Contribuţii Botanice - 2009, *XLIV*: 141-150
Grădina Botanică "Alexandru Borza"
Cluj-Napoca

LATE GLACIAL VEGETATION DEVELOPMENT IN THE FĂGĂRAŞ DEPRESSION

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Abstract: Pollen analysis from a peat core 4.30 m in length, taken from a bog near Arpaşu in a low-altitude area of the southern part of Transylvania, is used to reconstruct the Late Glacial vegetation history of the region. The vegetation record from Arpaşu starts during the Late Glacial Interstadial, being characterized by open arboreal vegetation dominated by *Pinus*. The vegetation from the last interstadial phase of the Late Glacial (Alleröd) appears as a mosaic of bogland and wooded meadows with *Pinus*, *Picea* and *Betula*. The arboreal vegetation was strongly affected by the cooling of the Younger Dryas period, and a strong decrease in the percentage of *Pinus* pollen was observed.

Keywords: Pollen analysis, vegetation history, forest dynamics, Late Glacial, Făgăraş Depression, Transylvania, Romania.

Introduction

The Late Glacial period was characterized by several climate oscillations at a global and regional scale [17]. Numerous studies show a clear response of the vegetation to the distinct climatic fluctuations during the Late Glacial in Europe [1, 2, 14, 17, 22, 24].

In Romania, the forest succession during the Late Glacial period is well known, largely due to the work of the Cluj palynological school [7, 18, 19, 20]. Only very recent studies, however, provide radiocarbon chronologies for Late Glacial fluctuation in vegetation dynamics [3, 4, 8, 10, 11, 12, 13, 27, 28, 31]. These studies have shown that past vegetation dynamics are not uniform in the Romanian Carpathians, as initially believed: differences exist in the timing of the expansion of several forest taxa [10, 11, 28]. In order to better understand this dynamic and its possible causes, new and well-dated sequences are needed from the different regions of the Carpathians.

The main objective of this paper is the study of the vegetation history of the Făgăraş Depression, during the Late Glacial period, based on pollen analysis. The analyses were performed on a peat core taken from the "Mlaca Tătarilor" peat bog, near Arpaşu de Sus (Fig. 1).

Following Pop's description [21], the "Mlaca Tătarilor" peat bog has a depth of *c.* 9 m, but recent studies have shown a total sequence 16 m in depth [9], of which approximately 13.5 m is represented by peat. Of these 16 m of the sequence, the upper 4 m were analyzed by Fărcaş *et al.* [9]. The palynological analysis emphasized the existence of the last two forest phases, developed during the Sub-Boreal and Sub-Atlantic periods.

Our study focuses on the lowest 4.30 m of the sequence.

The study area

The "Mlaca Tătarilor" peat bog or "Lacul Tătarilor" (45°43'00" N, 24°39'07" E) is situated in Făgăraş Depression, 3 km south of Arpaşu de Sus, at an altitude of 540 m, on a higher

terrace on the right side of the Arpaşu Mare river (Fig. 1-2). This *Sphagnum* bog occupies an area of about 3 ha, and has developed above fluvial Pleistocene deposits.

From a phytogeographical point of view, the peat bog from Arpaşu is located at the borderline between the Transylvanian and Carpathian provinces [6].

The vegetation is typical for peat bogs, the main association being *Sphagnetum magellanici* Malcuit, 1929, dominated by *Sphagnum magellanicum* and *Eriophorum vaginatum* species.

In the peat bogs are found species such as *Menyanthes trifoliata, Alnus glutinosa, Salix* spp., *Betula pubescens, B. hybrida, Populus tremula, Rhamnus frangula, Eriophorum vaginatum, E. gracile, E. angustifolium, Bruckenthalia spiculifolia, Carex lasiocarpa, Scirpus sylvaticus, Peucedanum palustre, Epilobium palustre, Myosotis palustris, Caltha laeta, Ranunculus flammula, Thelypteris palustris, Alisma plantago-aguatica, Scutellaria galericulata, Vaccinium vitis-idaea, V. myrtillus, Rhynchospora alba, Riccardia chamaedryfolia, R. multifida, R. palmata, Cephalozia connivens, Calypogeia sphagnicola, Lophocolea bidentata, Aneura pinguis* and *Cephaloziella rubella* [25].

The region is characterized by a temperate continental climate with cold winters and cool summers. The annual precipitation is >850 mm. For the mean annual temperature two values are available: 5°C [26] and 7°C [32]. The mean summer temperature is 17°C [26].

