



RADIOCARBON DATING OF RINDLE MOSS

Jessica Gauld, Arthur Lewis Building 1.046, Oxford Road, Manchester, M21 0DZ Jessica.gauld@postgrad.manchester.ac.uk

Background and Rationale

This report presents the first chronological data for Rindle Moss, a lowland raised bog located in the Greater Manchester region, north-west England. The site has been recently placed under conservation management, and its restoration is part of the Lancashire Wildlife Trust's 'Lancashire Peatlands Initiative'. The rationale for this study is to provide chronological control to aid future palaeoecological analysis, which aims to support and inform site restoration as part of the wider initiative to restore priority habitats for the benefit of communities, climate and biodiversity.

Methods

Fieldwork

Rindle Moss (SJ 70383 96747) is a fragment (c. 7 hectares) of the once-extensive Chat Moss lowland peatland complex, situated to the west of Greater Manchester. Although the site is heavily degraded, the vegetation cover includes some of the only remnant Chat Moss species, including *Erica tetralix* and *Sphagnum papillosum*, as well as *Polystrichum strictum*. The site additionally presents a high cover of *Molinia caerulea* and has a wooded border, though the wooded area bisecting the site (Figure 1) has been recently removed by Lancashire Wildlife Trust.

A 3.05 m core (RM22A) was collected from Rindle Moss in 2022 using a Russian corer and transported in guttering and plastic wrap to the laboratory fridges at the University of Manchester's Geography Laboratory. Permission for the fieldwork was obtained from Lancashire Wildlife Trust. The core surface was cleaned using a spatula and visual analysis of the stratigraphy was undertaken using the Troels-Smith Classification.

Radiocarbon analysis

The sampling strategy targeted basal and mid-core depths, as this was deemed to be a sensible preliminary dating strategy towards constraining sedimentation rates. Radiocarbon dates were provided by the 14CHRONO Centre through funding granted by the Quaternary Research Association. Radiocarbon age calibration was undertaken in R (version 3.6.3) using the package Bchron, which utilises Bayesian modelling methods using the algorithm outlined in Haslett and Parnell (2008).

Results

The results of the radiocarbon analysis are shown in **Table 1**, with a comparison of the results with of existing dates for a selection of sites in northwest England shown in **Table 2**. Site locations are illustrated in **Figure 2**.



Figure 1. Satellite image of Rindle Moss and, above, Rindle Field (Google Map image)

Lab ID	Total core length	Position (cm)	Material	Conventional C14 age	Calibrated age (2ơ range) cal. BP	Calibrated age (2ơ range) cal. BC/AD
UBA-48939	3.05	246	Bulk peat	4829 ± 29	5560 – 5480	3650-3528 cal. BC
UBA-48940	3.05	100	Bulk peat	3177 ± 30	3450 - 3360	1505-1405 cal. BC

Table 1 Radiocarbon dates for Rindle Moss as part of the current study. All radiocarbon dateshave been recalibrated in R using Bchron for this report.

