

THE STUDY OF THE LATE-AND POSTGLACIAL DYNAMICS OF THE VEGETATION FROM PESTEANA (POIANA RUSCA MOUNTAINS)

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Abstract: *Study of the late- and postglacial dynamics of the vegetation from Peșteana (Poiana Ruscă Mountains).* This work presents the results of the palynological studies carried out in the peat bog from Peșteana, lying on the plateau of the last peak of Poiana Ruscă Mountains, at an altitude of about 480 m. The first palynological study of this peat bog was done in 1971 [5]. Our work represents a continuation of this study, attempting to establish in the near future the absolute chronology of the vegetation history in the region. The palynological results from the studied sequence emphasize a lacunary evolution since the Late Glacial, as the ¹⁴C data and the configuration of the pollen spectrum from the basal level proves. The dynamics of the regional vegetation since the Lateglacial until present time are presented.

Key words: Lateglacial, Subatlantic, pollen analysis, vegetation history, Poiana Ruscă Mountains, peat-bog, database, diagrams, glacial refugia.

Introduction

On the occasion of our field trip/work in Poiana Ruscă Mountains (Figure 1) we have taken samples from the Peșteana peat bog, lying at the edge of the south-eastern sector of the Poiana Ruscă Massif. It is a mesotrophic type peat bog, locally known as "La Lac" (At the Lake), situated on the plateau of the last mountain ridge, above the Peșteana village, Densuș county, at about 480 m altitude.

Besides the botanical studies carried out in this location, Pop et al have also conducted a palynological study [5], which has revealed the Lateglacial age of the sediments from Peșteana. This fact has determined us to continue the study of this peat bog in order to finally establish an absolute chronology using ¹⁴C dating.

The present vegetation of the peat bog is represented by the association *Carici rostratae-Sphagnetum recurvi* Zóly. 31. Besides the mosses (*Sphagnum recurvum* var. *amblyphyllum*, *S. magellanicum*, *Polytrichum strictum*) and sedges (*Carex rostrata*, *C. stellulata*) that are dominant, other typical bog plants are present here: *Eriophorum vaginatum*, *Drosera rotundifolia*, *Menyanthes trifoliata*, as well as many birches (*Betula pendula*), black alders (*Alnus glutinosa*), willows (*Salix cinerea*), glossy buckthorns (*Frangula alnus*), spruce firs (*Picea abies*), poplars (*Populus tremula*) and hazels (*Corylus avellana*).

In its present evolution stage the peat bog is completely invaded by compact peat moss with some waterholes. The peat moss is a floating isle composed of a thin layer of relatively recent peat, not decomposed or poorly decomposed. This layer floats on a deep layer of water of about 3 meters under which there is the layer of ancient late-glacial peat and glacial sandy clay at the base.

Material and Methods

For sample taking, we have used a modified Russian corer furnished by the Laboratory of Historical Botany and Palynology from Marseille. The samples taken are semi cylindrical, with a diameter of about 5 cm and a length of 60 cm (figure 2). We have only succeeded in taking one sample from the floating peat layer (60 cm).

