Two millennia of vegetation history in the Smolyan lake area, Central Rhodopes Mountains (Bulgaria)

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Abstract. A palynological study was conducted on a 460 cm long core from Lake Blatisto (1540 m, Smolyan lake area) located in the Central Rhodopes Mountains and supplemented by two radiocarbon dates. The core consists mainly of peat deposited since the first centuries AD. The results show several distinct periods in the vegetation development and human impact, starting with a cultural phase at *ca*. 400 AD and followed by *Picea* – *Pinus* forest expansion between 590 AD and 910 AD. An enlargement of *Fagus* and *Abies* forests was established for the time interval 910–1600 AD with an intermediate short cultural phase *ca*. 1360 AD. During the last centuries the present-day vegetation dominated by spruce forests was shaped under a strong anthropogenic pressure. The analysis of the seeds preserved in the sediments allowed the reconstruction of the local vegetation in and around the lake. The basin with much influx of sandy gyttja material at the beginning of its existence has changed to a lake with stagnant water with accumulation of peat.

Key words: Lake Blatisto, pollen analysis, seed analysis, Smolyan area, vegetation history

Introduction

The Rhodopes Mountains are one of the refugial non-glaciated areas on the Balkan peninsula where various plants had survived the harsh conditions of the last glaciation. This evidence originates from palynological investigations carried out on sediments from peat-bogs and former lakes located in the western and central parts of the mountains (Bozilova & al. 2011). The characteristics of the main trends in the postglacial vegetation development, flora history and human impact are also supported by radiocarbon chronology. Continuous sediment cores of Lateglacial and Holocene age were obtained from the Biosphere Reserve Kupena (Huttunen & al. 1992; Tonkov & al. 2013) and from the area of the reservoir Shiroka Polyana (Filipovitch & Lazarova 2003; Stefanova & al. 2006). However, the majority of the sites studied cover only parts of the Holocene extending back either to the last 9000–7000 years (Bozilova & al. 2000; Lazarova & al. 2011) or to the most recent Subatlantic time (Lazarova 2003; Lazarova & Filipovitch 2004). Moreover, with a couple of exceptions, the time resolution of the upper parts of the pollen diagrams from the Rhodopes Mountains is rather low due to a slow deposition rate which does not provide a detailed picture of the environmental changes in historical times.

In this aspect the aim of the present paper was to reveal in more details the vegetation dynamics and human influence in the area of the Smolyan lakes for the last two millennia by the application of pollen and seed analyses, and radiocarbon dating of a sediment sequence from Lake Blatisto. The new palaeoecological information obtained could be also of interest for botanists, foresters, ecologists and organizations working on problems of nature protection and conservation.

Material and methods

Study area

The central part of the Rhodopes Mountains where the Smolyan lakes are located falls within the Chernatish geobotanical region. Forests of *Picea abies* (L.) Karst. are prevailing which form the largest single-dominant communities in Bulgaria. At some places are found associations dominated by *P. abies* with *Pinus sylvestris* L. as a subdominant. Forests of *P. sylvestris* or *Pinus nigra* Arn. are also common but they are mostly fragmentary dispersed. Forests of *Abies alba* Mill. are more rarely found at some places. In the eastern and partly in the northern areas of the region at lower elevations are found forests of *Fagus sylvatica* L. In the northwestern part vast areas are occupied by *Quercus dalechampii* Ten. Deciduous mixed forests composed of *F. sylvatica*, *Carpinus betulus* L., *Ostrya carpinifolia* Scop., *Fraxinus ornus* L. and *Q. daleschampii* are quite common in the deep ravines (Bondev 2002).

Lake Blatisto (N 41°37'17.26", E 24°40'41.27"; 1540 m a.s.l.) belongs to the group of the Smolyan lakes. They are situated in the coniferous belt of the Central Rhodopes Mountains on several swampy terraces along a small river in an area with a pyroclastic rocktype dating from the Oligocene and consisting of rhyolite (Fig. 1). The lakes were formed after landslides originating from failure of the southern slope of the surrounding mountain ridge, probably after an earthquake. Lake Blatisto is the second highest situated lake of the group being 178 m long and 158 m wide, with an area of *ca*. 1.7 ha and a maximum water depth of 4 m. Its bottom is sandy with boulders and gravel (Ivanov 1964). The northern and western slopes are covered by a dense *P. abies* forest with some admixture of *A. alba*,

