^{14}C DATING OF A NEOLITHIC FIELD SYSTEM AT CÉIDE FIELDS, COUNTY MAYO, IRELAND

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ABSTRACT. Céide Fields is a 12 km^2 Neolithic field system in North Mayo in the west of Ireland. The fields, enclosed by an integrated system of stone walls, have been preserved intact by a cover of blanket bog that is >4 m deep in places. At many locations within this blanket bog the stumps of ancient pines (*Pinus sylvestris*) are found *in situ*. The pine roots in most cases are either on the surface of the mineral soil under the peat or at an intermediate level in the peat itself. The age of the trees in the bog overlying Céide Fields is therefore of great significance for the dating of the fields, as the trees must be younger than the bog in which they are growing, which in turn must be younger than the field system beneath it. We present here the dates (N = 15) for pine trees from the bogs overlying Céide Fields and the dates (N = 29) of pine trees from other areas of the North Mayo blanket bog. We compare these pine dates with published dates of peat associated with a major pollen analytical study from within the fields and with published dates for bog pine from Scotland. The results of the study suggest that the dates for the construction and period of use of Céide Fields and other Neolithic pre-bog field systems in North Mayo are older than anticipated and that the date for initiation of blanket bog in many parts of North Mayo is also older than previously estimated. Further, the range of dates of the pine stumps indicates a synchronic event contemporary with a similar phenomenon observed in Scotland.

INTRODUCTION

North Mayo (Fig. 1) has a uniquely preserved and well-studied record of human occupation and alteration of the landscape contained within and under the 1000 km^2 of blanket bog in the region (DeValera and Ó Nualláin 1964; Caulfield 1978, 1983; Molloy and O'Connell 1995). *Ca.* 5.5 ka ago there was a major human impact on the landscape as large areas of forest were cleared and the landscape organized into a countryside of stonewalled fields. Certain regions were avoided, probably because the blanket bog was already established there by that time. The subsequent extension of the blanket bog enveloped the areas of settlement, forcing the abandonment of much of the region. Some time after the bog had become established, pine forest spread onto the bog in certain places, but this was a relatively short-lived episode preceding a return to bog growth that has remained unaltered to this day.

Because these pines grew on peat and were preserved by it, the ^{14}C dates of the pines are central to the determination of a *terminus ante quem* for the initiation of blanket bog in the North Mayo region. Underlying the bog are the stonewalled field systems extending over many square kilometers, now known as Céide Fields (Fig. 2). It follows that their construction must have taken place prior to the initiation of bog which, in turn, must have preceded the growth of the pines rooted in the bog.

The setting up of a new Radiocarbon Laboratory in the Department of Experimental Physics at University College Dublin (UCD) offered an opportunity for a collaborative research project involving the dating of pines from Céide Fields and other locations in North Mayo. The annual growth rings on individual pine stumps provide unlimited quantities of replicate samples of unknown but identical age, which may be cross-referenced to a single year, if necessary. The dating of these trees addresses two other questions of relevance to Neolithic studies in Ireland: 1) Do the pine trees that grew on the surface of the bog represent a synchronic event caused by a change in climate to drier and/or calmer conditions, and if so, what was the relevance of this change for human society at the

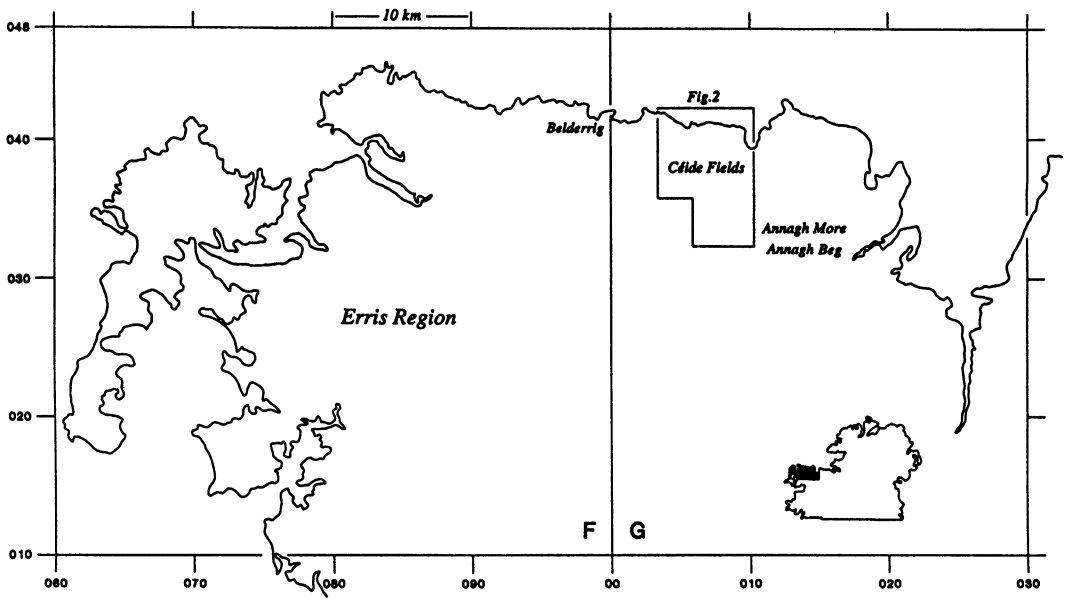

Fig. 1. Map of North Mayo (with National Grid coordinates) showing location of Céide Fields

time? 2) Does the depth of peat (up to 2 m) beneath these pine stumps indicate that the date of initiation of blanket bog in North Mayo was considerably earlier than the pine phase?