Site	Lab ID	Total core length)	Position (cm)	Material	Conventional C14 age	Calibrated age (2σ range) cal. BP	Calibrated age (2ơ range) cal. BC/AD	Reference
Chat Moss (Rindle Moss)	UBA-48940	3.05	100	Bulk peat	3177 ± 30	3450 - 3360	3650 – 3530 cal BC	This study; unpublished PhD work (J. Gauld)
Chat Moss (Rindle Moss)	UBA-48939	3.05	246	Bulk peat	4829 ± 29	5600 - 5480	1505 – 1405 cal BC	This study; unpublished PhD work (J. Gauld)
Holcroft Moss	Beta-629803	4.47	245	Plant tissue	2250 ± 30	2340 - 2150	315 – 205 cal BC	Unpublished PhD work (J. Gauld)
Holcroft Moss	Beta-629804	4.47	385	Bulk peat	3330 ± 30	3680 - 3410	1690 – 1520 cal BC	Unpublished PhD work (J. Gauld)
Holcroft Moss	Beta-456519	0.5	36.5	Plant tissue	550 ± 37	640 - 510	cal AD 1310 - 1440	Fletcher and Ryan (2018)
Holcroft Moss	Beta-443587	0.5	39.5	Plant tissue	560 ± 45	650 - 510	cal AD 130 – 1440	Fletcher and Ryan (2018)
Holcroft Moss	Beta-440756	0.5	46.5	Plant tissue	650 ± 37	555 - 670 - 560	cal AD 1280 – 1400	Fletcher and Ryan (2018)
Holcroft Moss	SUERC-103535	3.6	19	Sphagnum leaves	232 ± 37	430 - 2	cal AD 1520 – 1950	Wang <i>et al.</i> (2023)
Holcroft Moss	SUERC-102457	3.6	59	Sphagnum leaves	895 ± 37	910 - 730	cal AD 1040 – 1220	Wang <i>et al.</i> (2023)
Holcroft Moss	SUERC-102458	3.6	99	Sphagnum leaves	973 ± 37	930 - 790	cal AD 1000 – 1160	Wang <i>et al.</i> (2023)
Holcroft Moss	SUERC-102462	3.6	131	Sphagnum leaves	1169 ± 37	1180 - 970	cal AD 770 – 980	Wang <i>et al.</i> (2023)
Holcroft Moss	SUERC-102463	3.6	167	Sphagnum leaves	1578 ± 37	1530 – 1390	cal AD 420 – 570	Wang <i>et al.</i> (2023)
Holcroft Moss	SUERC-102464	3.6	199	Bulk peat	1883 ± 37	1880 – 1710	cal AD 70 – 240	Wang <i>et al.</i> (2023)
Holcroft Moss	SUERC-102465	3.6	239	Bulk peat	2198 ± 35	2330 - 2120	380 – 170 cal BC	Wang <i>et al.</i> (2023)
Holcroft Moss	SUERC-102466	3.6	279	Bulk peat	2482 ± 37	2720 - 2420	770 – 420 cal BC	Wang <i>et al.</i> (2023)
Holcroft Moss	SUERC-102467	3.6	319	Bulk peat	2864 ± 35	3140 - 2870	1190 – 920 cal BC	Wang <i>et al.</i> (2023)
Holcroft Moss	SUERC-103946	3.6	350	Bulk peat	3343 ± 36	3690 - 3410	1740 – 1520 cal BC	Wang <i>et al.</i> (2023)
Holcroft Moss	SUERC-102468	3.6	362	Bulk peat	4658 ± 37	5470 - 5310	3520 – 3370 cal BC	Wang <i>et al.</i> (2023)
Chat Moss (Astley Moss)	Beta-132269	2.5	16-17	nd	280 ± 60	500 - 270	cal AD 1460 – 1680	Davis and Wilkinson (2004)
Chat Moss (Astley Moss)	Beta-120498	2.5	34-35	nd	2140 ± 50	2310 - 1990	250 – 40 cal BC	Davis and Wilkinson (2004)
Chat Moss (Astley Moss)	Beta-120499	2.5	43-44	nd	2380 ± 60	2550 - 2310	600 – 370 cal BC	Davis and Wilkinson (2004)
Chat Moss (Astley Moss)	Beta-132270	2.5	239-240	nd	4460 ± 40	5290 - 4960	3340 – 3010 cal BC	Davis and Wilkinson (2004)

Table 2 : Radiocarbon dates for the current study and obtained from the literature for study site and surrounding sites in the north-west region. All radiocarbon dates have been recalibrated in R using Bchron for this report.

