Acta Palaeobot. 35 (2): 253–274, 1995

THE VEGETATIONAL HISTORY OF LOCAL FLORA AND EVIDENCES OF HUMAN ACTIVITIES RECORDED IN THE POLLEN DIAGRAM FROM SIDE REGETOVKA, NE SLOVAKIA

AGNIESZKA WACNIK

W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, 31–512 Kraków, Poland

ABSTRACT. Material for this palynological study comes from a fen at the village Regetovka (Slovakian part of the Low Beskids). Five samples of deposit were radiocarbon dated. The results of pollen analysis were used to reconstruct the successional changes in the plant cover during the Middle and Younger Atlantic, the Sub-Boreal and Sub-Atlantic. Five pollen assemblage zones (PAZ) have been distinguished in the diagram. The record of man's economic activity on the vegetation have been observed from the samples before 6700 BP through the whole profile, but with variable intensity (four settlement phases).

KEY WORDS: palynology, Holocene, NE Slovakia, Low Beskids, pollen assemblage zones (PAZ), human impact

INTRODUCTION

The Low Beskids with the adjoining area of the Jasło-Sanok Depression have repeatedly attracted attention of both palaeobotanists and archaeologists. A number of palynological studies on changes occurring in the plant communities with time has been published since the thirties: Roztoki (Szafer & Jaroń 1935), Cergowa Góra (Więckowski & Szczepanek 1963), Besko (Koperowa 1970), Kępa (Gerlach et al. 1972), Szymbark (Gil et al. 1974), Jasiel (Szczepanek 1987), Roztoki (Harmata 1987, 1995 a, b) and Tarnowiec (Harmata 1987, 1995 a, b).

This study was designed to widen our knowledge on vegetation history of the Slovakian part of the Low Beskids poorly explored so far. An investigation has been carried out as a part of the interdisciplinary programme: "First agricultural and stock-breeding farmers on both sides of the Low Beskids", carred out chiefly by archaeologists at cooperation between the Institute of History of Material Culture, Polish Academy of Sciences (at present the Institute of Archaeology and Ethnology, Polish Academy of Sciences) in Warsaw and the Institute of Archaeology, SAScs in Nitra in 1991 (Machnik & Macala 1992).

The purposes of the present work have been to recognized the stratigraphy of organogenic deposits, to reconstruct vegetational history, to find the moment of first appearence of agriculture in this area, to analyse the disturbances in the primary plant cover under the influence of settlement and to refer the phases of the intensification of agricultural activity to the cultural changes in the study area.

GENERAL CHARACTERISTICS OF NATURAL ENVIRONMENT IN THE LOW BESKIDS LOCATION, RELIEF AND GEOLOGICAL STRUCTURE

The Low Beskids are the easternmost part of the West Carpathians. They bridge the eastern and western ranges of the Beskids. The Low Beskids occupy an area of 1789 km and extend as a 20–30 km-wide belt for about 100 km. Their relief is characteristic of low mountains rising to an altitude of 500–850 m, exceptionally even above 1000 m, eg. Busov (1010 m), the highest segment elevation in the Slovakian territory, and Lackowa (1001 m) on the Polish side (Adamczyk & Gerlach 1983). They form the lowest and narrowest segment of the Carpathian arch, begining at the Tylicz Pass (683 m) in the west, being it boundary with the Nowy Sącz Beskids (Radziejowa

1265 m), and extends tu the Łupków Pass (640 m), which in the east separates the Low Beskids from the Bieszczady Mts. (Tarnica 1348 m). The Beskid hills decreasedistinctly in altitude towards the north and the south. The loweslying bottoms of the river valleys in the areas of the Jasło-Sanok Depression and of Ciężkowice Foot-hills on the northern side, and in the Ondava and Labeorc Uplands on the southern side lie at an altitude of 200–300 m. This region is characterized by the NW-SE course of the main ridges and hills (Adamczyk & Gerlach 1983). In the eastern part the ridges form more district and longer ranges than in the western part, where typical are small groups of mountains scattered like islands or very short ranges of variable course.