Prior to this study, a ^{14}C date of 4460 ± 80 BP had been reported for an oval-shaped enclosure discovered within one of the large rectangular fields in the Céide Fields system, formerly referred to as Behy/Glenulra (Caulfield 1978). This date was (and still is) the earliest recorded for an archaeological specimen from the Céide Fields system; hence, the fields were (tentatively) considered to date to the latter half of the third millennium BC (uncalibrated). However, as explained in detail below, the extensive series of new dates produced in the present study demonstrates unequivocally that, at least from the townlands of Behy to Ballyknock, the construction and use of the fields must date to the first half of the third millennium BC. In other words, we have extended by a further half millennium the date of pre-bog fields in Mayo, which were already the earliest known in Europe, by *ca.* 1 ka.

Methods

All the pine (N = 44) and peat (N = 2) samples dated in the present study were collected in the Céide Fields system and elsewhere in the North Mayo blanket bog in 1995. Upon return to UCD they were pretreated using recommended techniques (Olsson 1979; Gupta and Polach 1985; Williams 1989) and converted to benzene in the new facility. Counting was carried out using either a Wallac Quantulus 1220™ LSC or a Tri-Carb® 2770TR/SL LSC. A full description of the procedures used as well as the calibration of the UCD facility is given elsewhere (O'Donnell 1997). It is appropriate to record that the reproducibility of the facility was confirmed by the satisfactory multiple-dating of replicate pine samples from Céide Fields (O'Donnell 1997). Absolute calibration was established by the successful dating (blind) of a number of international intercomparison materials (Rozanski 1991; Rozanski *et al.* 1992; Gulliksen and Scott 1995) including Crannog wood, Ellanmore whole peat, Icelandic peat, Waikato Kauri wood and Two Creeks wood (Table 1). We currently use NIST-supplied SRM 4990-C and SRM 4990 as our primary standards, with a secondary, working standard of ANU Sucrose.

