Review of the PhD thesis of Přemysl Bobek

Holocene fire history of forest vegetation in central Europe based on soil and sedimentary charcoal

The thesis comprises a general introduction and four chapters that correspond to individual papers published in international journals. For three of these four papers, P. Bobek is the first author with a dominant contribution, and for one paper he is the second author with a significant contribution.

The thesis deals with the Holocene fire regimes and vegetation history of selected regions in the Bohemian Massif. Two studies are focused on the sandstone area of Bohemian Switzerland, one study deals with an old-growth mountain forest of Žofín, and the last study provides a synthetic view on fire history of the Bohemian sandstone areas vs. the Bohemian borderland mountains. The structure of the thesis is logical, and the introductory text provides a useful framing for the case studies.

In the following, I provide some comments and questions on the individual chapters/papers.

Chapter 2: Forest fires within a temperate landscape: A decadal and millennial perspective from a sandstone region in Central Europe – a paper in Forest Ecology and Management

This study analysed soil charcoal data and recent forestry records of fires in Bohemian Switzerland. Based on the combined evidence from both sources, it shows that fires are a natural disturbance factor occurring in this landscape for millennia. The study also shows that fires are positively related to pine forests on rock tops and south-facing slopes.

Questions

1. The spatial analysis of the data on recent forest fires indicated high fire incidence on rocky sites and south-facing slopes, while the soil for charcoal analysis was only sampled on flatland or gentle slopes in order to exclude the effects of charcoal redeposition. Is there any feasible method to obtain direct evidence of historical fire frequency on slopes in this area (e.g. fire scars on trees)?

2. The spatial pattern of charcoal was studied in a pilot area of 4 x 2 km in Bohemian Switzerland, but radiocarbon dating was done from soil profiles distributed across the whole area of Bohemian Switzerland. Why? And to what extent does this spatial mismatch affect the results of the study?

3. Fig. 4 contains graphs with unlabelled axes. Can you please explain which variables are on the axes and how are they scaled?

Chapter 3: Human-induced changes in fire regime and subsequent alteration of the sandstone landscape of Northern Bohemia (Czech Republic) – a paper in The Holocene

This paper uses multi-proxy evidence (a peat core, soil samples, pollen, charcoal, coprophilous and fire-dependent fungi) to assess the development of vegetation in Bohemian Switzerland. It explains the "Late Bronze-Age environmental collapse", described earlier by Vojen Ložek based on malacological evidence, as a change triggered by fire disturbances related to slash-and-burn agriculture.

Questions

4. Looking at the pollen and charcoal diagrams presented in the study, it seems that the proportions of Pinus, Quercus and Betula did not change much between the Middle Holocene and later periods (including the critical period of the Late Bronze Age). Changes mainly concerned the noble hardwoods and Corylus on the one hand (decline) vs. Fagus and Abies on the other hand (increase). Do you think this diagram can be interpreted as an evidence for relative stability of vegetation on the tops of sandstone plateaus (with a continuity of pine-dominated forests throughout the Holocene, supported by poor soil and occasional fires) vs. dramatic Late-Bronze-Age change on the lower slopes and valley bottoms (with a transition from noble hardwood forests to acidophilous Fagus-Abies-Picea forests)?

5. If there was slash-and-burn agriculture in the sandstone areas, which habitats, in your opinion, were preferentially selected for cultivation: plateaus or valley bottoms?

6. Why did you use Pb dating for recent samples, given that the focus of the study is on what happened between the Early Holocene and the Middle Ages? It does not seem that dating of the youngest layers was used for any interpretations in this paper.

7. What represents the sample in the middle of the graph of the age-depth model (Fig. 2, page 42)? Was it excluded from the calculations? If so, why?

8. The effect of time on pollen composition was quantified using DCCA, i.e. a method assuming a unimodal response of species to environmental factors. Was it really realistic to expect the unimodal relationships, given that most species were present throughout the whole time span of the study, and only their quantities changed? Moreover, the use of DCCA in the analyses of age effects is inconsistent with the use of RDA (a method assuming a linear response) in the analyses of the effects of fire history and grazing pressure.
[A side remark: The citation of this method, Hill & Gauch 1980, is wrong, because these authors published DCA (an indirect ordination method), whereas DCCA (a direct ordination method) was invented only some years later by Cajo ter Braak.]

9. In RDA, Age was used as a covariable, but in the ordination diagram (Fig. 6, p. 48) it seems to have a stronger influence than explanatory variables. I would expect the arrow of Age to be short because of the removal of its effect by defining it as a covariable. Moreover, as fire incidence increased over time, the use of Age as a covariable may have diminished the effect

of the explanatory variable Fire frequency because of its negative correlation with Age. Can you please comment on this?