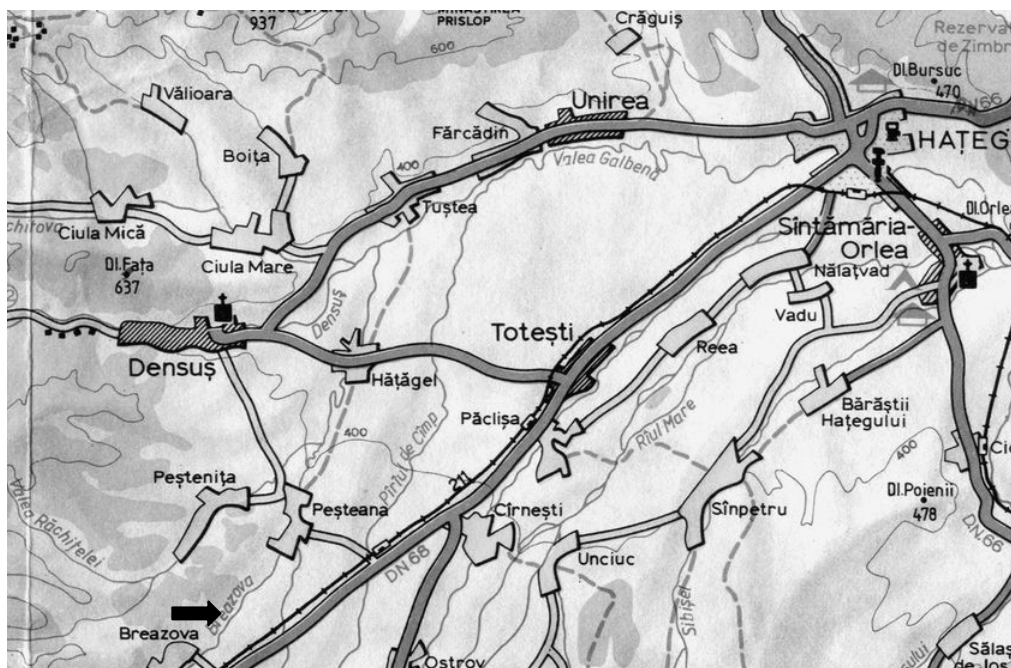


Fig. 1: Location of the studied site

The following samples have been taken from the depth of 370 cm, to 580 cm. The lithostratigraphical examining of the lab samples has shown a succession of peat layers, lax at first, then greasy dark brown and brittle blackish followed by cinder-bluish clay, with silicates and iron oxides in its composition, that has proved to be sterile from a palynological point of view.

From the existing samples, small pieces of about 1 cm³ each have been taken, so as to avoid as much as possible their reciprocal contamination. The chemical treatment of the small samples was done combining the classical method of G. Erdtman [1], with the modern ones, used in the European laboratories [3].



Fig. 2: Peșteana sample taken with the russian corer

For the preparation of microscopic slides, a part of the sediment from the centrifuge tubes has been transferred in Eppendorf centrifuge polypropylene micro tubes and anhydrous glycerin has been added. Anhydrous glycerin has also been used as inclusion medium for the microscopic slides, instead of the classical mixture of gelatin and glycerin.

Separately, 6 samples of about 1 cm³ have been taken to be sent to the Radiocarbon Laboratory from Poznań, Poland, for ¹⁴C dating with the A.M.S. method.

Microscopic determinations, statistical calculations, database

In the obtained microscopic slides we have determined at the optical microscope a number of 94 taxa (families respectively), framed in the following categories:

- tree pollen:

a). conifers – pine tree (*Pinus sylvestris*), spruce fir (*Picea abies*), fir tree (*Abies alba*), larch (*Larix decidua*), Swiss stone pine (*Pinus cembra*), juniper (*Juniperus* sp.);

b). deciduous - beech (*Fagus sylvatica*), hornbeam (*Carpinus betulus*), oriental hornbeam (*C. orientalis*), oak (*Quercus* sp.), elm (*Ulmus* sp.), lime (*Tilia* sp.), maple (*Acer* sp.), alder (*Alnus* sp.), birch (*Betula* sp.), willow (*Salix* sp.), ash (*Fraxinus* sp.), nut tree (*Juglans regia*), poplar (*Populus* sp.), dogwood and female cornel (*Cornus mas*, *C. sanguinea*), mountain ash (*Sorbus aucuparia*);

- **shrub pollen:-** hazel (*Corylus avellana*), seaberry (*Hippophäe rhamnoides*), ivy (*Hedera helix*), sheepberry (*Viburnum* sp.), hawthorn (*Crataegus*), European bladdernut (*Staphylea pinnata*), jointfir (*Ephedra* sp.), mountain avens (*Dryas octopetala*);

- herbaceous plant pollen:

a). families - *Ranunculaceae*, *Urticaceae*, *Caryophyllaceae*, *Chenopodiaceae*, *Rosaceae*, *Fabaceae*, *Apiaceae*, *Brassicaceae*, *Primulaceae*, *Scrophulariaceae*, *Rubiaceae*, *Valerianaceae*, *Dipsacaceae*, *Convolvulaceae*, *Boraginaceae*, *Lamiaceae*, *Saxifragaceae*, *Campanulaceae*, *Asteraceae* *asteroideae* and *cichorioideae*, *Liliaceae*, *Iridaceae*, *Cyperaceae*, *Poaceae* and different aquatic plants;

b). genera and species – *Nuphar* sp., *Nymphaea alba*, *Thalictrum* sp., *Cannabis* tip, *Scleranthus* sp., *Cerastium* sp., *Rumex* sp., *Filipendula* sp., *Sanguisorba officinalis*, *Potentilla* sp., *Bupleurum* sp., *Lathyrus* sp., *Helianthemum* sp., *Calluna vulgaris*, *Euphrasia* sp., *Plantago lanceolata*, *P. major*, *P. media*, *Phyteuma orbiculare*, *Artemisia* sp., *Centaurea* sp., *Cereal* type, *Secale*, *Lemna minor*, *Typha latifolia*, *Typha minima*/Sparganium;

- **moss and fern spores:** *Sphagnum*, *Botrychium*, *Dryopteris*, *Polypodium*;

- **peat rhizopods and rotifers:** *Arcella artocrea*, *Assulina seminulum*, *Ditrema flavum*, *Euglypha alveolata*, *Heleopera picta*, *Hyalosphenia papilio*, *Nebela collaris*, *Callidina angusticollis*.

