A contribution to the Holocene vegetation history in the Northwestern Pirin Mountain (Bulgaria): the plant fossil record from peat-bog Mozgovitsa

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Abstract

Plant macrofossil analysis was performed on a peat core collected from the Mozgovitsa valley in the Northwestern Pirin Mountain. The results were combined with the information from pollen analysis and radiocarbon chronology so that a detailed palaeovegetation reconstruction for the last 9500 years was presented. *Betula* forests with groups of various *Pinus* species had dominated the landscape 9500-7300 years ago, while mixed deciduous *Quercus* forests were distributed below them. From this period the first macrofossil record of *Picea abies* indicated its presence in the study area. The change to a more humid climate after ca. 7500 years ago had resulted in the formation of a coniferous belt composed of *Pinus sylvestris*, *P. peuce* and *Abies*. Around 3000 years ago *P. abies* had started to expand in the coniferous belt and shaped the tree-line with *P. sylvestris* and *P. peuce*. The fossil record indicated an intensification of the anthropogenic impact on the natural vegetation since historical time by practicing animal husbandry and deforestation to obtain pasture land.

Key words: plant macrofossils, pollen analysis, vegetation, Holocene, Pirin Mountain

Introduction

The Holocene vegetation history of the Northern Pirin Mountain was intensively studied during the last decade mainly by application of pollen analysis and radiocarbon dating on cores collected from lakes and peat-bogs. This research activity has resulted in the delimitation of the main stages in forest development, tree migrations, climate changes and human impact [1-6]. However, until now the potential of plant macrofossil analysis as a method which provides additional valuable information on the presence of

trees and herbs was not sufficiently explored in this area. In this aspect the aim of the present paper was to fill in this gap by a complex study of a peat-bog located in the Northwestern Pirin Mountain, from where still few palaeoecological related to plant macrofossils investigations were conducted [7-8].

Study area

Pirin Mountain (2914 m) is the third highest massif on the Balkan peninsula situated in Southwestern Bulgaria. The northern part of the mountain is the highest, built up of marble limestone and granite. The modern vegetation is distributed in six altitudinal belts. Above the oak - hornbeam forests, dominated by *Quercus pubescens, Q. frainetto, Carpinus orientalis* and *C. betulus,* there is a fragmented beech belt (1000-1500 m) where the communities of *Fagus sylvatica* are mixed in some places with *Abies alba, Pinus nigra* and *Picea abies*. The coniferous belt (1500-2000 m) is the most compact, composed of *Pinus peuce, P. abies,* and *Pinus heldreichii* exclusively on limestone areas. The subalpine belt (2000-2500 m) is dominated by *Pinus mugo* and *Juniperus sibirica,* above it the alpine area is occupied by various herbaceous communities [1].The site of the present investigation is a peat-bog located at 1800 m within a thin coniferous forest in the deep valley of the Mozgovitsa river [2].

Material and Methods

The peat profile was sampled at 10 cm intervals for plant macrofossil analysis. The samples were soaked for 5-10 min in 10% KOH and afterwards sieved through 0.4 mm and 0.16 mm meshes. The two fractions were analyzed under binocular at magnification 10-40x using the reference collection in the Department of Botany at Sofia University and literature sources [9-11]. Charred wood (> 2 mm) and non-charred (> 5 mm) particles were studied under reflected light and light microscopes, respectively. Their determination was based on sections in three anatomical plains (transversal, tangential and radial) [12]. The results were plotted as histograms on a composite diagram (Fig. 1) together with the pollen curves of the most common plant taxa [2] with the program TGView ver.2.0.2. [13]. The plant macrofossils were represented as absolute numbers of determinable items (needles, seeds, nutlets, etc.) per sample volume of 20 ml. The vegetative parts like wood particles, stems and others

were not quantified but given in black dots as presence. The radiocarbon dates in C^{14} years BP [6] were indicated on the left side of the diagram and calibrated ages in the text are given as "years ago".

Results and Discussion

The diagram was divided into four complex zones (1-4) which reflect successive changes in the vegetation cover in the study area during the last ca. 9500 years.