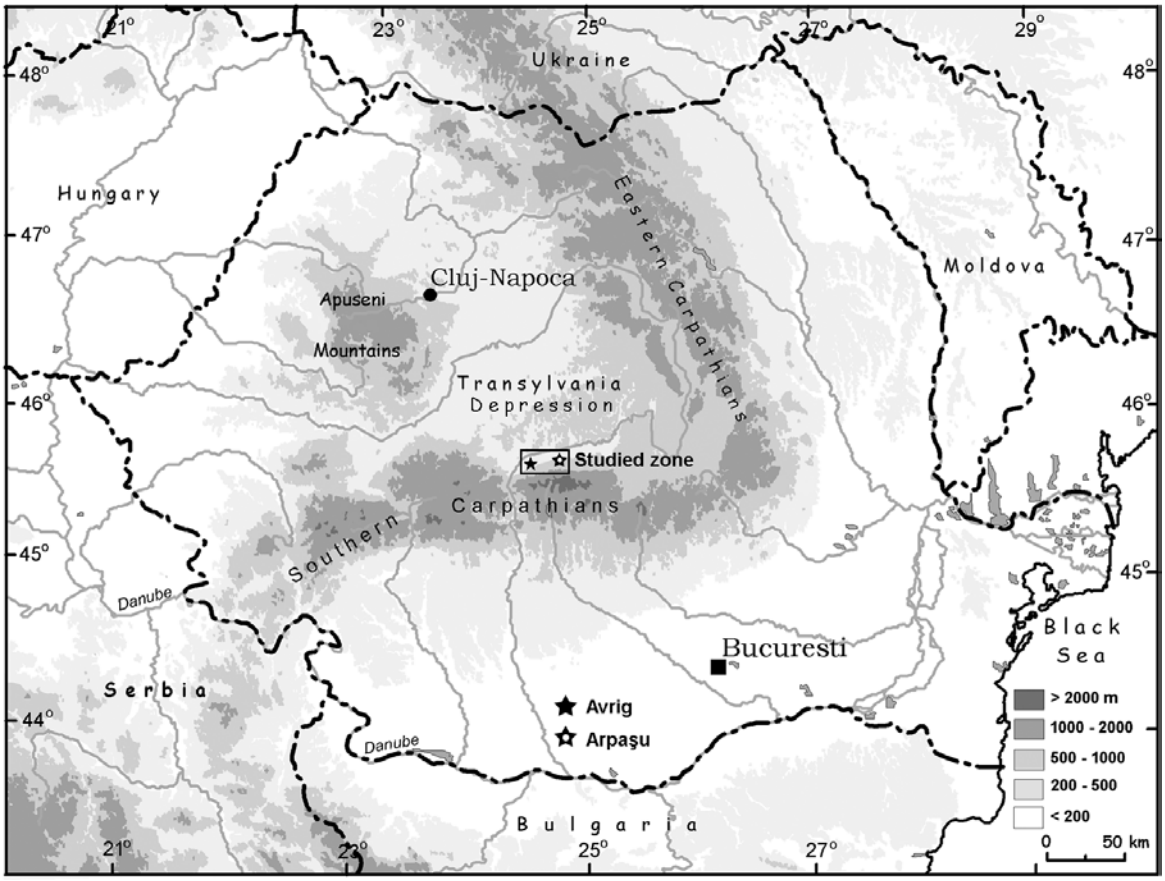

Fig. 1: Location map of the study zone near the Făgăraş Mountains.

Materials and Methods

Our cores were taken in summer 2004 with a hand-operated "Russian sampler" providing cores of 8 cm in diameter. The core from the centre of the peat bog reached basal sediments at 16.00 m. The cores were described in the field, thereafter placed in half PVC tubes, and wrapped in plastic film. Before laboratory sub-sampling, all cores were carefully cleaned and described again.

For pollen analysis, the cores were regularly sub-sampled (1 cm^3) at 4 cm intervals. Sample preparation followed a standard procedure: acetolysis in the case of peat and gyttja samples, flotation with Thoulet liquid [16] for clay samples. Microscope thin sections were prepared from the residue and scored for pollen. A minimum of 300–350 grains of tree pollen were counted from each sub-sample, except when pollen concentration was low. Nomenclature for vascular plants follows *Flora Europaea* [29].

Pollen diagrams were prepared using the GpalWin software [15]. The frequencies of pollen for each taxon were calculated as percentages of the total sum (AP+NAP). For ecological reasons the spores and cyperaceous pollen were excluded from the pollen summation. In the pollen diagrams (Fig. 3-4) pollen values lower than 0.5 % are represented by dots.

In the absence of the radiocarbon dating for the Arpaşu sequence, relative ages (chronozones) were assigned by comparison with the Avrig sequence [28], a locality situated in the same region and where a complete dating series has been carried out (Table 2, Fig. 4).