Site	Lab ID	Total core length)	Position (cm)	Material	Conventional C14 age	Calibrated age (2σ range) cal. BP	Calibrated age (2ơ range) cal. BC/AD	Reference
Chat Moss (Barton Moss)	GU-5366	4.0	20-30	Peat (humic acid)	3280 ± 50	3630 - 3390	1640 – 1440 cal BC	Hall <i>et al.</i> (1995); Bayliss <i>et al.</i> (2015)
Chat Moss (Barton Moss)	GU-5367	4.0	70-80	Peat (humic acid)	4300 ± 60	5050 - 4800	3100 – 2850 cal BC	Hall <i>et al.</i> (1995); Bayliss <i>et al.</i> (2015)
Chat Moss (Barton Moss)	GU-5368	4.0	105-115	Peat (humic acid)	4870 ± 60	5730 – 5470	3790 – 3520 cal BC	Hall <i>et al.</i> (1995); Bayliss <i>et al.</i> (2015)
Chat Moss (Barton Moss)	GU-5369	4.0	152-162	Peat (humic acid)	6020 ± 60	7000 – 6730	5060 – 4780 cal BC	Hall <i>et al.</i> (1995); Bayliss <i>et al.</i> (2015)
Chat Moss (Barton Moss)	GU-5370	4.0	215-225	Peat (humic acid)	6850 ± 60	7790 – 7580	5840 – 5630 cal BC	Hall <i>et al.</i> (1995); Bayliss <i>et al.</i> (2015)
Chat Moss (Barton Moss)	GU-5372	4.0	330-360	Peat (humic acid)	8480 ± 50	9540 - 9420	7590 – 7480 cal BC	Hall <i>et al.</i> (1995); Bayliss <i>et al.</i> (2015)
Chat Moss (Barton Moss)	GU-5372	4.0	380-400	Peat (humic acid)	7750 ± 60*	8610-8410*	6660 – 6460 cal BC*	Hall <i>et al.</i> (1995); Bayliss <i>et al.</i> (2015)
Chat Moss	Q-683	nd	3-5	Peat	2645 ± 100	2970 – 2430	1020 – 480 cal BC	Godwin and Switsur (1966); Hall <i>et al.</i> (1995)
Chat Moss	Q-682	nd	14-16	Peat	3070 ± 150	3580 – 2860	1630 – 910 cal BC	Godwin and Switsur (1966); Hall <i>et al.</i> (1995)
Chat Moss (Nook Farm)	GU-5356	0.55	5-10	Peat (humic acid; Eriophorum)	2170 ± 50	2320 - 2040	370 – 90 cal BC	Hall <i>et al.</i> (1995); Bayliss <i>et al.</i> (2013; 2015)
Chat Moss (Nook Farm)	GU-5272	0.55	38-48	Peat (wood peat)	3710 ± 60	4240 - 3890	2240 – 1940 cal BC	Hall <i>et al.</i> (1995); Bayliss <i>et al.</i> (2013; 2015)
Chat Moss (Nook Farm)	GU-5325	0.55	nd	Wood (carbonised)	3930 ± 80	4580 - 4150	2630 – 2200 cal BC	Hall <i>et al.</i> (1995); Bayliss <i>et al.</i> (2013; 2015)
Chat Moss (Nook Farm)	GU-5354	0.55	5-10	Wood and peat (humic acid)	4020 ± 50	4800 - 4400	2700 – 2450 cal BC	Hall <i>et al.</i> (1995); Bayliss <i>et al.</i> (2013; 2015)
Chat Moss (Nook Farm)	GU-5280	0.55	nd	Wood (waterlogged)	4570 ± 50	5450 - 5050	3380 – 3100 cal BC	Hall <i>et al.</i> (1995); Bayliss <i>et al.</i> (2013; 2015)
Chat Moss (Nook Farm)	GU-5271	0.55	25-40	Peat (wood peat)	4590 ± 70	5470 - 5040	3530 – 3090 cal BC	Hall <i>et al.</i> (1995); Bayliss <i>et al.</i> (2013; 2015)
Chat Moss (Nook Farm)	GU-5273	0.55	30-40	Peat (wood peat)	4670 ± 60	5580 - 5300	3540 – 3350 cal BC	Hall <i>et al.</i> (1995); Bayliss <i>et al.</i> (2013; 2015)

 Table 2 : Radiocarbon dates for the current study and obtained from the literature for study site and surrounding sites in the north-west region. All radiocarbon dates have been recalibrated in R using Bchron for this report.

 *Authors note and reversal and notantial contamination of dated material.

*Authors note age reversal and potential contamination of dated material.