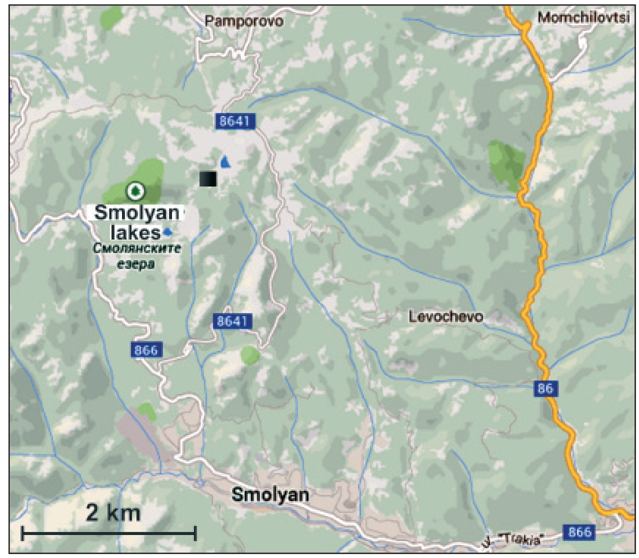

Fig. 1. Map of the Smolyan lake area and the study site: ■ – Lake Blatisto.

P. sylvestris and *Juniperus communis* L. Remarkable are the enormous, still growing *Sphagnum* islands which occupy nearly 60 % of the lake surface (Fig. 2). Between the islands and the borders of the lake the vegetation consists of *Carex acuta* L., *C. echinata* Murr., *C. rostrata* Stokes, *Juncus effusus* L., *Eleocharis palustris* (L.) R. Br., *Equisetum hiemale* L., *E. fluviatile* L. *Mentha aquatica* L., *Hypericum tetrapterum* Fries, *Menyanthes trifoliata* L., etc. The surrounding meadows are dominated by grasses and scattered stands of *P. sylvestris, Betula pendula* Roth. and *J. communis*. The present-day vegetation composition in the area of the lakes has been in-

Fig. 2. A view of Lake Blatisto in 2012 (photo by E. Komitov).

fluenced by grazing of domestic animals, cultivation of cereals and potatoes, timber production, and more recently, the construction of tourist complexes and hotels (Huis & al. 2013).

The local climate is both under the Mediterranean and mountainous influence resulting in two precipitation maxima in June and December. The average amount of precipitation is *ca*. 1100 mm. The mean annual temperature is 5°C – 0°C. The summers are relatively cool while the winters are milder with plenty of clear, sunny days and in general more than 1 m thick snow cover. The region is protected from the cold winds by the northerly situated mountain ridges (Tishkov 1982).

Core and lithology

The sediment profile is 460 cm deep and was collected with a Streif corer in sections of one meter from a *Sphagnum* island in the central part of the lake. The lithology of the sediments is the following: 0–150 cm – *Sphagnum-Equisetum* peat; 150–300 cm – peat with plant remains; 300–370 cm – sedge peat; 370–400 cm – peat with sand; 400–460 cm – sandy gyttja.

Pollen analysis

The core was sampled every second centimeter. For the peat samples the chemical treatment was boiling in 10% KOH for 5 minutes followed by acetolysis (Faegri & Iversen 1975). Heavy liquid separation with 96% bromoform-alcohol mixture was applied for the gyttja sandy samples in the lowermost part of the core. The determination of fossil pollen and spores was performed with a Leitz microscope at 400x or 1000x magnification using the reference books of Faegri & Iversen (1975), Erdtman & al. (1963) and Beug (1961). The pollen sum (AP+NAP=100%) includes all pollen grains except those of *Cyperaceae* and aquatics, spores of mosses and pteridophytes. The presence of the most common fossil pollen grains and spores is presented on a percentage pollen diagram (Fig. 3) constructed by the program TGView ver. 2.0.2 (Grimm 2004). The levels where charcoal particles of various sizes were observed are also indicated on the diagram. Five local pollen assemblage zones (LPAZ, Sm-1 to Sm-5) are recognized.

Macrofossil analysis

Samples of 10 cm^3 sediment were taken at 10 cm interval and boiled in 5% KOH for 5 minutes. Afterwards the samples were filtered in four fractions through meshes of 500, 250, 160 and 100 μm. The content of the fractions was examined under a binocular with 10x or 25x magnification. All available seeds and some plant remains (leaves of mosses, small stems, etc.) were separated but only the seeds were determined using the books of Bertsch (1941), Beijerinck (1947), Berggren (1969), Katz & al. (1965) and Nilsson & Hjelmqvist (1967). The results were plotted as histograms (Fig. 4) representing the absolute number of determinable seeds per sample volume of 10 cm^3 with the program TGView ver.2.0.2 (Grimm 2004) (Fig. 4). The diagram is divided into four local macrofossil assemblage zones (LMAZ, M-1 to M-4) which reveal successive changes in the lake vegetation development and its surroundings.

