PALEOENVIRONMENT DATA AND VEGETATION HISTORY FROM A SMALL MESOTROPHIC SITE IN THE CURVATURE SUBCARPATHIANS. CASE STUDY: INK QUAKING BOG, ROMANIA

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ABSTRACT

Clearing down the chronology of Holocene's history vegetation was made by exploring some important sites from Romania. The sequences of the forest phases in Holocene are well known because of the studies made by the School of Palynology from Cluj (Romania). These have shown that past vegetation dynamics are not uniform in the Romanian Carpathians, as initially believed. The Ink quaking bog is situated in the contact area of the Carpathians and the Subcarpathians Curvature's sector at the altitude of 560 meters. The surrounding vegetation is highlighted by deciduous forest and meadow or swamp vegetation, having mesotrophic and meso-eutrophic characteristics. The peat bog deposit layer is 70-80 cm thick, and it's represented by a very darkened made of soil peat bog, with some maceration variations. The swamp was dug with a gravity corer, attached with collecting tubes, which allowed a continuous circulation of the inner material column. The samples were collected for the sporopollenin analysis and radiocarbon dating (^{14}C). The material collected from the -65 cm layer, dating from 7861±50 B.P., was placed at the limit between Boreal and Atlantic (*Alnus* - 27,6%; *Ulmus* - 16,35%; *Tilia* - 12.78%; *Quercus* – 5.45%; *Picea* - 4.94%; Pinus - 4.1%;). The -55 cm layer, dating from 2986±50 B.P., being on the crossover of Subboreal 2 and Subboreal 3 (*Picea* - 11.3%; Pinus - 3.91%; *Alnus* – 37.82%; *Ulmus* – 9.56%; *Tilia* - 6.95%). The -35 cm layer, dating from 658±50 B.P., was placed in Subatlantic, were the climate's cooling and rising humidity determined the beech and fir expansion. Based on Ink quaking bog sporopollenin analysis and ^{14}C dating, we better understand the paleoenvironmental condition around Bîrseşti archaeological site (Late Hallstatt).

Keywords: vegetation history, radiocarbon dating, mesotrophic quaking bog, Curvature Subcarpathians, Romania

INTRODUCTION

In Romania, establishing the chronology of Holocene vegetation history was done by investigating key sites in the Carpathian and Sub-Carpathian areas. The succession of the Holocene forest phases is well-known due to the palinological researches developed in the high mountain and sub-mountain peatlands [1], [2], [3], [4], [5], [6], [7], [8], [9]. The current spreading and zoning of flora and vegetation is the result of palaeogeographical and climatic changes that have influenced the succession of the particularities of the cenos and of the vegetal carpet as a whole [3]. The post-glacial cenogenetic evolution of the Carpathians in Romania differs substantially from the Northern Carpathians and Central Europe. This phenomenon is due to different intensity of glaciation [1], [2], [3], [4], [5]. The territory located on the exterior of the Carpathian arch lies at the contact between the latitudinal vegetation areas characteristic of the Eurasian steppe but also the altitude characteristic of Central Europe [6], [7], [8], [9]. The contact between these areas, more exactly the problem of the relationship between the forest area and the steppe area, has been concerned with many naturalistic researchers, especially since the limit has migrated during the Holocene.

The detailed reconstruction of the history of Holocaust vegetation in the Vrancea's Subcarpathians is difficult to achieve because the eutrophic marshes, less acid and with intense microbial activity, do not offer the best conditions for pollen conservation [11], [12], [13]. However, the analysis of peat samples taken from a mesotrophic site may bring new contributions to the knowledge of the environmental conditions of prehistoric civilizations that have habitat in these areas [6]. This study is based on Ink quaking bog (Subcarpathians Curvature's) sporopollenin and radiocarbon dating, and the analysis has been achieved to understand the paleoenvironmental condition and vegetation history around Late Hallstatt Bîrseşti archaeological site [10] (Fig. 1).