Figure 2. Location of study site (Rindle Moss) and surrounding sites in relation to the extent of peat cover and the former Chat Moss boundary.

Discussion

Rindle Moss has been subjected to historic peat cutting; therefore, it presents an incomplete sequence. Moreover, the core sequence lacks stratigraphic evidence of key bog development stages, such as an obvious fen - bog transition. The stratigraphic sequence (Figure 3) derived from visual inspection of the cores presents seven stratigraphic units, though the first may be a topsoil or recovery peat layer. The upper part of the stratigraphy (Unit 2) presents a very dry and highly decomposed peat. Unit 3 is comprised of fibrous peat, with noted cotton grass and sedge fragments at lower depths. Unit 3 is the only unit with evidence of some Sphagnum macrofossil content. This means this unit could mark a shift toward Sphagnum bog, with the main sections of Sphagnum peat lost to peat cutting, though this is a tentative suggestion. Unit 4 presents the longest stratigraphical unit of the sequence. The upper part of the unit continues to present a fibrous texture with the presence of fine rootlets, with the degree of decomposition increasing

with depth and macrofossil content becomingly notably less after 2 metres. In the lowest units, the peat transitions to a dark grey and silty sediment and then to light-coloured, smooth clay.

The basal age of Rindle Moss is 5480 – 5600 cal BP. This is stratigraphically the lowest datable sediment in the sequence due to the transition to clay indicated in the stratigraphical description and Figure 3. The date from the overlying peat, corresponding with the lower boundary of Unit 3, is 3450 - 3360 cal BP. The radiocarbon dates presented here imply a peat accumulation rate of 0.73 mm per year, based on an assumption of linear accumulation rates. Extrapolation upwards would suggest an approximate age for the uppermost stratigraphy of 2131 cal BP. This is consistent with a historical loss of peat corresponding to the last approximately two thousand years. This extrapolated age is also consistent with the ages of shallow depths reported for other Chat Moss sites (Table 2).



Figure 3. Visual stratigraphy and stratigraphic units for core RM22A

The data presented here suggests that the age of Rindle Moss is comparable with most of the surrounding sites in the Chat Moss complex, as well as Holcroft Moss. The general ages reported in Table 2 indicate that the Chat Moss sites started forming between 9540 - 4960 cal BP, giving the basal ages a maximum range of 4580 years. However, Barton Moss has a basal age that is notably older than the basal ages of surrounding sites in the Chat Moss complex and including the basal age of Barton Moss hides the broad similarity of the basal ages of the other sites. Considering the basal ages of Chat Moss sites without Barton Moss, the sites start forming between 5600 - 2860 cal BP, with a maximum range of 2740 years.

The older basal age of Barton Moss compared to Rindle Moss and other Chat Moss sites, plus Holcroft Moss, aligns with Hall *et al.*'s (1995) postulated asynchronous mire development within the region. It is suggested that Chat Moss began in a number of isolated kettle holes, with the larger complex forming through lateral expansion over of intervening mineral ground from these deeper hollows (Hall *et al.*, 1995). Therefore, with the exception of Barton Moss, the basal age range discussed earlier could indicate the timing of this paludification and the lateral growth of the Chat Moss complex.

The basal age of Rindle Moss is also younger than other sites within the wider north-west region, such as Worsley Farm (basal age: 10500 – 10200 cal BP; Hall et al., 1995; SJ71109432), Red Moss (basal age: 11840 - 10650 cal BP; Hibbert et al., 1971; Hall et al., 1995, SD 638100), and Walker's Heath (basal age: 11100 - 10500 cal BP; Leah et al., 1997; SJ 86707045). Both ages are within the temporal range of welldocumented shifts of varying magnitude to wetter conditions, which are noted in a number of north-west Europe bogs (namely occurring between 5900 - 5300cal BP and 3450 – 3800 cal BP; Hughes et al., 2000; Barber and Charman 2003). However, further proxy work is needed to constrain bog development and hydrology at the site. As the uppermost date marks the start of stratigraphic unit with highest Sphagnum content in the core (Unit 3), the alignment with this widely noted wet shifts may represent an important phase in the bog development.

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