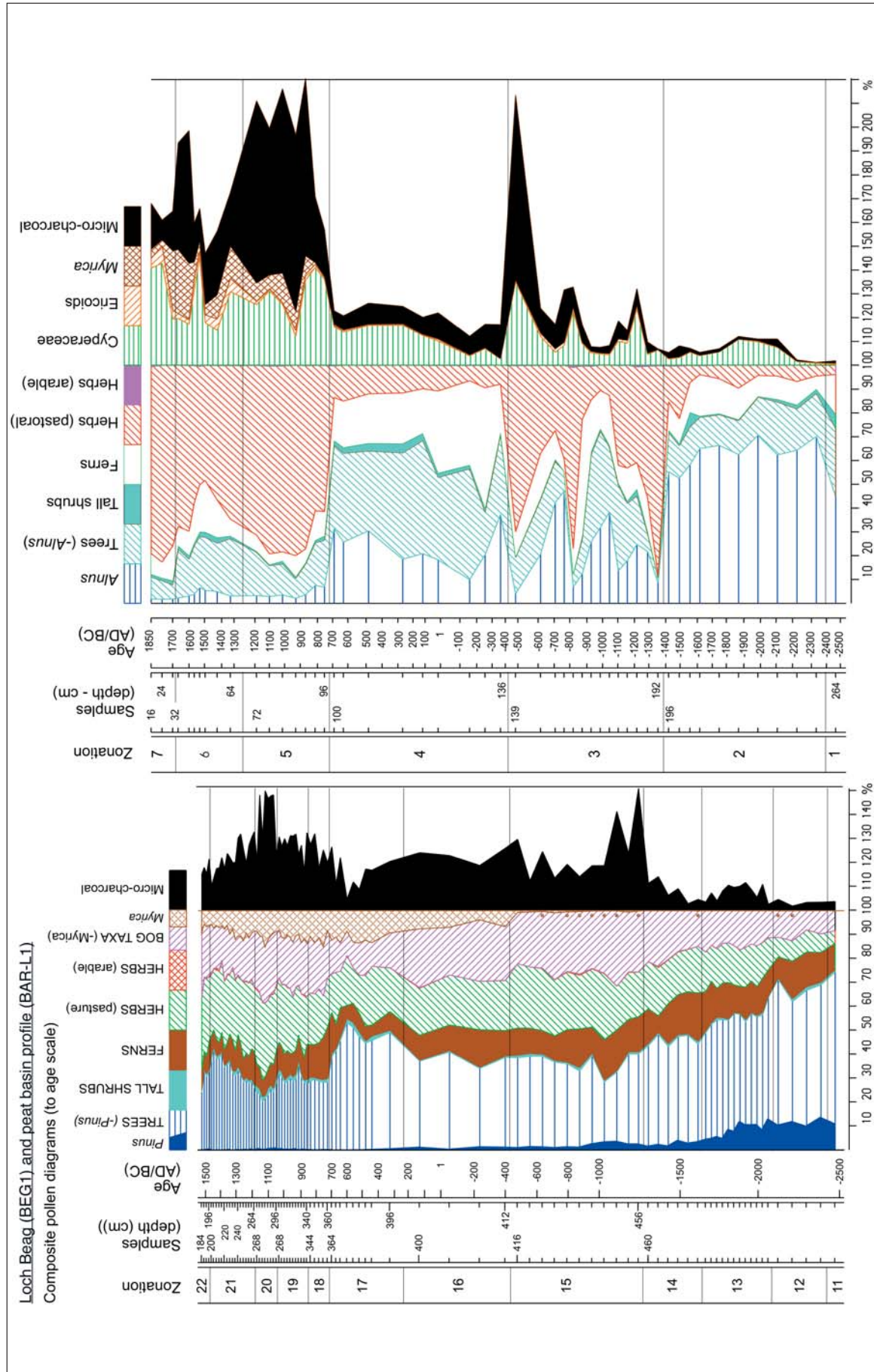
Figure 13. Composite percentage pollen diagrams: profile BEG1 from Loch Beag (upper part only) and BAR-L1 from the peat basin. The diagrams are drawn to a common calibrated timescale.

of the hornwort, *Phaeoceros laevis*, which are also indicative of arable activity; Fig. 11). Fires were probably common on the mire and the surrounding area and were probably man-made rather than natural (micro-charcoal values are high and macro-charcoal is well represented; Fig. 12). The peak in ash values towards the top of the zone suggests soil erosion, the result presumably of local farming activity.

In subzone 3c, the peat is less woody, which suggests that woody vegetation on the mire had become less important. This conclusion is also borne out by the strong representation of *Sphagnum* and Cyperaceae (also *Anagallis tenella*; Fig. 12). Substantial clearances in the catchment may have resulted in increased runoff and hence wetter conditions in the basin that favored these hygrophilous species.

Zone BAR-L1-4 (spectra 136–100 cm; c. *400 B.C.–A.D. 700).* This zone is characterised by relatively high AP and low NAP. Species-rich woodland, in which oak, alder, birch, and hazel had substantial roles, was important in the vicinity of the basin. The high *Salix* values probably reflect willow growing in or at the margin of the basin; alder and birch may also have been common in these situations. *Ilex, Lonicera* and ferns, including all three species of filmy fern (*H. wilsonii, H. tunbrigense*, and *T. speciosum),* were important (Fig. 10). Low NAP and especially *P. lanceolata* values suggest greatly reduced human activity. Ferns, including filmy ferns, were important probably in the woodlands on mineral soils and also within the basin.

The peat in the lower part of the zone (also top of subzone 3c) was dark due to much fine charcoal. In the upper part of the zone where charcoal is no longer obvious in the peat (no firing), the bog surface appears to have become much wetter and supported hygrophiles such as *Potamogeton* and *Hypericum elodes* (Fig. 12). The wetter conditions presumably contributed to a decrease in fire frequency on the peat surface. Ash values are relatively high (Fig. 12), which suggests substantial inwash. This inwash may be attributable to increased run-off rather than farming activity.

A macrofossil sample from near the top of the zone (105 cm; analysed to obtain material for an AMS ^{14}C date) yielded *R. fruticosus* agg. stones (5) and also *Carex* utricles (10), *P. polygonifolius* (10) and *R. flammula* (1) fruit, and *Juncus* seed. Apart from the *R. fruticosus* agg. stones, these records suggest locally wet conditions on the mire surface, a conclusion supported by the pollen evidence. In this part of the profile, *Rubus* pollen is unrecorded. The *Rubus* seed may have been carried onto the mire surface by a variety of means including birds.

The possibility that firing led to slowing down of peat growth, or even loss of peat and hence a hiatus in the lower part of the record, cannot be dis-counted. The age model indicates at least a slowing down of peat accumulation (Fig. 9). The particularly sharp changes in the pollen curves at the upper zone boundary might be regarded as indicative of a hiatus. However, there are several sharp changes at various points in the profile which support the idea that the profile has a strong local character and hence is not subject to an averaging/smoothing effect expected in a regional record that integrates pollen from a large area. A hiatus at the zones 4/5 transition or elsewhere in the profile is regarded as improbable.

Zone BAR-L1-5 (spectra 96–72 cm; c. *A.D. 700–1250).* The low AP values (average: 19%) suggest a more or less totally open landscape at least in the vicinity of the site. Oak, birch, and hazel were probably still common in the wider area. The vegetation surrounding the basin was dominated by grasses. Poaceae caryopses were not recorded in this interval (Fig. 12), which suggests that grasses growing in the basin are not the main contributors of Poaceae pollen. *P. lanceolata* is less important than might be expected given the high Poaceae values. Conditions were presumably not particularly favorable for ribwort plantain because of increasing soil podzolization and widespread peat initiation. Evidence for arable farming is weak. Cereal-type pollen are not recorded, but single *Cannabis/Humulus* pollen are recorded near the top of this zone and at the base of zone 6 (Fig. 11) and may reflect cultivation of *C. sativa* as a source of hemp, at least in the wider region (see BAR1–5 above). In most spectra, occasional pollen of plants indicative of a disturbed biotope were recorded, but these may have been associated with disturbed habitats other than arable situations.

Another notable feature of zone 5 is the increased representation of bog taxa. Cyperaceae representation is particularly high (*c.* 30%), substantial curves for *Narthecium* and *Myrica* are initiated, and *Sphagnum* peaks at the top of the zone. *Calluna* is poorly represented. Plants growing in the basin were probably the main contributors to these pollen taxa, though vegetation growing on the surrounding podzolised mineral soils and shallow peats was undoubtedly, by this time, contributing substantially to these curves. The high *Narthecium* values suggest that wet conditions prevailed within the basin. However, very wet conditions, as indicated by the *Potamogeton* and *Hypericum elodes*-type curves, ceased shortly after the zone opens. Subsequent to this shift, the curve for micro-charcoal expands and macro-charcoal is frequent (Fig. 12). The firing probably was part of the farming regime.

Zone BAR-L1-6 (spectra 64–36 cm; c. *A.D. 1250–1700).* In this zone, AP recovers somewhat, other woody taxa are well represented (*Ilex, Hedera*, and *Ulex*), but NAP continue to have high representation. It appears that farming declined somewhat

compared with the previous zone. This decline facilitated limited woodland regeneration in the general area and possibly also in the vicinity of the basin (at least shrubby vegetation, e.g., *Ilex* and *Ulex*). Particularly high ash values were recorded at the start of the zone, and sand lenses were noted in this part of the core. These findings point to considerable erosion of mineral soils. Interestingly, the high ash values coincide with increased *Quercus* and *Alnus* representation, which suggests that woodland regeneration was centered some distance from the basin, most probably at lower elevations where woodland remnants persist today. The mire itself continued to carry wet blanket bog vegetation, and *Myrica* expanded considerably towards the top of the zone. These findings, and the decline in ash values, suggest less intensive grazing.