- **the unidentified pollen grains or spores** have been included in the “indeterminate” class.

The determinations have been done at family, genus or species level, as possible according to case. The reading of the microscopic slides has been generally done for 250 tree/arborum pollen grains (A.P.= "arborum pollen") from each slide, plus the corresponding N.A.P. ("non arborum pollen") and spores.

The percent calculations have been done in two ways:

a). by dividing all the taxa, both trees and herbaceous plants (represented by the numerical values of their pollen or spores), by the sum of tree/arborum pollen (Σ A.P.), sum that also includes the pollen from shrubs.

b). by dividing all taxa by the total sum of arbor/tree and herbaceous pollen (Σ A.P.+ Σ N.A.P.).

The spore-pollen information expressed as percents thus obtained represent the pollen spectrum of the respective level. We have also calculated the percentile weight of tree pollen compared to the total sum, to better illustrate the dominant type of ecosystem according to the period, ratio reflected in the first pollen diagram (figure 3).

In order to obtain the graphical representation by diagrams of the palynological results from the Peșteana peat bog, a corresponding database has been created with a file comprising the list of taxa corresponding to the analyzed profile and another file containing the number of samples and the numerical values obtained for each taxon, family respectively, from each level. This task was accomplished using the special palynology program , Gpal3 of the Laboratory of Historical Botany and Palynology from Marseille [2].

Through the graphical representation of the pollen spectra from the analyzed profile in our database, the spore-pollen diagram has been obtained, in which each taxon, family respectively, is compared to the total sum. Because of space considerations we have split this diagram into three parts (figures 3-5).

Results and Interpretation

Chronology

Uncalibrated ^{14}C ages of bulk sediment are given in Table 1 and they are also shown at the corresponding depth in the pollen diagrams (figures 3-5).

Table 1: AMS ^{14}C dates from Peșteana

Depth (m)	Laboratory number	Age B.P.	Remarks
0.59-0.61	Poz-16837	102.42 $\pm$ 0.37 BP	modern
3.74-3.76	Poz-16838	108.58 $\pm$ 0.38 BP	modern
4.24-4.26	Poz-16839	12300 $\pm$ 70 BP	
4.59-4.61	Poz-16840	13420 $\pm$ 70 BP	
4.89-4.91	Poz-16841	13390 $\pm$ 70 BP	
5.04-5.06	Poz-16842	13670 $\pm$ 70 BP	

Pollen analysis

Examining the pollen diagrams we have obtained in the Peșteana sequence, we can see the syncopate evolution of the vegetation from the area, starting with the würmian Lateglacial until present day.

The clay samples from the base of the sequence (580-515 cm) were palynologically sterile.

The pollen spectra from the levels of 510-455 cm belong to a Lateglacial stadial, if we take into consideration the percentages of the main indicator species: *Pinus*, *Poaceae* and *Artemisia*. We can thus observe, especially at the level of 505 cm, that the *Poaceae* percentage increase is correlated with the decrease of *Pinus* percentages.

In the pollen spectra of these levels we find high values for pine (30-45%) - characteristic to the Lateglacial period, significant values for arolla pine (*Pinus cembra*) and birch (*Betula* sp.) – around 5%, and small values, under 1% for spruce (*Picea*), larch (*Larix*), juniper (*Juniperus*).

Among deciduous forest trees, a special attention must be paid to the oak (*Quercus*), with a continuous curve, under 5%, accompanied by *Fraxinus*, *Carpinus orientalis/Ostrya*, *Salix*, *Alnus* and *Cornus sanguinea* sporadically, with smaller values.

The C^{14} ages (table 2) confirm the presence of the Oldest Dryas, stadial developed between 15000-13000 years B.P. [4].

As far as the grasses are concerned, besides the *Poaceae* (17-30%) and *Artemisia* (under 10%), high values have the sedges (*Cyperaceae* – max. 30%), followed, with much lower values by the *Ranunculaceae*, *Urticaceae*, *Rosaceae*, *Chenopodiaceae*, *Primulaceae*, *Rubiaceae*, *Lamiaceae*, etc.