Zone-1 (150 - 100 cm; 9500-7800 years ago)

The macrofossil samples were rich in nutlets of *Betula*. Seeds and needles from conifers (*Pinus peuce*, *P. sylvestris*/*mugo*) and in one sample needles of *Picea abies* were found. Both charcoal particles and subfossil wood fragments of *Pinus* sp. indicating local forest fires were determined. Elements of the peat-bog vegetation were presented mainly by nutlets of *Scirpus sylvaticus*, fruits of *Carex* sp., *C. echinata* and *C. acuta*. The pollen samples were dominated by *Betula* (up to 30%), *Pinus diploxylon*-type (up to 20%), *P. peuce, Juniperus,* and less (<5%) *Picea* and *Abies*. Pollen grains of deciduous trees like *Quercus* (up to 30%), *Carpinus orientalis/Ostrya*, *C. betulus, Tilia, Ulmus* and *Fagus* originated from lower altitudes due to upslope wind transport.

This zone revealed the characteristic features of the early Holocene vegetation at higher altitudes in response to the improvement of the climate. The dominant role in the initial phase of afforestation was played by birch (*Betula pendula*) which had occupied vast areas together with groups of pines (*P. sylvestris, P. peuce, P. mugo*) and junipers (*Juniperus*). Alder (*Alnus*) and willows (*Salix*) were spread along the streams. Birch had colonized barren soils and had shaped the upper tree-line. The needles of *Picea abies* dated back to 9000 years ago were the oldest ones, established so far, from all mountainous areas in Bulgaria. Alongside with the pollen data, the macrofossil evidence serves as a reliable proof that small populations of moisture-demanding trees (*Abies, Fagus* and *Picea*) were already present at the beginning of the Holocene. Below the birch forests deciduous *Quercus* forests with elm (*Ulmus*), lime (*Tilia*), maple (*Acer*), hazel (*Corylus)* and hornbeam (*Carpinus betulus*) had started to expand. Hazel, like birch, appeared as a pioneer element on open areas prior to the other migrating

trees. Natural fires were also quite common as indicated from the presence of macro-charcoal fragments, some of them identified as from *Pinus*.

Zone – 2 (100 - 80 cm; 7800-7300 years ago)

The zone was dominated by nutlets of *Betula* which subsequently disappeared from the fossil record. Subfossil wood of *Salix* and *Alnus* was also found. A substantial increase in the presence of fruits/nutlets of various *Carex* species, *Scirpus sylvaticus* and *Juncus effusus*–type was observed. Deciduous tree pollen from *Quercus, Betula, C. betulus, Corylus, Alnus* declined at the expense of coniferous pollen (mainly *P. diploxylon*-type). The continuous pollen curves of *Abies* and *Picea* also emerged. The variety of herb pollen taxa was the same like in the previous zone.

The birch forests continued to expand at this altitude while the conifers remained restricted in distribution. Gradually, after ca. 7500 years ago, the communities of *Pinus* and *Abies* had started to enlarge their areas replacing the birch and deciduous oak forests at many places. A significant change to more humid climate, favorable for the growth of the conifers, had occurred in the mountains of Southwestern Bulgaria [6]. The macrofossils of *S. sylvaticus* and *Carex acuta* indicated eutrophication of the peat-bog as they grew predominantly in habitats rich in nutrition elements, while the nutlets of *Ranunculus* cf. *nemorosus* pointed to meadows in the surroundings.

Zone 3 (80 - 50 cm; 7300-4800 years ago)

The macrofossil record comprised needles and seeds of *P. peuce*, *P. sylvestris*/*mugo* and *Pinus* sp. Nutlets of *Carex* sp., *C. acuta, C. echinata*, and *J. effusus*–type were also determined. The highest quantities of *P. diploxylon*-type pollen (up to 55%), *P. peuce* (up to 25%) and increasing values for *Picea* and *Abies* were recorded. Pollen of deciduous trees became of less importance.

In the course of several millennia the main constituents of the coniferous forests (*P. sylvestris, P. peuce,* partly *Abies*) had dominated the vegetation of the valley. Spruce was still less abundant in these forests but the slow increase in its pollen frequences indicated that this tree had started to gain importance. Macrofossil analysis from a site on the Northeastern Pirin Mountain for the time after 7500 years ago had also shown the appearance of needles of *Pinus* sp., *P. peuce, Abies alba* [14].