The Low Beskids are a watershed range. The main drainage areas from the rivers Biała Dunajcowa, Ropa with Sękówka, Wisłoka, Jasiołka, Wisłok, Osława and on the southern side the rivers Topla with its tributaries Kamenec, Svierzovka and Rusucká Voda, Ondava with Kapišovka and Lubomirka, and Laborec with Vydranka. The hydrological regime of the rivers and streams is characterized by the greatest flow during the spring thaw and the smallest in autumn. The geological substratum of the Low Beskids shows a high degree of folding and fissuring (Starkel 1972). On the basis of differences in the appearance, arrangement and nature of these forms, and their geological structure five main geomorphological units have been distinguished: the Grybów Mts., Magura Range, Dukla Beskids, Rymanów Beskids and the Jaśliska-Wisłok-Komańcza Depression (Adamczyk & Gerlach 1983). The various morphogenetic processes occur in the area of the Low Beskids, such as mechanical denudation (landslide, soil creep, solifluction), deflation and chemical denudation (dissolution, leaching). It is a classical region of gravitational movements, the most characteristic of which are the landslides. Their origin conditioned by a suitable inclination of rock layers in the substratum and by the occurrence of impermeable shales underlying the porous rocks. Typical of this part of the flysch Carpathians is also the process of reactivation of landslides resulting in the occurrence of landlises varying in age in close neighbourhood to each other. The anthropogenic influence on the formation of same landslides, brought about by the improper location of roads or railway lines is worth mentioning here (Adamczyk & Gerlach 1983).

Soils

Acid and leached brown soils, brown soils and lessive soils, pararendzinas, podzolic soils proper, hydrogenic, initial and other soils have mainly developed in the study area in connection with the differentiated land relief (Święs 1982). The floors of valleys are usualy lined with clay-dust soils on sands and gravels. The flat-topped ridges moderately high and low foothills, sloping down towards the valleys are covered by clay-loam soils with a low proportion of skeletal elements. On steep portions of the slopes of montains and high foot-hills claystone, more rarely clay soils occur (Adamczyk & Gerlach 1983).

The soils show a broad range of depths, proportions of skeletal parts and moisture. They are generaly poor in phosphorus, somewhat richer in potassium, contain either considerable or only trace amounts of calcium, the rock outcrops and slope weathering waste are usually rich in calcium, hence, the xerothermic and calciphilous vegetation is much more frequently grouped in lower positions than in higher parts of valleys or on summits (Święs 1982).

Differentiation of climatic elements

The situation and the diverse nature of relief of the Low Beskids exert an influence upon the individual features of climatic conditions. This region constitutes a climatic boundary between the West and the East Carpathians, which has also been confirmed by geobotanical studies of this area (Święs 1982).

Two climatic zones have been distinguished in the Low Beskids: a moderately warm and humid zone and a moderately cool and humid one. In river valleys and depressions the moderately warm zone reaches up to 460 m a.s.l. and on convex form to 620 m a.s.l. It is characterized by the mean annual temperature exceeding 6° C. The moderately cool zone extends above the foregoing altitudes and the mean annual temperature is below 6° C here.

The annual precipitation ranges from 600 to 900 mm. The number of days with snow cover is from 81 at Dukla to 99 at Wisłok Wielki and its maximum thickness fluctuates from 73 cm at Rymanów to 113 cm at Komańcza (Adamczyk & Gerlach 1983). The climate of the Low Beskids is more continental than that of the West Carpathians and as consequence the vegetation season begins about 7–9 days later but the first phases of spring development are shorter (Obrębska-Starklowa 1983). The whole vegetation season lasts from 215 days in low-lying places to 182 days on summits (Hess 1965).