Radiocarbon dating

The radiocarbon age of two bulk sediment samples was determined in the Physical Laboratory of the State University of Gröningen, the Netherlands. The calibration (95.4% probability) was performed with the OxCal v3.10 program (Bronk Ramsey 2005). The following results were obtained:

Lab. № GrN 8441: depth 208–215 cm, 575 ± 55 BP (cal. 1290 AD to 1440 AD; mean value 1365 AD)

Lab. № GrN 8442: depth 420–428 cm, 1530 ± 60 BP (cal. 410 AD to 640 AD; mean value 530 AD)

The nearly 5 meter deep core spans a rather short, recent period of the Subalantic, dating back from the first centuries AD till recent times. The sediment accumulation rate has been very quick, particularly after the *Sphagnum* development started. The calculations show a sediment accumulation rate for the interval between the two radiocarbon dates of 3.9 yrs/cm and for the uppermost 220 cm this value is 2.7 yrs/cm. By extrapolation the age of the bottom sandy gyttja could be provisionally assigned to *ca*. 400 AD or even older.

Results

Pollen stratigraphy (Fig. 3)

LPAZ Sm-1, 460–400 cm (<400 AD – 590 AD)

This zone comprises the oldest part of the core and is characterized by the highest NAP percentages ranging between 60% and 80%, attributed mainly to *Poaceae* (up to 40%), the cultivars (*Cerealia*-type up to 12% and *Secale* 5%). Anthropogenic indicators such as *Rumex, Plantago, Urtica, Artemisia, Cichoriaceae* are recorded with values *ca*. 5–10 %. Deciduous trees are represented by *Quercus* (up to 15 %), *Fagus* (5–10 %), *Betula* (5 %), *Carpinus betulus, C. orientalis/Ostrya* and *Corylus* (each below 5 %). The conifers participate with comparatively low percentages: *Pinus diploxylon*-type (up to 10–12 %), *Picea* (below 5 %), *Abies* and *Juniperus* with scattered pollen grains. Charcoal is regularly found.

LPAZ Sm-2, 400–315 cm (590 AD – 910 AD)

The most characteristic feature is the decline of NAP at the beginning of the zone to 20–30 % due to *Poaceae* (10 %), the disappearance of the cereals and the reduction of the accompaning anthropogenic indicators (*Rumex, Plantago, Urtica*). The pollen curves of *Pinus diploxylon*-type and *Picea* rise to 35–40 % and 20–25 %, respectively. The percentages of the deciduous trees keep the same values. A tendency for a rise of *Fagus* and *Abies* is recorded at the transition to the next zone. Lower percentages are established for pollen of *Cyperaceae* and *Poaceae*. Charcoal is nearly absent in this zone.

LPAZ Sm-3, 315–200 cm: (910 AD – 1360 AD)

The arboreal pollen curve varies between 50 % and 80 %, with maximal values for *Fagus* (*ca*. 20 %), *Abies* (10 %), *Quercus* (7 %), and continuous presence for *Carpinus betulus, C. orientalis/Ostrya, Corylus, Alnus* and *Betula* (each below 5 %). The pollen curve of *Pinus diploxylon*-type declines to 10–20 %, while *Picea* keeps *ca*. 10–15 %. Among the herbs should be mentioned *Poaceae* (15–30 %), *Brassicaceae, Asteraceae, Cichoriaceae* and the anthropogenic indicators *Galium*-type, *Rumex, Plantago, Urtica*. Pollen of *Triticum, Secale* and *Cerealia*-type appears again. In this zone are recorded the highest percentages for spores of *Polypodiaceae* and constant presence of charcoal.

LPAZ Sm-4, 200–135 cm (1360 AD – 1600 AD)

In this zone AP reaches maximal values exceeding 90 % caused by an increase of *Pinus diploxylon*-type (up to 60 %), *Picea* (10–18 %), *Fagus* (15 %), *Betula, Alnus, Carpinus betulus* and *C. orientalis/Ostrya* (each up to 5 %). Pollen of *Juniperus* is scarcely found. The lowest values are recorded for *Poaceae* (5–10 %) and for most of the herbs (*Asteraceae, Cichoriaceae, Rumex, Plantago*). The same is valid for the hygrophytes and spores of ferns.