We attribute the next interval (450- 405 cm), to the Lateglacial Interstadial, a period of the Lateglacial characterized by a milder climate, developed between 13000-11000 years B.P. [4]. It is difficult to divide it, because, as can be observed in the first diagram, the oscillations of the *Pinus/Poaceae* curve are extremely numerous, indicating numerous climate oscillations, but the age of 12300 ± 70 B.P., place the interval 450-420 cm in the Bølling period (13000-12000 years B.P.).

This period is characterized by high percentages of pine pollen, accompanied by birch, and by spruce and *Pinus cembra*. The alder peak is interpreted as a result of local over-representation due to edaphic factors.

We also notice the presence of oak in the pollen spectra, with significant values, which might indicate the presence of glacial refuges in the region. The same conclusion can be drawn for ash, which appears constantly with values over 1% in the pollen spectra from these levels.

Among the grasses, we remark the *Poaceae*, *Cyperaceae*, *Rosaceae*, *Urticaceae* families as well as *Artemisia* and *Filipendula*. The distinctive character of this period is the mosaic aspect of the forest-steppe vegetation from the region. The presence of the bog is pointed out by the high percentage of *Cyperaceae*.

From 420 to 405 cm, we can separate, based on the increase of *Artemisia* percentages, a Lateglacial stadial, named Older Dryas (Dryas II or Middle Dryas). It is a cold interval at the beginig of Alleröd. According to European climate schemes, this event begin at around 12000 years B.P. [4]. In the levels belonging to this interval, we can also spot a maximum for willow (the absolute maximum of 10%) and a new maximum for *Poaceae*.

A possible slight warming of the climate is characterized, in the 405 cm level, by the decrease of *Artemisia* and *Poaceae* percentages, proportional with the increase of *Pinus* percentage. Taking into account the lower altitude of the location, we consider that the pine pollen is *Pinus sylvestris* pollen and not *Pinus mugo* pollen, as *Pinus mugo* was located on high altitudes in the mountain areas, being specific to the subalpine level.

Unfortunately, the beginning of the Postglacial (Holocen) - 10,000 years ago - does not appear in the diagrams because the conditions of sedimentation in the interval 400- 380 cm did not allow pollen conservation, these layers being sterile.

The composition of the pollen spectra from the 375-370 cm differs totally from the ones previously discussed, fact that suggests their belonging to a different climatic period, more recent, warm and wet, characteristic to the Subatlantic. The ^{14}C age of 108.58 ± 0.38 B.P., confirm this attribution. The pollen of birch, beech and hornbeam is dominant, along with alder, oak, hazelnut tree and spruce fir.

The pine pollen decreases significantly in this interval compared to the Lateglacial to values as low as 5% and indicates its retreat to higher altitudes as a result of the structuring of vegetation in altitudinal belts. The curves of *Poaceae* și *Cyperaceae* decrease in the same drastic manner.

The presence of a maximum of aquatic plants and the first appearances of the rhizopodes and rotifers indicate a very wet, swampy environment, characteristic to the climate of Subatlantic.

We notify the first occurrences of pollen of walnut (*Juglans*), cereals (*Cerealia*) and hemp (*Cannabis type*), as an indicator of human presence in the region. The ^{14}C datings will supply data on the absolute age of these levels and therefore on the first signs of agricultural activities in this area.