The Low Beskids are characterized by the considerable prevalence of southerly winds (50%) over northerlies (20%) and easterly and westerly winds (15% either).The occurence of the foehn winds from south called the Dukla or Rymanów winds, is of particular significance (Hess et al. 1978). These strong winds (more than 10m/sec) or very strong winds (more than 15m/sec) persist from one to several days. In the foot-hill zone (Szymbark) the number of days with foehn makes 16% of the year days, falling chiefly in the period of November to May and only sporadically in the summer. Their appearence in the spring brings a remarkable warming and in the winter they cause the formation of snow-drifts. They inducing the erosion of windward slopes and the soil deposition on the leeward slopes and deposition of this material on the leeward slopes.

Forest communities

In connection with their transitional nature of Low Beskids were a frequent object of interest for geographers and geobotanists. Geobotanical investigations were started here in the 19th century, but first detailed studies were published only by Święs in 1980 and 1982. The Low Beskids are not high enough to develop the spruce mountain forest zone (above 1000m a.s.l.) and so only hornbeam forests on foothills and beech woods of the mixed mountain forest zone have developed, in which nearly all forest communities described so far from other Carpathian regions were found (Święs 1982).

Tilio-Carpinetum stands occur in small areas on mostly steep and stony slopes, uncultivated by man, in the region of the foot-hills. *Carpinus, Quercus robur, Acer pseudoplatanus* and *Acer campestre* occur in the association. Small areas on the valley bottoms, more rarely on the slopes and in places of local water seepage are covered by swamp alderwoods (Alnetum incane) with grey alder, sycamore maple or ash and a small addition of hornbeam, aspen and willow. The largest areas is occupied by the Carpathian beech forests (Dentario glandulosae-Fagetum) with beech, fir and sycamore maple. On the rocky bends the stands of Phyllitido-Aceretum occur with the dominant sycamore maple accompanied by beech, elm and ash. Large areas in the western part of the Low Beskids are occupied by fertile fir forest of the order Fagetalia and poorer fir forests from the alliance Vaccinio-Piceion. Acid beech wood (Luzulo-Fagetum), dominated by beech with contribution of fir, occurs very rarely on flats and on ridges (Fabianowski & Rutkowski 1983). The most common forest associations are Dryopterido dilatatae-Abietetum, occurring in different sub-association on the fertile moist slopes of brook ravines or up to the summits of hills, and Vaccinio myrtilli-Abietetum, occupying most frequently the flats, more rarely the slopes. Carici ramotae-Fraxinetum, occuring on silty-sandy muds along the streams, is a characteristic though sporadically occurring forest community (Święs 1982).

As a result of man's economic activity the areas occupied primarily by forest communities have been mostly turned, into fields. The forests of foot-hill zone has been replaced by wheat-rye-clover agrocenoses, the forests of the lower mountain zone, to a more limited extent, by oat-grassland agrocenoses, and in its higher parts by hay-growing meadows and pastures (Adamczyk & Gerlach 1983).

Site discription

Material for palynological analyses was collected from a fen, about 2.55 ha in area (Dostal 1981), situated in the village of Regetovka (49° 25'30"N, 21° 16'45"E) in the Slovakian part of the Low Beskids, in about 5 km distance from the southern boundary of Poland (Fig. 1). The geological structure of the Regetovka area favours gravitational movements generating landslides. According to the geobotanical maps of Slovakia (Michalko 1986), Regetovka lies in the border zone between the moderately warm and humid climate (the mean January temperature –6 to –3.5° C, the mean July temperature 17 to 17.5° C, the annual precipitation 650–850 mm), and the moderately cool and humid climate (the mean January tem-