Chapter 4: Biotic controls on Holocene fire frequency in a temperate mountain forest, Czech Republic – a paper in the Journal of Quaternary Science

Based on a charcoal analysis from several soil profiles and pollen analysis from a local peat bog, this study reconstructs the Holocene history of vegetation and fires in the Žofín reserve. It shows that fires were common in the Early and Middle Holocene pine and spruce forests, but they almost disappeared after the expansion of beech and fir and the formation of the mixed beech-fir-spruce forests.

Question

10. The study shows that the expansion of Picea into the previous Pinus forest between the Early and Middle Holocene did not lead to declining fire activity. This pattern differs from the Scandinavian studies of the past expansion of Picea. Normally Picea forests are less fire-prone than Pinus sylvestris forests, but is this difference because of lower flammability of Picea than Pinus, or because Picea tends to occur more frequently at wetter sites than Pinus? Are there some comparative observations of flammability of these two tree species, e.g. from their nearby plantations in comparable environments?

Chapter 5: Divergent fire history trajectories in Central European temperate forests revealed a pronounced influence of broadleaved trees on fire dynamics – a paper in Quaternary Science Reviews

This paper synthesizes charcoal and pollen data from multiple sites in the Bohemian sandstone areas and Bohemian borderland mountains. It shows that (1) fire activity increased at the beginning of the Holocene and decreased in the Middle/Late Holocene due to increasing dominance of Fagus, first in the mountains and later in the sandstone areas.

Questions

11. The study found a low frequency of fires at the end of the Late Glacial. The authors admit that this conclusion is based on data from only two sites (one in each region), but still, this finding is mentioned among the main conclusions of the paper. Apart from the low number of samples, I wonder whether this conclusion cannot be misled by a biased proxy, i.e. charcoal particles from woody plants only. At the Pleistocene/Holocene transition, large parts the Bohemian Massif were probably covered by steppe, in which the main fuel was dry grass litter, not wood. Can you safely exclude the possibility of high frequency of grassland fires in the Late Glacial and Early Holocene? What is known about these fires?

12. The trend of decreasing fire activity due to beech spread in the Middle/Late Holocene seems to be rather convincing for the mountain areas. However, the observed decline in fire activity in the sandstone areas concerns a short period of a few centuries, while beech percentage in pollen further increases over this period and afterwards. This decline is based on evidence from 4-5 charcoal sites only. Are these sites from different sandstone areas?

Can you see a simultaneous increase of beech and decrease in fire activity in each of these areas separately?

13. What was the reason for selecting these two regions (Bohemian sandstone areas and Bohemian borderland mountains) for this study? There are many other sites with pollen (and probably also charcoal) record from Central Europe.

14. Why did you use raw pollen percentages of the main tree species rather than the REVEALS-based estimations of their frequency in the landscape? Such estimates are now available in the works of Vojtěch Abraham and your supervisor.

I also have one formal comment on all the papers. I find it rather disturbing that no abstract or title of the chapters/papers mentions the specific areas where the study was conducted. The first and the last paper mention just Central Europe, the second one mentions northern Bohemian sandstone areas (but not Bohemian Switzerland) and the third one mentions just the Czech Republic. The same holds true for the abstract of the whole thesis, which does not deal with the whole of Central Europe, as the title would suggest, but only with some areas within the Bohemian Massif. I point out to this because the results of palaeoecological studies are highly region-dependent. Therefore their abstracts should clearly indicate whether it is a local case study (and if so, from which site) or a synthetic study covering the whole region mentioned in the title. Otherwise, the abstracts can be misleading, and the papers can be also easily overlooked by researchers searching for literature on specific regions.

Conclusion

The PhD thesis of Přemysl Bobek presents original high-quality research, which significantly contributes to knowledge of fire history and past vegetation dynamics in the Bohemian sandstone areas and mountain areas of the Bohemian Massif. The results are broadly relevant for palaeoecologists, vegetation ecologists, environmental historians, archaeologists and nature conservationists. The author proved his ability to collect palaeoecological data in the field, identify plant species in charcoal material, analyse palaeoecological data using up-to-date statistical methods, interpret the results in the context of current knowledge of regional palaeoecology, forest dynamics and landscape history, and lead preparation of publications that meet the standards of the top international scientific journals in the field. The thesis meets international standards for a PhD degree in botany or ecology. I recommend it for defence.

Brno, 6 October 2019 Milan Chytrý