Long-term climate change and vegetation dynamics in bogs

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Introduction

Humanity has been facing global climate change in the last decades and needs to estimate the perspective of this phenomenon and its impact on our environment. Dendrochronology is one of the fields that can help in understanding climate change processes by reconstructing various aspects of climate history. Dendrochronological studies also document vegetation dynamics and causal factors, thus enabling to decide the possible reaction of vegetation to changing conditions. This paper illustrates how climatic fluctuations have influenced long-term forest dynamics in Lithuanian bogs over the last two millennia. Such kind of knowledge is essential for assessing forthcoming environmental changes and making environmental decisions.

Material and Methods

In this study the growth dynamics of *Pinus sylvestris* L. palaeo-woodlands have been investigated in a raised bog in western Lithuania. Subfossil pine timbers collected from oligotrophic peat deposits (more than 300 specimens from depths ranging between 0.0 and 2.8 m) were dendrochronologically analysed using standard dendrochronological technique. Thirty specimens were radiocarbon dated. Based on the established growth dynamics of the bog palaeo-pinewoods a qualitative reconstruction of the changes in past ecological conditions has been performed and compared to past climate evaluations known from other sources.

Results

About half of the growth series of the subfossil pine trees were cross-dated and used to build a long-term chronology. Mostly short-lived trees were rejected. Five clusters of cross-dated timbers were formed. The clusters were ^{14}C-dated. It was established that pine woodland had not covered the study area for the whole two-millennia period since the bog turned to oligotrophic phase. Separate afforestation phases in the raised bog vegetation history became evident (see Figure 1).

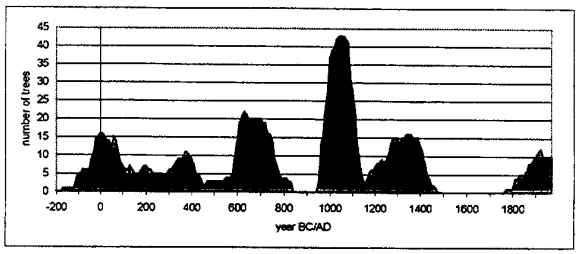

Fig. 1: Sample depth variation in cross-dated and radiocarbon–dated pine timbers from a raised bog indicating separate afforestation phases.

Investigation of the present day raised bog vegetation in Lithuania (Baleviciene 1991) indicate that woodland type plant communities usually spread over dryer areas with lower water table. Open-land type communities occupy wetter areas. Obtained relationships of bog pine radial growth with climatic parameters (Pukiene 1998) suggest that higher rates of annual radial increment (wider rings) indicate the years with higher temperatures from early spring through vegetative season and/or lower precipitation.

Reconstructed pinewood growth dynamics in the bog indicated favourable ecological conditions for pine growth (warmer and/or dryer climate, decrease in bog water table) around the BC/AD turn, in the 2nd – 3rd centuries AD, in the 7th - 8th centuries, around the 11th century and from the end of the 18th century. Unfavourable conditions (upraised bog water table, colder and/or humid climate) were detected at the beginning of the Subatlantic period until the 1st century BC, in the first half of the 4th century AD, in the 5th-6th centuries, in the 9th century, in the middle of the 12th century, in the 16th-18th centuries.

The changes in reconstructed ecological conditions based on the bog pinewood growth dynamics agree to a large extent with aspects of past European climate evaluated by other researchers (e.g. Lamb 1972, 1977, 1995; Zumbühl and Holzhauser 1988; Briffa *et al.* 1992). This agreement indicates that ecological conditions and

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growth dynamics of *Pinus sylvestris* stands in the bog reflect larger (European) scale climatic fluctuations. Especially this could be said about the well-documented climatic periods of the "Medieval Warm Epoch" (circa AD 1000), when the bog was densely afforested with pine and the "Little Ice Age" (approximately 16th–18th centuries), during which open-land type plant communities dominated in the investigated area for about three centuries.

Discussion and Needs for Further Research

Our results suggest that the present climate warming may cause the spread of forest vegetation over raised bogs. In order to corroborate this assumption the current movements of tree line in undisturbed bogs should be studied. Investigations in another Lithuanian bog by J. Karpavicius have also revealed a dense forest phase around 1000 AD and a more than 500-year gap between that and the present-day forest phases. This indicates the afforestation during the "Medieval Warm Epoch" and extinction of stand during the "Little Ice Age" could be a larger scale phenomena. In order to confirm this and more deeply understand global ecological processes it would be worth to investigate if the same phases of forest or open land bog vegetation took place more or less synchronously in other regions or even continents.

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climate change, vegetation dynamics, radial increment, bog, subfossil logs, *Pinus sylvestris*, Lithuania

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