LPAZ Sm-5, 135–0 cm (1600 AD – till recent time)

An increase for NAP to 50–55 % is observed in this zone, attributed to *Poaceae* (45 %), *Cichoriaceae* (5 %), *Rumex, Plantago*, *Caryophyllaceae* (each up to 5 %), *Cerealia*-type (10 %) and constant presence of *Secale* and *Triticum*-type. Notable for this zone is the uninterrupted pollen curve of *Juniperus* with a maximum of 20 %, the regular find of *Juglans* pollen, and the decline for *Abies* and *Fagus*. Most of the deciduous trees participate with lower values. Among the hygrophytes with high percentages are present *Cyperaceae*, *Menyanthes* and *Equisetum*. Spores of *Sphagnum* are regularly found.

Macrofossil analysis (Fig. 4)

LMAZ M-1, 460–360 cm (<400 AD – 740 AD)

The highest abundance of seeds is in this zone. Most of them originate from the marshy vegetation and swampy meadows: *Juncus effusus, J. articulatus, Carex echinata, C. rostrata, C. curta, Eleocharis palustris, Mentha aquatica, Montia fontana*. Small quantities of seeds were determined from plants growing on drier places (*Poa pratensis, Ranunculus repens, Potentilla erecta, Prunella vulgaris, Hypericum* sp.). The presence of *Sagina procumbens* and *Agrostis* sp. as indicators for sandy habitats complete the general picture of the local vegetation. Noteworthy is the absence of seeds from trees and shrubs.

LMAZ M-2, 360–275 cm (740 AD – 1070 AD)

The presence of seeds from marshy species sharply decreases and there are only scattered finds of *Carex echinata, Juncus effusus, J. bufonius* and *J. articulatus*. Seeds of *Ranunculus repens* and *Agrostis* sp. are regularly found and few from *Poaceae* and *Sagina procumbens*.

LMAZ M-3, 275–170 cm (1070 AD – 1470 AD)

There is again some increase for seeds from *Carex echinata, C. curta, Juncus effusus* and the presence of grasses (*Poaceae*, *Agrostis* sp., *Poa pratensis*). Only in this zone are found a nut from *Fagus* and seeds from *Betula* sp. and *Alnus incana*.

LMAZ M-4, 170–0cm (1470 AD – till recent time)

Fossil seeds are rarely present in this zone which could be explained by their low state of preservation in the *Sphagnum*-*Equisetum* peat. Most common are the finds of *Carex echinata, C. curta* and *Juncus bufonius*. Seeds of *Menyanthes trifoliata* were determined only in this zone. Among the plants growing on drier places could be mentioned *Prunella vulgaris* and *Potentilla erecta*.