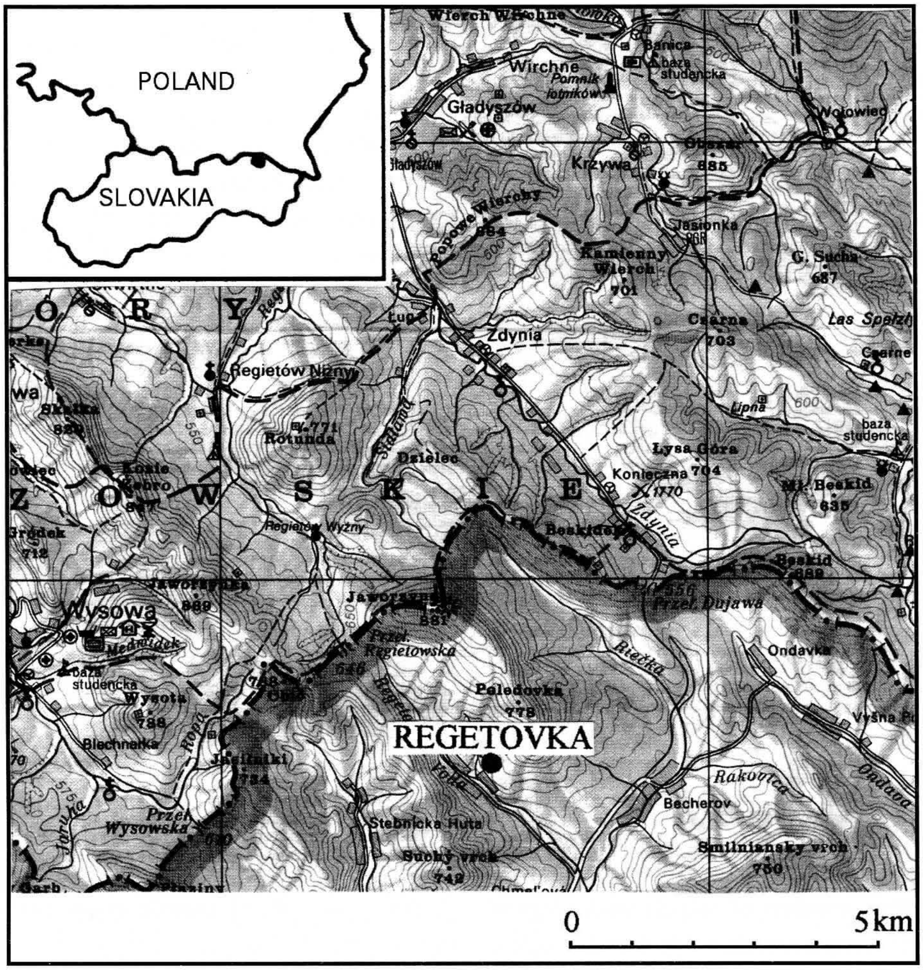

Fig. 1. Location of the Regetovka village

perature from –6 to –4° C and annual precipitation 800–900mm). The differences in temperatures between convex and the concave landforms are small (Fig. 2). The vegetational season begins in the first half of April and lasts for about 203 days (Obrębska-Starklowa 1983).

Carpathian flysch with claystones, formed

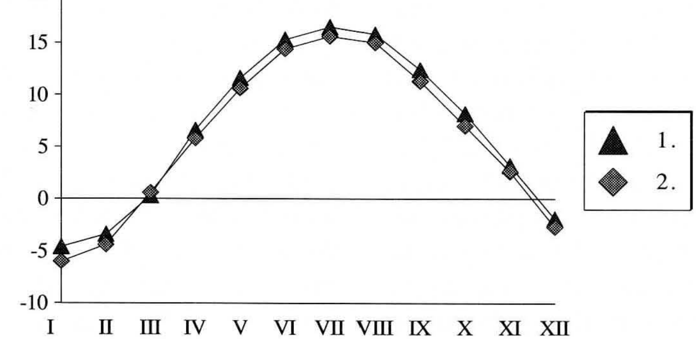

Fig. 2. Differences in the temperature between the convex and the concave landforms in the Low Beskids according to Obrębska-Starklowa (1983), data from 1951–1971 for altitude of 500 a.s.l.; 1 – convex landforms, 2 – concave landforms