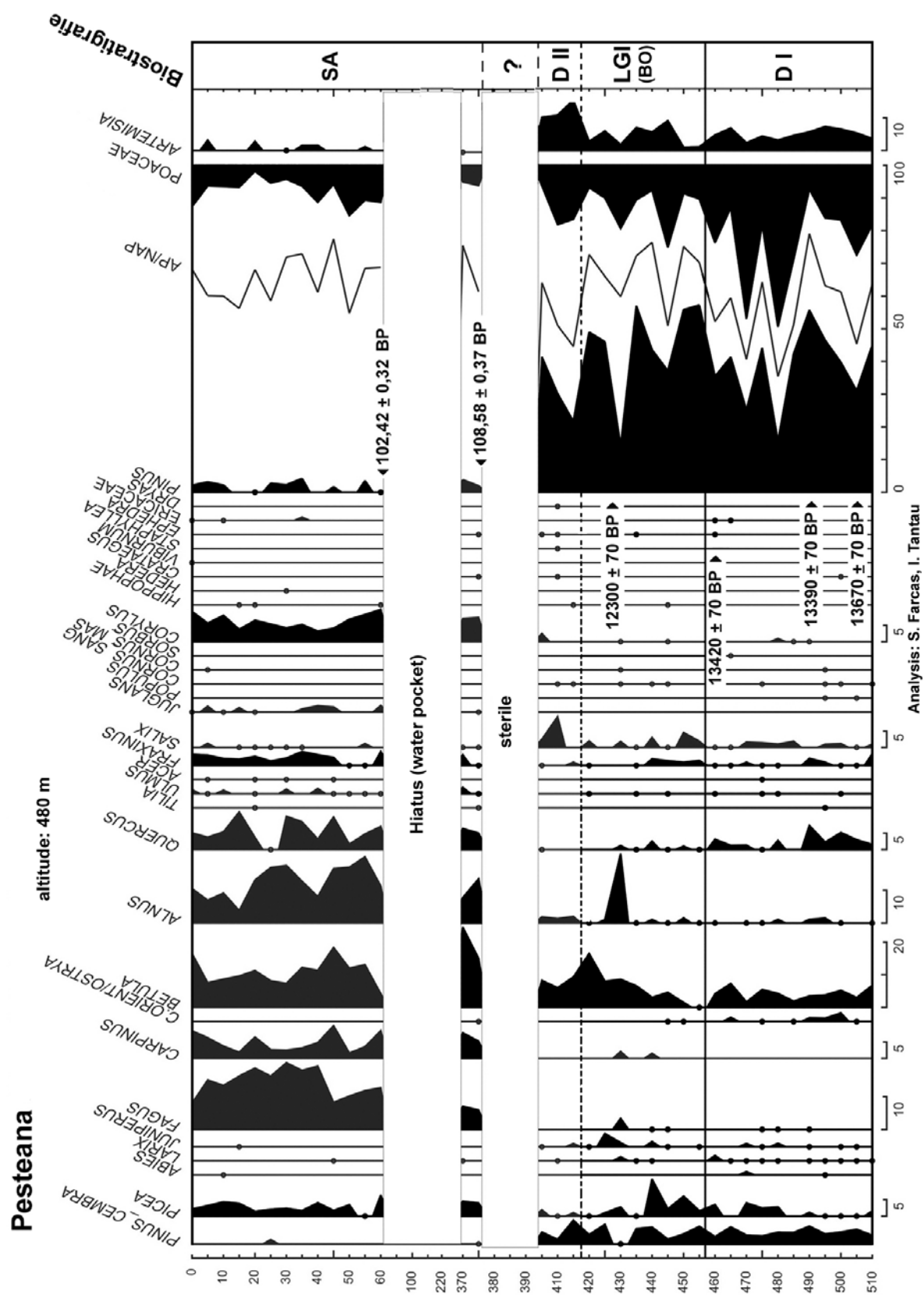


Fig. 3: Pollen diagram of the woody taxa and their correlation with the *Poaceae* and *Artemisia* curves in the Pestean sequence (D I-Oldest Dryas, LGI-Lateglacial Interstadial, BO-Bolling, D II- Older Dryas, SA-Subatlantic)