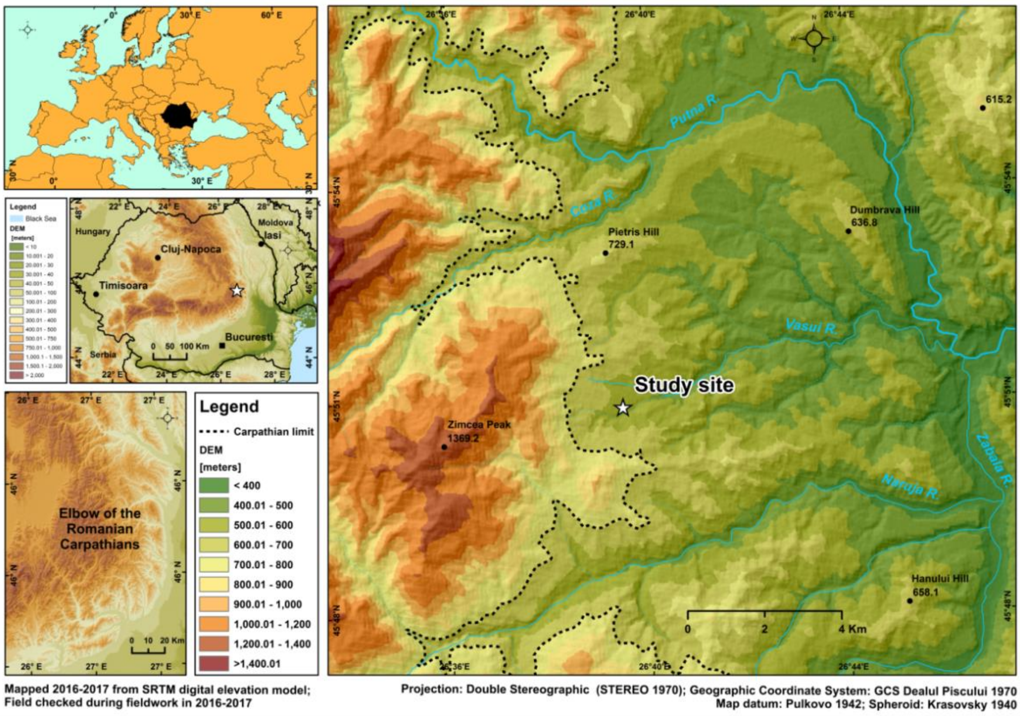

Figure 1. Location map of the studied area in the Curvature Subcarpathians (Romania)

CASE STUDY: INK QUAKING BOG (CURVATURE SUBCARPATHIANS)

The Ink quaking bog is situated in the contact area of the Carpathians and the Subcarpathians Curvature's sector at the altitude of 560 meters (Fig. 2). The surrounding vegetation is highlighted by deciduous forest and meadow or swamp vegetation, having mesotrophic and meso-eutrophic characteristics. The peat bog deposit layer is 70-80 cm thick, and it's represented by a very darkened made of soil peat bog, with some maceration variations. In the past centuries, artists used natural pigments that they could produce from plants or humic materials. For example, in England and Germany, the Vandyke Brown color refers to the humic pigment taken from the lower layers of the peatland near Cologne [15]. In the villages of the Vrancea's Subcarpathians for the dyeing of wool and fabrics were used certain parts of plants or even turbid material. Ink quaking peat material was used to obtain the black pigment or as a mordant for color fixation. Thus, the name of the analyzed site was attributed by local communities because of the peat's ability to dye some fabrics, of which the most commonly worked was wool.