Zone BAR-L1-7 (spectra 32–16 cm; c. *A.D. 1700–1850)*. In the two uppermost spectra, *Pinus* achieves 1.5% and 4.2%, respectively (it is at *c.* 0.1% for most of the diagram), while the other AP curves decrease or are unchanged. The increase in *Pinus* representation is presumably the result of widespread planting of Scots pine that was already well underway in eighteenth-century Ireland (Anon 1902, Dickson 2005: 173). At about the same time, a strong increase in population began, a development facilitated by widespread cultivation of the potato. This demographic shift led to greatly increased pressure on remaining woodland, and ultimately to more or less total woodland clearance as population peaked prior to the Great Famine (1845–47). The expansion of *P. lanceolata* suggests intensification of pastoral farming which probably also had a role in the decline in *Myrica*. Potato cultivation is assumed to have been important by the end of the zone, though this is not recorded (*S. tuberosum* is "silent" in pollen records). Failure to record cereal-type pollen suggests that cereal cultivation was unimportant, at least in the vicinity of the basin. The uppermost peat was not analysed because of the possibility of disturbance.

Results and Interpretation - Profile BEG1 from Loch Beag

The oldest record discussed above, BAR-L1, goes back to *c.* 2500 B.C., i.e., late Neolithic/transition to the Bronze Age. Profile BEG1 from Loch Beag, on the other hand, provides a detailed record that spans the Holocene, apart from the last five centuries (Overland 2007). Part of this record, which corresponds time-wise with the long peat core, is briefly considered here. To facilitate this, composite pollen diagrams for BEG1 and BAR-L1, drawn to a common timescale, are presented in Figure 13.

Like BAR-L1, BEG1, being from a small basin, is also local in character. Lake sediments have quite different characteristics compared with peat as a source for pollen records. Records from lakes may be complicated by factors such as sediment mixing at the sediment/water interface and focusing, whereby the lighter sediment fraction differentially moves to the deeper part of the basin (Blais and Kalff 1995). For this and other reasons, the pollen curves from lakes tend to be smoother, as is the case here. The presence of secondary pollen arising from soil inwash (due to farming activity and/or climate change) or reworking of marginal sediments (especially during periods of low lake levels) are further complications associated with lake sediments. In the present instance, for example, inwash during medieval times (*c.* A.D. 700–1200) has resulted in ^{14}C dates that are considerably older than expected. At these levels, secondary (redeposited) pollen is probably present, though the record does not seem to be seriously compromised (Overland 2007).

In lake profiles, bog taxa are included in the pollen sum because the pollen in question does not arise within the lake. In the case of peat profiles, the bog taxa, because of their predominantly local origin, are excluded to avoid these taxa unduly influencing the other curves (cf. interpretation of BAR-L1 above). It follows that the percentage curves for AP and NAP will be depressed *vis-à-vis* peat profiles as the contribution of bog and heath taxa increases.

Not surprisingly then, given the differences in location and deposit type and the associated taphonomic processes, there are substantial differences but also similarities between the records from the peat basin and Loch Beag (Fig. 13). During the early and mid-Bronze Age (*c.* 2500–1400 B.C.), AP dominate in both profiles, but the diversity of AP is much greater in BEG1 (the local woodland consisted mainly of oak, pine, and birch), while in the vicinity of the peat basin, alder dominates. At both sites, there is substantial opening up of the landscape in the later Bronze Age (1400–450 B.C.; part of the Iron Age may be included here), mainly as a result of pastoral farming that included an arable component. Profile BEG1 shows that expansion of bog also contributed to increased openness of the landscape, and a sharp increase in micro-charcoal suggests increased use of firing. The lake is rather distant from the nearest Bronze Age copper mine (site J, approximately 1 km to the south; Fig. 1d) and so it is unlikely that fires associated with this or other prehistoric mines in the wider region are reflected in either the lake or peat profiles.

In the interval 450 B.C.–A.D. 700, human activity is greatly reduced in the vicinity of the peat basin and there is also a reduction in activity in the vicinity of the lake, particularly at the end of the Iron Age and the beginning of the medieval period (*c.* A.D. 200–700). This shift facilitated a regeneration of birch and yew, and ash to a lesser extent (Overland

2007). In the vicinity of the bog basin, woodland regeneration involved mainly willow, birch (both probably predominantly at the margin of the bog), and oak.

At both sites, intensive human activity associated with the historical period began to register at *c.* A.D. 700. In the vicinity of the peat basin, most trees and tall shrubs were cleared in the context of mainly pastoral-based farming. A very intensive land-use phase, in which firing and mineral soil erosion (peat with conspicuous bands of sand) featured, lasted until close to A.D. 1200. After this, farming activity continued, but with somewhat lower intensity until about the early 1700s, when activity again increased in the context of a rising population. At Loch Beag, a similar pattern is recorded. Initially farming was more or less exclusively pastoral based, but by the late 9th century, cereal growing had become a distinct feature of the local farming economy, a situation that continued until the 16th century, i.e., the end of the lake record. Cereal-type pollen attained maximum representation between A.D. 1000–1200 when AP was also at its lowest—some of the AP is undoubtedly secondary due to inwash of "old" organic matter during this time—presumably due to local farming.

Discussion

Land-use, vegetation, and landscape change

The results from the short monoliths and the long peat core, BAR-L1, are summarised schematically in Figure 14. The sketches are drawn to a calibrated timescale, and the corresponding non-calibrated 14C timescale is also indicated. Woodland cover, which includes tall shrubs, is indicated as low, medium, and high, i.e., completely open, partially open, and a fully wooded landscape, respectively (same scale used for all profiles). In BAR-L1, intervals with well-defined cereal cultivation are indicated, with line thickness indicating relative importance. In the case of the short profiles, cereal cultivation is only indicated for BAR1. This representation should not be construed as connoting no cereal cultivation at/near the other locations; rather, it was not important in the local farming economy.

Periods when the mire surface in the basin supported vegetation indicative of very wet conditions are suggested (thicker line indicating wetter conditions). A particularly wet interval is indicated in BAR3.

In the case of the short monoliths, the following additional features are shown. On the right-hand side, a schematic drawing depicts the wall, the location of monoliths in the trench section, and where samples were taken for pollen analysis and 14C dating. The following, in addition to woodland cover, is shown on the left-hand side (on a common timescale): a schematic drawing of a wall shows the approximate date of wall construction, a rectangle shows the interval for which pollen data are available (PAZs indicated where appropriate), and a wedge is used to schematically depict initiation and growth of peat.

Other information provided includes the main cultural periods for Ireland and an age range for the main archaeological features recorded in the study area based on 14C dates derived from recent archaeological excavations (W. O'Brien, pers. comm.; details in O'Brien, in press).

The data, as summarised in Figure 14, indicate that the walls that have been archaeologically investigated were constructed in the first half of the first millennium A.D. The main oval-shaped enclosure (cf. Trench 1) pre-dates the linear walls by some centuries and was probably constructed in connection with other late Iron Age activity in the uplands (the circular stone-walled enclosure, i.e., Site A, being part of this activity). While the pollen data relating to the short monoliths, BAR2 to BAR5, indicate open landscape supporting mainly grassland and some heath, the profile from BAR1 suggests local presence of alder, even though pasture and some arable farming were being actively pursued locally. Surprisingly, the bog profile, BAR-L1, suggests that farming activity in the vicinity of the peat basin was quite subdued during most of the Iron Age (from 400 B.C.) and that low levels of farming activity continued into the medieval period (to A.D. 700). This scenario contrasts with substantial Iron Age farming that continued to the end of the 1st century A.D. at lower elevation (vicinity of Loch Beag) and also on slopes above the peat basin and especially in the immediate vicinity of the main enclosure (cf. BAR1, BAR2, and Site A). The main phase of wall construction took place during the late Iron Age/early medieval period (4th–5th centuries A.D.), while widespread peat growth began somewhat later (but prior to the 2nd millennium A.D.). It should be noted that the number of linear walls investigated is relatively small. On the basis of wall morphology and overall setting in the landscape, it is assumed that wall construction was broadly contemporaneous. The wall systems that are indicated in the first and later editions of the OS maps (walls are shown more or less exclusively at lower elevations where there is little or no peat growth) are probably of more recent origin, though an early date cannot be ruled out for at least parts of this system. Features such as field wall boundaries are conservative landscape elements and so undergo little change over time especially in liminal landscapes such as Barrees, a viewpoint supported by the close similarity between the situation at the time of the first OS (1842) and the present day.