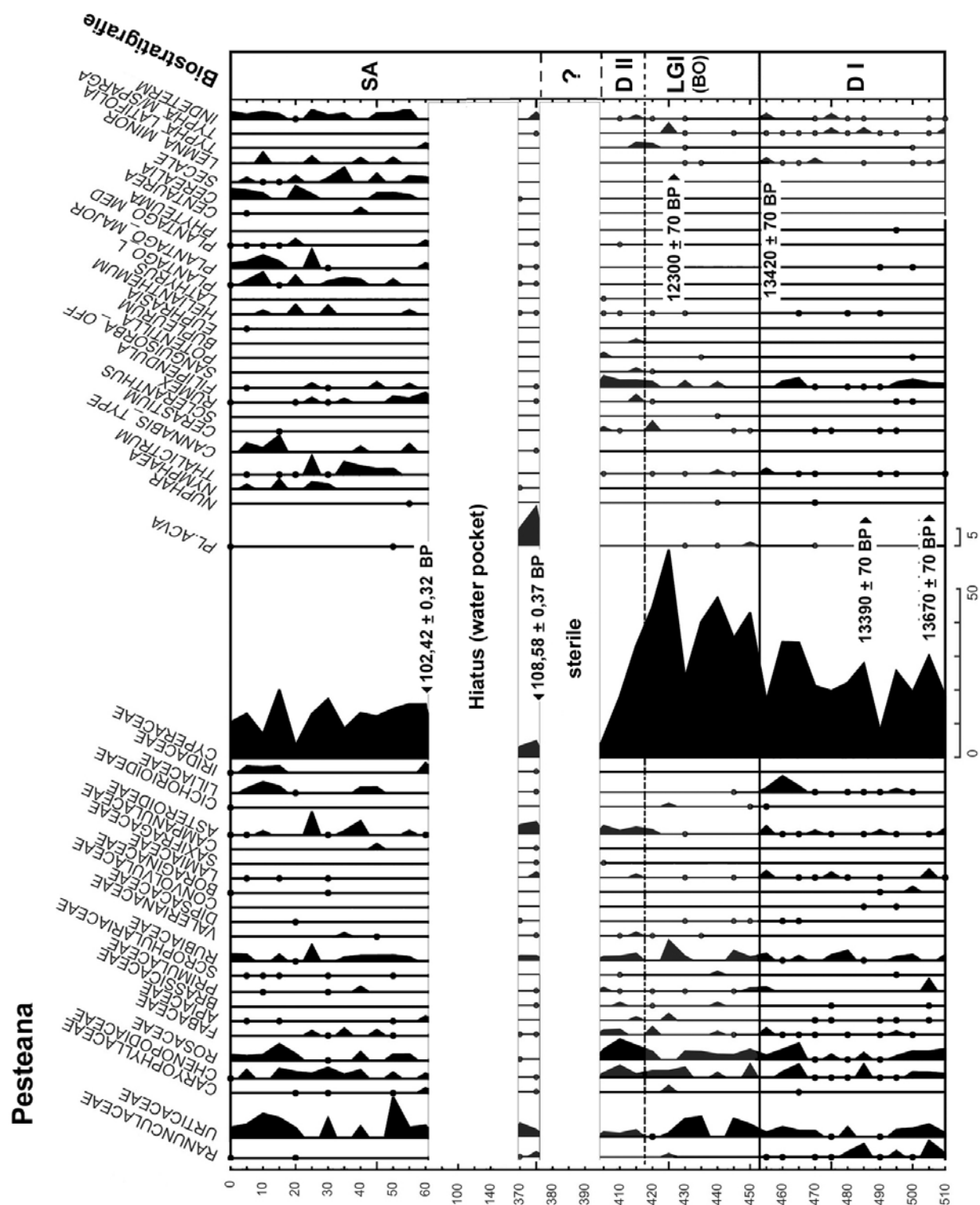


Fig. 4: Pollen diagram of the herbaceous taxa from the Peșteana sequence

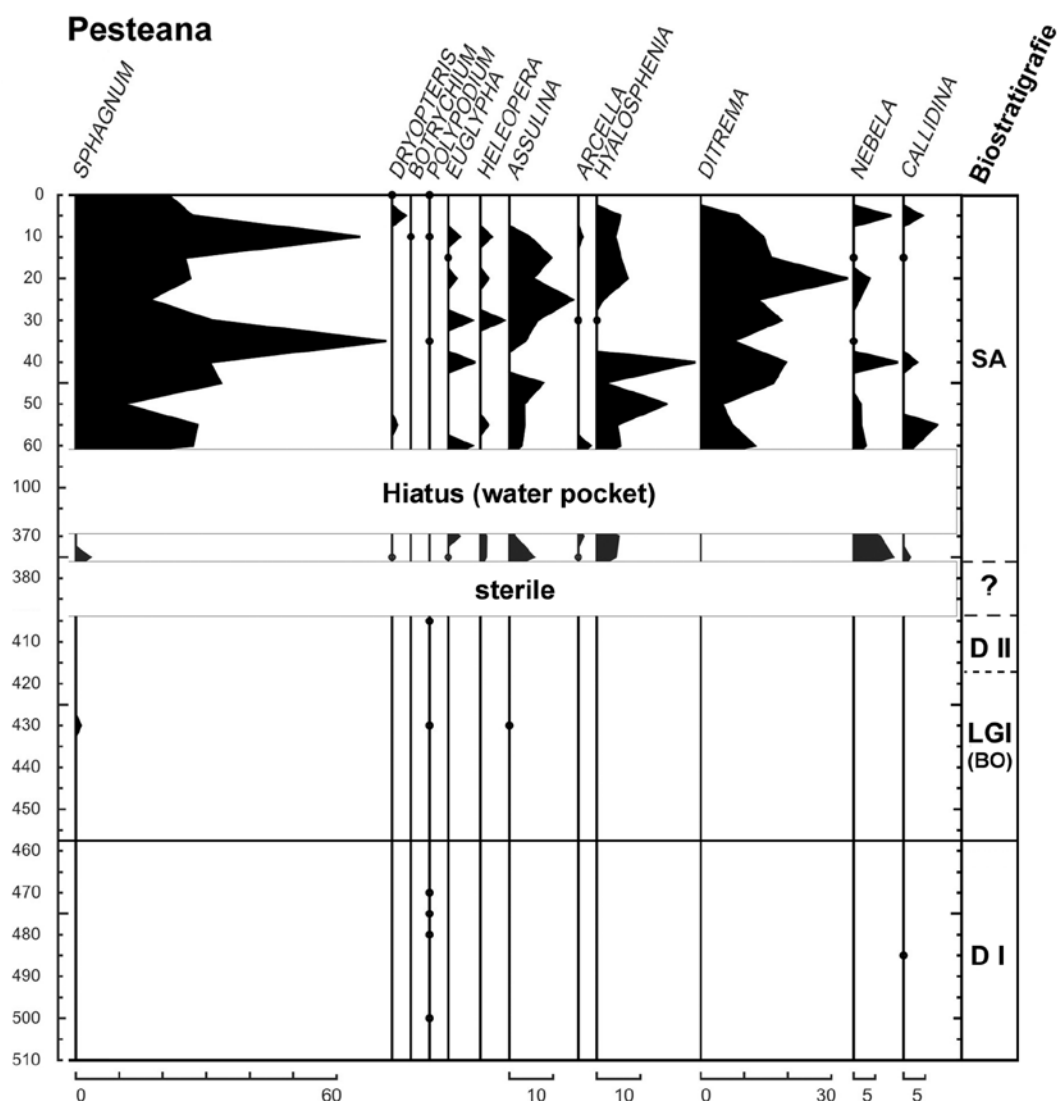


Fig. 5: The diagram of moss and fern spores, peat rhizopods and rotifers, from the Peșteana sequence

Above the depth of 370 cm there is a water layer, up to 65 cm, indicating a humidity increase that has led to the flooding of the peat basin of sedimentation.

The pollen spectra of the floating peat are dominated, of the tree group, by beech pollen, with percents up to 10%. Besides it there is also much pollen of birch, alder, hornbeam, oak and hazelnut. The almost complete absence of fir pollen from the pollen spectra is to be remarked. The pine tree pollen significantly decreases in the surface pollen spectra and the spruce fir is also present with low values, indicating its vertical remoting from the altitude of the studied site.

In what regards the herbaceous plants we especially remark those with anthropic significance: *Poaceae*, *Urticaceae*, *Plantago sp.*, *Chenopodiaceae* etc. Rye pollen (*Secale*) also appears in the 60 cm layer.

The curve of *Sphagnum* has large amplitude in the Subatlantic surface spectra, as expected. The pollen of *Cyperaceae*, as well as the peat rhizopods and rotifers, especially *Ditrema*, *Hyalosphenia* and *Assulina* also have a significant weight.

By examining the AP/NAP ratio in these Subatlantic levels, we notice a dominance of trees, therefore the presence of forests in the region.

Conclusions

The pollen spectra obtained from the Peșteana bog reflect the evolution of the vegetation from the region, starting with Lateglacial until the currently developing Subatlantic.