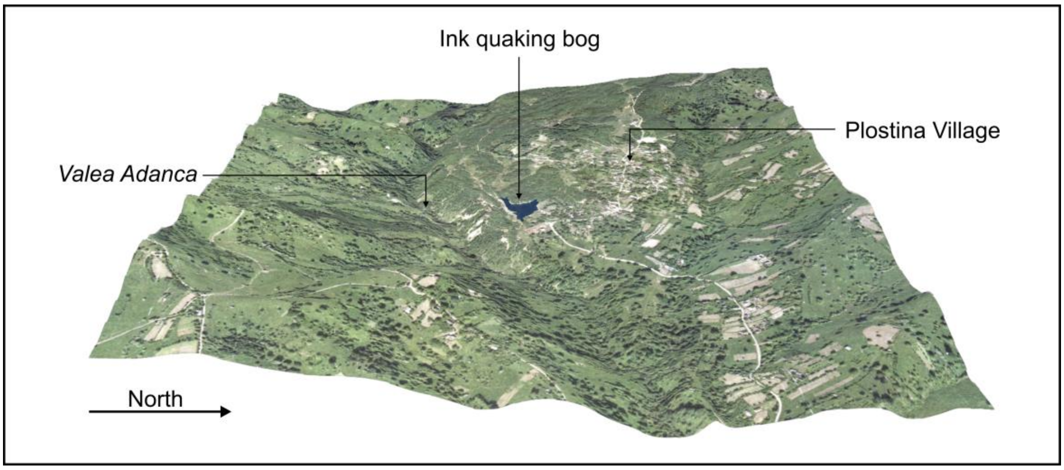

Figure 2. 3D view of the Ink quaking bog and the surrounding area

METHODS AND TECHNIQUES

The samples were taken for sporo-polonic analysis and for the dating of the radiocarbon dating (14C). The peat layer was drilled using a gravity probe with tubes that allowed the transport of a continuous column of material (10 cm in diameter) into the laboratory. For the sporopolinic material analysis samples were taken from 10 in 10 cm, then from 5 in 5 cm. Following the separation of pollen using the Erdtman method, hydrocarbons appeared in the form of perfectly colorless oily droplets. This fact forced us to repeat samples without acetolysis. Palinological preparations were obtained by boiling in 10% KOH, separation by centrifugation and collecting in anhydrous glycerol. We have identified more than 400 tree pollen grains for each sample. Timeline setting was performed sequentially by radiocarbon dating in the ETH Zürich Laboratory.

RESULTS AND DISCUSSION

Chronology. Of the 4 samples tested for chronology, only 3 were valid: ETH-70053 (deepth 30-40 cm) – 765±21 yr BP; ETH-70056 (deepth 50-60 cm) – 2,986±21yr BP; ETH-70057 (deepth 60-70 cm) – 7,861±24 yr BP. The sample results from the 40-50 cm depth range (ETH-70055) were not used due to the anomalies most likely caused by the surface layer mixture at the time of sampling (Table 1). The calibration curve indicates a low sedimentation rate because in only 40 cm accumulated organic material dated in the range 7800-650 BP (Fig. 3).

Table 1. ETH ^{14}C dates from Ink quaking bog

Depth (cm)	Lab. number*	Tested material	^{14}C yr BP	$F^{14}C$	Date use (cal yr BP)	Remarks
0 – 30						Wather pocket
30 – 40	ETH-70053	Macrofossils	765±21	0.9092	765	no remarks
40 – 50	ETH-70055	Macrofossils	658±21	0.9213		anomalous not used
50 – 60	ETH-70056	Wood	2,986±21	0.6896	2,986	no remarks
60 – 70	ETH-70057	Macrofossils	7,861±24	0.3758	7,861	no remarks

*ETH Zürich Laboratory; ^{14}C age [BP (before 1950 AD)]; Calendar age 2σ range AD/BC -- calibrated ranges 95% con. Level: Fraction Modern: $F^{14}C = \exp(-F^{14}C\ age/8033)$; If $F^{14}C > 1$, the sample indicates presence of „bomb peak ^{14}C” (post 1950AD)