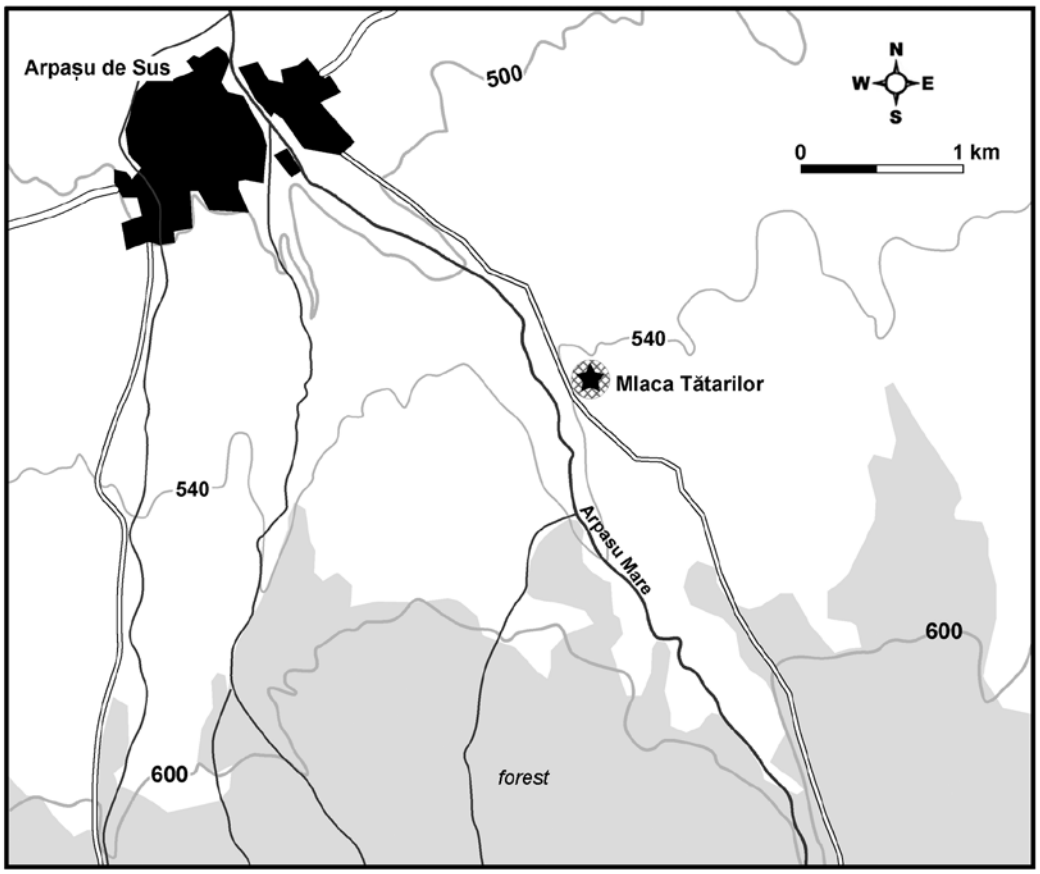

Fig. 2: Location map of the our study site (Mlaca Tătarilor) near Arpaşu de Sus.

Results and Discussions

Lithostratigraphy

A simplified stratigraphic sequence of the analyzed deposit, between 11.70-16.00 m, is presented in Table 1. The lowest part of the core consists of limnic organic clay.

Chronology

As it has not yet been possible to achieve radiocarbon dating for the Arpaşu sequence, we used for comparison the absolute age dating of the Avrig deposits [28], from a peat bog situated in the neighborhood of "Mlaca Tătarilor" (Fig. 1). Thus, the correlation of results obtained in the two sites aims towards better interpretation of Late Glacial events from the study area (Table 2).

Table 1: Simplified stratigraphic description of the sequences from Arpaşu

11.70 – 13.30 m	*Carex* peat, fibrous, light brown, slighty humified.
13.30 – 13.42 m	*Carex-Sphagnum* peat, fibrous, brown, slightly humified.
13.42 – 13.46 m	Transition from gray gyttja to peat.
13.46 – 14.87 m	Peaty gyttja, dark gray.
14.87 – 15.95 m	Gray clayey gyttja, with macro-remains.
> 15.95 m	Limnic organic clay.

Table 2: Correspondence between the pollen zones in the two sequences from Arpaşu and Avrig: OSD-Oldest Dryas, BO-Bölling, LGI-Late Glacial Interglacial, "AV"-"Avrig", AL-Alleröd, YD-Younger Dryas.

<table>
<tr><th>LPAZ Arpaşu</th><th>LPAZ Avrig</th><th>^{14}C data from Avrig (uncal. yr BP)</th><th colspan="2">Biostratigraphy</th></tr>
<tr><td>7</td><td>8</td><td rowspan="9">10300 ± 60 yr BP

12360 ± 70 yr BP
12670 ± 70 yr BP

13880 ± 90 yr BP</td><td colspan="2" rowspan="2">YD</td></tr>
<tr><td>6</td><td>7</td></tr>
<tr><td>5</td><td rowspan="3">6</td><td rowspan="3">AL</td><td rowspan="5">LGI</td></tr>
<tr><td>4</td></tr>
<tr><td>3</td></tr>
<tr><td>2</td><td>5</td><td>“AV”</td></tr>
<tr><td>1</td><td>4</td><td>BO</td></tr>
<tr><td></td><td>3</td><td colspan="2" rowspan="3">OSD</td></tr>
<tr><td></td><td>2</td></tr>
<tr><td></td><td>1</td></tr>
</table>

Pollen analysis

For the Arpaşu sequence, 147 pollen spectra were analyzed and 87 taxa were identified. To facilitate the description and interpretation of the pollen diagram with respect to vegetation changes, seven Local Pollen Assemblage Zones (LPAZ 1-7) were established for Arpaşu (Table 2, Fig. 3) and correlated with the eight pollen zones from Avrig (LPAZ 1-8) (Table 2, Fig. 4). These zones were established visually by comparing frequencies and dynamics of the principal taxa and each zone boundary denotes significant changes in pollen deposition and represents major changes in vegetation cover. The pollen zones from Arpaşu are described below.