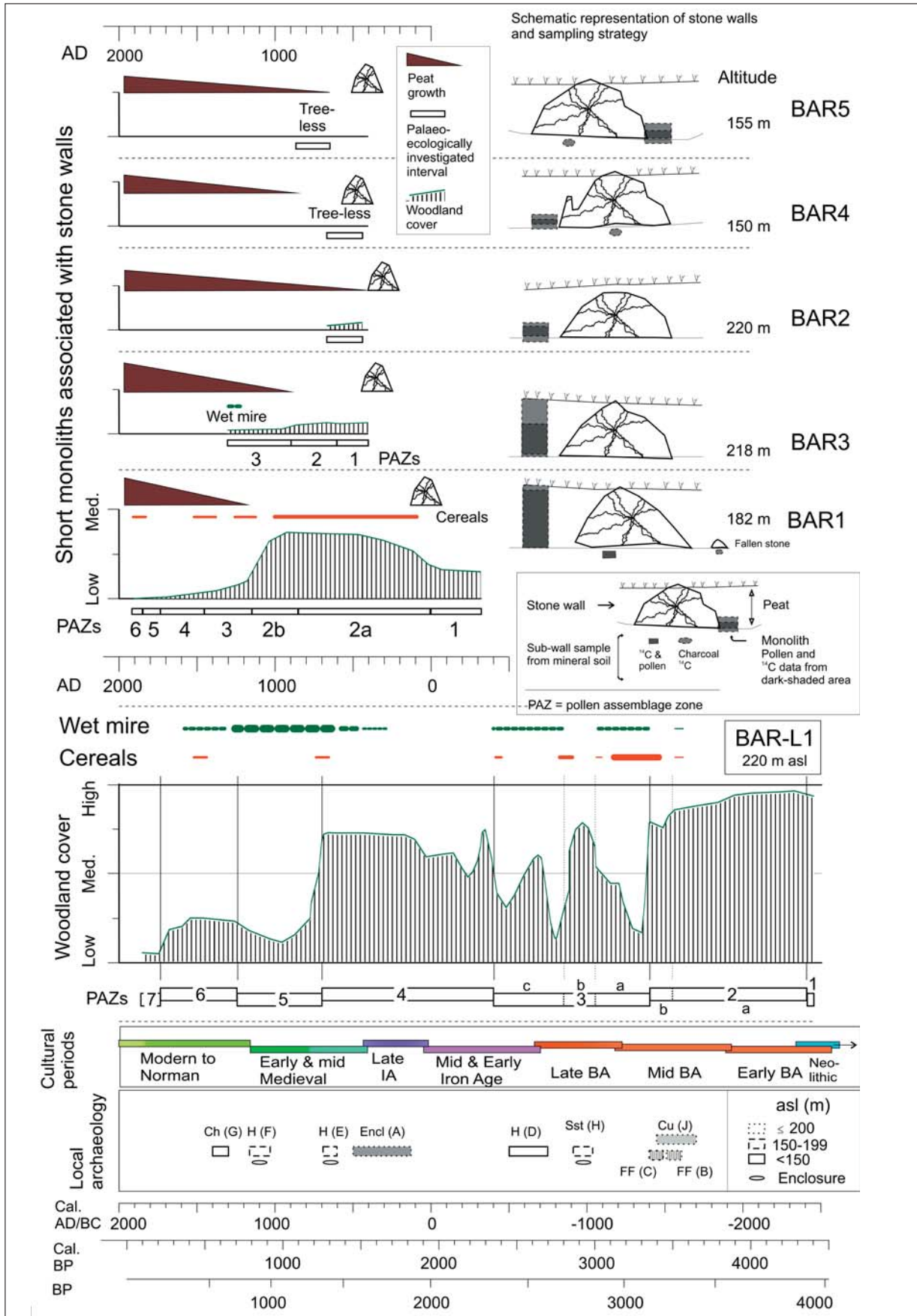Interestingly, the evidence from BAR-L1 indicates increasingly wetter conditions beginning

Figure 14. Schematic representation of main paleoecological data and archaeological information relating to the main study area, Barrees (see Discussion).

at, or shortly before, A.D. 500. This wetter period precedes, and in some instances coincides with, the initiation of peat growth in the vicinity of the walls that were trenched and sampled (cf. BAR2, i.e., the site at highest elevation). Farming and settlement in the uplands would be expected to have been favored by drier and warmer conditions in the late Iron Age (lake levels in Loch Beag appear to have been lower at this time). The cooler, wetter conditions that followed (cf. mire wetness at BAR-L1 as indicated schematically in Fig. 14), presumably favored peat initiation. The climatic deterioration associated with the Little Ice Age (c. A.D. 1300–1750) and also a general reduction in overall farming activity, and hence land management, also presumably favored peat expansion in late medieval times.

Floristic elements of biogeographical interest

Filmy ferns. Micro-fossil records of particular note include the filmy ferns, *H. tunbrigense, H. wilsonii*, and *T. speciosum*. Kerry and west Cork constitute the center of distribution of these ferns in a European context (EHSNI 2007; Jalas and Suominen 1972; Preston et al. 2002). *T. speciosum* has by far the most restricted distribution, the sporophyte stage being confined mainly to Ireland, where it is known from at least 30 sites (Ratcliffe et al. 1993; EHSNI 2007). In Europe as a whole, it has a pronounced hyper-oceanic southern distribution pattern, with the northernmost stations located in Arran and Kintyre, SW Scotland (Rumsey et al. 1999). The gametophyte generation on the other hand, which uniquely in the context of the vascular flora of Europe seems to occur independently of the presence of the sporophyte, is more frequent than the sporophyte and has a much a wider ecological amplitude and distribution (it has been recorded as far east as the Czech Republic; Kingston and Hayes 2005, Rumsey et al. 1998).

Attention here is focused on the sporophyte generation as this produces the spores that are readily preserved in the fossil record. Under present conditions, fertile fronds are rare in Britain and Ireland. Fertile fronds were noted in only four Irish colonies and one British colony by Ratcliffe et al. (1993), and only 5–10% of the fronds in these colonies were fertile. According to Page (1997:380), "the few fertile fronds are said to wither after spore discharge, which happens perhaps only in occasional dry summers." Spore production is therefore presumably very low, and given the main habitat in these islands—wet caves and rock crevices by waterfalls and cascades where there is deep shade—poor dispersal is also expected. The wider distribution pattern of the gametophyte points to some efficiency in spore dispersal. It should be borne in mind, however, that the gametophyte is perennial and is

capable of reproducing asexually by gemmae (Page 1997, Vogel et al. 1993), i.e., its presence is not necessarily attributable to, or dependent on, efficient spore dispersal. It is assumed that the sporophyte is strongly under-represented in pollen diagrams.

T. speciosum was recorded, mainly as single spores, in a single spectrum in subzone BAR-L1-3a (c. 1150 B.C.), in two spectra at the base of zone BAR-L1-4 (c. 350 and 250 B.C.) and also in two spectra in BAR1-2a (2nd half of first millennium A.D.). This filmy fern is known from several locations on Beara, all north of Eyeries (Preston et al. 2002). In the past, suitable habitat in Barrees would have been provided by local streams and cascades within the context of a more wooded landscape. Former local presence in the peat basin, for instance, cannot be excluded given that *T. speciosum* is known to occur as an epiphyte (though only one such occurrence has been reported) and also on peaty banks (Ratcliffe et al. 1993). Given that *T. speciosum* is probably very under-represented in pollen diagrams, postulating a local presence in the later Bronze Age and again in the mid- and late Iron Age on the basis of the available records seems justified.

As regards the *Hymenophyllum* species, local and regional presence for most of the period under consideration (from c. 2500 B.C. to the present) is not in doubt. Of the two species, *H. tunbrigense* is the more temperature sensitive, more shade tolerant, and has greater sensitivity to high radiation than *H. wilsonii* (Proctor 2003, Richards and Evans 1972). *H. tunbrigense* has a considerable scatter of stations in Ireland, but it is unknown from the midlands and mid-eastern Ireland. In Britain, it has a predominantly western distribution that does not extend to northern Scotland (the Isle of Skye is more or less its northern limit; Preston et al. 2002). It has isolated occurrences in continental Europe as far south as Italy (cf. Jalas and Suominen 1972, Muller et al. 2006). It appears to be at its optimum in the Killarney and Glengarriff woodlands, where it festoons the sides of shaded boulders within the oak woodlands and it is also frequent on the lower trunks of oaks. *H. wilsonii*, while less profuse than *H. tunbrigense* in the Killarney and Glengarriff woods, is more frequent in western Scotland. Its range extends to the Shetlands, Faeroe Islands, and western Norway as far north as Trondheim. Its continental European range, on the other hand, is limited to a few stations on the northwestern coast of France (Jalas and Suominen 1972).

As regards spore production and dispersal, much higher spore production (x2) in *H. tunbrigense* is probably more than offset by more frequent sori production in *H. wilsonii* (Richards and Evans 1972). Since the latter can tolerate more open conditions—for instance, it occurs locally within

heathland vegetation in Barrees (see Description of the Study Area)—spore dispersal is probably more efficient. Good dispersal undoubtedly contributes to the relatively high frequency of spores (but low percentage values) of *H. wilsonii* in Holocene pollen diagrams from western Ireland (published and unpublished diagrams, Palaeoenvironmental Research Unit, NUI, Galway, Ireland).

The microfossil data from the two long profiles, BAR-L1 and BEG1, are summarised in Figure 15. Informal intervals, based on levels of spore representation, are distinguished. In profile BEG1, the record begins in the Boreal (*c.* 7250 B.C.) with occasional spores of *H. wilsonii*. In interval 1, i.e., up to *c.* 3750 B.C. (Fig. 15), only two spores of *H. tunbrigense* were recorded. The Elm Decline marks the beginning of interval 2 and also the period of highest representation of both *H. wilsonii* and *H. tunbrigense* (though the latter remains less well represented than *H. wilsonii*; Fig. 15). Several factors may have been responsible, such as changing woodland dynamics (*Alnus* expands, *Ulmus*, which is a minor component, declines, and at the end of the interval *Taxus* expands). There is no evidence, however, for a Landnam-type clearance during this period, which extends over the greater part of the Neolithic. During interval 3, which spans the Bronze Age to the mid-medieval period (2250 B.C.–A.D. 1170), occasional spores of *H. tunbrigense* and *H. wilsonii* were recorded in only 18% and 38% of the spectra, respectively, while in interval 4 (extends to *c.* A.D. 1550) there are only occasional records (only one spore of *H. wilsonii* was recorded). It is assumed that the better representation of *H. tunbrigense* is connected with limited local regeneration of woodland during the last mentioned period.

In the BAR-L1 profile, both filmy ferns are fairly consistently represented throughout the profile, though *H. tunbrigense* is recorded in only three spectra from 96 cm upwards, i.e., from *c.* A.D. 700 (zones 5–7; Figs. 10 and 15). As in profile BEG1, *H. wilsonii* is generally more strongly represented than *H. tunbrigense*, though the latter achieves highest representation overall in BAR-L1-3b (216 spores per 10,000 AP). During subzone 3b and also zone 4 (1050–850 B.C. and *c.* 400 B.C.–A.D. 700), when *H. wilsonii* is particularly strongly represented, fern populations in general are favoured in the context of woodland recovery that followed a reduction in human impact. Degree of woodland cover, rather than climatic shifts, seems to be the main determinant of *Hymenophyllum* spore representation.

The overall stronger filmy fern spore representation in the peat as compared with the lake profile is noteworthy (Fig. 15). This difference is probably attributable to the very local character of profile BAR-L1 and the relatively higher AP representa-

tion in BEG1 due partly at least to its more regional character, though differences in spatial distribution pattern of the various tree species may also contribute. Where spore representation is consistent and high, local presence is assumed in the case of both profiles. Where there are only occasional records (and often single spores), there is less certainty. Given that these ferns are probably severely underrepresented in the microfossil records, low representation, however, is regarded as indicative of at least extra-local presence.