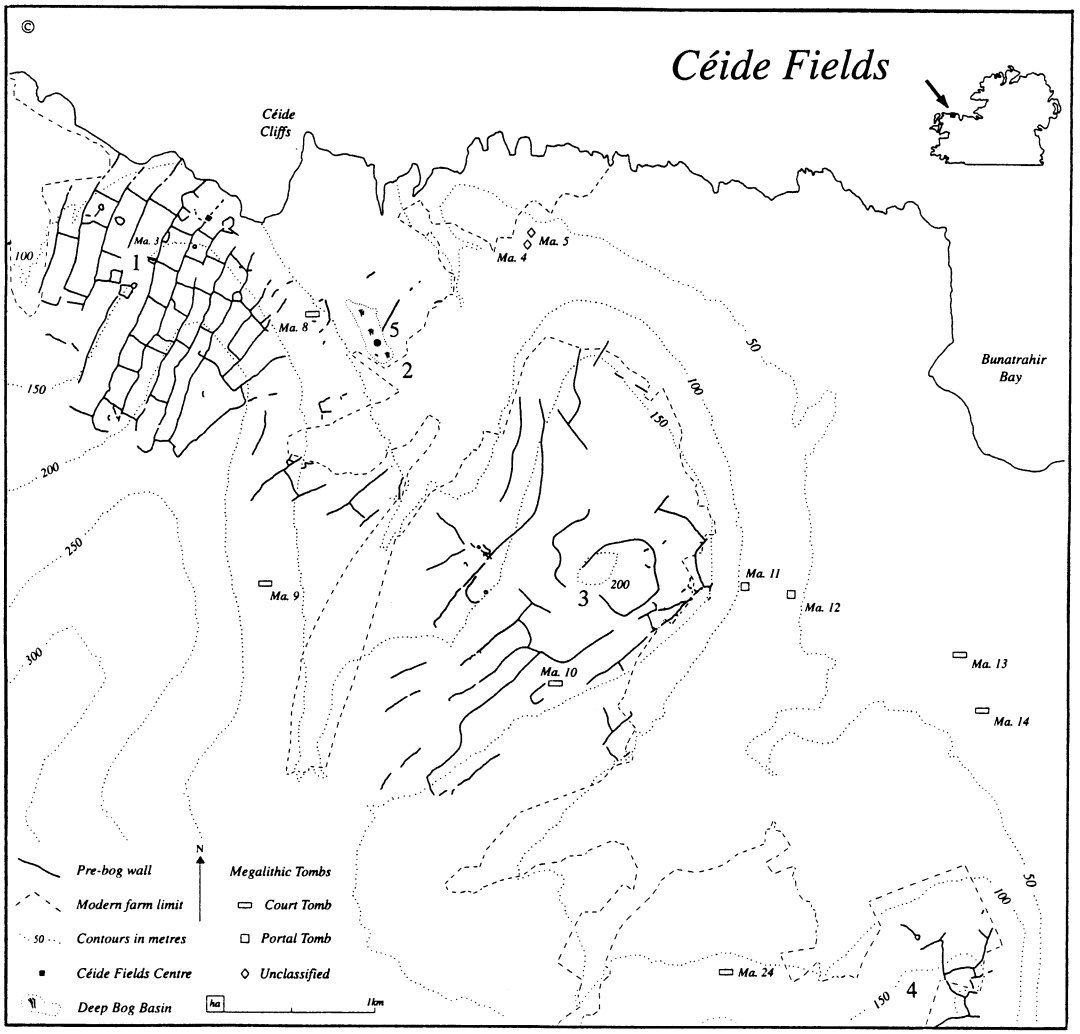

Fig. 2. Map of Céide Fields. 1 = Behy; 2 = Glenulra; 3 = Ballyknock; 4 = Aghoo; 5 = Pollen sampling site

TABLE 1. UCD-Dated ^{14}C Ages for Selected International Intercomparison Materials

Lab Code	Material	Consensus age (BP ± 1σ)	UCD age (BP ± 1σ)
TIRI-I*	Travertine	11,060 ± 17	11,107 ± 145
TIRI-J*	Crannog wood	1605 ± 8	1675 ± 25
TIRI-K*	Turbidite	18,155 ± 34	18,127 ± 260
TIRI-H*	Ellanmore whole peat	11,152 ± 23	10,860 ± 150
TIRI-M*	Icelandic peat	1682 ± 15	1646 ± 25
IAEA-C2†	Travertine	7163 ± 12	7240 ± 90
IAEA-C4†	Waikato Kauri wood	43,550–49,970	43,430 ± 1,090
IAEA-C5†	Two Creeks wood	11,835 ± 32	11,745 ± 180

*Source: Gulliksen and Scott (1995)
†Source: Rozanski (1991); Rozanski *et al.* (1992)

Results and discussion

^{14}C dates for 44 subfossil pine stumps and 2 peat samples from the North Mayo blanket bog are given in Table 2. In the following discussion, the data from Céide Fields are treated on a townland basis and are compared with data from other areas of North Mayo, including Belderrig and Annagh More/Annagh Beg. The dates are also compared with a series of dates from a major pollen analysis study within Céide Fields by Molloy and O'Connell (1995). Finally, we consider the synchroneity of the pine phenomenon, the date of initiation of blanket peat and their implications for the extension by half a millennium of the date of the oldest field systems known.

Céide Fields (Behy, Glenulra, Ballyknock and Aghoo Townlands)

Behy

Three pine samples were ^{14}C-dated from Behy townland, close to Behy megalithic tomb. Sample C45, which lay on the mineral soil 1 m from a pre-bog wall, dated to 4450 ± 60 BP; sample C51, which was found lying horizontally in the bog and was taken from 5 cm above the mineral soil, dated to 4500 ± 60 BP; and sample C57, which was 65 m west of the tomb and lying on the mineral soil, dated to 4420 ± 50 BP. A cross-section of sample C57 indicated by the curvature of its rings that it is an outer remnant of a very large trunk of a fallen pine and is not part of the root system.

Glenulra

The date of C42 (4530 ± 60 BP), a pine stump on 90 cm of peat near the edge of the deep peat basin from which the pollen core was taken, is similar to the dates for the Behy pines to the west and the Ballyknock pines to the south. The date for C44, a pine stump at the base of the peat, is 5370 ± 70 BP and is earlier than the clearly defined pine phase. The depth at which it occurs and its date agree with the date for the peat at just over 500 cm depth in the pollen core discussed below, a level at which burnt fragments of pine were found.

Ballyknock

Of the six samples ^{14}C-dated from the Ballyknock area, four were *ca.* 4500 BP, which is a clear indication that the pine forest was well established on blanket bog formed over abandoned Neolithic fields at this time. Specifically, sample C21, which was 10 cm above the mineral soil, dated to 4490 ± 60 BP; sample C23, which was 75 cm above the mineral soil, dated to 4540 ± 60 BP; sample C29, which was 30 cm above the mineral soil, dated to 4510 ± 50 BP; and sample C37, which was 30 cm above the mineral soil, dated to 4500 ± 50 BP. Also, because three of the four samples were growing on at least 30 cm of peat, it is reasonable to assume that blanket bog was well established by 4600 BP. Samples C28 and C34 (4230 ± 60 BP and 3950 ± 60 BP, respectively) illustrate the longevity of the pine episode at this particular location. The range of dates from Ballyknock spans almost the entire pine phase and is representative of the general range of pine dates from North Mayo.