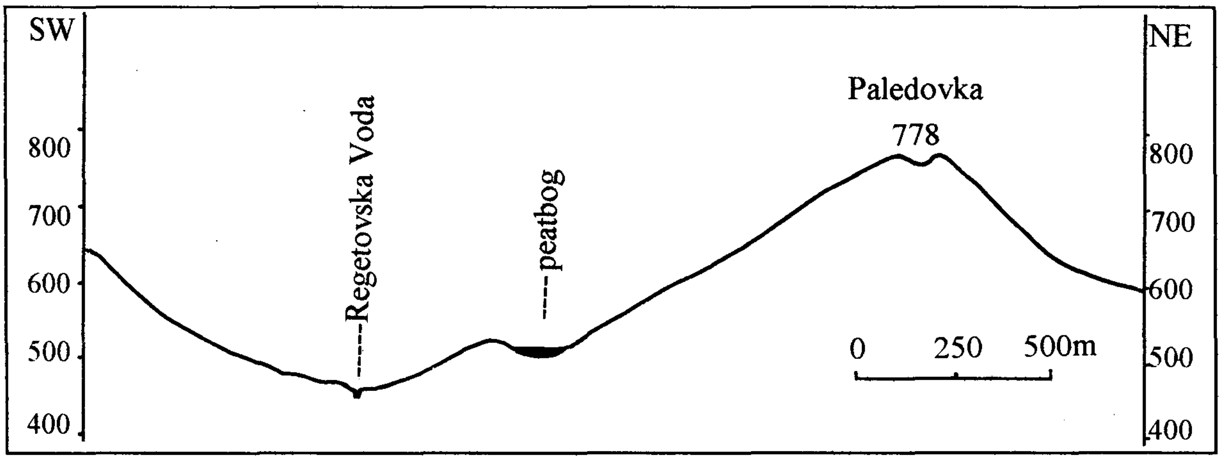

Fig. 3. Schematic transverse section of the Regetovska Voda valley (acc. to Harcar 1995 – modified)

in the Palaeocene till middle Eocene periods, constitutes the geological substratum, on which various types of brown soils and pararendzinas have developed.

The surroundings of Regetovka are overgrown by calciphilous beechwoods from the alliance Cephalantero-Fagion and, in a limited area, by Carpathian oak-hornbeam forests from the alliance Carici pilosae-Carpinion betuli (Michalko 1986).

The fen under study had developed in the depression of a landslide at an altitude of 515–520 m (Fig. 3) in consequence of the intensive and quick overgrowing of the water body. The formation of such a thick layer of organogenic sediments was favoured by the supply of abundant mineral material from the surrounding rocky slopes. The fen is protected as a nature reserve. At present the whole fen, situated about 500m from the channel of the Regetovska Voda river, is overgrown with sedges, and – in its central part clumps of shrubs (*Alnus glutinosa, Viburnum opulus, Salix cinerea, Frangula alnus, Salix pentandra, Sorbus aucuparia, Rosa* sp and *Juniperus communis*), classified as Carici elongatae-Alnetum sphagnetosum are gruped (Dostal 1974, 1981).

MATERIAL AND METHODS

Organogenic deposits about 10 m deep and with clay at bottom fill the depression behind the front bank of the landslide. A series of six exploratory borings were performed along the shorter axis of the fen in 1994. The core was taken from the deepest place, 46.7 m away from the northern edge of the fen and 40.3 m from its southern edge. A 9.5-metre core of deposit was collected by means of an Instorf borer, however, the clay substratum was not reached. From the 19 segments obtained, 50 cm long each, samples, 1cm^3 in volume, were taken for palynological analyses. Samples at intervals of about 20 cm from the whole profile were analysed to make a preliminary stratigraphic survey of deposits. Later, other 19 samples from the part of profile, covering the Neolithic period were studied. A total of 67 samples have been analysed.

The samples for pollen analysis were prepared by the modified Erdtman's acetolysis method with additon of standard indicator tablets containing *Lycopodium*. As the peat deposit over the whole length of the profile contained mineral material, the samples were pre-treated with hydrofluoric acid (Moore et al. 1991).