In the short profiles, the spores of both *Hymenophyllum* species are recorded in several spectra, particularly in the lower (older) parts of the profiles. The best representation is achieved in the basal part of BAR1 (first millennium A.D.), where spores of all three filmy ferns are recorded (for *T. speciosum* see above). Here, *H. wilsonii* has a continuous curve that includes values >1%. Local tree cover (mainly *Alnus*) was probably important in providing suitable conditions.

Given the frequency of the records for spores of the filmy ferns and especially *Hymenophyllum* spores, the present-day distribution of these ferns in the west Cork and Kerry regions, and the relatively large numbers of pollen diagrams, the paucity of fossil records is surprising. Some of the records may have gone unreported or simply have not been published (McDonnell 1991, Wolters 1996), but there is also the probability that the spores have gone unrecognised. Yet, there are several records of filmy ferns from interglacial deposits in Ireland (Gortian, which is generally regarded as equivalent to the Holsteinian; e.g., Jessen et al. 1959, Watts 1959), and an appreciation of the value of a good fossil record for understanding present-day distribution patterns is not wanting (cf. Coxon and Waldren 1997).

Myrica gale. Distinguishing *Myrica* pollen from that of *Corylus* is regarded as difficult and hence is often not attempted. We contend that it is possible to make the distinction on the basis of the criteria given in Fægri and Iversen (1989), descriptions by Mohr (1990), and consultation of modern reference material. Use of phase contrast during routine counting, as done here, is also helpful in that it enables surface features and pore structure to be more easily and clearly observed. It is important that the distinction be made, given the very different ecology and overall indicative value in the pollen record of *Myrica* and *Corylus*, and the possibility that, at many sites, *Myrica* makes substantial contribution to the *Corylus/Myrica* curve (also referred to, as Coryloid, especially in the older literature).

In the profile BEG1, *Myrica* pollen is consistently recorded from *c.* 1250 B.C., but remains below 1% until 400 B.C., when a sharp increase is recorded (Fig. 13) that suggests local expansion of

bog myrtle. Overall bog taxa representation does not increase greatly, which suggests that *Myrica* partly displaced, or at least overshadowed, other bog taxa. *Myrica* usually spreads by suckers and can produce dense thickets, especially in a sheltered situation where grazing pressure is low (cf. Skene et al. 2000). In profile BAR-L1, local expansion began at about A.D. 800, i.e., shortly after the onset of woodland clearance. As regards the short profiles, high values were recorded only in BAR1 and then only from after *c.* A.D. 1500. It should be noted that at the other

sites where short monoliths were taken, the records do not extend to recent times.

Today, *Myrica* is not particularly abundant in the uplands, which was probably also the case in the past and particularly in periods with heavy grazing pressure. However, in western Ireland generally, *Myrica* is frequent in a variety of wet habitats associated with blanket bog and transitional fens, and the margins of lakes. Jessen (1949), on the basis of macrofossil and pollen records, was able to show that it was common in Ireland during the Subboreal (after the Elm Decline)
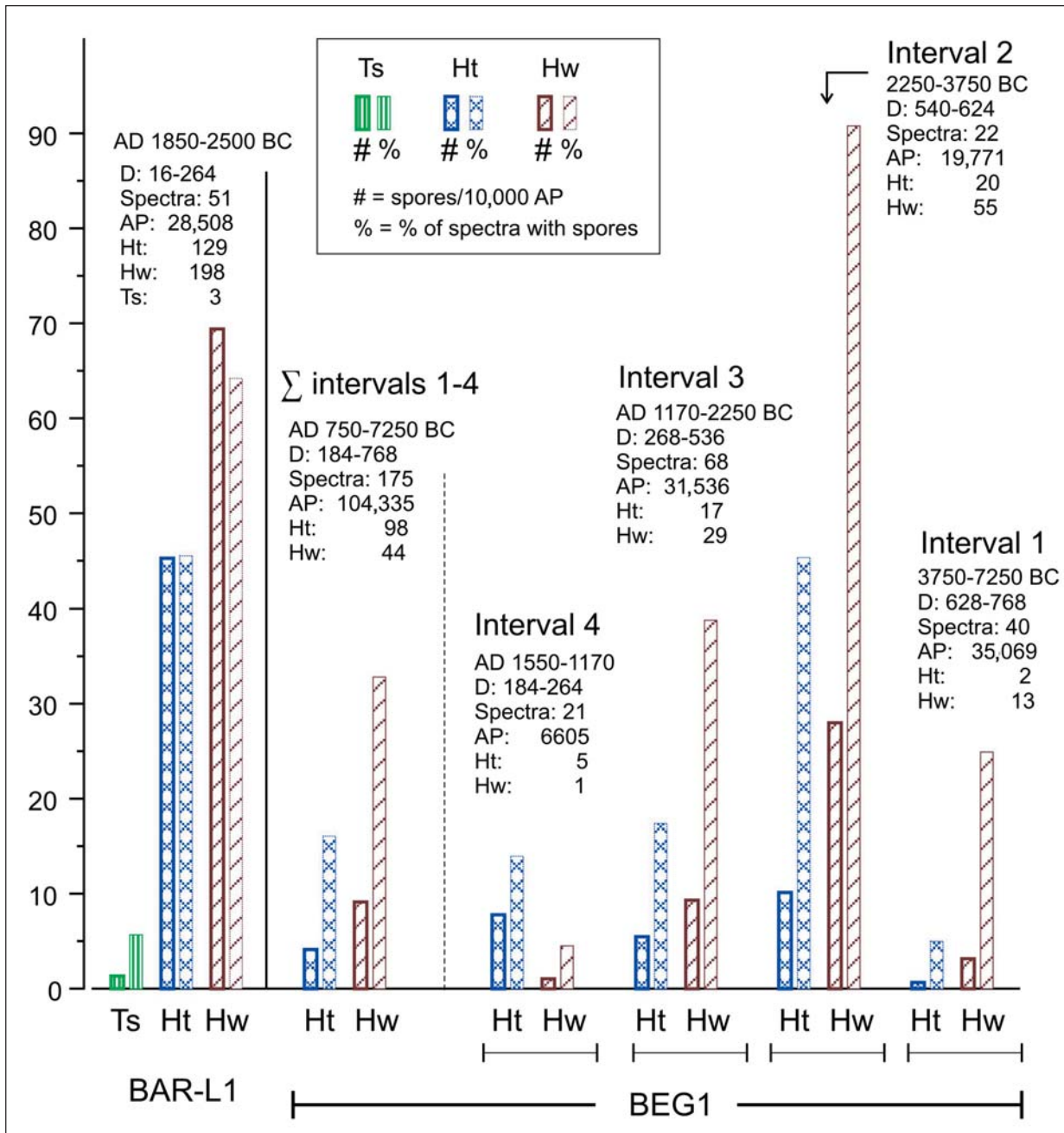

Figure 15. Summary chart with statistics of filmy fern representation in the peat profile, BAR-L1 and lake profile, BEG1. In the selected intervals, numbers of spores per 10,000 AP (including *Corylus*) and the percentage frequencies with which the particular spore type was recorded (based on the number of spectra in the particular interval) are indicated. Dates are in calibrated/calendar years. Abbreviations: D = depths (cm) of the top and bottom spectra, Ht = *Hymenophyllum tunbrigense*, Hw = *H. wilsonii*, and Ts = *Trichomanes speciosum*.

and expanded further in the Subatlantic (late Bronze Age onwards). Interestingly, in the profile Cashelkeelty I, the main expansion is recorded shortly before 1000 B.C., and *Myrica* achieved best representation during periods of reduced human impact such as the Late Iron Age Lull (Lynch 1981). In the Netherlands and northern Germany where *Myrica* is also common, there are examples of local expansion as far back as *c.* 3000 B.C. (e.g., Bakker and van Smeerdijk 1982), but widespread expansion may have taken place considerably later (2000–1000 B.C.; Behre and Kučan 1995, Overbeck 1975). As in the case of many species, several factors, and especially climate and human impact, probably played a role in the spread and expansion of *Myrica* in western Europe.

Ulex. Pollen of *Ulex* spp. is seldom recorded in pollen diagrams (but cf. van Zeist 1964), presumably because of poor pollen production and dispersal. In Ireland, two species are potentially represented, i.e., *U. europaeus* and *U. gallii*. *U. minor,* native to southern England where it has a restricted distribution, is not regarded as native to Ireland (Preston et al. 2002) and so can be discounted. Today, *U. europaeus* is common in most parts of Ireland and also in Beara, and especially on poor soils where there is reduced farming pressure and neglect of the land. *U. gallii,* on the other hand, has a decidedly southern distribution, with the distribution in northern Ireland being quite restricted (Preston et al. 2002, Stokes et al. 2003). In Beara, as elsewhere in western Ireland, it occurs mainly in the context of heath and cutover bog. Both species are usually regarded as native, though the range and abundance of *U. europaeus* have been augmented by widespread planting for fencing and fodder in recent centuries, especially in parts of western Ireland (Lucas 1960). A comprehensive account of the distribution, ecology, and past uses of furze, as *Ulex* is commonly called in Ireland, is given by Feehan (2003), who, incidentally, regards *U. europaeus* as introduced.

The BEG1 profile shows that *Ulex* has had a role in Barrees from the Boreal period onwards (*c.* 8000 B.C.; Overland 2007), with expansion beginning in the Bronze Age presumably as a result of increased opening-up of the landscape. This scenario is supported by the results of charcoal analysed by van Rijn and Vorst (see O'Brien, in press). In a charcoal assemblage from site B, i.e., a *fulacht fiadh* at 210 m asl that was ^{14}C dated to *c.* 1600 B.C. (median calibrated age), *Ulex* constituted 5.8% of the charcoal fragments analysed. *Ulex* was also recorded (single fragment) in a charcoal assemblage that has been ^{14}C dated to *c.* 630 B.C. from hut site D at 125 m asl. Interestingly, in Brittany, van Zeist (1964) recorded *Ulex* pollen records not only after an opening-up of the landscape as a result of farming, but also from pre-Neolithic contexts. As regards Britain, Godwin

(1975) notes that the available pollen records all derive from settlement sites that are Neolithic or younger in age.