Aghoo

Farther to the southeast lies the townland of Aghoo, which is also part of the Céide Fields system. Four pine samples were dated from this region: sample C22, which was 25 cm above the mineral soil and dated to 4210 ± 60 BP; sample C27, which was 30 cm above the mineral soil and dated to 4170 ± 50 BP; sample C30, which was 20 cm above the mineral soil and dated to 4190 ± 50 BP; and sample C33, which was 30 cm above the mineral soil and dated to 4100 ± 60 BP. Statistically, these are indistinguishable in age. They were also found at virtually the same height above the mineral soil. However, what is even more remarkable is that the growth of pine at this location could be as

TABLE 2. ^{14}C Dates (± 1σ) for North Mayo Subfossil Pine Stumps (and Basal Peat)

Lab code	Location	Grid reference	Height above mineral soil (cm)	^{14}C age (yr BP)
Céide Fields				
UCD-C45	Behy, 1 m from wall	G-050-404	0	4450 ± 60
UCD-C51	Behy, near tomb	G-050-404	5	4500 ± 60
UCD-C57	Behy, 65 m west of tomb	G-047-405	0	4420 ± 50
UCD-C42	Glenulra	G-063-399	90	4530 ± 60
UCD-C44	Glenulra	G-063-399	0	5370 ± 70
UCD-C21	Ballyknock	G-076-387	10	4490 ± 60
UCD-C23	Ballyknock	G-072-382	75	4540 ± 60
UCD-C28	Ballyknock	G-072-382	20	4230 ± 60
UCD-C29	Ballyknock	G-072-382	30	4510 ± 50
UCD-C34	Ballyknock	G-073-382	35	3950 ± 60
UCD-C37	Ballyknock	G-074-383	30	4500 ± 50
UCD-C22	Aghoo	G-086-354	25	4210 ± 60
UCD-C27	Aghoo	G-092-360	25	4170 ± 50
UCD-C30	Aghoo	G-089-357	20	4190 ± 50
UCD-C33	Aghoo	G-089-357	30	4100 ± 60
Belderrig (7 km west of Behy)				
UCD-C04	Belderg More	F-997-412	30	4480 ± 60
UCD-C11	Belderg More	G-008-408	50	4010 ± 60
UCD-C14	Belderg More	G-013-409	25	4310 ± 70
UCD-C18	Belderg More	F-997-413	0	4150 ± 60
UCD-C49	Belderg More	F-997-412	on a wall	4580 ± 60
UCD-C07	Belderg Beg	F-976-402	70	3330 ± 50
UCD-C31	Belderg Beg	F-984-406	0	4510 ± 50
UCD-C58	Belderg Beg	F-975-402	75	3960 ± 60
UCD-C60	Belderg Beg	F-985-405	unknown	3930 ± 50
UCD-C47	Geevraun	F-983-409	45	4210 ± 60
UCD-C46	Geevraun (peat)	F-983-409	5 (beneath C47)	5710 ± 90
Annagh More/Annagh Beg (3 km east of Aghoo)				
UCD-C26	Annagh More	G-115-343	on a wall	4350 ± 60
UCD-C50	Annagh More	G-115-343	0	4440 ± 60
UCD-C24	Annagh Beg	G-118-323	180	4440 ± 60
UCD-C38	Annagh Beg	G-119-323	140	3820 ± 60
Erris Region (to the west of Belderrig)				
UCD-C01	Inver	F-784-338	75	4240 ± 60
UCD-C02	Aghoos	F-857-351	65	4340 ± 60
UCD-C12	Aghoos	F-854-356	75	3950 ± 60
UCD-C05	Carnhill	F-824-356	135	4250 ± 60
UCD-C13	Muings	F-781-309	200	3990 ± 60
UCD-C16	Bunalty	F-927-339	65	4490 ± 60
UCD-C19	Gortmelia	F-803-338	10	4530 ± 60
UCD-C20	Carrowmore	F-817-314	65	4230 ± 60
UCD-C25	Glencullin	F-875-272	15	4460 ± 60
UCD-C35	Graghil	F-791-376	40	4440 ± 50
UCD-C36	Gortbrack North	F-815-356	125	3090 ± 50
UCD-C43	Muingerroon South	F-848-318	30	4080 ± 60
UCD-C41	Muingerroon South	F-848-318	0	6720 ± 90
UCD-C52	Tullaghanbaun	F-753-149		4070 ± 60
UCD-C48	Tullaghanbaun	F-753-149	80	7530 ± 100
UCD-C54	Tullaghanbaun (peat)	F-753-149	beneath C48	8660 ± 130

much as 300 yr later than that at Ballyknock. This suggests a phased spread of pine onto different areas of the bog, possibly because of local differences in climatic and physical conditions. On the other hand, the discrepancy in dates between these and the older samples may be due to the wide uncertainty in the calibration curve between ^{14}C dates of 4250 BP and 4000 BP.