The history of the vegetation appears to be unfortunately discontinuous because of the stagnation of bog deposition (water layer), as well as to the impossibility of pollen conservation at certain levels (sterile), for various reasons.

The C¹⁴ dating sustained by absolute chronologic marks the changes of the vegetation structure, due to climatic causes, or, more recently, to human impact.

It is worth noting the constant presence of oak and ash pollen in the basal Lateglacial spectra of this sequence, having significant percentages. The obtained results strengthen the hypothesis we have previously stated, referring to the existence of glacial refuges for oak, and sustain the possibility of glacial refuges for ash as well, hypothesis which will be confirmed or infirmed by the molecular genetics analysis which is currently in progress.

The small values, less than 1% or sporadic, of other woody taxa in the Lateglacial of Peșteana raises certain questions. If for some of these taxa we accept the idea of their lateglacial presence in the region, in certain ecological niches with a proper microclimate (*Ulmus*, *Alnus*, *Corylus*), for others, such as beech (*Fagus*) and fir (*Abies*), we are not justified to accept the idea of glacial refuges.

An interesting problem is the presence of *Carpinus orientalis*/*Ostrya* pollen type, which appears in these Lateglacial spectra quite frequently. Taking into consideration the current distribution of *Carpinus orientalis* in Romania and the absence of *Ostrya*, we can logically assume that this pollen belongs to *C. orientalis*, which appears to have vegetated 10000 years ago near the studied location, in adequate microhabitats. As we know, today, oriental hornbeam is present in locations relatively close to Peșteana (Banat, Cerna Mountains, Godeanu, etc.), so it is possible that its presence in these pollen spectra is evidence of its persistence in the region.