In each sample an average of 600 pollen grains of trees and shrubs and all the accompaning herb pollen and spores were counted (except for several low frequences samples were the basic sum was reduced to about 450 AP. The percentage values were calculated on the basis of the total sum including trees and shrubs (AP) and herbs (NAP), and exclusive of pollen of aquatics and spores. On the basis of the obtained pollen diagram four samples were chosen for 14C dating, and dated at the Radiocarbon Laboratory, Silesian Technical University at Gliwice. Because of a beakdown of the vacuum equipment during the purification of carbon dioxide the result of dating for the sample at 715–725 cm is unreliable. To check this result the next sample at 725–735 cm was dated (Tab. 1).

Table 1. Regetovka. Results of 14 C dating

No	Depth (cm)	Lab. No.	Age BP	Remark
1	110–120	Gd 7654	480±40	
2	370–385	Gd 7655	3200±40	
3	485–495	Gd 7656	4570±50	
4	715–725	Gd 11203	4790±90	the result is unreliable
5	725–735	Gd 11229	6720±80	

PROFILE STRATIGRAPHY

A small tuft of peat moss was taken as the 0 cm sample.

5–167 cm	fibrous peat poorly decomposed, with pieces of reeds and sedges, wood fragments at 120 cm
167–195 cm	whole core filled with wood fragments, samples not representative
195–215 cm	peat compact, reddish from rotten wood
215–235 cm	brown-rusty peat, fairly compact, wood pieces at 225 cm
235–275 cm	greasy peat with plant remains, wood pieces and twigs
275–300 cm	very strongly water saturated peat, plant remains present, a twig of *Betula* sp. at 285 cm
300–330 cm	peat compact well hydrated, gyttja-like
330–340 cm	lighter peat well hydrated, with plant detritus
340–350 cm	darker peat, rather greasy, a small number of plant remains
350–365 cm	lighter peat, greasy, wood pieces at 350 cm
365–370 cm	darker peat strongly decomposed
370–390 cm	red-beige peat, wood pieces at 375 cm
390–400 cm	black peat, brittle, with fragments of twigs
400–405 cm	gyttja-like peat with plant remains
405–425 cm	peat with light clay bands, hard and sticky without plant remains
425–465 cm	light beige peat, more compact
465–470 cm	darker peat
470–490 cm	lighter, more greasy peat with some gyttja
490–500 cm	peat with a high proportion of wood pieces
500–550 cm	harder, more compact peat, still fibrous
550–595 cm	sticky peat with a small amount of plant debris
595–735 cm	very fibrous, sticky peat, a large number of non-decomposed remains of fen vegetation
735–900 cm	peat changing in colour from beige to brown, with an admixture of gyttja, a large amount of plant detritus from 775 cm
900–905 cm	grey sticky peat with considerable proportion of gyttja
905–950 cm	black-brown peat, well decomposed, compact; small numbers of macroscopic remains of reeds and sedges.

HUMAN SETTLEMENT IN THE AREA OF THE LOW BESKIDS AND ADJACENT REGIONS

No traces of Palaeolithic man have been found so far in the area of the Low Beskids, although he is known to have penetrated the neighbouring regions, like the Nowy Sącz Beskids and the Jasło-Sanok Depression. Both Palaeo- and Mesolithic people little disturbed the balance of natural environment, on account of the form of their activities and, in consequence, it is very difficult to discover any palynological traces of their presence. Any significant colonization of the Beskids by the earliest Neolithic tribes (about 4600–3900 BC), associated with the Linnear Pottery Culture, is not substantiated. On the other hand, there are fairly numerous traces of that settlement on the patches of loess at the so-called Carpathian threshold: on the river Raba in the Bochnia region and between Rzeszów and Przemyśl (Valde-Nowak 1988). Due to the new archaeological discaveries, the time and territorial limits for the appearance of Neolithic man in the area concerned have been extended. Still, utilization of natural routes by the Łupków and Dukla Passes by people from the circle of Linnear Pottery Culture in the initial phase of settlement (Valde-Nowak 1988) and, in consequence any penetration of the Low Beskids by those people is still a controversial problem. However, in the final phase of its development these routes might already have rather essential importance. This is suggested by the fact that the people of the Linnear Pottery Culture were them influenced by populations of the so-called Bukowe Góry Culture (Bükk Culture). The settlements and producing place of obsidian products have recently been discovered in the Ondava Upland, about 30 km south of Regetovka (Machnik pers comm.). A remarkable increase in the range of permanent settlement occured in the younger phase of the Lengyel-Polgar Cycle, when certain foot-hill regions may have been colonized (Valde-Nowak 1988). Dispersed sites are known from the area between the Low Beskids and foot-hills evidencing not so much the penetration of the area by people for economic reason as their infiltration over the lowering of the Carpathian arch in the eastern part of the Low Beskids. The fertile soils chiefly in river valleys were cultivated most often, although there was already a tendency to occupy higer-situated terrains, too.

