BIOMARKERS OF PEAT-FORMING PLANTS AND THEIR SIGNAL IN TIDAL FLAT SEDIMENTS OF THE GERMAN BIGHT

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Introduction

Intertidal areas represent an important region of organic matter transport, recycling, degradation and accumulation. Induced by the Holocene sea level rise a number of different peat layers developed in the subsurface of today´s Wadden Sea of NW Germany. Furthermore, lipid analysis of Wadden Sea sediments (VOLKMAN *et al.,* 2000) showed a significant component of terrestrial organic matter derived from erosion of peat layers in this highly dynamic area.

In order to characterise these peats and their remnants in tidal flat sediments in a paleochemotaxonomical way Recent plant material as well as different raised bog peats, transition bog peats and fen peats were selected for biomarker investigation. The plants were chosen according to microscopic paleobotanical analysis, which revealed them as being main constituents in the peat sections of different sediment cores drilled in this area. Recent plant material was then linked paleochemotaxonomically to deposited peats and Wadden Sea sediments by means of selected biomarkers.

Materials and methods

The peat-forming plants were obtained from the Loyer Moor and Ipweger Moor NW of Oldenburg at the end of the vegetation period in October/November. Additional peat-forming plants which cannot be found in today´s mires any more were taken from the botanical garden in Oldenburg. The analyzed peat and sediment samples were collected at low tide at the surface of the backbarrier area of Spiekeroog island. For a geochemical overview of the surface sediment lipids, a sediment core (0-60 cm depth) was taken off the coastline of Neuharlingersiel and divided into 12 core sections for biomarker analysis.

Lipids were extracted, fractionated, identified by gas chromatography-mass spectrometry (GC-MS) and quantified by GC according to the methods previously described by KÖLLER (2002).

Results and discussion

Depending on the supply of nutrients and water, basically two types of peat consisting of remnants of different plant communities are distinguishable in wetlands of NW Germany: 1. eu- or mesothrophic **fen** peat with a wide variety of different plant genera, and 2. ombotrophic **raised bog** peat.

More than 20 plants of modern peat-forming vegetation were selected for geochemical analysis. Fen peat-forming plants like reed (*Phragmites australis*) and sedges (*Carex rostrata*) were analyzed in the same way as bog peat-forming plants like leaved heath (*Erica tetralix*) and cotton grass (*Eriophorum vaginatum*). In addition, fen woodlands plants like birch trees (*Betula pubescens*) and pine (*Pinius sylvestris*) were included to represent the lipid distribution pattern of a transition bog peat-forming plant community. The distribution patterns and abundances of lipids in the plant leaves, stems and roots/rhizomes were determined separately in order to obtain additional information about their biosynthesis and function in the different parts of the plants. To test whether plant lipids can be used either qualitatively or quantitatively to reconstruct plant inputs to ancients peats, the abundances of lipids in different peat types of the coastal area of NW Germany were determined.

The ***n*-alkane** distribution patterns of peat-forming plants show a strong predominance of odd over even carbon numbers in all samples typical for higher plant waxes (EGLINTON & HAMILTON, 1967). A significant variation in the maximum of the carbon number distribution between raised bog plants and fen plants was detected. The raised bog plants show an *n*-alkane maximum at C_{31}, the fen plants at C_{27} and C_{29}.

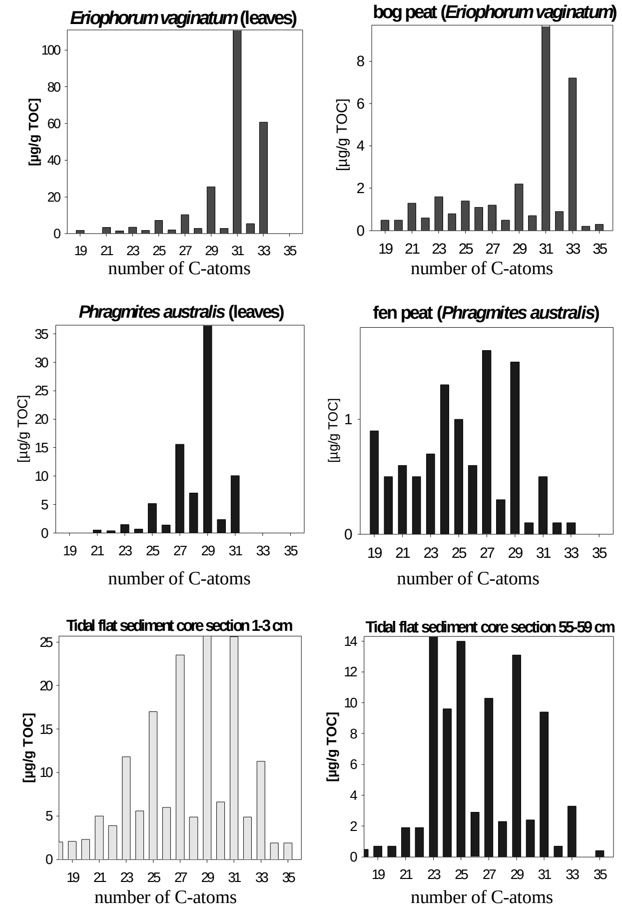

Fig. 1. Histogram of the *n*-alkane distributions of a bog peat-forming plant (*Eriophorum vaginatum*) and a fen peat forming plant (*Phragmites australis*) and their peats in comparison with two selected samples froma sediment core from Neuharlingersiel.

