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Research paper

Expanding NPP analysis to eutrophic and forested sites: Significance of NPPs in a Holocene wood peat section (NE Germany)

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ABSTRACT

Alnus glutinosa-dominated peatlands are widespread in central Europe, but the generally bad preservation of micro- and macrofossils has hampered palaeoecological research of their peats. Because of its large carbon sequestration rate, however, peat accumulation in forested peatlands is of special interest for climate change research. This study identifies indicator groups for various types of alder (*A. glutinosa*) carr and sedge (*Carex*) fen vegetation, elaborated by analysis of non-pollen palynomorphs (NPPs) from peat and surface samples. The indicator value of fungal spores and decomposition products of wood was tested by correlation with pollen (especially ALNUS) and macrofossils. Only few indicators of alder carr also occurred with low and constant values during distinct open sedge fen phases, which indicates that small and plane shaped NPPs can be dispersed extra-locally. The diversity and abundance of NPPs appeared to depend on vegetation type and resulting nutrient supply and to water regime and resulting decomposition intensity during peat development.

1. Introduction

Forests dominated by *Alnus glutinosa* have been present in Central Europe since the Early Holocene (Lang, 1994; Berglund et al., 1996). At present, *A. glutinosa* has a Euro-Siberian distribution. In Europe, it is only absent from northern Scandinavia, the central and eastern parts of the Iberian Peninsula and parts of Greece (Meusel et al., 1965). In Northeast Germany, *A. glutinosa* is widespread in peatlands, where alder wood peat is also abundant. Because of the predominantly bad preservation of fossils, only few studies (Marek, 1965; Brown, 1988; Waller, 1993, 1994; de Klerk et al., 1997; Pokorný et al., 2000; Barthelmes et al., 2006) have addressed the palaeoecology of alder carrs. Due to their rapid sequestration rate and large carbon storage (Dommain et al., 2011), however, forested peatlands are of special interest in climate change research (Barthelmes, 2009).

Inclusion of non-pollen palynomorphs (NPPs, 'types' sensu van Geel, 1972), especially fungal spores, has in the last decades substantially progressed palynological research (van Geel and Aptroot, 2006). Spores of coprophilous fungi were recognised as indicators of herbivores and grazing intensity (e.g. Bos et al., 2005; Davis and Shafer, 2005; Blackford et al., 2006; Graf and Chmura, 2006; Cugny et al., 2010; Feeser and O'Connell, 2010; Ejarque et al., 2011), whereas other spores appeared to provide useful information on fire and woodland disturbance (Blackford and Innes, 2006; Innes et al., 2010) or on the conditions of bogs (Yeloff et al., 2007) and lakes (Kramer et al., 2010). Fungal spores also facilitated the reconstruction of human activity and environmental change in archaeological research (e.g. van Geel et al., 2003; Mighall et al., 2006).

Despite the widespread use of NPPs, the knowledge on their taxonomic identification and the distribution and ecology of the inferred species is still very poor (Blackford et al., 2006). Furthermore, the ecological interpretation of the NPP record sometimes conflicts with that of the associated micro- and macrofossil assemblages (Ryan and Blackford, 2010; Wood and Wilmshurst, 2011). Our knowledge of fungal NPPs has to be improved urgently, e.g. through surface sample studies along gradients of fen types (Prager et al., 2006, 2012–this issue), grazing intensity (Blackford and Innes, 2006) or other abiotic parameters (Mulder et al., 2003).

Fungi growing on decaying wood, roots, litter and living trees (Michael and Henning, 1967; Ellis and Ellis, 1997) and remnants of incompletely decomposed wood (Odier and Monties, 1983; Bauer, 2004) may provide valuable indicators in alder carrs. Some NPPs have indeed been attributed to fungal species that may decompose wood, like HdV-7A (ascospore of *Chaetomium*), HdV-44 (ascospore of *Ustulina deusta*), HdV-112 (ascospore of *Cercophora*), HdV-143 (ascospore of *Diporotheca rhizophila*), HdV-172 (ascospore of *Coniochaeta* cf. *ligniaria*), HdV-359 (fungal spores), HdV-360 (spore of cf. *Brachysporium*) or represent wood fragments, like HdV-114 (scalariform perforation plate; van Geel, 1978; Pals et al., 1980; van Geel et al., 1980/81; Bakker and van Smeerdijk, 1982; van der Wiel, 1982; van Geel et al., 1982/83; van Geel and Aptroot, 2006), but

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only a few studies have until now focussed on NPP analysis of eutrophic and forested sites (Barthelmes et al., 2006; Prager et al., 2006).

While Prager et al. (2006) presented very preliminary results, Prager et al. (2012–this issue) process the complete data and conclusions from an extensive surface sample study of NE German fen vegetation and elaborate distinct indicator values of NPPs. All related papers of Prager et al. and Barthelmes et al. introduce several new EMA-types with detailed morphological descriptions and exhaustive ecological interpretations. Barthelmes et al. (2006) used the preliminary data from Prager et al. (2006) to reconstruct peatland development of a highly decomposed wood peat section from NE Germany. Our paper aims to improve the indicative value of NPPs by combining the latest results from this surface sample study with that of an until now unpublished fossil wood peat section. This methodological work will support the interpretation of NPP assemblages (esp. of NPPs deriving from fungal spores and plant tissue) and highlights some special challenges of their application in palaeoecology.