LPAZ 1

The beginning of the sequence of Arpaşu is characterized by the presence of *Pinus* pollen with values around 60%. The other tree species are less represented: *Picea* has an insignificant presence (below 1%). Pollen of *Betula* values are around 5% until the end of this period, when it an increase of *Betula* presence to 40% is observed. Among the herbaceous taxa, *Poaceae* are well represented (15%), *Artemisia* has a frequency below 10 %, and pollen of *Filipendula* and *Dryas* have a significant presence.

LPAZ 2

By contrast to the previous zone here a decrease in *Pinus* pollen values is observed, correlated with a slight increase of *Betula* pollen. Towards the end of this period *Picea* pollen is recorded at a frequency greater than 1%. The increase in the percentage of herbaceous taxa (especially *Poaceae* and *Apiaceae*) suggests a period of cooling.

LPAZ 3

This period is characterized by the presence of *Pinus* pollen with a presence percentage of *c.* 55-60%, *Picea* under 1%, and *Betula* approximately 15%, with a slight increasing tendency

towards the end. *Poaceae* generally decrease, with the exception of the middle part when they show a maximum of 20%. Together with these also appeared *Artemisia, Filipendula* and *Apiaceae.*

LPAZ 4

During this period a diminishing tendency of *Pinus* pollen presence can be observed, correlated with a significant increase of *Picea*, which reaches values of up to 50%. Similar to the previous zone, *Betula* is present at a mean percentage of *c.* 15%. Poaceae and *Artemisia* record a decrease in their presence, associated with a frequency increase (>5%) of *Potamogeton* pollen.

LPAZ 5

This maintains a relatively low presence of *Pinus*, but by contrast to the previous zone a frequency in the decrease of *Picea* can be observed. Herbaceous plants, especially Poaceae and *Artemisia*, show a percentage increase of up to 20% and 10% respectively. Together with these, *Potamogeton* has a significant presence.

LPAZ 6

The characteristic feature of this zone is the decrease of *Picea* pollen to below 1%, associated with a frequency increase of *Betula* to over 50%. Among trees, a presence of more than 1% is recorded for *Salix* and *Alnus.* A pronounced increase in non-arboreal pollen (*Poaceae, Artemisia* and *Chenopodium*) is observed.

LPAZ 7

The beginning of this period is characterized by a low presence of *Betula*, the value of which gradually increases until the end of the period (30%). The frequency of *Pinus* species exceeds the value of 50%. Other tree genera with a presence of over 1% are: *Alnus, Quercus* and *Picea.* By comparison with the previous zone, an increasing frequency of herbaceous plants can be observed: *Poaceae* (15%), *Artemisia* (10%) and *Chenopodium* (10%).

Late Glacial vegetation history

The Late Glacial period spans between the Last Glacial Maximum (LGM) and Holocene and covers the time period 15,000–10,000 years BP [5, 23, 30]. It is characterized at a regional scale by some significant climatic oscillations and at a local scale by lower climatic oscillations [17]. As a response to the climatic fluctuations, the vegetation suffered changes: either it progressed or it withdrew according to the period or also suffered dramatic changes in composition.

Oldest Dryas (15,000–13,000 yr BP)

The first stadial of Late Glacial period, which coincides with the Oldest Dryas, was not identified in the Arpaşu sequence but was recorded in the Avrig sequence (Table 2: LPAZ 1-3), and is characterized by high percentages of *Artemisia* and *Poaceae* pollen (Fig. 4). The arboreal vegetation is composed primarily of pine (*Pinus*) and birch (*Betula*). Juniper (*Juniperus*) and willow (*Salix*) are also present in the area.

Late Glacial Interstadial (13,000–11,000 yr BP)

Bölling (13,000–12,000 yr BP)

The first part of the Late Glacial interstadial corresponds to a climatic amelioration which emerged after an episode of cooling from the Oldest Dryas stadial. This period was characterized by open arboreal vegetation dominated by *Pinus*. Other taxa, such as *Betula* and *Salix*, are also present but with lower presence. The peak of *Betula* that is observed at the end of this period can be due to the sampling of a stamen-rich level. Herbaceous steppic taxa (*Artemisia, Thalictrum, Poaceae, Chenopodiaceae*) are subordinate to arboreal taxa. The existence of humid habitats is revealed by the presence of pollen of *Filipendula* and *Cyperaceae.*