Settlement representing the Funnel-Beaker Culture (about 3100–2400 BC) is very distinct in the Carpathian Foot-hills (Wieliczka, Strzyżów and Dynów Foot-hills). It reaches to the border of the Low Beskids, eg. in the region of Lesko (Machnik pers comm.), and its sites are nearly exclusively situated in the higher parts of hummocks and hills elevations at 350–500 m a.s.l. (Machnik 1989). The expansion of the fire-clearance agrarian system combined with the breeding of cattle, goats and sheep (Kruk 1980) was connected with that culture. The extremely repressive impact of this type of husbandry upon the environment, leading to the deforestation of large areas in the loess uplands, might even have resulted in a specific economic crisis about the middle of the 3rd millennium BC (Kruk 1993). This may have caused an invasion the population of Funnel-Beaker Culture into the Carpathian Foot-hills up to the Beskid piedmont, where favourable condition for cereal cultivation using the fire-clearance method existed in the higher landscape zone (Machnik 1994). Presumably, the people of the Funnel-Beaker Culture not only expanded in northern Beskid Foreland but also encroached upon the foot-hills on the southern side. The finds of single artefacts showing features characteristic of that culture have been reported from there since long ago (Machnik 1994). A striped-flint axe, typical of the Funnel-Beaker Culture was found at the village of Ondavka (Budinský-Krička 1991), relatively near the studied site. Similarly, traces of settlement of the Badenian Culture (a settlement at Olšavka near Bardejov) concurrent in time with the Funnel-Beaker Culture, come from the nearby Ondava Upland (Machnik pers. comm.) From about 2300 to 1800 BC the area of foot-hills was occupied by pastoral groups of the Corded Ware Culture. They also spread in the Beskids as evidenced by single artefacts of this culture (stone axes and flint tools) found there (Valde-Nowak 1988). These groups crossed over to the south mainly by the Dukla and Łupków Passes and there they next expanded, chiefly in the area of the Ondava and Laborec Uplands and on the southern slopes of the Beskids. On both the Polish and the East Slovakian side of the Beskids the permanent land occupation by the pastoral tribes of the Corded Ware Culture is indicated by the occurrence of grave-mounds. Very many of them survived on the southern side of Beskids, which is still forested to a great extent till today. They are located on the flat hill tops distributed sometimes over their nearly whole lengths. In the same places are found detached stone and flint axes, remaining there after the destruction of the mounds in later times, notably on the Polish side of the Beskids.