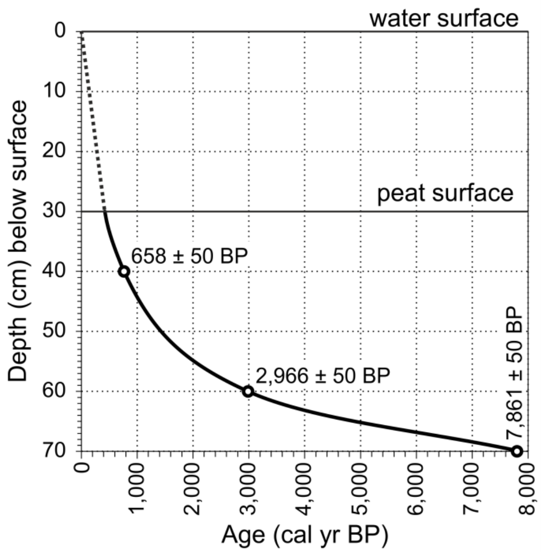

Figure 3. Calibrated radiocarbon data and age–depth model for Ink quaking bog

Vegetation history. The material collected from a depth of 65 cm (7.861 ± 24 yr BP) was deposited at the Boreal-Atlantic limit. The forests were predominantly of Ulmus (16.35%), Tilia (12.78%) and Quercus (5.45%) in much Alnus (27.6%). Other deciduous genres were present in 1-2%. Among the conifers, Picea (4.94%) show an expansion trend and Pinus (4.09%) reduction, being approximately equally represented. The herbaceous layer was richer and more diversified than in the other analyzed samples. The variation of the curves recorded on the thermophilic elements is less pronounced as a result of the lower pollen productivity of these essences on the one hand and on the other hand due to the lower expansion of the thermophilic elements in the Oriental Carpathians to the Apuseni Mountains [3], [4], [5]. The fluctuations of herbage pollen curves also highlight a particularity of the climate during this period as a result of increased humidity due to higher temperatures that have been demonstrated since Boreal and continued in the Atlantic and Subboreal [1], [2], [3] (Fig. 4).
The material collected from the depth of 55 cm deep (2,986 ± 21 yr BP) was deposited at the limit between Subboreal 2 (Sb2) and Subboreal 3 (Sb3) and is not very rich in pollen. In some studies, for polinic spectrum in the Prut river, 3290 ± 80 yr BP for Sb2, and 2650

± 50 yr BP for Sb3 [9]. Another argument that supports the placement of our probe at the Sb2/Sb3's limit is that of a low frequency given by the Carpinus, with 3%, knowing that this species had 2 pic-uri in Sb1(Carpinus betulus – species found on the plains or hills, being resistant to cold and late freezing, but vulnerable to early heat, drought or dryness) and Sb3 (Carpinus orientalis – thermophilic spcies, very xerophytic, not pretentious to the soil, flourishing in a warm environment) and a redundancy between the two (our case scenario).

Higher values are found for Picea (11.3%) and Pinus (3.91%), and Abies only present. Among the most represented species were Alnus (37.82%), Ulmus and Tilia (9.56% and 6.95% respectively) and even Betula and Corylus 4-5%. Elm and lime are thermophilic species, pretentious to climate and soil; the elm is eutrophic and eurifit species with great valences to adapt to soil moisture. Among the grass species belonging to the Poaceae families, Cichoriaceae and Asteracerae were more common (2-5%). The climate during this period was warm and with a high degree of dryness, revealed by the xerophilic herbaceous species. For the same period, the analyzes in the Bisoca marsh [3] shows the same decrease of the hornbeam compared to a previous period and the continued presence of the pattagina (Plantago lanceolata). This dynamic suggests anthropogenic pressure on the environment, also evidenced by the presence of rye pollen in the period 2500-1200 yr BP [3] (Fig. 4).

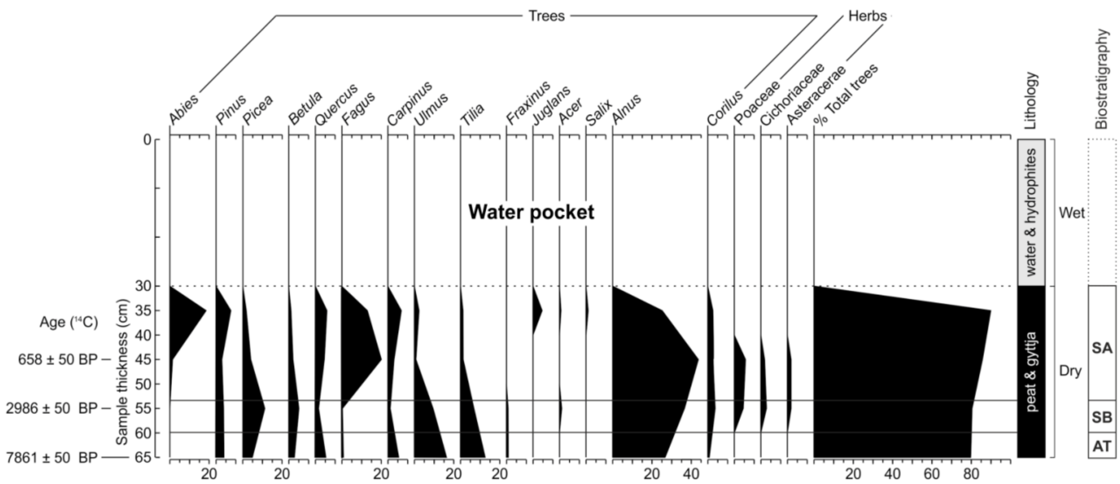

Figure 4. Pollen diagrams from Ink quaking bog: AT – Atlantic, SB – Subboreal, SA – Subatlantic