2. Material and methods

2.1. Sample collection

The alder wood peat section HBG (Hoher Birkengraben) originates from the 110 ha large Endinger Bruch fen in Northeast Germany (Fig. 1; N 54°14′45″, E 12°53′04″) (de Klerk, 2002). The Endinger Bruch is recently dominated by alder carrs and sedge fens. A 445 cm alder wood peat section was obtained with a 'Usinger corer' (100 cm length, diameter 8 cm; Mingram et al., 2007). Palynological samples were taken with an interval of ca. 10 cm.

2.2. Microfossil analysis

Sample preparation (Fægri and Iversen, 1989) included treatment with HCL, 20% KOH, sieving (120 μm) and acetolysis (7 min). Counting was carried out with a Zeiss axiolab light-microscope with 400× magnification; larger magnifications were used for the identification of problematic pollen grains.

In order to separate clearly between observed palynomorphological entities and inferred taxa, the former are displayed in the text in SMALL CAPITALS (Joosten and de Klerk, 2002). Palynomorphological entities were named following the keys used for identification. Pollen and plant spore types were identified with Moore et al. (1991) (indicated with the epitheton 'm' in Fig. 2), and the Northwest European Pollen Flora (Punt, 1976; Punt and Clarke, 1984; Punt and Blackmore, 1991) ('p', in Fig. 2). 'MONOLETE SPORES WITHOUT PERINE' includes Polypodiaceae spores without perine.

Pollen and NPP values were calculated relative to a sum of pollen types attributable to upland trees and shrubs (AP) and upland herbs

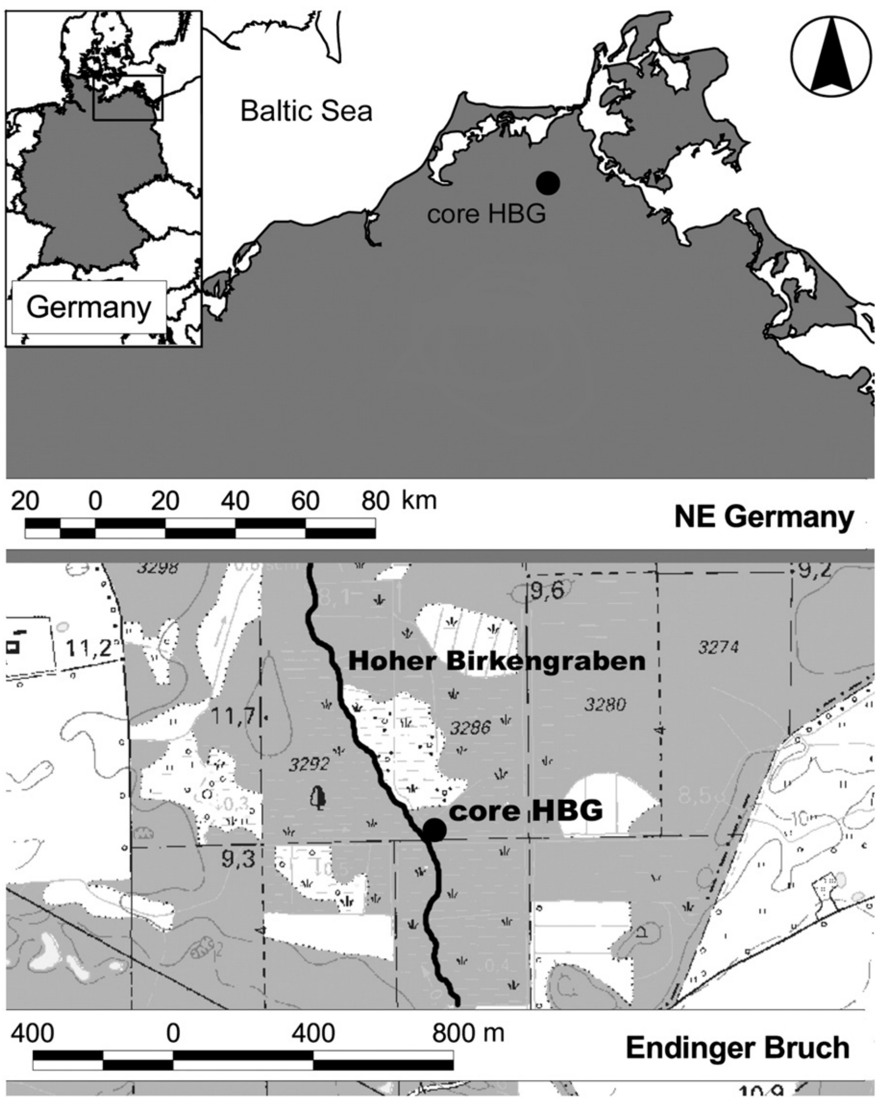

Fig. 1. Location of study site Endinger Bruch (core HBG).