The range of dates for the pine remains from the Behy, Glenulra, Ballyknock and Aghoo areas of Céide Fields must indicate an early date for the pre-bog fields. In Behy and Ballyknock the bog must have started to cover the fields by 4600 BP at the latest, given the dates of the pines and the depths of peat found beneath them. As there is no indication of any peat underlying the walls and as many of the stumps are in close proximity to walls, the very early date for the construction and use of the fields is not in doubt.

Belderrig

Belderrig valley, which includes the Belderg More, Belderg Beg and Geevraun townlands, lies *ca.* 7 km west of the new Interpretative Centre sited within Céide Fields. The pine tree on display at the Centre (C60) was from Belderg Beg and dated to 3930 ± 50 BP. Another nine pine samples were dated from this area and, as in the case of Céide Fields, they are closely associated with the archaeology of the region. Four of the five dates from Belderg More townland were sampled from beside and on top of stone walls. These were sample C04 (4480 ± 60 BP), which was located 2 m from a wall, 30 cm above the mineral soil; C18 (4150 ± 60 BP), which was located 30 m east of a wall junction in the mineral soil; C49 (4580 ± 60 BP), which was located 9 m south of the above junction and on top of the wall; and C11 (4010 ± 60 BP), which was located 1 km further to the east, and was 55 m from another wall junction 50 cm above the mineral soil. The fifth sample, C14 (4310 ± 70 BP), came from an area further again to the east 25 cm above mineral soil.

The above dates are a clear indication that the pre-bog field walls at Belderg More must be Neolithic in date. This is most vividly illustrated by sample C49, which was found rooted on top of a wall and which proved to be the earliest of the pine dates from the dominant pine expansion at 4580 BP. Hence, not only is it clear that the wall predates the pine date, but that the walls were constructed some considerable time before 4580 BP, given the depth of peat from the top of the pine stump to the mineral soil. Sample C18 (4150 ± 60 BP) is much later than the other dates and, moreover, it was rooted in the mineral soil. Hence, an earlier date would have been expected, considering its proximity to a wall and to the other older samples. Again, we cannot exclude the possibility that the uncertainty in the calibration curve may also be a factor here. A similar observation can be made about sample C11.

Three of the four dates from the vicinity of the Belderg Beg excavation, which lies 1.5 km west of Belderg More, substantiate the dates discussed above. Moreover, the date of C31 (4510 ± 50 BP), which was located 5 m from a wall at the Belderg site, is indistinguishable from C49 described above. Sample C58 (3960 ± 70 BP), which was 75 cm above the mineral soil and some 800 m southwest of C31, illustrates the late survival of pine in this area, as does sample C60, which dated to 3930 ± 50 BP. The final sample, C07 (3330 ± 50 BP), is one of two pine dates in the present study that fall later than 3800 BP. It was located on 70 cm of peat near C58 and suggests the very late survival of a limited number of pines in the area.

Annagh More/Annagh Beg

The Annagh More/Annagh Beg townlands lie 3 km east of Aghoo; four pine samples were ^{14}C-dated from this area. Two of the samples were from Annagh More and were taken on top of (C26)

and close to (C50) stone walls which establish their construction to at least the mid-Neolithic era. Sample C26 dated to 4350 ± 60 BP, which is consistent with trees from similar contexts from other areas of Céide Fields, as discussed above. Sample C50, which was found rooted in the mineral soil, dated to 4440 ± 60 BP, indistinguishable from the dates for Behy in Céide Fields.

Pollen Analysis at Céide Fields

The series of ^{14}C dates for pines from the peat overlying Céide Fields indicate that the fields must have been abandoned to peat growth by 4500 BP. A detailed pollen analysis of a core of deep peat from a small peat basin in Glenulra townland within Céide Fields carried out by Molloy and O'Connell (1995) supports this date. Their study gives ten ^{14}C dates for a section of the peat monolith from which the pollen was extracted between a lower depth of 518 cm and an upper limit of 319 cm depth (Table 3).

TABLE 3. Selected ^{14}C Dates (± 1σ) for a Pollen Profile of a Deep Peat Basin in Glenulra Townland (Source: Molloy and O'Connell 1995)

Lab code	Depth (cm)	^{14}C age (yr BP)
GLU IV-11	319–322	3510 ± 50
GLU IV-4	351–355	3890 ± 60
GLU IV-10	387–390	4070 ± 60
GLU IV-3	402–406	4110 ± 60
GLU IV-9	440–444	4470 ± 60
GLU IV-2	448–452	4550 ± 60
GLU IV-8	459–462	4500 ± 60
GLU IV-1	486–490	4840 ± 60
GLU IV-7	494–497	5170 ± 60
GLU IV-6	515–518	5100 ± 80

Between 490 and 486 cm, the pine pollen and other arboreal species had dropped dramatically and grass pollen showed a major increase. This level was dated to before 4840 ± 60 BP. Grass and other herbaceous pollen continued to increase for a time, but by 460 cm, the grass had given way to heather. This level was dated to 4500 ± 60 BP. Grass pollen is virtually absent from the pollen diagram between 460 and 390 cm. This upper level was dated to 4070 ± 60 BP. At 400 cm a major increase in pine pollen is recorded. This level was dated to 4110 ± 60 BP. This date for the final pine peak in the pollen profile is somewhat later than one would expect, given the location of the sampling site in the valley between Behy and Ballyknock, though the date is in close agreement with the dates for the pines from Aghoo townland at the southern end of Céide Fields.