The 45-cm-deep sample, dating from 658±50 B.P. years, entered the Subatlantic time. The climate's cooling and rising humidity were factors that determined the beech and fir expansion.The poline obtained is rich in pollen grains of trees, shrubs and grasses. The polar spectrum reveals predominance of foies, the alder shielding almost the other hardwoods: Alnus 5.08%). Conifers were represented by the three genres: Picea 4.1%, Pinus 3.07% and Abies 1.43%. The best-represented species, apart from the alder that is present throughout Holocene, is beagle (Fagus 20.08%) and which certifies the period we are in. Beech vegetates in a continental mountain climate, being demanding for humidity and precipitation. It is also sensitive to drought, dryness, late frosts and early frosts as well as excessive frosts. Favorable environmental conditions for beech and fir have become less favorable for lime (1.43%) and elm (0.82%) which have been greatly reduced. It is also sensitive to drought, dryness, late frosts and early frosts as well as

excessive frosts. Favorable environmental conditions for beech and fir have become less favorable for lime (1.43%) and elm (0.82%) which have been greatly reduced. (Fig. 4).
Connection with paleoenvironment and prehistoric civilizations. Chronologically, the Iron Age occurred during the last two periods of the Post-glacier: Sub-Boreal and Subatlantic. These two periods are characterized by climate change that has greatly influenced the way of life of human populations [16].
Chronologically, the Iron Age existed between the last couple post-glacial' periods, known as the Subboreal and Subatlantic. Theese two periods are characterized by climate change which greatly influenced the human's way of living [16].Based on sporopolinic analyzes and the results of other studies with similar themes [6], we conclude that on Hallstatt's passage the climatic variability directly influenced the way of life of prehistoric populations. The first part of the Subboreal (4000-3200 yr BP) characterized by a warmer and more dry climate is the period when the first cereal spores occured in the Carpathian Bend area as a sign of agricultural activity [3].
After Ink Lake's the sporopolinical analysis and also because of other studies [6], we can conclude by saying that over the Hallstatt, climate's variability directly inclueneed the way of how prehistoric men used to live. The first half of the Subboreal (4000-3200 B.P.) characterized bye a warmer and dryer climate, was the first time when methods of yield enhancement for cereal came into sight in the Curvature Carpathians area as a sign of agricultural activity [3]. The anthropogenic relief forms represented by the agroterages [14] on the right side of Putna river (Bîrsești area), whose age is not yet determined, are definitely worth mentioning, but they are certainly preceded by the first historical sources that refer to this area.
The next two parts of the Subboreal are characterized by climatic conditions similar to those of the current period with a cooling at the passage between Sb2 / Sb3. In this range between 3200-2600 yr BP, the presence of plants such as Plantago lanceolata suggests an antropic pressure exerted mainly by grazing. The transition to the Sub-Atlantic (2600 yr BP-present) has brought a cooler and more humid climate with the extension of the beech forests, but agricultural practices are still reported through the presence of rye pollen.

CONCLUSIONS

The Ink quaking bog is a small mesotrophic site situated in the contact area of the Carpathians and the Subcarpathians Curvature's (Romania). Radiocarbon dating indicated a maximum age of marshals of 7.861 ± 24 yr BP. Sporopolinic analyzes indicate that climatic variability directly influenced the way of life of prehistoric populations on Hallstatt. In Sb1 (4000-3200 yr BP) is the period when the first cereal spores appear in the Carpathian Bend area as a sign of agricultural activity. In Sb2 / Sb3 (3200-2600 yr BP), the presence of plants such as Plantago lanceolata suggests anthropogenic pressure exerted by pastority. In the Subatlantic (2600 yr BP - present) there are still signs of practicing agriculture through the presence of rye pollen. The results obtained in this study contribute to the reconstruction of the paleoenvironment of the archaeological site on the Dumbrava Hill (Bîrsești), 8 km from Ink quaking bog.

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