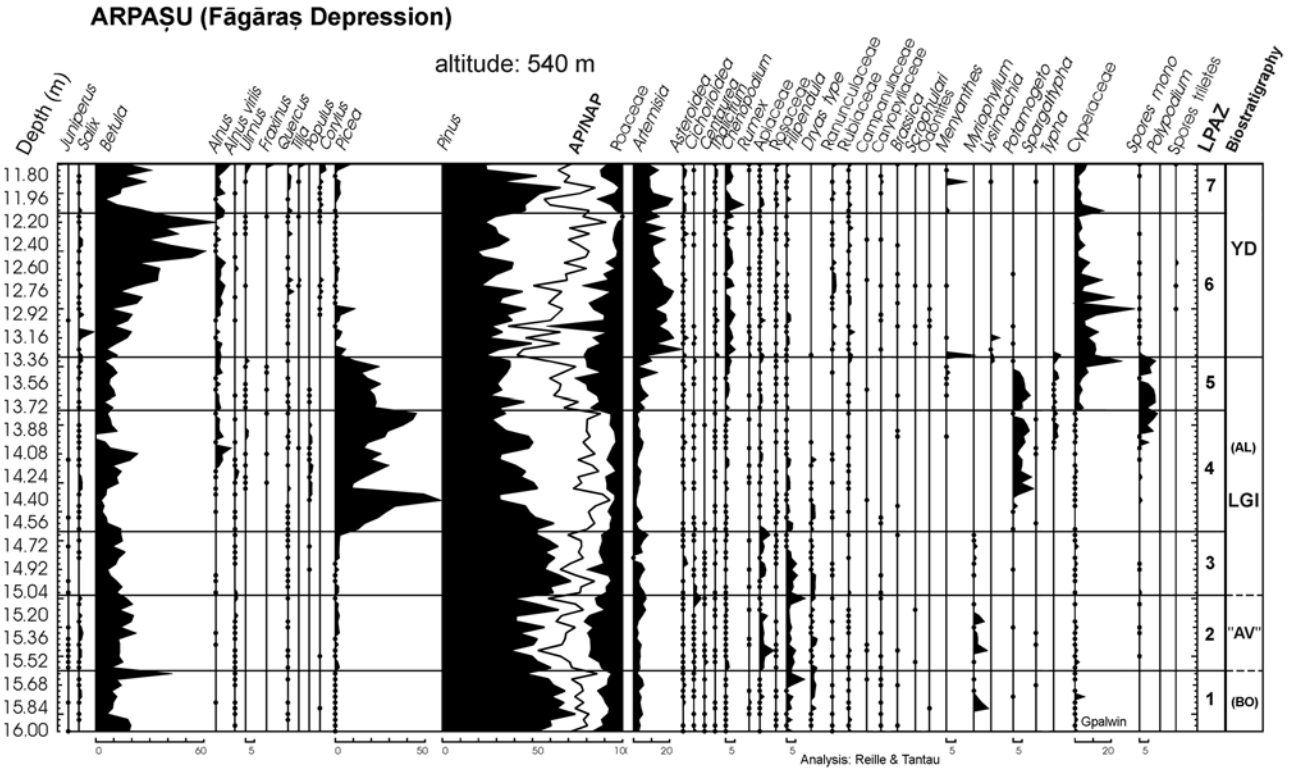

Fig. 3: Pollen diagram from Arpaşu: BO-Bölling. "AV"-"Avrig", LGI-Late Glacial Interglacial, AL-Alleröd, YD-Younger Dryas.