Zone 4 (50 - 0 cm; 4800 years ago - till present)

The most typical feature was the dominance of macrofossils from *P. abies* -needles and charred wood . Occasional finds of seeds of *Pinus* sp., needles and seeds of *P. peuce*, and subfossil wood of *Pinus* sp., *Juniperus, Salix* and charred wood of *Pinus* complemented the macrofossil record. Seeds and nutlets of *Teucrium montanum*, *Ranunculus* cf. *nemorosus* pointed to mountain meadows and those of *Parnassia palustris*, *Carex* and *Eriophorum* species – to wet local vegetation of the peat bog. The pollen samples in accordance with the macrofossil record showed a rise of *Picea* up to 10-15%, an increase for *Juniperus, Fagus*, and partly for *Betula*. Pollen of *Abies* decreased. Pollen grains of *Juglans, Castanea*, *Urtica, Plantago lanceolata* and other plants associated with human impact were regularly found.

An important change in the forest composition had started ca. 3000 years ago when the average temperatures had dropped and precipitation had increased [1]. Like in the Rila Mountain [15], *P. abies* had started to dominate in the coniferous belt of the study area shaping the tree-line at many places, solely or with *P. sylvestris* and *P. peuce*. By that time *Fagus sylvatica* had finally established at lower altitudes. The decrease in tree pollen, accompanied by an increase for grasses (Poaceae), and other herbs as Chenopodiaceae, *Urtica*, *Plantago lanceolata, Filipendula,* undoubtedly reflected anthropogenic interference in the natural vegetation**.** Local fires as shown by charred particles and wood of *P. abies* could have been caused by humans in order to increase pasture land. The existence of open habitats in the surroundings was indicated by the find of *T.montanum*, *Potentilla* sp. The peat-bog was overgrown by *Parnassia palustris*, *Eriophorum* sp. and *Carex* species.

Conclusions

The complex research of the peat-bog in the Mozgovitsa valley had contributed to elucidate in more details the Holocene vegetation history of the Northwestern Pirin Mountain for the last ca. 9500 years. The following main conclusions could be drawn:

1. The early Holocene vegetation between 9500 and 7500 years ago at high-mid altitudes was dominated by *Betula pendula* forests with groups of pines (*P. sylvestris, P. peuce, P. mugo*) and mixed *Quercus* forests below them.

2. Macrofossils from *Picea abies* at age of 9000 years ago were determined for the first time, implying that this tree had survived in refuges with sufficient moisture like the valley of the Mozgovitsa river.

3. The formation of a coniferous belt composed of *P. sylvestris, P. peuce* and *Abies* had begun 7500 years ago in the conditions of a more humid climate.

4. The expansion of *P. abies* in the coniferous belt had started ca. 3000 years ago and this tree had shaped the tree-line in the study area with *P. sylvestris* and *P. peuce*.

5. The anthropogenic impact on the natural vegetation was intensified since historical times, mainly by practicing animal husbandry and deforestation.

6. At several stages of its existence the peat-bog was overgrown by *Scirpus sylvaticus* and *Juncus* sp., while in most recent times various sedges (*Carex* sp., *Eriophorum* sp.) and *Parnassia palustirs* had started to prevail.