The most important result from pollen analysis is that the pollen of pasture is not recorded in the samples spanning the latter half of this millennium. The overall result of the pollen analysis has dated the pasture phase firmly to 5200–4500 BP and developing moorland with pine spreading onto its surface to 4600–4000 BP.

Because Céide Fields is so extensive, one paleobotanical problem is the extent to which the pollen record from the Glenulra basin is a true reflection of the vegetation of the entire Céide Fields area or whether the record reflects in the main a more local catchment closer to the sampling site.

Synchroneity of the Pine Forest

One of the most important questions to be resolved by our dating program was whether the phenomenon of pines in bog overlying Céide Fields was synchronic or diachronic. In other words, did this

expansion of pine onto blanket peat date to a narrow time window, as has been observed in Scotland (Birks 1975; Gear and Huntley 1991)? If it was a synchronous event it may represent two periods of climate change—one toward drier conditions, which allowed pines to spread onto the surface of the bog and thrive for some centuries, and then a second towards wetter conditions, which led to the renewed growth of the bog.

The majority of the 44 subfossil pine samples dated in this study were taken from stumps found preserved and standing upright in the peat. It is certain that these stumps are *in situ*, and it therefore follows that the roots and bases of these trunks were in an environment that preserved them, whereas, in most cases, the upper parts of the trees (trunks, branches, needles, cones) were not.

Clearly the pine dates for North Mayo are clustered very tightly together, except for five dates, three of which are earlier and two later (Fig. 3). If these five are excluded, the mean ^{14}C age of the main cluster ($N = 39$) of pine samples from the North Mayo blanket bog is 4280 ± 70 BP (at the 95% confidence level) and the most significant aspect of these dates is that there appears to be a definitive

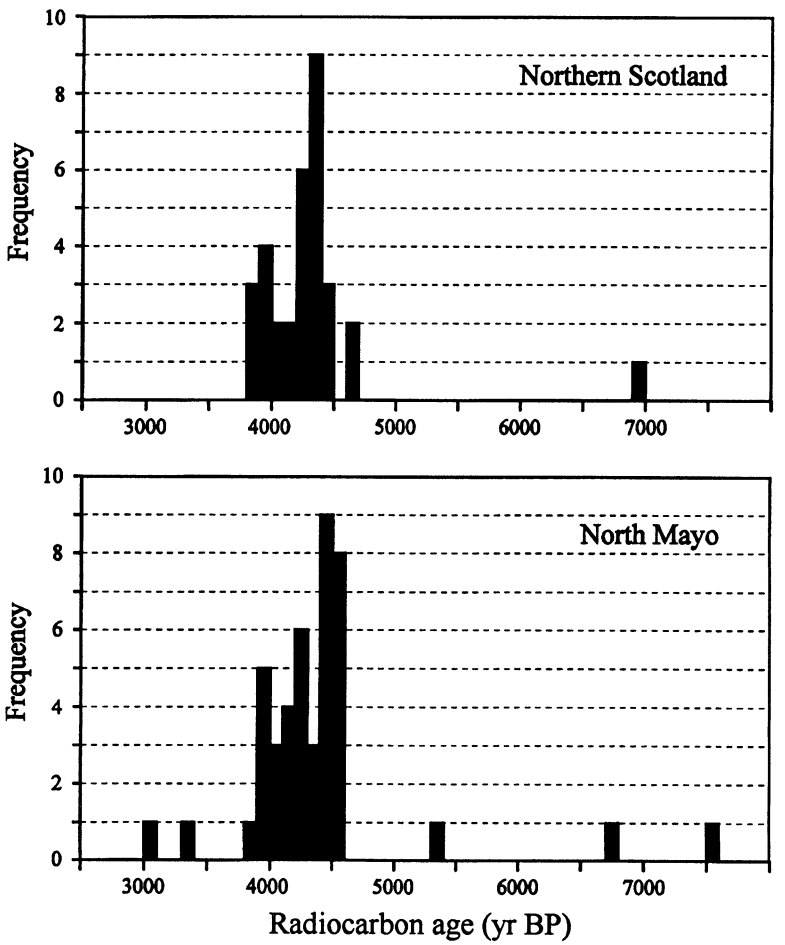

Fig. 3. Comparison of subfossil pine dates and duration in North Mayo and Scotland. Data ($N = 31$) for far northern Scotland (NW Highlands) compiled from Birks (1975) and Gear and Huntley (1991)

start-off point at 4600 BP, before which there are few, if any, pine trees. This suggests that whatever caused this onset of pine was quite dramatic. Further, the decline of the pine trees between 700 and 800 yr later happens very quickly at 3800 BP, although a very small number of pine trees seem to survive at various locations for a number of centuries later.