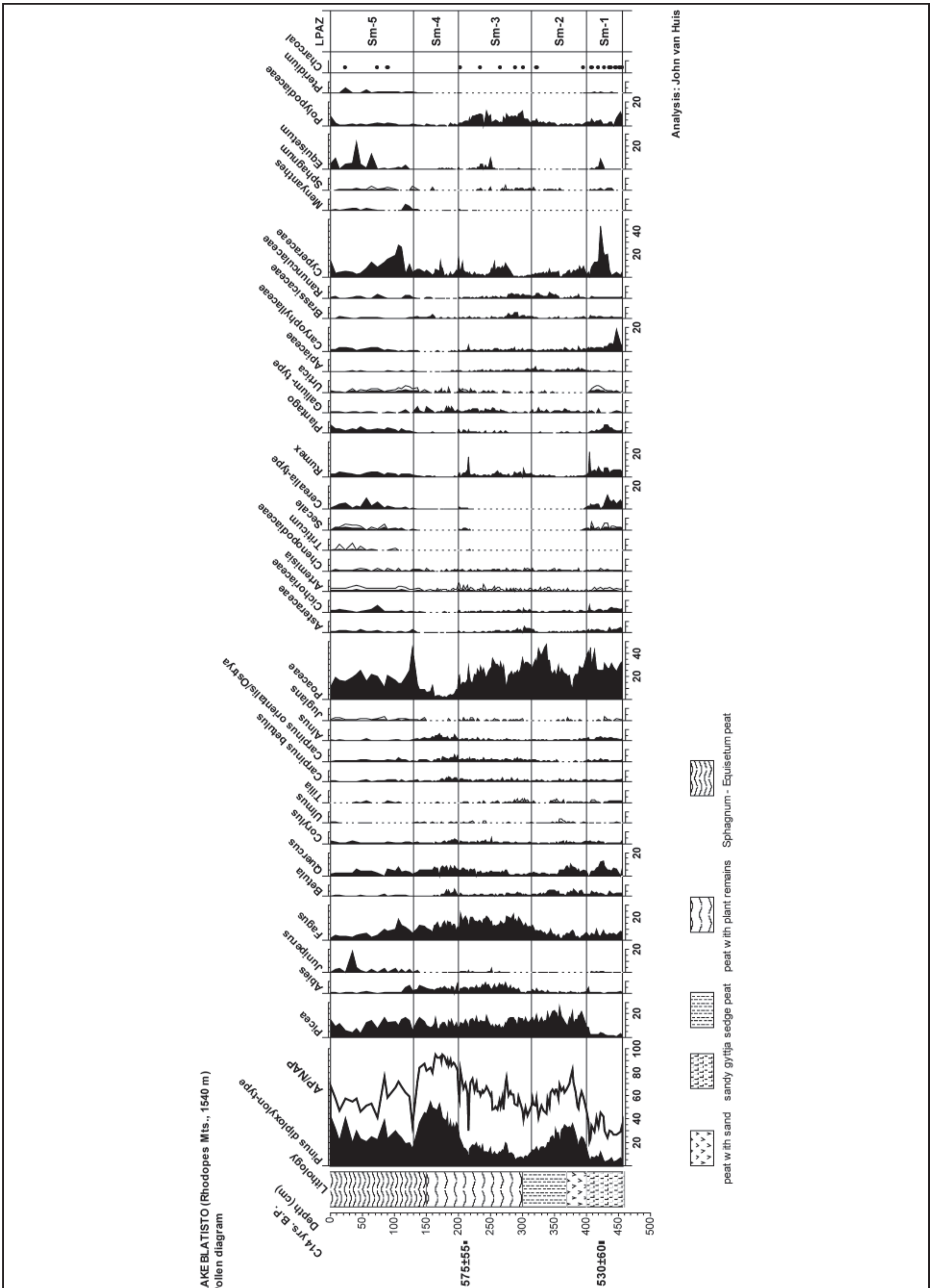

Fig. 3. Pollen diagram of Lake Blatisto.