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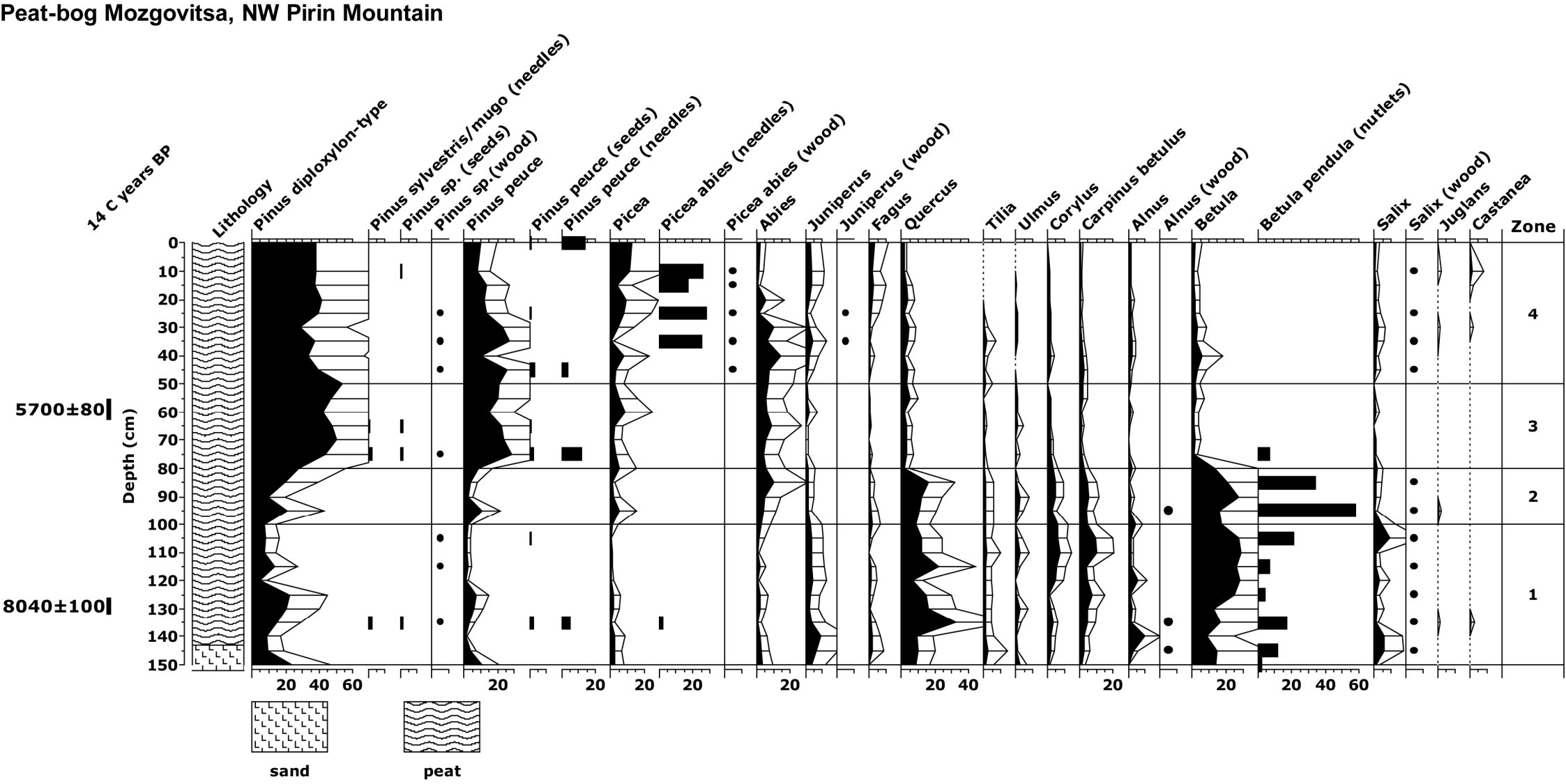
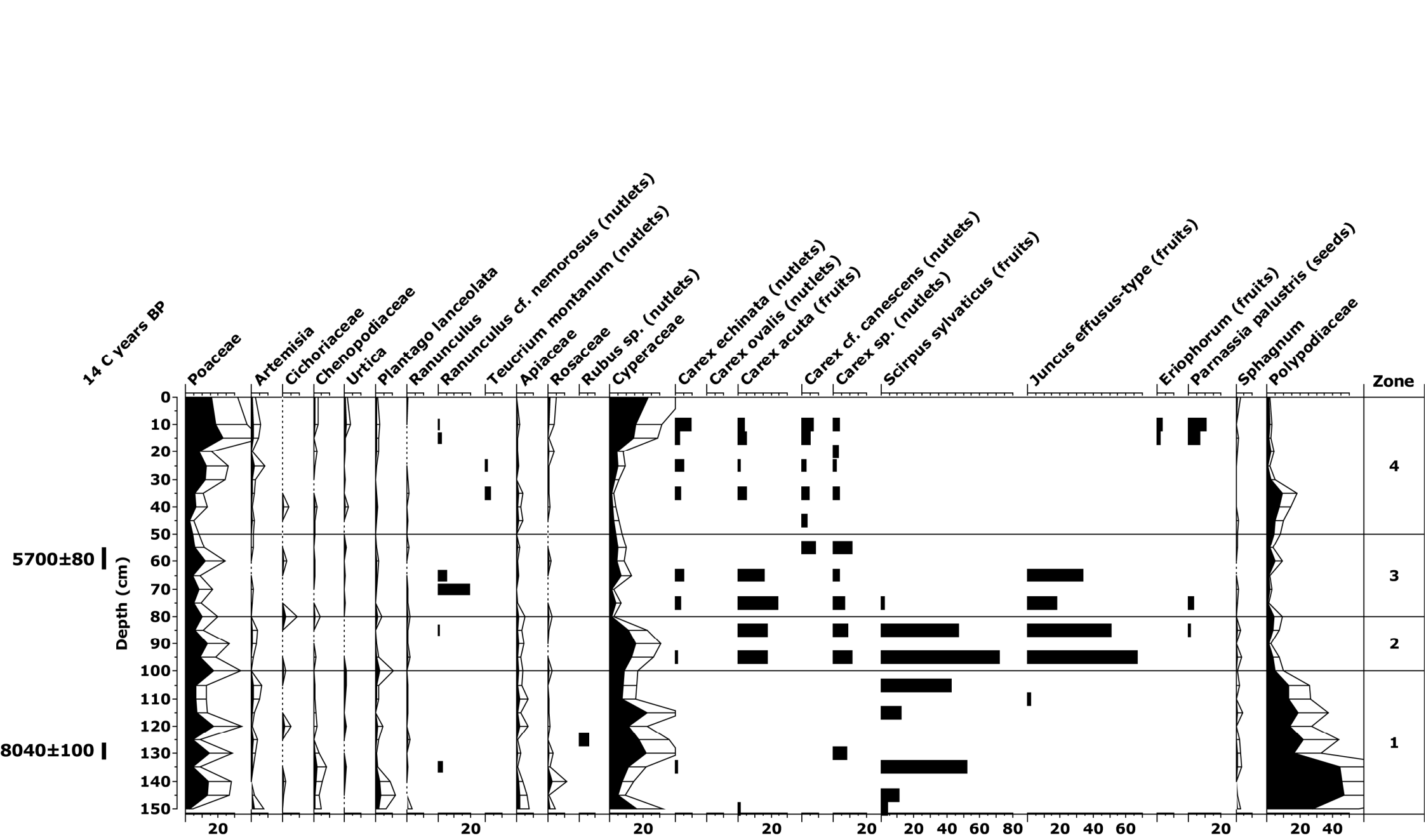

