Carbon isotopes in Tree Rings of Norway Spruce Exposed to Atmospheric Pollution

Mountain spruce forest story in the Bohemian Forest continues...

Players:
Norway spruce (*Picea abies*)
Bark beetle (*Ips typographus*)

Environmental conditions:
Climate
Atmospheric pollution
Soil conditions

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Place of storyline:

Bohemian Forest

Šumava Mnts.

Bavarian Forest
Climate: mean temperature increases

and a shift in rainfall distribution over the year brings drought in the spring

Full symbols – 1960 to 1990
Open symbols – 1991 to 2008
The Bohemian Forest was exposed to heavy atmospheric pollution during the last century. Total emissions of S and N compounds increased slowly until 1950s, then rapidly in the 1950-1980 period, peaked in the 1980s, and declined markedly between the middle 1980s and 2000.
The changes in acid deposition caused significant changes in the soil chemistry. MAGIC modeling showed a rapid **decline** in pH and nutrient availability, and increase in Al concentration of soil solutions after the 1950s (according to MAGIC modeling; Majer et al. 2003, Hydrol.Earth Syst.Sci.)
Did spruce trees reply to the changes in environmental conditions?
\[ \Delta^{13}C \approx 17-18 \% \]

Driven by stomata opening & photosynthesis rate

Insignificant effect of stress conditions \( \Delta^{13}C \approx 17-18 \% \)

Significant effect of stress conditions \( \Delta^{13}C < 17 \% \)

Stress – temperature, water and nutrient availability, ..........
Isotope composition of tree rings

Tree physiology was negatively affected from 1960s

Mean value (17.4 ‰)

Significant stress effect

Insignificant stress effect
Isotope composition of tree rings followed changes in atmospheric depositions and soil chemistry
Correlation with climate change is not so tight
Molar ratios Ca/Al and Mg/Al decrease in both the soil and wood and indicate decreasing availability of base cations and increasing Al toxicity.
Spruce trees in the Bohemian Forest are negatively affected by the change in environmental conditions.
Were consequences of Kyrill windstorm worse because of it?
Did it support bark beetle attack?
Co vyprávějí šumavské smrčiny
Průvodce lesními ekosystémy Šumavy

Hana Šantrůčková
Jaroslav Vrba
a kolektiv
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We know that spruce abundance regularly decreased in the past, with a period of about 200 years. Why?

Settlement and larger impact of human activity is not documented until Middle Ages (since before 1400 years).

Effect of bark beetle attack is likely explanation.
We know that bark beetle is an integral component of mountain spruce forests.

The warmer the climate, the faster his development.

The graph shows the relationship between temperature and development time of the bark beetle. As the temperature increases, the development time decreases. For example, at 10°C, the development time is approximately 49 days, while at 35°C, it is about 13 days.
Windstorm is an attribute of climate in Central Europe.

History file revealed that windstorm came through Czechia each century during last 500 years and it always resulted in windbreaks.
Recent data show that windstorm came through the Bohemian Forest six times since 1984.
Spruce trees have occurred in these mountains already 8,000 years ago.

Pollen diagram from sediment of the Plešné lake - one of five glacial lakes (depth of the sediment - 5.5 m, Jankovská 2006)