Under present-day conditions in Ireland, decline in grazing pressure usually leads to expansion of *Ulex*—in recent times, furze has expanded to a degree that it is now commonly regarded as a weed (Feehan 2003)—but the situation was more complex in the past. From at least medieval times onwards, furze was widely regarded in Ireland as an economic asset, and especially in the 18th and 19th centuries when trees became extremely scarce in most parts of the country. As a result, furze (more or less exclusively *U. europaeus*) was "cultivated" mainly for fencing and as a source of fodder, and also used for a multiplicity of purposes from domestic fires to roofing of houses and as a foundation for roads in boggy areas. Furthermore, there was a particularly strong tradition for the use of furze (both species) in Cork (Lucas 1960:188), where furze was not only extensively used for fencing but also as fodder for cattle and horses (Feehan 2003). Unfortunately, it is not possible to say if the pollen records presented here reflect local "cultivation" or merely represent local contraction and expansion due to changing environmental pressures and especially grazing.

Conclusions

The results of detailed, fine-spatial paleoecological investigations involving pollen and macrofossil analyses and radiocarbon dating, carried out in the context of archaeological survey and excavation, provide new insights into the development of a landscape that today is marginal in terms of present-day settlement patterns and agriculture, but at least in certain periods in the past, supported considerable farming and economic activities and indeed was probably "an integral and recognized part of the broader Atlantic socio-economic sphere" (Breen 2005:213). The fine-scale spatial changes in farming, vegetation, and landscape, and the environmental factors at play from the end of the Neolithic onwards, are now summarised.

Within the immediate vicinity of the small peat basin to which profile BAR-L1 relates, four distinctive phases are distinguishable as follows:

(1) From the final Neolithic until well into the Bronze Age (*c.* 2500–1500 B.C.; BAR-L1-1 and BAR-L1-2a), woodland dominated in the area immediately surrounding the small peat basin, and the basin peat supported carr and other wetland plant communities.

(2) Varying levels of human impact and corresponding phases of woodland clearance and regeneration characterised the mid- and

late Bronze Age (*c.* 1500–400 B.C.; BAR-L1-2b, 3). This finding is not unexpected given that the archaeological field evidence for human activity in the wider study area at this time was considerable (copper mining, *fulachta fiadh*, and standing stones; Figs. 1 and 14).

(3) Between *c.* 400 B.C.–A.D. 700 (BAR-L1-4), i.e., the Iron Age and early medieval period, there was reduced farming activity in the vicinity of the peat basin. There is evidence, however, for substantial activity elsewhere in the study area, and especially in the first centuries of the 1st millennium A.D. (see below).

(4) After A.D. 700, the area around the peat basin experienced intensive clearance of trees and shrubs in the context of farming that was mainly pastoral based but included an arable component (BAR-L1-5, 6 and 7). During this time, an open landscape, similar to that of today, was created. In the period *c.* A.D. 1300–1700 (BAR-L1-6), farming activity declined somewhat, which facilitated some woodland regeneration (probably regional rather than local) that involved mainly oak and birch, i.e., the trees that typify the present-day patches of open woodland. A charcoal pit situated at low elevation (115 m asl; site G) and dating to the mid-14th century A.D. yielded only *Quercus* (van Rijn and Vorst in O'Brien, in press), which also supports the idea of oak growing locally in late medieval times. Historical records also suggest a rather wooded countryside. The Civil Survey (1654-56) of Muskerry barony, for instance, indicates that 173 of the 340 townlands of the barony had some underwood, most had commercial timber, woodland was much more common towards the west, i.e., close to Beara, and in the decades subsequent to the Survey, substantial inroads were made into the surviving woodlands in this part of west Cork (Tierney 1998).

The record presented from Loch Beag (profile BEG1) shows progressive expansion of grassland and bog/heath from the final Neolithic/early Bronze Age (*c.* 2500 B.C.) onwards. Shortly before 1000 B.C., more or less maximum openness of landscape for the prehistoric period was achieved, mainly as a result of sustained human activity. In contrast to profile BAR-L1, there is no evidence for reduced human activity in the early/mid Iron Age. However, regeneration of woody vegetation is recorded between A.D. 300–700 which corresponds to the upper part of zone BAR-L1-4. General close correspondence between the upper

parts of profiles BEG1 and BAR-L1 is maintained into the later historical period. The profile BEG1 also shows evidence for woodland recovery after *c.* A.D. 1200 that continues to near the top of the profile (to shortly after A.D. 1500). Though the Normans had penetrated as far as southwest Cork by the early thirteenth century, Beara remained under the control of the O'Sullivan Beare, the local Gaelic chieftain during this period (Breen 2005). It is assumed that cattle, which were a key component of Gaelic farming (Lucas 1989), remained the mainstay of the economy, though historical sources hint at the importance of arable farming, presumably in the more fertile parts (Breen 2005: 112). Interestingly, it also seems that at the end of this period farming was still taking place in a largely open landscape without field boundaries (Breen 2005).

The short pollen profiles and individual pollen spectra from five excavation trenches provide key evidence for environmental conditions and farming activity associated with stone-wall construction and use in the uplands. The stone wall that formed the large enclosure is the oldest (*c.* 2000 years; see BAR1). At the time of construction and for several centuries afterwards, alder was locally common (pollen of woody species are rare in all the other short profiles, including nearby BAR2). Profile BAR1 also provides the best cereal-type pollen record and supports the idea that cereal growing was a part of the local upland farmland economy in the late Iron Age and early medieval period. The other investigated walls were constructed in open landscapes that were more or less devoid of trees, at least locally. Considerable soil erosion is recorded at BAR3 following wall construction, i.e., in the period *c.* A.D. 400–600. Wall construction at BAR2, BAR3, BAR4, and BAR5 relates to the early medieval period, i.e., *c.* A.D. 400–500. Relatively intensive farming, that was mainly pastoral based, continued into the medieval period and beyond (to close on A.D. 1500; cf. BAR1), which argues for continued use of the uplands even though podzolization and spread of peat must have had serious negative consequences for soil fertility.

A definitive statement regarding synchroneity of construction of the linear stone walls is not possible given the uncertainties that attach to the available dating. The archaeological evidence indicates substantial human activity in the early medieval period and also in the immediately preceding late Iron Age (especially at enclosure A; Fig. 14). The profile, BAR-L1, on the other hand, suggests a lack of human activity for much of this time, but this profile seems to be very local in character. Interestingly, the profile BAR1 indicates considerable local tree populations before, and for several centuries after, wall

construction. The stone wall in question constitutes the large enclosure and is older than the linear stone walls. While the rationale for wall construction is uncertain, it is assumed that the linear walls acted as delimiters of pastureland for beast and man. Cereal cultivation requires the exclusion of cattle, but this seems to have been achieved by temporary fencing until the 17th century in Ireland (Lucas 1960:27).

Construction of the walls that have been investigated took place in the context of a mainly pastoral-based farming economy, though the walls do not appear to constitute a regular field system such as the pre-bog stone-wall system at Céide Fields, north County Mayo (Caulfield 1978). The main wall system at Céide Fields, however, relates to the Neolithic (*c.* 5600 cal. B.P.; Molloy and O'Connell 1995), i.e., they are more than three millennia older than those reported here. While linear walls dating to the mid-Iron Age have been reported from sites such as Derryinver, western Connemara (Molloy and O'Connell 1993), enclosed landscape is a phenomenon ascribable to the period 1750–1850 in Ireland (Duffy 2007: 40), though enclosure may also have taken place much earlier, at least in parts under Norman control (cf. O'Sullivan and Downey 2007). Breen (2005) argues that enclosure in Beara is a post-medieval phenomenon. This chronology may indeed be true in that wall systems such as described here were probably no longer functional in the period—late sixteenth century—that he refers to. The so-called "tumble" walls of the Burren, the karstic landscape of north Clare, on the other hand, may be more or less contemporaneous with the walls under consideration here (dating of the Burren walls is based mainly on their association with ringforts; Drew 1993, Plunkett Dillon 1985).

The present investigations suggest that peat growth, i.e., blanket bog/wet heath, in the study area is a phenomenon traceable to the end of the 1st/beginning of the 2nd millennium A.D. Blanket bog growth as a landscape phenomenon is thus much younger than in other parts of Ireland (O'Connell 1990) but it is not exceptionally late with respect to southwestern Ireland generally. In most of the short profiles investigated by Lynch (1981), for example, peat accumulation began during the last two millennia.

It is probable that onset of wetter conditions in the second half of the first millennium A.D. (cf. Fig. 14) and also climatic deterioration during the Little Ice Age favoured peat initiation and spread. This process, however, is a complex phenomenon. If the evidence from the lake profile BEG1 is considered, then bog began to assume importance once opening-up of the landscape began at the beginning of the Bronze Age (*c.* 2500 B.C.; see curve for bog taxa, Fig. 13) and steadily increased in importance from that time onwards. The expansion of bog as recorded in BEG1 is probably reflecting largely the local situation where peat accumulation may have begun during the early Holocene in the basin that holds the lake. Interestingly, peat accumulation in the small basin where core BAR-L1 was taken seems to have begun towards the end of the Neolithic (the profile is from the center of the basin, where the peat is thickest and presumably oldest). It is concluded that the initial foci of bog growth probably relate to the late Neolithic/beginning of the Bronze Age, but widespread development of blanket bog in this area relates mainly to the medieval period when it was favoured by climatic changes such as the wetter and cooler conditions associated with the Little Ice Age.

Literature Cited

Anonymous. 1902. Statistical survey of Irish agriculture. Pp. 304–325, *In* W.P. Coyne (Ed.) Ireland: Industrial and Agricultural. Browne and Nolan, Dublin, Ireland. 532 pp.