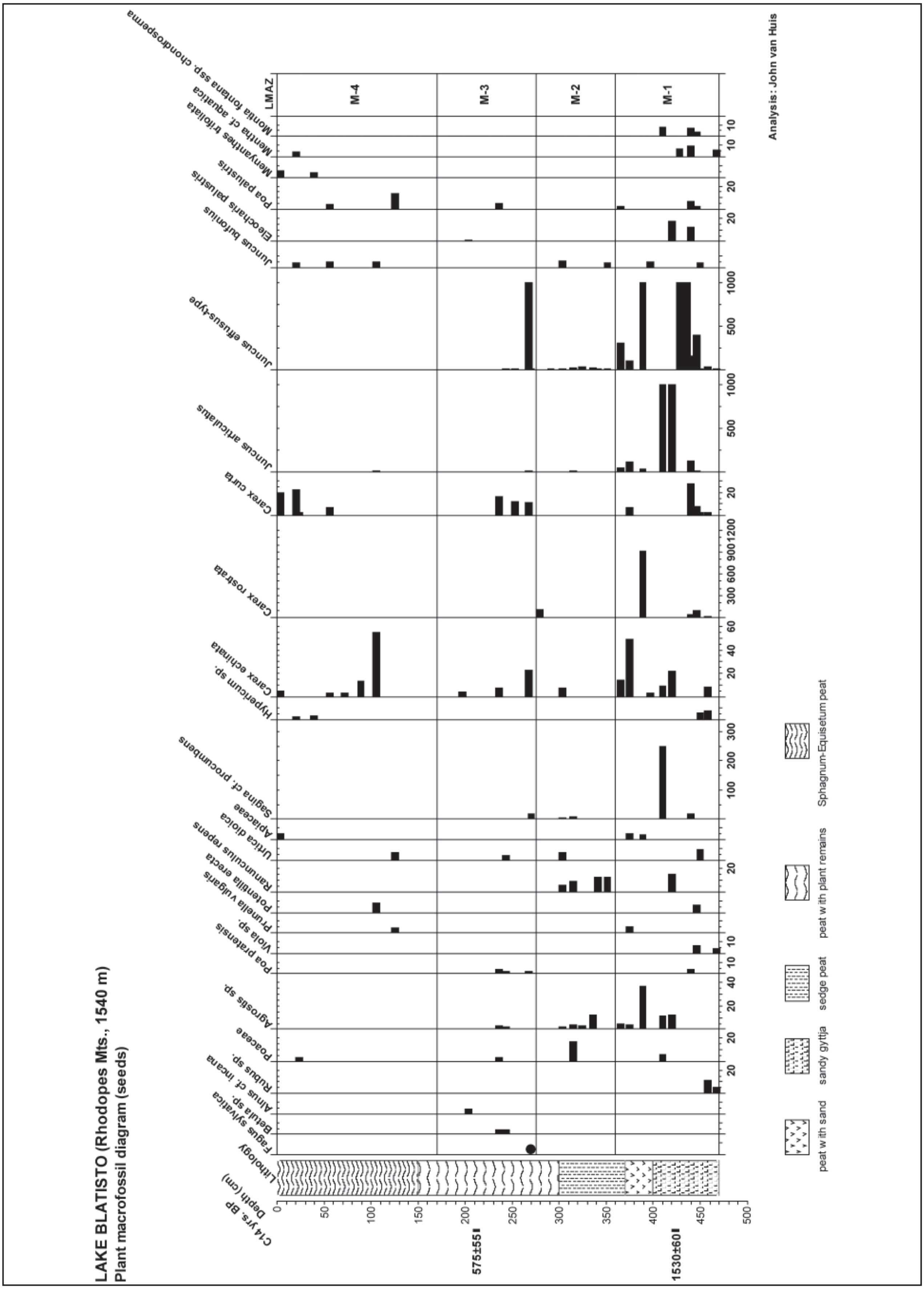

Fig. 4. Macrofossil diagram (seeds) of Lake Blatisto.

Discussion

Vegetation development

The pollen diagram reveals in details the vegetation history and human activities in the study area since historical times, i.e. the last *ca*. 1600 years. In the first centuries AD the area of the Smolyan lakes was intensively used for agricultural activities, cattle- and stock-breeding (LPAZ Sm-1) (Fig. 3). The local tribes cultivated *Secale* and other cereals as shown by the presence of pollen of Cerealia-type (*Avena, Hordeum*). An old cultural system was used in the Rhodopes Mountains. in which *Avena* was planted before *Secale* for a better aeration of the soil (Primovski 1973). The presence of *Artemisia, Chenopodiaceae* and *Brassicaceae* pollen could be considered as indicative for waste fields and leads to the conclusion that shifting cultivation was presumably practised in the vicinity of the lakes. After exhaustion of the soil by continuous agricultural use the small fields were left fallow for some years before to be used again. By that time the shepherds in the southern Rhodopes Mountains practised the transhuman system at which occasion they moved the flocks to the lower situated valleys and plains near the Aegean Sea during winter time and returned to the mountains in spring (Primovski 1973).

The relatively low percentages of *Pinus diploxylon*-type pollen (most probably *P. sylvestris*) and *Picea,* compared to those of deciduous trees, indicated that forest clearances by tree felling and possibly fires took place on a large scale in the coniferous belt close to the lakes around 500 AD, while *Fagus* and *Quercus* forests with some *Tilia* and *Ulmus* at lower altitudes remained less disturbed. During this old cultural phase grazing was common indicated by the frequent occurrence of ruderals and grassland species including *Rumex, Urtica, Plantago*, *Cichoriaceae* and *Caryophyllaceae*. The regular presence of *Juglans* pollen confirms its cultivation.

The open water of the lake was surrounded by marshy vegetation composed of species from *Cyperaceae, Juncaceae, Typhaceae*, *Alisma, Equisetum* and others. Swampy grasslands and drier pastures were presumably located close to the lake while the arable fields were situated at some distance, and this could explain the absence of seeds from cultivars in the deposits in spite of their abundance as fossil pollen (Figs 3 and 4).