The phenomenon is not unique to Ireland; a similarly rapid expansion of pine onto peat surfaces followed later by a sudden decline has also been observed in northern Scotland (Birks 1975; Gear and Huntley 1991). Further, the dates of both the onset and demise of the Scottish pines coincide with the dates from North Mayo. This is clearly illustrated in Figure 3, which compares the data from Mayo with the data from the Scottish studies. Both sets of data highlight the widespread and synchronous nature of the expansion and retreat of pine growth on blanket peat between 4600 and 3800 BP. Further, the mean ^{14}C age for the Scottish pines at 4230 ± 80 BP (N = 31) is indistinguishable from the corresponding mean of 4280 ± 70 BP for the North Mayo blanket bog.

Gear and Huntley postulate climatic change as the explanation for the expansion of pine onto blanket bog surfaces in northern Scotland. Climate change has also been invoked to explain margin shift in subfossil pines in Fennoscandia (Eronen and Huttunen 1987; Eronen and Zetterberg 1996). The widespread nature of this phenomenon in northwestern Europe and its occurrence at northern latitudes would seem to preclude the likelihood that the phenomenon was affected in any major way by human activity. In particular, it is difficult to accept Baillie's (1995) view that "humans were almost certainly involved in the demise of pine trees in Ireland". The climatic interpretation would appear to be supported by evidence of drier climatic conditions at this time based on glacier recession in the Swiss Alps, attributed to higher summer temperatures and/or decreased precipitation in winter and spring (Hormes, Schlüchter and Stocker 1998).

At present, the blanket bog region of North Mayo is a windswept and virtually treeless environment and is extremely unsuitable for tree growth, including *Pinus sylvestris*. However, the presence of pine stumps on some of the more extreme headlands and the islands off the west coast, which are apparently unsuitable for tree growth today primarily because of their exposure to wind, would seem to indicate that the climate of the time was less windy, or perhaps that strong westerlies were less frequent.

The Date of Initiation of Blanket Peat in North Mayo

The widespread expansion of blanket peat in North Mayo is of particular interest because of the extensive evidence of human settlement and the suggestion that human activity could have been a major factor in creating conditions suitable for such an expansion. Caulfield (1983) has rejected the human impact hypothesis and has suggested that early bog growth to the west of Belderrig could account for the apparent archaeological void in this region. The ^{14}C date for the lower of two pine layers at Muingerroon South (Bellanaboy), 8 km west of Belderrig, suggests that sufficient peat to preserve this tree had formed by 7110 ± 75 BP (Håkansson 1974). The date of 4340 ± 65 BP for the upper layer, 20 cm above the lower, fits with the late pine phase and the gap of 2800 yr between the dates of the two layers suggests that the rate of growth was exceptionally slow. Indeed, the double layer of pine stumps has been replicated in the present study with dates of 6720 ± 90 BP (C41) and 4080 ± 60 BP (C43) for the same general location. Farther west, in an intertidal zone at Tullaghanbaun on the east side of Blacksod Bay, a still earlier date was obtained for a pine on 80 cm of peat. The pine was dated to 7530 ± 100 BP (C48) and the peat beneath it to 8660 ± 130 BP (C54). These dates confirm the earlier limited indication that bog began to form in early postglacial times in the region to the west of Céide Fields.

The ^{14}C dates for the many pines falling *ca.* 4500–4300 BP and rooted wholly in peat must mean that peat initiation was earlier and, in some cases, much earlier than these dates. There is now evidence to suggest that peat was already accumulating not just in the west of North Mayo but also in close proximity to the human settlements throughout the entire region. At Geevraun, 300 m west of the Belderg Beg excavation, a pine stump 45 cm above the mineral soil was dated to 4210 ± 60 BP (C47). A peat sample 5 cm above the mineral soil immediately under this pine stump was dated to 5710 ± 90 BP (C46). It is clear from this date that peat was already accumulating on this low ridge prior to the beginnings of farming a few hundred meters away. Even to the east of Céide Fields, it now seems certain that peat was starting to grow long before the arrival of farming communities. At Annagh Beg, on a flat intermediate plateau to the south of Annagh More, two pine stumps that dated to 4440 ± 60 BP (C24) and 3820 ± 60 BP (C38) grew on peat of 180 and 140 cm depth, respectively. Peat would also have formed at an early stage in the Glenulra basin, but this would be expected in a confined hollow. It seems now that early farming communities entering North Mayo would have found a patchwork of forest and areas already going over to blanket bog. While the need for a further series of dates of the basal peat beneath the pine stumps is now indicated, it is obvious from the evidence already available that blanket bog formation in Mayo is early and almost certainly unconnected with human activity.