Bakker, M., and, D.G. van Smeerdijk. 1982. A paleoecological study of a late Holocene section from "Het Ilperveld," western Netherlands. Review of Palaeobotany and Palynology 36:95–163.

Behre, K.-E. 2007. Evidence for Mesolithic agriculture in and around Central Europe? Vegetation History and Archaeobotany 16:203–219.

Behre, K.-E., and D. Kučan. 1995. Die Geschichte der Kulturlandschaft und des Ackerbaus in der Siedlungskammer Flögeln, Niedersachsen, seit der Jungsteinzeit. Probleme der Küstenforschung im südlichen Nordseegebiet 21:1–227.

Berglund, B.E. (Ed). 1998. The Cultural Landscape during 6000 Years in Southern Sweden: The Ystad Project. Ecological Bulletins No. 41. Munksgaard, Copenhagen, Denmark. 495 pp.

Beug, H.-J. 2004. Leitfaden der Pollenbestimmung für Mitteleuropa und Angrenzende Gebiete. Pfeil, Munich, Germany. 542 pp.

Blais, J.M., and J. Kalff. 1995. The influence of lake morphometry on sediment focusing. Limnology and Oceanography 40:582–588.

Bleasdale, A., and M. Sheehy Skeffington. 1992. The influence of agricultural practices on plant communities in Connemara. Pp. 331–336, *In* J. Feehan (Ed.). Environment and Development in Ireland. Environmental Institute, University College, Dublin, Ireland. 620 pp.

Breen, C. 2005. The Gaelic Lordship of the O'Sullivan Beare. A Landscape Cultural History. Four Courts, Dublin, Ireland. 256 pp.

Bunting, M.J. 2003. Pollen-vegetation relationships in non-arboreal moorland taxa. Review of Palaeobotany and Palynology 125:285–298.

Callaghan, C., and W. Forsythe. 2000. The Berehaven copper-mining industry: A maritime perspective. Archaeology Ireland 14(1):16–19.

Caulfield, S. 1978. Neolithic fields: The Irish evidence. Pp. 137–143, *In* H.C. Bowen, and P.J. Fowler (Eds.). Early Land Allotment in the British Isles. A Survey of Recent Work. BAR British Series, 48, Oxford, UK. 201 pp.

Conry, M., and P. Ryan. 1963. Soils. Pp. A-15–A-43, *In* D. Murphy (Ed.). West Cork Resource Survey. An Foras Taluntais, Dublin, Ireland.

Coxon, P., and S. Waldren. 1997. Flora and vegetation of the Quaternary temperate stages of NW Europe: Evidence for large-scale range changes. Pp. 103–117, *In* B. Huntley, W. Cromer, A.V. Morgan, H.C. Prentice, and J.R.M. Allen (Eds.). Past and Future Environmental Changes: The Spatial and Evolutionary Responses of Terrestrial Biota (NATO ASI Series, Ser. I, Vol. 47). Springer-Verlag, Berlin, Germany. 523 pp.

Cross, J.R. 2006. The potential natural vegetation of Ireland. Biology and Environment (Proceeding of the Royal Irish Academy) 106B:65–116.

Dickson, D. 2005. Old World Colony: Cork and South Munster 1630–1830. Cork University Press, Cork, Ireland. 726 pp.

Dimbleby, J.W. 1985. The Palynology of Archaeological Sites. Academic Press, London, UK. 176 pp.

Dörfler, W. 1990. Die Geschichte des Hanfanbaus in Mitteleuropa aufgrund palynologischer Untersuchungen und von Grosrestnachweisen. Praehistorisches Zeitschrift 65:218–244.

Drew, D. 1993. Ballyelly-Coolmeen; Ancient field boundaries. Pp. 27–34, *In* W.P. Warren and M. O'Connell (Eds.). The Burren, Field Guide No. 15. Irish Association for Quaternary Studies, Dublin, Ireland. 71 pp.

Duffy, P.J. 2007. Exploring the History and Heritage of Irish Landscapes. Maynooth Research Guides for Irish Local History: Number 12. Four Courts Press, Dublin, Ireland. 264 pp.

Durell, P., and C. Kelly (Eds.). 2000. The Grand Tour of Beara. Cailleach Books, Allihies, County Cork, Ireland. 214 pp.

Environment and Heritage Service Northern Ireland (EHSNI). 2007. All Ireland Species Action Plan: Killarney fern *Trichomanes speciosum*. 1–10 pp. Available online at www.ehsni.gov.uk/draftkillarne yfernallirelandsapmar07-2.pdf. Accessed February 12, 2008.

Edwards, K.J., and G. Whittington. 1990. Palynological evidence for the growing of Cannabis sativa L. (hemp) in medieval and historical Scotland. Transactions of the Institute of British Geographers (New Series) 15: 60–69.

Erdtman, O.G.E. 1924. Mitteilungen über einige irische Moore. Svensk Botanisk Tidskrift 18: 451–459.

Fægri, K., and J. Iversen. 1989. Textbook of Pollen Analysis. 4th Edition, by Fægri, K., P.E. Kaland, and K. Krzywinski. Wiley, New York, NY, USA. 328 pp.

Feehan, J. 2003. Farming in Ireland. History, Heritage, and Environment. University College Dublin, Faculty of Agriculture, Dublin, Ireland. 606 pp.

Fries, M. 1967. Lennart von Post's pollen diagram series of 1916. Review of Palaeobotany and Palynology 4:9–13.

Godwin, H. 1975. The History of the British Flora, 2nd Edition. Cambridge University Press, Cambridge, UK. 541 pp.

Grime, J.P., J.G. Hodgson, and R. Hunt. 2007. Comparative Plant Ecology: A Functional Approach to Common British Species, 2nd Edition. Castlepoint Press, Dalbeattie, UK. 748 pp.

Havinga, A.J. 1971. An experimental investigation into the decay of pollen and spores in various soil types. Pp. 446–479, *In* J. Brooks, P.R. Grant, M.D. Muir, P. van Gijzel, and G. Shaw (Eds.). Sporopollenin. Academic Press, London, UK. 718 pp.

Jalas, J., and J. Suominen. (Eds.). 1972. Altas Florae Europaeae. 1. Pteridophyta (Psilotaceae to Azollaceae). Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo, Helsinki, Finland. 121 pp.

Jessen, K. 1949. Studies in late Quaternary deposits and flora-history of Ireland. Proceedings of the Royal Irish Academy 52B:85–290.

Jessen, K., S.T. Andersen, and A. Farrington. 1959. The interglacial deposit near Gort, Co. Galway, Ireland. Proceedings of the Royal Irish Academy 60B:1–77.

Kelly, D.L. 1981. The native forest vegetation of Killarney, southwest Ireland: An ecological account. Journal of Ecology 69:437–472.

Kingston, N., and C. Hayes. 2005. The ecology and conservation of the gametophyte generation of the Killarney fern (*Trichomanes speciosum* Willd.) in Ireland. Biology and Environment (Proceedings of the Royal Irish Academy) 105B:71–79.

Little, D.J., F.J.G. Mitchell, S. von Engelbrechten, and E.P. Farrell. 1996. Assessment of the impact of past disturbance and prehistoric *Pinus sylvestris* on vegetation dynamics and soil development in Uragh Wood, SW Ireland. The Holocene 6:90–99.

Lucas, A.T. 1960. Furze: A Survey and History of its Uses in Ireland. Stationery Office (for the National Museum of Ireland), Dublin, Ireland. 203 pp.

Lucas, A.T. 1989. Cattle in Ancient Ireland. Boethius Press, Kilkenny, Ireland. 330 pp.

Lynch, A. 1981. Man and environment in southwest Ireland, 4000 B.C.–A.D. 800. BAR, British Series 85: 1–175.

MacCarthy, I.A.J. 2007a. The South Munster Basin of southwest Ireland. Journal of Maps, 2007, 149–172.

MacCarthy, I.A.J. 2007b. The South Munster Basin of southwest Ireland (western part) [Geological Map]. Available online at www.journalofmaps.com. Accessed February 12, 2008.

McDonnell, K. 1991. Investigations Towards the Reconstruction of the Palaeoenvironment at the Dromteewakeen Prehistoric Sites, Iveragh Peninsula, Co. Kerry. M.Sc. Thesis. Department of Botany, University College Galway (National University of Ireland, Galway), Galway, Ireland. 60 pp.

Mighall, T.M., and J.G.A. Lageard. 1999. The prehistoric environment. Pp. 41–59, *In* W.F. O'Brien (Ed.). Sacred Ground. Megalithic Tombs in Coastal Southwest Ireland. Department of Archaeology, National University of Ireland, Galway (Bronze Age Studies 4), Galway, Ireland. 333 pp.

Mighall, T.M., F.M. Chambers, J.M. Lanting, and W.F. O'Brien. 2000. Prehistoric copper mining and its impact on vegetation: Palaeoecological evidence from Mount Gabriel, Co. Cork, southwest Ireland. Pp. 19–29, *In* R.A. Nicholson and T.P. O'Connor (Eds.). People as an Agent of Environmental Change. Symposia of the Association for Environmental Archaeology No. 16. Oxbow Books, Oxford, UK. 135 pp.

Mighall, T.M., S. Timpany, J.J. Blackford, J.B. Innes, C.E. O'Brien, W. O'Brien, and S. Harrison. 2007. Vegetation change during the Mesolithic and Neolithic on the Mizen Peninsula, Co. Cork, southwest Ireland. Vegetation History and Archaeobotany, Online First, DOI 10.1007/s00334-007-0136-4.

Mitchell, F.J.G., and T. Cooney. 2004. Vegetation history in the Killarney valley. Pp. 481–493, *In* W. O'Brien (Ed.). Ross Island. Mining, Metal and Society in Early Ireland (Bronze Age Studies 6). Department of Archaeology, National University of Ireland, Galway, Ireland. 768 pp.

Mohr, R. 1990. Untersuchungen zur nacheiszeitlichen Vegetations- und Moorentwicklung im nordwestlichen Niedersachsen mit besonderer Berücksichtigung von *Myrica gale* L. VAG Vechtaer Arbeiten zur Geographie und Regionalwissenschaft 12:1–144.