The period between 590 AD and 910 AD (LPAZ Sm-2, Fig. 3) was marked by a rapid regeneration of the coniferous forests composed of *Pinus*, *Picea abies* and some *Abies alba* after the period of human activity. The fields in the highlands were more or less abandoned probably after exhaustion of the soil on the terraces by intensive cultivation in the preceding period. As *Pinus* is relatively insensitive to soil conditions the fast development of its juvenils was an advantage in the competition with *Picea abies* during the first phase of forest regeneration on desolated or burned places. For spruce after a slow start in development of the juvenils the former increases quickly even faster than pine. The distribution of the deciduous trees was restricted to lower altitudes (*Quercetum*-mixtum elements) or in more remote locations (*Fagus*). The stands of *Betula* in this situation could be considered as an intermediate stage between the clearances during the preceding period and the development of the coniferous and deciduous forests. The emphasis on the cultural activities was replaced from the terraces to the valley-grounds. The continuous presence of meadow plants pointed to the existence of grasslands frequently used for grazing. It seems that the terraces were not completely abandoned in this time, probably being occasionally visited by shepherds.

The deposition of sandy gyttja in the lake was first replaced by accumulation of peat mixed with sand, and subsequently by sedge peat. The comparatively poor macrofossil record represented by occasional finds of seeds of *Juncus* and *Carex,* and some seeds of *Ranunculus repens*, *Poaceae* and *Agrostis* sp. (Fig. 4) suggests a decay in the local marshy vegetation caused by a change in the water level.

The natural forest regeneration until 1360 AD (LPAZ Sm-3, Fig. 3) continued with an increasing importance of the deciduous elements, *Fagus* in particular, which expanded on the mountain slopes pushing *Picea abies* to higher altitudes. The relatively high percentages of *Fagus* and the find of a beech-nut give support that beech has reached the vicinity of the lake. The favourable climatic conditions around X^{-th} century AD, i.e. increased air-humidity and milder temperatures (Cowie 2007), have had possibly a positive influence on the development of the deciduous trees. Meanwhile, *Abies alba* also enlarged its areas forming single-dominant or mixed communities with beech or spruce. In the forests the participation of ferns (*Polypodiaceae*) in the understorey became considerable.

The terraces were still used for grazing and covered with meadow flora (*Rumex*, *Cichoriaceae, Galium*, *Plantago*, *Caryophyllaceae*, etc.). The cultivation of cereals seems unlikely or practised on a very small scale. A subsequent change in this situation was indicated by the second appearance of pollen of *Secale* and *Cerealia*-type, besides the good representation of meadow plants and ruderals. Quite probably, part of the local population has moved to higher situated mountainous places. Human interference has become more pronounced at the end of this period when forest clearings and burnings periodically took place in order to extend meadow land. On more open places in the forests and along the forest edges the pioneers *Corylus, Carpinus orientalis, Juniperus, Pinus* and to less degree *Betula* could establish themselves.

The presence of seeds from different *Carex* species and *Juncus bufonius*, as well as spores from *Sphagnum* and *Equisetum,* suggest that the marshy vegetation was developed in the shallower parts along the shores of the lake (Fig. 4). The formation of *Sphagnum* beds in a more stagnant lake could have probably started as a result of disappearance of water outlet at the surface, after which water has to follow underground fissures through the rhyolithic rock like the present-day situation.

After the short second cultural phase forest regeneration started again and the pioneer trees *Corylus* and *Betula* established on more open places (LPAZ Sm-4, Fig. 3). The populations of coniferous trees expanded regionally, particularly those of *Pinus*, reaching maximal distribution in the study area. The conifers formed also mixed stands with *Fagus.* Meanwhile *Quercus, Carpinus betulus, C. orientalis* also increased as did *Alnus* on wetter areas. The expansion of *Pinus* could be very well correlated with a climate change during the Little Ice Age when colder and/or wetter conditions prevailed (Cowie 2007), an inference also supported by the absence of charcoal fragments. The low presence of herbs gives an indication that the fields on the terraces were abandoned by the local people and an undisturbed forest development could take place.

The development of *Sphagnum* beds has continued and the plant remains of *Equisetum*, *Carex,* and mosses in the sediments indicate their transgression from the peripheral to the central parts of the lake. This could be facilitated by a lower water level during the period 1360–1600 AD.

