Habilitation thesis

Quaternary palaeoenvironments

– From palynological analysis to multi-proxy studies –

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Abstract

The main results that I obtained after the PhD thesis (2003) until the present were focused on the reconstruction of the: 1) History and dynamics of vegetation during the Late Pleistocene and the Holocene; 2) Vegetation response to climate changes during the Late Pleistocene and the Holocene; 3) Vegetation response to human impact during the Holocene.

The main method used to achieve the objectives of my research was the pollen analysis, supported by radiocarbon data on peat, lacustrine and guano sequences, from sites located in the Romanian Carpathians and Transylvanian Depression. Since 2009, with the support of my collaborators (students, PhD students, researchers), along with palynological analysis and radiocarbon data new methods have beeen used, and thus my researches became interdisciplinary. We used carbon isotope composition, macro– and microcharcoal remains, Loss on Ignition (LOI), plant macroremains, testate amoebae, grain size particles and malacofauna analysis, in order to reconstruct more accurate the relationship between the vegetation, climate, fire and human impact during the last 20 ka in Romania and in other zones from Central and Eastern Europe.

My results show that important changes in vegetation composition during the Late Pleistocene were produced by the climate fluctuations. The most evident vegetation response documented so far in Romania for this period is related to the Allerød (13.8–12.7 ka) warm interval, and to the Younger Dryas (YD) (12.7–11.7 ka) cold event. Apart from regional climate, local factors determined by the elevation and topography of the study sites were also important. The results also show that the amplitude of the vegetation response to climate

change was more important at sites located between 800 and 1100 m a.s.l., and rather significant around 400 m a.s.l. The vegetation response was less important at at sites located at higher elevations (above 1600 m a.s.l.). The vegetation from sites located at mid altitude was more sensitive to short climatic changes as compared to sites located at higher elevations because the tree line was probably situated at ca. 1100 m a.s.l. The pollen records suggest that the landscapes in the Romanian Carpathians and its lowlands during the Lateglacial period were covered by open forest mixed with steppe vegetation. The forest taxa were mainly of boreal type (*Picea abies, Pinus,* and *Juniperus*) and cool temperate trees (*Alnus, Betula, Salix*). Scattered pollen of mesophilous deciduous trees (*Ulmus, Quercus, Fraxinus, Corylus avellana*) was also recorded. The pollen records also indicate that the forest composition has been dynamic throughout the Holocene with changes in tree diversity and distribution. These tree taxa can be grouped into five temporal categories: tree taxa that expanded at the onset of the postglacial (*Betula, Larix decidua, Pinus, Picea abies, Ulmus*); tree taxa that expanded during the early Holocene (*Ulmus, Quercus, Tilia, Fraxinus, Acer*); tree taxa that were the abundant during early–mid Holocene (*Corylus avellana* and *Picea abies*); tree taxa that expanded during the late Holocene (*Carpinus betulus, Fagus sylvatica* and *Abies alba*); and tree taxa that show re-increasing values during last centuries (*Picea abies, Pinus*) as well as the early successional species (*Alnus, Betula, Corylus avellana, Salix, Pinus, Fraxinus*).

It is known that, in many regions, the human impact effect was important on the extent of forest cover especially during the Late Holocene. A common feature in the pollen records is the discontinuous presence of pollen types associated to ruderal places, pastures and meadows (secondary anthropogenic pollen indicators) during the early Holocene. There are also occurrences of pollen of cultivated plants (primary anthropogenic pollen indicators) at most of the sites from ca. 7.5 ka. Evidence of cultivated fields were identified especially in the lowland records (Transylvanian Depression) revealing the most continuous and sustained human impact. The continuous presence in the Holocene pollen diagrams of wild plants (*Corylus avellana, Cornus, Sambucus, Vitis, Prunus* type) may indicate that these plants were used by human communities as food resources during the Mesolithic and Neolithic periods. A more continuous and abundant occurrence of secondary anthropogenic pollen indicators (*Plantago lanceolata* and *Rumex*) and an increase in herbaceous diversity is noted from about 4–3 ka (corresponding to the Bronze Age/early Iron Age) until the present.

Most of these results were obtained because I was involved in a significant number of national and international research grants, both as a Principal Investigator (PI) and as a member of the research teams. The funds obtained allowed me to develop several research facilities and to conduct researches in Palynology and in Quaternary Palaeoenvironments.

In the future I plan to continue my researches in order to contribute to a better understanding of the Quaternary vegetation-climate-human interactions, in Romania and in Europe, using multidisciplinary approaches. The specific objectives of my researches will be: a) to explore patterns of change in vegetation composition and diversity along elevational and latitudinal gradients; b) the quantitative reconstructions of the regional paleovegetation using the relative pollen productivity estimates (RPPs) of dominant plant taxa and applying the REVEALS (Regional Estimates of Vegetation Abundance from Large Sites) model to previous and future palynological analyses; c) to reconstruct hydroclimatic changes based on testate amoebae analysis and carbon isotopic composition δ13C. We intend to use transfer-functions method in order to obtain quantitative reconstruction of the water table depth in oligotrophic peat bogs; d) to explore the impact of Rapid Climate Change (i.e. 10.4, 9.5, 8.2, 6.6, 3.4 ka, Medieval Climate Anomaly, Little Ice Age, etc.) on vegetation and on prehistoric communities; e) to explore the human-environmental interaction, especially to document the role of anthropogenic fires and human activities on land cover change and erosion rates; f) to estimate the organic matter and carbonate contents and also to calculate the carbon accumulation rate in sediments; g) to calculate the dust fluxes over the time, inspect what are the conditions that affect dust deposition, and compare our data with data from Europe to see similarities and/or differences.

For the achievement of these objectives I plan to apply for new grants with national funding and, if it is possible, with European funding. PhD theses will be financially and scientifically supported by these research projects, which will directly support the next generation of scientists interested in understanding the complexity of environmental changes, and will lead to creation of new jobs. The involvement of young researchers and students in these projects is important for sustainig my research team. A strong research team is the key for successful research results and high quality publications.

For the future, I plan to develop my teaching activity through several prioritary directions: helping students to identify their skills (and skill gaps); teaching students to use critical thinking skills and critical reading strategies to become better writers of scientific articles; developing new academic courses focused on quaternary paleoenvironments (the global interes in climate changes is increasing and Romania cannot afford lacking profesisonals in this field); inviting guest speakers (lecturers and students) to my courses with benefits for my students, for me, and also for guest lecturers; developing and maintaining a personal website for educational purposes.