Neolithic Settlement in North Mayo

Céide Fields has been known for over a quarter of a century and, together with Belderg Beg, has provided the evidence for land enclosure and bounded fields prior to 4000 BP. That such field systems date to the Neolithic in Ireland is based on both archaeological evidence and a few ^{14}C dates. Neolithic pottery and stone artifacts were discovered in an oval enclosure in Glenulra townland. A ^{14}C date of 4460 ± 115 BP was obtained for charcoal from a hearth within the enclosure (Caulfield 1978). Three hundred meters away, beside a megalithic Court tomb in Behy townland, the lower levels of peat were dated by Smith, Pearson and Pilcher (1973), as illustrated in Table 4. The conclusion was that a Neolithic presence was there by the middle of the millennium and that the bog was already beginning to engulf the fields by 4000 BP (Caulfield 1983).

TABLE 4. Peat ^{14}C Dates (± 1σ) from beside Behy Megalithic Tomb (Source: Smith, Pearson and Pilcher 1973)

Lab code	Relative height (cm)*	^{14}C age (yr BP)
UB-158F	36–38	3930 ± 105
UB-155	30–34	3630 ± 70
UB-153F	24–28	3890 ± 110

*Mineral soil/peat interface was *ca.* 24–28 cm

At Belderg Beg, 7 km to the west, Neolithic artifacts associated with pre-bog walls again indicated the early date of the walls (Caulfield 1978). The outer rings of a pine tree with its root system on the surface of the mineral soil, 14 m from a pre-bog wall, was dated to 4220 ± 95 BP (Caulfield 1978). The wall must be older than the bog, which in turn must have begun to form before the tree that is growing within it.

Over the last decade, many archaeologists involved in Neolithic research have focused on the evidence for continuity from the Mesolithic into the Neolithic. Long-established patterns of nomadism and movement along pathways through pristine terrain is the favored interpretation of several of them. Barrett (1994) suggests that the enclosure of fields and the creation of an agricultural land-

scape only took place at the end of the second millennium BC. Even to suggest that field systems existed in the Neolithic was described by Thomas (1991) as "astonishing". Thomas (1996) has attempted to overcome the problem of reconciling the evidence for Neolithic fields at Céide Fields with his theories of nomads' pathways by dismissing the already published dating evidence for Céide Fields as "equivocal", but he offers no reason for considering the previously published dates from Behy and Glenulra within Céide Fields to be equivocal.

The series of dates presented above remove any question about the Neolithic date of the Mayo pre-bog fields. The dates of many of the pines from within areas of Céide Fields such as Behy and Ballyknock now show that the fields are not just Neolithic in date but that they must be redated to the first half of the fifth millennium BP, rather than to the second half. As discussed above, the evidence for the pasture phase in the pollen analysis supports this date.

To the west of Céide Fields, the new pine dates from Belderg More and Belderg Beg on the two sides of Belderrig valley agree with the dates from Céide Fields. In Belderg Beg, midway between the previously dated pine (SI-1470) and a pre-bog wall, the outer rings of another pine with its roots in the mineral soil was dated to 4510 ± 50 BP (C31). The preservation of this tree stump depended on the bog covering up its base before or very shortly after the death of the tree. In Belderg More townland, 2 km to the northeast of the Belderg Beg excavation, a pine on top of a wall gave the very early date of 4580 ± 60 BP (C49) and a second pine beside the wall was dated to 4480 ± 60 BP (C04). In Annagh More, 8 km to the east of Céide Fields, two dates for pines, one lying on top of a wall and another 3 m away, had dates of 4350 ± 60 BP (C26) and 4440 ± 60 BP (C50), respectively. West of Céide Fields, in Glencullin in the Erris region, a pine tree that grew on 15 cm of peat located within 5 m of a pre-bog wall was dated to 4460 ± 60 BP (C25). Six kilometers to the north in Gortmelia, a pine stump on 10 cm of peat located 40 m from a pre-bog wall was dated to 4530 ± 60 BP (C19).

It is obvious from these dates that the early date of Céide Fields is not unique in North Mayo. On the contrary, there are many locations in this region where the dates of the pine trees in the bogs provide unequivocal evidence that the field boundaries beneath the bog must predate 4500 BP, at the latest. Whether the Neolithic field systems of North Mayo are a unique regional phenomenon or whether they are unique only in their survival is an important question for Neolithic research. The occurrence of extensive field systems in an otherwise normal Neolithic context in Mayo suggests that the accepted late date for the phenomenon of land enclosure elsewhere should be thoroughly reexamined in the light of the evidence presented above.

Conclusion

Our key findings may be summarized as follows:

- The phenomenon of *Pinus sylvestris* found in North Mayo blanket bog was a synchronous event. The widespread expansion of pine had commenced by *ca.* 4600 BP and the subsequent demise occurred *ca.* 3800 BP. These dates are in exact agreement with a similar phenomenon that has been observed in Northern Scotland.
- At the latest, blanket bog was widespread in North Mayo by 4500 BP. Indeed, it is reasonable to suggest that it was widespread some 500 yr earlier, given the depth of peat beneath some of the pine stumps and the (near) basal peat date at Geevraun.
- Much of Céide Fields and other Neolithic pre-bog field systems in North Mayo were abandoned and already covered by shallow peat by 4500 BP. Thus, the dates of construction and the period of use of Neolithic field systems in the region are older than was anticipated.

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