Peat-bog Mozgovitsa, NW Pirin Mountain
14 C years BP
Lithology
Pinus diploxylon-type
Pinus sylvestris/mugo (needles)
Pinus sp. (seeds)
Pinus sp.(wood)
Pinus peuce
Pinus peuce (seeds)
Pinus peuce (needles)
Picea
Picea abies (needles)
Picea abies (wood)
Abies
Juniperus
Juniperus (wood)
Fagus
Quercus
Tilia
Ulmus
Corylus
Carpinus betulus
Alnus
Alnus (wood)
Betula
Betula pendula (nutlets)
Salix
Salix (wood)
Juglans
Castanea
Zone
Depth (cm)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
5700±80
8040±100
4
3
2
1
20 40 60
20
20
20
20
20
20 40
20
20
20 40 60
sand
peat


14 C years BP
Poaceae
Artemisia
Cichoriaceae
Chenopodiaceae
Urtica
Plantago lanceolata
Ranunculus
Ranunculus cf. nemorosus (nutlets)
Teucrium montanum (nutlets)
Apiaceae
Rosaceae
Rubus sp. (nutlets)
Cyperaceae
Carex echinata (nutlets)
Carex ovalis (nutlets)
Carex acuta (fruits)
Carex cf. canescens (nutlets)
Carex sp. (nutlets)
Scirpus sylvaticus (fruits)
Juncus effusus-type (fruits)
Eriophorum (fruits)
Parnassia palustris (seeds)
Sphagnum
Polypodiaceae
Zone
Depth (cm)
5700±80
8040±100
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
4
3
2
1
20
20
20
20
20
40
60
80
20
40
60
20
20
40