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A 2800-year palaeoclimatic record from Tore Hill Moss, Strathspey, Scotland: the need for a multi-proxy approach to peat-based climate reconstructions

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Abstract

Analyses of plant macrofossils, testate amoebae and humification have been carried out on a 2800-year core from Tore Hill Moss, a raised bog in the Strathspey region of Scotland. All three analyses were carried out at the same 4 cm intervals allowing exact correlation, and the core was dated by nine Accelerator mass spectrometry radiocarbon dates and the Glen Garry tephra layer. The results have been combined and compared to present a bog surface wetness (BSW) record within which the limitations of each proxy method can be assessed and this has highlighted the advantages of a combined rather than a single proxy approach. Significant wet shifts are recorded at ca cal. 560 BC, 60 BC, AD 430, AD 570, AD 700, AD 1090 and AD 1640. Significant shifts to drier periods are also suggested ca cal. AD 220, AD 500 and AD 820. Some of the recorded shifts and phases are related to phases of wetter and drier climate such as the Sub-boreal/Sub-atlantic transition, the Dark Age deterioration and the Romano-British Warm Period. The Dark Ages are notable as a period of rapid peat accumulation and frequent water table fluctuations. Time-series analysis revealed a significant wet-shift cycle of 560 years from the testate amoebae data.

1. Introduction

Over the past 20 years ombrotrophic (rain-fed) bogs have been recognised as being able to provide important palaeoclimatic archives. They are dependent on precipitation for moisture, and therefore their bog surface wetness (BSW) is governed by the effective precipitation (precipitation–evapotranspiration) that the site receives. Proxy records of BSW have therefore been used to infer climate changes. Indicators of BSW have included humification analyses (Aaby, 1976; Aaby and Tauber 1974; Blackford and Chambers, 1991, 1995; Chambers et al., 1997; Mauquoy and Barber, 1999; Chiverrell, 2001), macrofossil analyses (Barber, 1981; Barber et al., 1994, 2000, 2003; Hughes et al., 2000) and testate amoebae analyses (Charman et al., 1999; Hendon et al., 2001). Single proxy records have not been without complications and as a result multi-proxy records have been advocated. However, there are relatively few well-dated multi-proxy records from peat bogs in the UK (Charman et al., 1999; Chiverrell, 2001; Mauquoy et al., 2002a; Mauquoy and Barber, 2002; Langdon et al., 2003). In theory a multi-proxy approach is preferable to allow comparison between proxies and to prevent erroneous interpretations derived from any individual proxy. In practice, this is rarely executed owing to the large amount of time required. This paper offers a high-resolution multi-proxy record together with a good quality chronology for the Strathspey region of Scotland over the last 2800 years and provides an assessment of the sensitivity of each proxy.

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2. Site details

Tore Hill Moss is a small (30 ha) raised bog in Abernethy Forest, north-eastern Scotland (National Grid Reference NH 299 817; Fig. 1). The site is surrounded by Scots pine woodland (*Pinus sylvestris*) and is bordered to the south by Tore Hill (339 m OD) and the Cairngorms. The crown of the bog is intact, displaying a hummocky microtopography consisting of *Sphagnum imbricatum* with swathes of open *Sphagnum* section *Acutifolia* lawn. The existence of *S. imbricatum* hummocks is an intriguing feature given the well-documented decline of this species from many sites (Barber, 1981; Smith, 1985; Wimble, 1986; Stoneman et al., 1993; Mauquoy and Barber, 1999) in Britain. Its presence here is in contrast to the situation at Mallachie Moss, only 3 km away, where this species is absent on both the surface and throughout the core analysed for plant macrofossils (Langdon, 1999). Additional surface vegetation consists of *Calluna vulgaris*, *Erica tetralix* and *Eriophorum vaginatum* on more elevated microforms, with *S.* s. *Acutifolia*, *S. cuspidatum* and *S. magellanicum* in pool and lawn areas. Encroachment of *P. sylvestris* (Scots pine) is evident on the site but tree coring has revealed that these are a maximum of 150 years old with more mature trees confined to the periphery. Evidence of peat cutting can be observed on the eastern side of the bog, and is also peripheral. Although recent fires have occurred, local residents suggest that these have been confined to the surrounding forested areas.

Annual precipitation in the area is around 1005 mm (Barrow et al., 1993). The mean annual temperature is 6.8 °C, and the minimum and maximum monthly temperatures are about −1.7 °C in January and 17.7 °C in July (Barrow et al., 1993). There is a small water deficit in May, June and July, but the high average annual relative humidity of around 85% and effective precipitation of 514 mm ensure a wet environment conducive to *Sphagnum* growth.

3. Methods

3.1. Field and laboratory sampling

A master core from the central area of the bog was obtained using a 9 cm × 30 cm Russian corer (Barber, 1984). The initial 40 cm from the surface was recovered using a monolith tin. All samples were placed in airtight

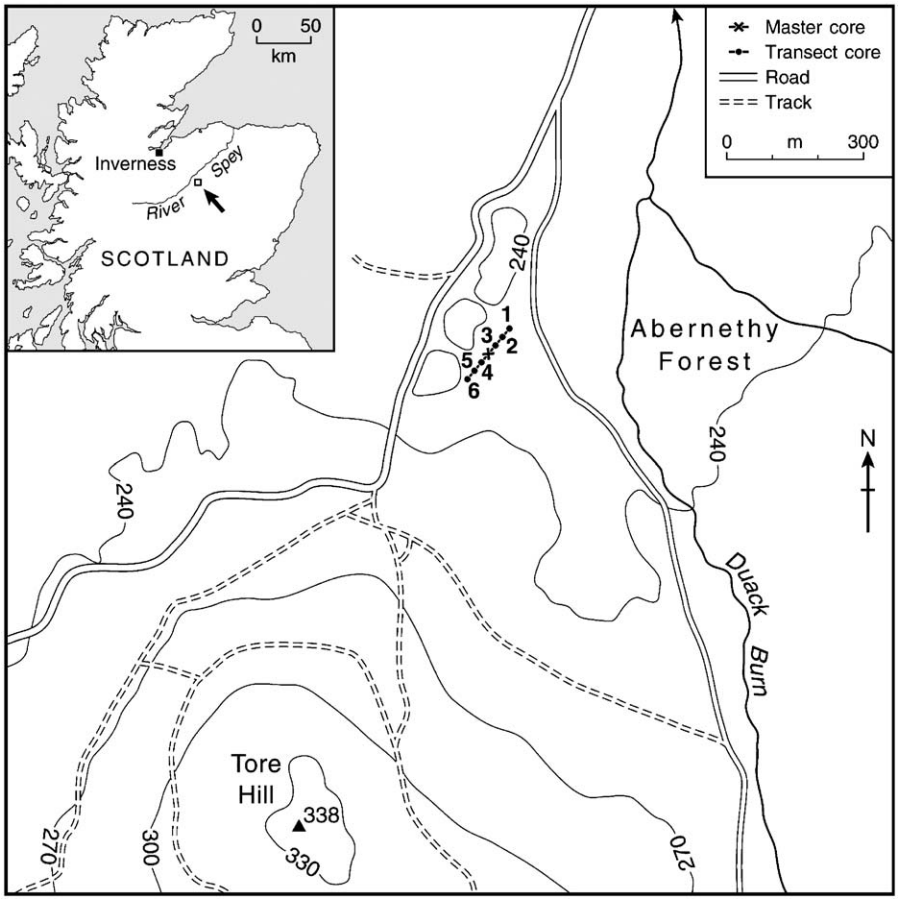

Fig. 1. Location of Tore Hill Moss, stratigraphic transect and master core.