The last stage in the vegetation development which started *ca*. 1600 AD (LPAZ Sm-5, Fig. 3) was characterized by several alternating regression phases in the forest development caused probably by tree felling, fires and grazing. The fluctuating AP/NAP curve and the individual pollen curves reflect the sequence of these phases: cultivation/grazing – fallow land with pioneers and heliophytes – forest regeneration. However, the rate of forest regeneration was under the influence of the continuous human impact. The increasing intensification of human activities is demonstrated by the cultivation of *Secale, Triticum* and other cereals (probably *Hordeum*), and by the extension of the pasture land and arable fields. Stock-breeding was practised on a large scale as traced by pollen of *Juniperus*, ruderals and species from grasslands (*Rumex*, *Cichoriaceae*, *Plantago*, *Caryophyllaceae, Asteraceae*), and some seeds from *Poaceae*, *Prunella vulgaris, Ranunculus repens* and *Apiaceae*.

In general, the uppermost pollen spectra reflect the contemporary situation in the study area with the prevailance of forests of *Picea abies,* and some *Pinus sylvestris* at a larger distance from the lake. The decreasing pollen values for deciduous trees (*Fagus, Quercus, Carpinus*) indicate an impediment of the forest development at lower elevations under the human pressure.

In spite of the comparatively low amount of seeds from the local vegetation preserved in the sediments (*Carex echinata, C. curta, Juncus bufonius, Menyanthes trifoliata, Poa palustris*) (Fig. 4), the plant remains of *Carex*, *Juncaceae*, and the spores of *Sphagnum, Equisetum*, indicate a progressive accumulation of *Sphagnum-Equisetum* peat in the lake and the formation of its present-day appearance.

Regional comparisons

As earlier mentioned only a couple of palynological records from the Rhodopes Mountains provide some more detailed information for the vegetation changes since historical times in the frame of an insufficient (peat-bog Mugla; Lazarova 2003) or lacking radiocarbon control (peat-bogs Trigrad; Lazarova & Filipovitch 2004). From these records a general similarity in the pattern of the vegetation development with Lake Blatisto is observed which could be precised by future investigations supported with additional radiocarbon dates.

The pollen diagram from Mugla (Central Rhodopes Mountains) reflects a period of well-developed coniferous forests in an area dominated by *Pinus* and *Picea abies* during the Late Subatlantic. As an admixture, in these forests were also found *Abies alba* and single trees of *Pinus peuce*. Below the coniferous forests were distributed communities of *Fagus*, *Carpinus betulus* and *Abies alba*, while at lower altitudes the mountain slopes were covered by mixed *Quercus* forests with some *Tilia* and *Ulmus*. In moister habitats were growing stands of *Alnus* and *Salix* (Lazarova 2003). The identification of cereal pollen (*Triticum*/*Avena*, *Secale* and *Hordeum)* in the lowermost part of the pollen diagram, alongside with other anthropogenic indicators, points to a cultural phase coincident with the oldest one established for the area of the Smolyan lakes. The single radiocarbon date of 1670±60 BP (cal. 245–535 AD) from this pollen profile marks the beginning of important changes in the vegetation cover characterized by a quick enlargement of the forests, primarily caused by *Pinus* and *Picea abies*. Optimal conditions have already existed for the expansion of *Fagus.* The reasons for this increase of beech were most probably rather complex, including climate change and human interference as well. A similar trend in the vegetation development was recorded *ca*. 590 cal. AD in the vicinity of Lake Blatisto.

The subsequent changes in the forest composition till recent time in the area of Mugla were a reflection of periods of more or less pronounced human activities, including mainly vast-scale deforestation for obtaining new pasture and agricultural land. The final stage of the vegetation development has led to the formation of the recent forest communities dominated by spruce or spruce with pines.

The palynological results from the peat-bogs located in the area of Trigrad reveal the dominance of coniferous forests composed of *Pinus* and *Picea abies* for the youngest part of the Subatlantic with a general trend in their reduction in most recent time as a result of enhanced anthropogenic activities (Lazarova & Filipovitch 2004). The lack of radiocarbon control does not provide a reliable basis for more precise conclusions and comparisons with other sites studied, Lake Blatisto included.

The general picture of the vegetation development in the Central Rhodopes Mountains during the last two millennia shows a vast distribution of coniferous forests at higher altitudes dominated by *Picea abies* and *Pinus,* with an admixture of *Abies alba, Fagus* and *Pinus peuce* at some places. This vegetation pattern was also formed under the increasing human impact and corresponds to the last phase of the vegetation palaeosuccession in the Bulgarian part of the Rhodopes Mountains (Huttunen & al. 1992; Bozilova & al. 2000; Filipovitch & Lazarova 2003; Stefanova & al. 2006; Lazarova & al. 2011) and in the Greek part as well (Athanasiadis & al. 1993; Gerasimidis & Athanasiadis 1995).

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