These characteristic distribution pattern of the *n*-alkanes were also the result of geochemical analysis of different types of Holocene peat layers in this area (Fig. 1), illustrating the potential of geochemical investigations for vegetation reconstruction (e. g., KÖLLER, 2002).

In the selected Wadden Sea sediment core the *n*-alkane distribution showed an odd over even carbon number predominance with maxima at C_{27}, C_{29} and C_{31} in the sediment surface layer, indicating an origin from different peat types.

The significant change in the distribution pattern at 51-59 cm depth shows the input of typical fen peat material (Fig. 1). In contrast to this, *n*-alcohols, ω-hydroxy fatty acids, *n*-alkan-2-ones, mid-chain alcohols, steroid ketones and alcohols do not allow a distinction between fen-peat-forming plants and raised-bog-forming plants.

However pentacyclic triterpenoids are characteristic biomarkers for both plant communities. Their distribution patterns and total amounts allow a clear distinction between raised bog-forming plants and fen peat-forming plants.

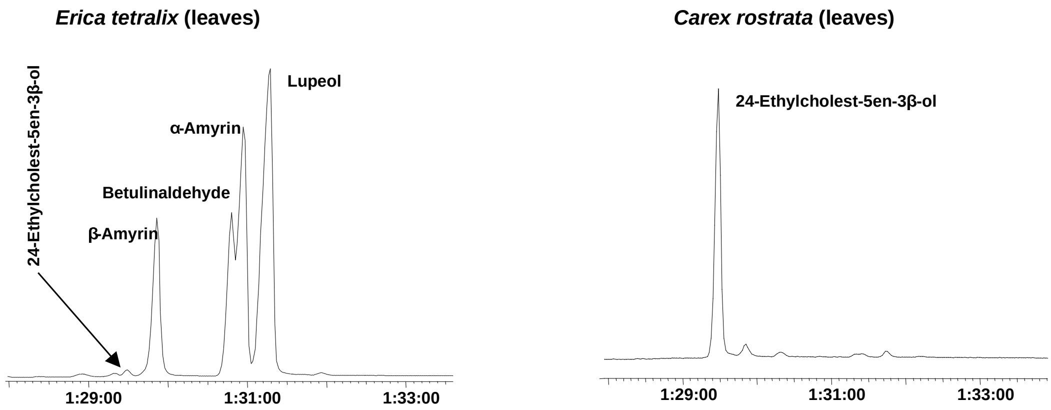

Fig. 2. RIC of *n*-hexane soluble extract of a raised bog-forming plant (*Erica tetralix*) and a fen peat-forming plant (*Carex rostrata*)

Whereas all analyzed fen peat-forming plants were barren of triterpenoids, raised bog-forming plants like *Erica tetralix* contain triterpenoids at a level of more than 10% of the total lipid extract (Fig. 2). All other bog-forming plants also contain high amounts of triterpenoids like α-amyrin, β-amyrin, friedelin, lupeol, multiflorenon and taraxerol. However, individual triterpenoids are not plant-specific biomarkers because of possible diagenetic effects. When titerpenoids were found in fen peats they were due to the influence of non-peat-forming plant material like birch trees (*betula sp.*) which supply, e. g., betulin. Most of the investigated sediment core samples show a high concentration of betulin and lupeol, which demonstrate the significance of organic matter from trees of the *Betulaceae* family (VOLKMAN *et al.*, 2000).

Summary

The distributions of characteristic biomarkers shows that the molecular composition of peat-forming plants corresponds to that of the lipid extracts from Wadden Sea sediments. These data attest to the importance of recycled ancient organic material in the carbon cycle of this coastal environment. They are complementary to the results of microscopic paleobotanical analysis and highly specific. Based on the distribution of selected biomarkers a paleochemotaxonomical classification of organic matter of peats was possible. The distribution patterns of selected biomarkers are useful indicators, even if common methods of botany fail to classify organic matter types of peats, e. g. due to poor preservation of plant remnants or a low content of organic matter in sediments.

Acknowledgements

We thank R. Starmer for his assistance in collecting the peat-forming plants and identifying them by field observation and the Botanical Gardens Oldenburg for providing plant material. Thanks are due to M. Bartels for botanical characterization of the peat samples. We also thank G. Liebezeit and the technical staff of the TERRAMARE Institute, Wilhelmshaven, for their assistance during many sampling campaigns and core drilling in the Wadden Sea area.

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