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STUDIUL DINAMICII TARDI- ȘI POSTGLACIARE A VEGETAȚIEI DE LA PEȘTEANA (M-ȚII POIANA RUSCĂ)

(Rezumat)

Mlaștina de turbă de la Peșteana se găsește la limita sectorului sud-estic al Masivului Poiana Ruscă, pe platoul ultimei culmi muntoase, deasupra satului Peșteana, comuna Densuș, la o altitudine de 480 m. Mlaștina este invadată în întregime de un sfâgnet compact, presărat cu ochiuri de apă. Acest sfâgnet constituie un plaur alcătuit dintr-un strat de turbă relativ recentă, cu o grosime mică. Acest strat plutește pe o pânză de apă cu grosime mare, de aproximativ 3 m. Sub pânza de apă se găsește stratul de turbă veche, iar în bază argilă glaciară nisipoasă.

Din examinarea diagramelor polinice obținute din secvența de la Peșteana se distinge evoluția sincopată a vegetației din regiune, începând cu Tardiglaciul würmian și până spre zilele noastre. Eșantioanele argiloase din baza secvenței (580-515 cm) s-au dovedit a fi sterile d.p.d.v. palinologic.

Spectrele polinice de la nivelele 510-455 cm ar putea aparține Dryas-ului cel mai vechi, luând în considerare procentajele principalelor specii indicatoare: pinul, gramineele și *Artemisia*. Dintre foioase, o atenție specială merită stejarul (*Quercus*), cu o curbă continuă, sub 5%. Prezența acestui stadiu al Tardiglaciului nu va putea fi, oricum, confirmată decât de datările C14, aflate în curs de desfășurare.

Pe baza datărilor radiocarbon obținute, atribuim intervalul următor (450-405 cm), interstadialului Tardiglaciului, perioadă climatică mai blândă din cadrul Tardiglaciului, desfășurată în intervalul 13000-11000 de ani B.P. Această perioadă se caracterizează prin procente ridicate ale polenului de pin, însoțit de mesteacăn, dar și ale polenului de molid și *Pinus cembra*. Se constată prezența în spectrele polinice a polenului de stejar, cu procentaje semnificative, care ar putea indica existența unor refugii glaciare în regiune. Aceeași concluzie se poate trage și în cazul frasinului, care apare constant și cu procente supraunitare în spectrele polinice ale acestor nivele.

De la 420 la 405 cm se poate separa un alt stadial Tardiglaciului, pe baza creșterii procentajelor de *Artemisia* și a unei datări de 12300 ± 70 ani BP, obținute sub acest interval. Este vorba de Dryas-ul vechi (Dryas II sau Dryas mediu), un interval rece de la începutul Allerödului. Conform schemelor climatice europene mai recente, acest eveniment a avut loc începând cu 12000 de ani B.P.

Din păcate, în diagrame nu a putut fi semnalat debutul Postglaciului (Holocenului), ce a avut loc acum 10000 de ani, deoarece în intervalul 400-380 cm condițiile de sedimentare nu au permis conservarea polenului, orizonturile fiind sterile.

Compoziția spectrelor polinice al nivelelor 375-370 cm diferă total de cele anterioare, fapt care sugerează apartenența la o perioadă climatică diferită, mai recentă, mai caldă și umedă, caracteristică Subatlanticului. Această atribuire este susținută și de datările ^{14}C obținute. Predomină polenul de mesteacăn, fag și carpen, însoțit de cel de arin, stejar, alun și molid. Polenul de pin scade foarte mult în acest interval față de Tardiglaciul, ajungând la valori sub 5%. Notificăm primele apariții ale polenului de nuc (*Juglans*), cereale (*Cerealia*) și cânepă (*tip Cannabis*), ca indicator al prezenței umane în regiune.

Deasupra se găsește un strat de apă, până la adâncimea de 65 cm. Spectrele polinice ale turbei de plaur sunt dominate, dintre arbori, de polenul de fag, cu procentaje de până la 10%. Alături de acesta mai apare mult mesteacăn, arin, carpen, stejar, alun. Dintre plantele ierboase se remarcă în special cele cu semnificație antropică: *Poaceae*, *Urticaceae*, *Plantago sp.*, *Chenopodiaceae* etc. În orizontul 60 cm apare și polenul de secară (*Secale*).