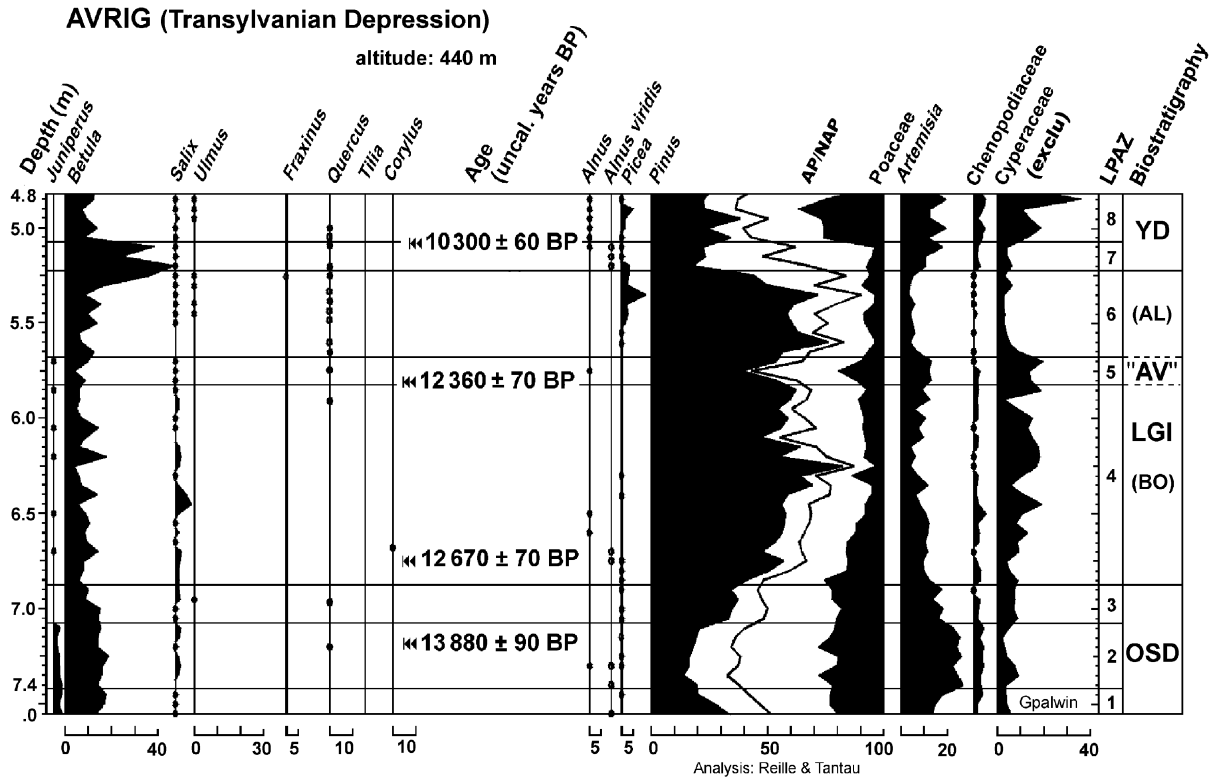

Fig. 4: Simplified pollen diagram from Avrig (after Tanțău *et al.*, 2006 - modified): OSD-Oldest Dryas, BO-Bölling, LGI-Late Glacial Interglacial, "AV"-"Avrig", AL-Alleröd, YD-Younger Dryas. Uncalibrated ^{14}C ages (^{14}C yr BP) are shown in the figure where they were collected.

"Avrig" (Older Dryas?) (12,000–11,800 yr BP)

This period corresponds to an episode of cooling, an aspect revealed by the presence at a high percentage of steppic vegetation dominated by *Artemisia, Poaceae* and *Apiaceae.* Arboreal vegetation is represented by pine (*Pinus*), birch (*Betula*), willow (*Salix*) and spruce (*Picea*). The landscape may have consisted of open birch woodland with some tree habitats. The upper boundary is marked by increases of *Pinus* and decreases in NAP.

Alleröd (11,800–11,000 yr BP)

The last interstadial phase of the Late Glacial is characterized by a maximum presence of *Picea* pollen and a decline in B*etula.* The participation of spruce pollen at a frequency of about 50% indicates the presence of this taxon in glacial refuges situated not far away from the study area.

The presence of typical steppic herbaceous plants is reduced, some taxa of *Poaceae* and *Apiaceae* being identified. Also, during this period mesophilous trees (*Quercus, Fraxinus*) appeared sporadically. Arboreal pollen predominates comparatively with NAP. However, there is a small amount of heliophilous herbs (*Asteroideae, Campanulaceae, Thalictrum*), indicating that limited open habitats were present in the boreal forest cover. The presence of floating plants fixed by roots (*Potamogeton*), ferns and hygrophilous trees (*Alnus, Populus*) reveals the existence of some humid zones.

Younger Dryas (11,000–10,000 yr BP)

The beginning of this period corresponds to an episode of sharp climatic deterioration, characterized by a decline of *Pinus* and the expansion of some plants typical of dry and cool climates: *Chenopodiaceae, Poaceae, Ranunculaceae, Artemisia, Ephedra* and *Helianthemum*, suggesting widespread aridity through the Younger Dryas episode. Increased values of *Betula* may point to a wide distribution of these pioneer trees in open forests. The pollen spectra of the Younger Dryas indicate a substantial restructuring of the Late Glacial vegetation cover, with treeless landscapes, cold steppe and part-tundra communities becoming dominant. The presence of hygrophilous plants (Cyperaceae, *Menyanthes*) reveals the existence of some local humid zones.

Conclusions

The first botanical manifestations of the sudden expansion from the extreme climatic conditions of the Weichselian are represented by a steppic vegetation dominated by *Artemisia* and *Poaceae* [2, 24]. For the first time in Romania this climatic oscillation (Oldest Dryas) has been dated at 13880 ± 90 years BP, at Avrig [28].

The beginning of the climatic amelioration of Bölling was identified in both sequences: Arpaşu and Avrig, being characterized by open arboreal vegetation dominated by *Pinus* and at a lower percentage by *Betula* and *Salix.* Isolated occurrences of pollen of *Picea* result from long-distance transport from refuges undoubtedly located at middle/lower altitudes. The herbaceous steppe species (*Artemisia* and *Poaceae*) are decreasing. By contrast with Arpaşu, at Avrig there can be observed the existence of some more humid habitats due to the presence at a high percentage of *Cyperaceae* pollen.

A cooling climatic episode, dated at Avrig at 12,360 ± 70 years BP, is characterized, at both sites, by steppic vegetation with *Artemisia, Poaceae* and *Apiaceae*. The arboreal vegetation is restricted to some plots dominated by *Pinus*, with *Betula* and *Salix*. This oscillation may correspond from the chronological point of view to the Older Dryas, but the date which was obtained at Avrig was "too old" to correspond to this period. In the absence of a more detailed chronology, this stage received the local name of "Avrig".

The vegetation from the last interstadial phase of the Late Glacial (Alleröd) appears like a mosaic of bogland and wood-meadow with *Pinus* and *Betula*. The success of these two taxa is explained by the high capacity of treeless areas to colonization, in either humid or dry environments.

During this period, at Arpaşu an intense development of spruce (*Picea*) forest can be observed, a phenomenon which occurred later and with less intensity at Avrig, probably due to the long distance between the site and the wooded area.

The constant appearance of herbaceous plants during this period (especially *Artemisia* and *Poaceae*) is due to some difficulty in the dense establishment of forests, rather than to climatic degradation, taking into account that the Alleröd was a period of climatic amelioration.