Molloy, K., and M. O'Connell. 1993. Early land use and vegetation history at Derryinver Hill, Renvyle Peninsula, Co. Galway, Ireland. Pp. 185–199, *In* F.M. Chambers (Ed.). Climate Change and Human Impact on the Landscape. Chapman and Hall, London, UK. 303 pp.

Molloy, K., and M. O'Connell. 1995. Palaeoecological investigations towards the reconstruction of environment and land-use changes during prehistory at Céide Fields, western Ireland. Probleme der Küstenforschung im südlichen Nordseegebiet 23: 187–225.

Molloy, K., and M. O'Connell. 2004. Holocene vegetation and land-use dynamics in the karstic environment of Inis Oírr, Aran Islands, western Ireland: Pollen analytical evidence evaluated in the light of the archaeological record. Quaternary International 113: 41–64.

Monk, M.A., J. Tierney, and M. Hannon. 1998. Archaeobotanical studies and early Medieval Munster. Pp. 65–75, *In* M.A. Monk and J. Sheehan (Eds.). Early Medieval Munster: Archaeology, History, and Society. Cork University Press, Cork, Ireland. 210 pp.

Moore, P.D., J.A. Webb, and M.E. Collinson. 1991. Pollen Analysis, 2nd Edition. Blackwell, London, UK. 216 pp.

Muller, S., C. Jerôme, and T. Mahevas. 2006. Habitat assessment, phytosociology, and conservation of the Tunbridge Filmy-fern *Hymenophyllum tunbrigense* (L) Sm. in its isolated locations in the Vosges Mountains. Biodiversity and Conservation 15:1027–1041.

O'Brien, W. 1996. Bronze Age Copper Mining in Britain and Ireland. Shire Archaeology, Princes Risborough, 64 pp.

O'Brien, W. 2000. Megalithic tombs, metal resources, and territory in prehistoric southwest Ireland. Pp. 161–176, *In* A. Desmond, G. Johnson, M. McCarthy, J. Sheehan, and E. Shee Twohig (Eds.). New Agendas in Irish Prehistory. Papers in Commemoration of Liz Anderson. Wordwell, Bray, Ireland. 231 pp.

O'Brien, W. 2003. The Bronze Age copper mines of the Goleen area, Co. Cork. Proceedings of the Royal Irish Academy 103C:13–59.

O'Brien, W. 2004. Ross Island. Mining, Metal and Society in Early Ireland. Bronze Age Studies 6. Department of Archaeology, National University of Ireland, Galway, Ireland. 768 pp.

O'Brien, W. In press. Local worlds. Early Settlement Landscapes in Southwest Ireland. Collins Press, Cork.

O'Connell, M. 1986. Reconstruction of local landscape development in the post-Atlantic based on palaeoecological investigations at Carrownaglogh prehistoric field system, County Mayo, Ireland. Review of Palaeobotany and Palynology 49:117–176.

O'Connell, M. 1987. Early cereal-type pollen records from Connemara, western Ireland and their possible significance. Pollen et Spores 29:207–224.

O'Connell, M. 1990. Origins of Irish lowland blanket bog. Pp. 49–71, *In* G.J. Doyle (Ed.). Ecology and Conservation of Irish Peatlands. Royal Irish Academy, Dublin, Ireland. 218 pp.

O'Sullivan, M., and L. Downey. 2007. Fieldscapes: Anglo-Norman footprints. Archaeology Ireland 21: 32–35.

Odgaard, B. 1994. The Holocene vegetation history of northern West Jutland, Denmark. Opera Botanica 123: 1–171.

Overbeck, F. 1975. Botanisch-geologische Moorkunde. Wachholtz, Neumünster, Germany. 719 pp.

Overland, A. 2007. Palaeoecological investigations of lake sediments and peats towards reconstruction of long-term environmental changes at Barrees, Beara Peninsula, Southwest Cork. Ph.D. Thesis. Department of Botany, National University of Ireland, Galway, Ireland. 259 pp.

Overland, A., and M. O'Connell. In press. Palaeoecological investigations towards reconstruction of late Holocene environmental change in Barrees, Beara Peninsula, S.W. Cork. *In* W. O'Brien (Ed.). Local Worlds. Early Settlement Landscapes in Southwest Ireland. Collins Press, Cork, Ireland.

Page, C.N. 1997. The Ferns of Britain and Ireland, 2nd Edition. Cambridge University Press, Cambridge, UK. 540 pp.

Parkes, H.M., and F.J.G. Mitchell. 2000. Vegetation history at Clonmacnoise, Co. Offaly. Biology and Environment (Proceedings of the Royal Irish Academy) 100B:35–40.

Plunkett Dillon, E.C. 1985. The field boundaries of the Burren, County Clare. PhD Thesis. University of Dublin (Trinity College), Dublin, Ireland.

Power, D. 1992. Archaeological Inventory of County Cork. Volume 1: West Cork. Stationery Office, Dublin, Ireland. 432 pp.

Pracht, M. 1997. Geology of Kerry-Cork. A geological description to accompany the bedrock geology 1: 100,000 scale map series, sheet 21, Kerry-Cork. Geological Survey of Ireland, Dublin, Ireland. 97 pp.

Preston, C.D., D.A. Pearman, and T.D. Dines (Eds). 2002. New Atlas of the British and Irish Flora. Oxford University Press, Oxford, UK. 912 pp.

Proctor, M.C.F. 2003. Comparative ecophysiological measurements on the light responses, water relations, and desiccation tolerance of the filmy ferns *Hymenophyllum wilsonii* Hook. and *H. tunbrigense* (L.) Smith. Annals of Botany 91:717–727.

Ratcliffe, D.A., H.J.B. Birks, and H.H. Birks. 1993. The ecology and conservation of the Killarney fern *Trichomanes speciosum* Willd. in Britain and Ireland. Biological Conservation 66:231–247.

Reille, M. 1992. Pollen et spores d'Europe et d'Afrique du nord. Laboratoire de Botanique Historique et Palynologie, Faculté des Sciences et Techniques Saint-Jérôme, Marseille, France. 520 pp.

Reille, M. 1995. Pollen et spores d'Europe et d'Afrique du nord. Supplement 1. Laboratoire de Botanique Historique et Palynologie, Faculté des Sciences et Techniques Saint-Jérôme, Marseille, France. 325 pp.

Reimer, P.J., M.G.L. Baillie, E. Bard, A. Bayliss, J.W. Beck, C.J.H. Betrand, P.G. Blackwell, C.E. Buck, G.S. Burr, K.B. Cutler, P.E. Damon, R.L. Edwards, R.G. Fairbanks, M. Friedrich, T.P. Guilderson, A.G. Hogg, K.A. Hughen, B. Kromer, G. McCormac, S. . Manning, C.B. Ramsey, R.W. Reimer, S. Remmele, J.R. Southon, M. Stuiver, S. Talamo, F.W. Taylor, J. van der Plicht, and C.E. Weyhenmeyer. 2004. Intcal04 terrestrial radiocarbon age calibration, 0–26 cal kyr BP. Radiocarbon 46:1029–1058.

Richards, P.W., and G.B. Evans. 1972. Biological flora of the British Isles. *Hymenophyllum.* Journal of Ecology 44:245–268.

Rohan, P.K. 1975. The Climate of Ireland. Stationery Office, Dublin, Ireland. 112 pp.

Rumsey, F.J., J.C. Vogel, S.J. Russell, J.A. Barrett, and M. Gibby, 1998. Climate, colonisation, and celibacy: Population structure in central European *Trichomanes speciosum* (Pteridophyta). Botanical Acta 111: 481–489.

Rumsey, F.J., J.C. Vogel, S.J. Russell, J.A. Barrett, and M. Gibby. 1999. Population structure and conservation biology of the endangered fern *Trichomanes speciosum* Willd. (Hymenophyllaceae) at its northern distributional limit. Biological Journal of the Linnaean Society 66:333–344.

Skene, K.R., J.I. Sprent, J.A. Raven, and L. Herdman. 2000. *Myrica gale* L. Biological flora of the British Isles, No. 215. Journal of Ecology 88:1079–1094.

Smith, A.J.E. 1978. The Moss Flora of Britain and Ireland. Cambridge University Press, Cambridge, UK. 706 pp.

Stace, C. 1997. New Flora of the British Isles, 2nd Edition. Cambridge University Press, Cambridge, UK. 1130 pp.

Stokes, K.E., J.M. Bullock, and A.R. Watkinson. 2003. *Ulex gallii* Planch. and *Ulex minor* Roth (Biological flora of the British Isles, No. 232). Journal of Ecology 91:1106–1124.

Sugita, S. 1994. Pollen representation of vegetation in Quaternary sediments: Theory and method in patchy vegetation. Journal of Ecology 82:881–897.

Sugita, S. 2007. Theory of quantitative reconstruction of vegetation II: All you need is LOVE. The Holocene 17:243–257.

Tauber, H. 1965. Differential pollen dispersion and the interpretation of pollen diagrams. Danmarks Geologiske Undersøgelse, Række II 89:1–69.

Tierney, J. 1998. Wood and woodlands in Early Medieval Munster. Pp. 53–58, *In* M.A. Monk, and J. Sheehan (Eds.). Early Medieval Munster: Archaeology, History and Society. Cork University Press, Cork, Ireland. 210 pp.

van Zeist, W. 1964. A palaeobotanical study of some bogs in western Brittany (Finistere), France. Palaeohistoria 10:157–180.

Vogel, J.C., S. Jessen, M. Gibby, A.C. Jermy, and L. Ellis. 1993. Gametophytes of *Trichomanes speciosum* (Hymenophyllaceae: Pteridophyta) in Central Europe. Fern Gazette 14:227–232.

Waller, M.P., and J.E. Schofield. 2007. Mid- to late Holocene vegetation and land-use history in the Weald of southeastern England: Multiple pollen profiles from the Rye area. Vegetation History and Archaeobotany 16:367–384.

Watson, E.V. 1981. British Mosses and Liverworts, 3rd Edition. Cambridge University Press, Cambridge, UK. 519 pp.