The last climatic manifestation of the Late Glacial (Younger Dryas) was recorded at both Arpaşu and Avrig. The arboreal vegetation was strongly affected by the cooling of the Younger Dryas period, and a strong decrease in the percentage of *Pinus* pollen was observed. In most of sequences described in Romania [3, 8, 27], this episode is associated with a dramatic decrease of *Betula* pollen. The sequences of Arpaşu and Avrig are exceptions, as *Betula* reaches a maximum which may be explained by the local conditions that favoured this development: high humidity and lower temperatures.

The Younger Dryas cooling was not enough for the extinction of spruce. Even if *Picea* pollen frequencies do not exceed 1%, this taxon appears more or less sporadically in both regions.

The Younger Dryas cooling was a major climatic event affecting all regions of Europe, from northern Norway to the Mediterranean [30].

Acknowledgments: This study was supported by a PN II-Idei grant from the Romanian Ministry of Education and Research (PN II-ID_2263).

REFERENCES

1. Ammann, B., Lotter, A.F., 1989, Late-Glacial radiocarbon and palinostratigraphy on the Swiss Plateau, *Boreas*, **18**: 109-126.
2. Beaulieu, J.L. de, Pons, A., Reille, M., 1988, L'historie de la flore et de la végétation du Massif Central (France) depuis la fin de la dernière glaciation, *Cahier de Micropaléontologie*, **3**(4): 5-36.
3. Björkman, S., Feurdean, A., Cinthio, K., Wohlfarth, B., Possnert, G., 2002, Late glacial and early Holocene vegetation development in the Gutâiului Mountains, northwest Romania, *Quaternary Science Reviews*, **21**: 1039-1059.
4. Björkman, S., Feurdean, A., Wohlfarth, B., 2003, Late Glacial and Holocene forest dynamics at Steregoiu in the Gutâiului Mountains, Northwest Romania, *Review of Palaeobotany and Palynology*, **124**: 79-111.
5. Brauer, A., Litt, T., Negendank, J.F.W., Zolithschka, B., 2001, Lateglacial varve chronology and biostratigraphy of lakes Holzmaar and Meerfelder Maar, Germany, *Boreas*, **30**: 83-88.
6. Ciocârlan, V., 2000, *Flora ilustrată a României* (*Pteridophyta* et *Spermatophyta*) [Illustrated flora from Romania]. Editura Ceres, Bucureşti, 1138 p.
7. Diaconeasa, B., Fărcaş, S., 1995-1996, Stejărişurile amestecate, evoluția şi dinamica lor în pleistocenul din România, Contrib.Bot., **33**: 93-102.
8. Fărcaş, S., Beaulieu, J.L. de, Reille, M., Coldea, G., Diaconeasa, B., Goeury, C., Goslar, T., Jull, T., 1999, First ^{14}C dating of Late Glacial and Holocene pollen sequences from Romanian Carpathes, *Comptes Rendus de l'Académie des Sciences de Paris*, **322**: 799-807.
9. Fărcaş, S., Tanțău, I., Beaulieu, J.L. de, Miclăuş, M., Ruicănescu, A., 2004, L'analyse palynologique d'une séquence d'age subboréal de"Arpaşu de Sus" (Département de Sibiu), Contrib.Bot., **39**: 233-240.
10. Feurdean, A., 2004, *Palaeoenvironment in Romania during last 15,000 years*. Ph.D. Thesis Stockholm University, Sweden, 44 pp+4 appendix.
11. Feurdean, A., 2005, Tracking Lateglacial and early Holocene environmental change: a paleolimnological study of sediment at Preluca Tiganului, NW Romania, *Studia Universitatis Babeş-Bolyai, Geologia*, **50**(1-2): 3-11.

12. Feurdean, A., Bennike, O., 2004, Late Quaternary palaeoecological and paleoclimatological reconstruction in the Gutâiului Mountains, NW Romania, *Journal of Quaternary Science*, **19**: 809-827.
13. Feurdean, A., Björkman, L., Wohlfarth, B., 2001, A Paleoecological Reconstruction of the Late Glacial and Holocene based in multidisciplinary studies at Steregoiu site (Gutâi Mts., NW Romania), *Studia Universitatis Babes-Bolyai, Geologia*, **46**(2): 125-140.
14. Feurdean, A., Wohlfarth, W., Björkman, L., Tanțău, I., Bennike, O., Willis, KJ, Fărcaş, S., Robertsson, AM., 2007, The influence of refugial population on Lateglacial and early Holocene vegetational changes in Romania, *Review of Palaeobotany and Palynology*, **145**: 305-320.
15. Goeury, C., 1997, GpalWin: gestion, traitement et représentation de la paléoécologie. In: XV-ème Symp. de l'A.P.L.F., sept. 1997, Lyon, p. 31.
16. Goeury, C., Beaulieu, J.L. de, 1979, A propos de la concentration du pollen à l'aide de la liqueur de Thoulet dans les sédiments minéraux, *Pollen et Spores*, **21**(1-2): 239-251.
17. Litt, T., Schmincke, H.U., Kromer, B., 2003, Environmental response to climatic and volcanic events in central Europe during the Weichselian Lateglacial, *Quaternary Science Reviews*, **22**: 7-32.
18. Pop, E., 1929, Analize de polen în turba Carpaților Orientali (Dorna-Lucina), *Buletinul Grădinii Botanice Cluj*, **9**(3-4): 81-210.
19. Pop, E., 1932, Contribuții la istoria pădurilor din nordul Transilvaniei, *Buletinul Grădinii Botanice Cluj*, **12**: 29–102.
20. Pop, E., 1942, Contribuții la istoria pădurilor din nordul Transilvaniei, *Buletinul Grădinii Botanice Cluj*, **22**: 101–177.
21. Pop, E., 1960, *Mlaştinile de turbă din Republica Populară Română*, Ed. Academiei, Bucureşti, 514 p.
22. Ralska-Jasiewiczowa, M., Goslar, T., Madeyska, T., Starkel, L., 1998, *Lake Gosciaz, Central Poland, A monographic study*. Part I. W. Szafer Institute of Botany, Krakow, 340 p.
23. Ravazzi, C., 2003, An overview of the Quaternary continental stratigraphic units based on biological and climatic events in Italy, *Italian Journal of Quaternary Sciences*, **16**: 11-18.
24. Reille, M., Pons, A., Beaulieu, J.L. de, 1992, Late and postglacial vegetation, climate and human action in the French Massif Central, *Cahier de Micropaléontologie*, **7**: 93-106.
25. Ştefănuţ, S., 2004, The peat bogs from Arpaşu de Sus, *Acta Horti Bot. Bucureşti*, **31**: 73-77.
26. Ştefănuţ, S., 2005, Raport de Cercetare: Viitoarea rezervaţie naturală "Lacul Tătarilor", *Revista de Politica Ştiinţei şi Scientometrie*, Număr special: 1-11.
27. Tanțău, I., 2003, *Recherches pollenanalytiques dans les Carpates Orientales (Roumanie). Historie de la vegetation et de l'action humaine*. These de doctorat, Université de Droit, d'Économie et des Sciences d'Aix Marseille, France şi Universitatea Babeş-Bolyai Cluj Napoca, România.
28. Tanțău, I., Reille, M., Beaulieu, J.L., Fărcaş, S., 2006, Late Glacial and Holocene vegetation history in the southern part of Transylvania (Romania) pollen analysis of two sequences from Avrig, *Journal of Quaternary Science*, **21**(1):49-61.
29. Tutin, T.G. *et al.* (eds), 1964-80, *Flora Europaea*, vol. 1 (1964); vol .2 (1968); vol. 3 (1972); vol. 4 (1976); vol. 5 (1980), Cambridge University Press, Cambridge.
30. Walker, M.J.C., 1995, Climatic changes in Europe during the Last Glacial/Interglacial transition, *Quaternary International*, **28**: 63-76.
31. Wohlfarth, B., Hannon, G., Feurdean, A., Ghergari, L., Onac, B.P., Possnert, G., 2001, Reconstruction of climatic and environmental changes in NW Romania during the early part of the last deglaciation (15,000-13,600 cal years BP), *Quaternary Science Reviews*, **20**: 1897–1914.
32. *** 1966, *Atlasul Climatologic al României*, Editura Academiei Române, Bucureşti.

ISTORIA VEGETAȚIEI TARDIGLACIARE ÎN DEPRESIUNEA FĂGĂRAŞULUI

(Rezumat)

Analiza palinologică a unei secvențe turboase de 4,30 m lungime, prelevată întro zonă de joasă altitudine din sudul Depresiunii Transilvaniei, a fost utilizată pentru a reconstitui istoria vegetației tardiglaciare din regiune. Turbăria "Mlaca Tătarilor" se găsește în Depresiunea Făgăraşului, la 3 km sud de Arpaşu de Sus, la o altitudine de 540 m. Deoarece nu a fost încă posibilă realizarea datărilor de vârstă absoluta pentru secvența de la Arpaşu, am folosit pentru corelare datările de la Avrig, turbărie situată aproape de cea de la Arpaşu. Corelarea rezultatelor obținute în cele două situri permite o mai bună interpretare a evenimentelor tardiglaciare din regiunea studiată.

Înregistrarea istoriei vegetației debutează în timpul Dryasului I (Oldest Dryas) la Avrig şi în timpul Interstadialului Tardiglaciar (Bölling) la Arpaşu. Pentru debutul Tardiglaciarului a fost identificată o vegetație de stepă dominată de *Artemisia* şi Poaceae. Ameliorarea climatică din timpul Böllingului era caracterizată de o vegetație de tip "păduri deschise", dominate de *Pinus*. Vegetația din ultima fază interstadială a Tardiglaciarului (Alleröd) apare ca un mozaic compus din zone înmlăştinite şi zone împădurite cu *Pinus, Picea* şi *Betula*. Vegetația forestieră a fost puternic afectată de răcirea climatică din perioada Dryasului Recent (Younger Dryas) când se înregistrează o reducere importantă a procentelor polenului de *Pinus*.

Received:30.06.2009; Accepted: 5.10.2009