Watts, W.A. 1959. Interglacial deposits at Kilbeg and Newtown, Co. Waterford. Proceedings of the Royal Irish Academy 60B:79–134.

Webb, D.A., J. Parnell, and D. Doogue. 1996. An Irish Flora, 7th Edition. Dundalgan Press, Dundalk, Ireland. 337 pp.

Weir, D.A. 1995. A palynological study of landscape and agricultural development in County Louth in the second millennium BC and the first millennium AD. Pp. 77–126, *In* Discovery Programme Reports: 2. Project Results 1993. Royal Irish Academy/Discovery Programme, Dublin, Ireland. 126 pp.

White, J., and G. Doyle. 1982. The vegetation of Ireland. A catalogue raisonné. Pp. 289–368, *In* J. White (Ed.). Studies in Irish Vegetation. Royal Dublin Society, Dublin, Ireland, 368 pp.

Wolters, S. 1996. Pollen analytical investigations towards the reconstruction of late Holocene environmental change in Kilmore Td., Corca Dhuibhne, Co. Kerry. M.Sc. Thesis. Department of Botany, National University of Ireland, Galway, Ireland. 171 pp.

Online Supplementary Table 1 to: Overland, A., and M. O'Connell. 2008. Fine-spatial Paleoecological Investigations Towards Reconstructing Late Holocene Environmental Change, Landscape Evolution, and Farming Activity in Barrees, Beara Peninsula, Southwestern Ireland. Journal of the North Atlantic 1:37–73.

Note: the content of supplementary files is not subject to proof editing by the journal staff. Thus, the responsibility for the accuracy of all information and correctness of its presentation in this file lies solely with the author(s).

Supplementary table 1. Dates from trench contexts (short monoliths; AMS and conventional ^{14}C dates).

[14]C lab. no.	Galway no.	Depth (cm)*	Age (BP)	Age[†] (cal. B.C./A.D.)	Median probability	Dated material[§]
BAR1						
GrA-24362	BAR1-5	-36 to -37	1110 ± 120	A.D. 775-1026	A.D. 914	*Juncus*[1]
GrN-29003	BAR1-8	-35 to -36	100.2 ± 0.6%	A.D. 1699-1915	A.D. 1825	Peat (humin)
GrN-29056	BAR1-8	-35 to -36	360 ± 36	A.D. 1465-1626	A.D. 1541	Peat (alk. extr.)
GrA- 24363	BAR1-4	-27 to -28	905 ± 45	A.D. 1043-1178	A.D. 1121	Charcoal; *Juncus*[2]
GrN-29002	BAR1-7	-18 to -20	670 ± 60	A.D. 1275-1390	A.D. 1324	Peat
GrN-29055	BAR1-7	-18 to -20	995 ± 35	A.D. 993-1147	A.D. 1036	Peat (alk. extr.)
GrA-24366	BAR1-2	-12 to -13	2280 ± 330	780 B.C.-A.D. 2	359 B.C.	*Juncus*[3]
GrN-29001	BAR1-6	-11 to -12	920 ± 60	A.D. 1036-1163	A.D. 1113	Peat (humin)
GrN-29054	BAR1-6	-11 to -12	1150 ± 40	A.D. 783-968	A.D. 889	Peat (alk. extr.)
GrA-24367	BAR1-1	-4 to -5	1860 ± 120	A.D. 21-325	A.D. 158	*Juncus*[4]
GrA-24348	BAR1(2)-l	1 to 2	2220 ± 270	743 B.C.-A.D. 53	285 B.C.	*Juncus* (*c.* 70)
GrA-25528	BAR1_Salix		975 ± 35	A.D. 1019-1150	A.D. 1086	*Salix* charcoal (1)
BAR2						
GrA-24342	BAR2-2	-5 to -6	1375 ± 40	A.D. 623-675	A.D. 653	Charcoal[5]
GrA-24346	BAR2-1	-1 to -2	1535 ± 45	A.D. 435-578	A.D. 520	Charcoal & *Juncus*[6]
BAR3						
GrA- 25517	BAR3-2	-17.5 to -19.5	1535 ± 45	A.D. 435-578	A.D. 520	*Juncus* & *Rubus*[7]
GrN-29004	BAR3-3	-2.5 to -5	1340 ± 60	A.D. 643-769	A.D. 688	Peat (humin)
GrN-29057	BAR3-3	-2.5 to -5	1560 ± 40	A.D. 434-543	A.D. 492	Peat (alk. extr.)
GrA-24368	BAR3-1	-0.5 to -2.5	1620 ± 100	A.D. 265-550	A.D. 431	*Juncus*[8]
BAR4						
GrA-24345	BAR4-1	-1 to -2	1125 ± 90	A.D. 781-994	A.D. 900	*Juncus*[9]
BAR5						
GrA-24332	BAR5-1-2	-5 to -6	1110 ± 45	A.D. 892-984	A.D. 933	Charcoal[10]
GrA-24343	BAR5-1-1	0 to -1	1325 ± 45	A.D. 654-766	A.D. 696	Charcoal (*c.* 30)
GrA-24630	BAR5-2	Pre wall	1650 ± 60	A.D. 264-531	A.D. 400	Charcoal[11]

[§] Main component listed; details are given in footnotes. *Juncus* refers to seeds; no. of items given in parentheses.

[†] Calibrated age range (1σ, i.e. 68.3% confidence level; based on Calib ver. 5.0.1).

* Positive and negative depths refer to above and below mineral ground, respectively.

---

[1] *Juncus* seeds (*c.* 30); charcoal (a few); unknown seeds (2 half).

[2] Charcoal (*c.* 10); *Juncus* seeds (*c.* 25); unknown seed (1).

[3] *Juncus* (*c.* 30); unknown seeds (2).

[4] *Juncus* (*c.* 30); unknown seed (2).

[5] Charcoal (*c.* 50); *Juncus* (2).

[6] Charcoal (*c.* 30); *Juncus* (*c.* 20).

[7] *Juncus* (≥50); *Carex* utricles (2); *Rubus* stone (1); unknown seeds (3); charcoal (few pieces).

[8] *Juncus* seeds (*c.* 50); *Carex* utricle (1); unknown seeds (2); charcoal (few pieces).

[9] *Juncus* seeds (*c.* 60); charcoal (*c.* 10); unknown seeds (3).

[10] Charcoal (*c.* 30); *Juncus* (1).

[11] Fine charcoal; *Juncus* seed (1); unknown seed (1).

Online Supplementary Table 2 to: Overland, A., and M. O'Connell. 2008. Fine-spatial Paleoecological Investigations Towards Reconstructing Late Holocene Environmental Change, Landscape Evolution, and Farming Activity in Barrees, Beara Peninsula, Southwestern Ireland. Journal of the North Atlantic 1:37–73.

Note: the content of supplementary files is not subject to proof editing by the journal staff. Thus, the responsibility for the accuracy of all information and correctness of its presentation in this file lies solely with the author(s).

Supplementary table 2. AMS ^{14}C dates from bog core, BAR-L1.

[14]C lab. no. (GrA-)	Galway no. / Depth (cm)	Age (BP)	Age[†] (cal. years)	Material extracted[¶]	Dated material[§]
30083	BAR-L1-9 55–58	385 ± 35	A.D. 1448–1617	*Carex* utricles (2); *Juncus* (+); *Betula* twigs (+)	*Carex* utricles (several); *Juncus* (several); *Betula* twigs (several)
24371	BAR-L1-5 84–85	1125 ± 40	A.D. 887–977	Charcoal (+); *Juncus* (2); fibres (3); *E. vaginatum* spindles (3)	Charcoal fragments; *Juncus* [*c.* 10]; *E. vaginatum* spindles [5–10]
24255	BAR-L1-4 105–106	1450 ± 40	A.D. 584–644	Charcoal (+); mineral matter (+); *Juncus* (+); *Coenococcum* (3); fibres (2); *Carex* utricles (3); *P. polygonifolius* fruits (3); *R. fruticosus* agg. fruit stones (1); *R. flammula* fruit (+)	*Carex* utricles [*c.* 10]; *P. polygonifolius* [*c.* 10]; *R. fruticosus* [5]; *R. flammula* fruit [1]; *Juncus* [*c.* 4]
30080	BAR-L1-8 112–114	1810 ± 40	A.D. 137–242	Wooden twigs, incl. *Betula* (1); bark (+); *Carex* utricles (+); *E. tetralix* leaf (+); *R. squarrosus* (+); *unidentified moss* (+); *R. alba* nutlets (1); *Juncus* seed (+); *Sphagnum* leaf (+); *P. polygonifolius* (3)	All except *P. polygonifolius*
27265	BAR-L1-6 135–137	2285 ± 35	399–236 B.C.	Wood (+); mineral matter (+); *Juncus* (1); fibres (2); charcoal (+); insect parts (+); *Carex* (+)	Wood
30077	BAR-L1-7 145–147	2545 ± 35	795–594 B.C.	Woody twigs (2); *Carex* utricles (+); *Juncus* (3); *Rhynchospora* nutlets (+); sand (+)	All except sand
24252	BAR-L1-3 182–183	2970 ± 40	1263–1128 B.C.	Wood (1); mineral matter (+); *Juncus* (+); fibres (3); *Carex* utricle (+)	Wood; *Juncus* [4]; *Carex* utricle [2]
24278	BAR-L1-2 204–205	3290 ± 40	1614–1520 B.C.	Wood (2); mineral matter (+); *Juncus* (1); *Carex* utricle (+); fibres (2)	Wood; *Juncus* [10–20]; *Carex* utricle [1]
24272	BAR-L1-1 257–259	3910 ± 45	2470–2341 B.C.	Wood (2); *Coenococcum* (3); fibres (2)	Wood

Juncus indicates *Juncus* seed.

[¶] Quantities as recorded during macrofossil analyses are indicated using a scale of '+' to '3' (in parentheses).

[§] No. of individuals included in sample for AMS ^{14}C dating is shown in brackets.

[†] Calibrated age range (1σ range, i.e. 68.3% confidence level); calibration carried out using Calib ver. 5.0.1.