At the beginning of the Bronze Age (1800–1300 BC) the foot-hill area was inhabited by communities of various cultures, eg. the Mierzanowice and Ottoman Cultures, whose traces may occur in the Low Beskids as well. They were connected with the higher landscape zone, too. The further development of settlement in this region took place from the Middle Bronze Age (1300 BC) till the beginning of the Iron Age (700–400 BC). The Lusatian Culture expanded then in the valleys of the Vistula and Odra rivers and on the southern side of the Carpathians, where its presence has been pointed out in the south-eastern and middle part of Slovakia. In Carpathians people of this culture founded their settlements and burial grounds in the valleys, on the terraces of rather large rivers. The finds of ceramic fragments at Biecz, of ornaments (armlets, bracelets) at Załęże on the Wisłok and many bronze objects, including a sword of the Liptów type at Wysowa, provides evidence of animated contacts with the southern side of the Carpathians as early as the Middle Bronze Age (Parczewski 1986). Starting from the Late Bronze Age, the region in question influenced by the Gava Culture, witch expanded in the eastern Slovakia, and using the routes along the river channels of the Ondava, Topla and Torysa crossed the Carpathians by the Dukla Pass into Poland. This is evidenced by the site at Wietrzno on the Jasiołka on the northern side of the pass (Gedl 1989). The time when the Tarnobrzeg group of the Lusatian Culture disappeared has not been exactly determined. Part of that population may have persisted in the catchment area of the river San and in the Sub-Carpathians till the appearance of Celts in the younger Pre-Roman Period (Parczewski 1986).

The first cultural breakdown occurred in the middle of the 6th century BC under the pressure of the Scythian nomads coming to the Carpathian Basin from the steppes in the Black Sea region. The next ones about 400 BC and again about the 3rd century BC were connected with the invasions of Celts from the west (Gedl 1989). From the beginning of the 2nd century BC to about 450 AD the typically agricultural Przeworsk Culture dominated in southern and central Poland and about the 2nd century it extended its range southwards, beyond the Carpathians. The late Roman Period is characterized by a rise in the density of settlements and the widering of its trrritorial range in southern Poland. The distribution of archaeological sites in the region of the Dukla Pass and in the Slovakian uplands points to the exsistance of organized economic life from the 1st to the 5th century AD. The early Migration Period (4th-6th centuries) was distinguished in southern Poland and in the Carpathians by the incursions of the nomadic Huns from the Asiatic steppes. Their aggression and the resulting ethnic movements were the likely cause of the Przeworsk Culture (Parczewski 1986). The economic downfall was also connected with the displacements of some German tribes.

The archaeological material collected so far contains incomplete information about settlement in the Low Beskids in the early Middle Ages (6th-7th centuries). However, it is known that from the middle Bronze Age up to the early Middle Ages the colonization of the Carpathian regions under discussion involved mainly of the San and Wisłok river valleys and the Jasło-Sanok Depression, where it found the most favourable conditions. Our information concerning the later period of settlement, from the 10th to the 14th century, is also scanty. In connection with the position of this area in the frontier zone, the conflicts between Hungary, Ruthenia and Poland were frequent here at the time of the formation of the state structures. Such an unsteady political situation must have exerted a disadvantageous influence on the life of the local population. From the 13th century onwards raids of the Tartarian hordes swept the territory and contributed exceedingly to the extermination of the population and the devastation of local forests. The raids stopped in the 14th century, and an economic development period started then, in connection with the definitive incorporation of this area into Poland and the commencement of colonization during the reign of Casimir the Great. The foundation charters were then conferred on many settlement situated mostly in the river valleys. 14th–17th centuries are the time of Wallachian colonization. Some nomadic people wandered from the Romanian territory westwards, along the mountain ridges of the Carpathians. Some pastoral groups settled on the slopes and flat tops of mountains in the proximity of streams and small rivers. Flocks of sheep and goats, grazing outright in forests and on meadows close to the timber line, caused the considerable lowering of this line (Korpel 1989). The Wallachians engaged mainly in mountain pasturage, were probably also familiar with some forms of agriculture. Apart from the Wallachian migrations, Polish settlement also developed, about the 15th century. In consequence of the contacts of the pastoral populations with the less numerous agricultural colonizers the agro-pastoral population of Lemks was formed. Because of the great overpopulation of villages even the high-lying small plots were put under cultivation (Kwilecki 1974). A successive period of the intensive colonization followed in the 19th century in connection with the discovery and beginning extraction of oil beds in the region of Krosno. In 1941–1947 a multistage operation of the Lemks displacement was held on a large scale in the territory belonging to Poland (Kwilecki 1974). The abandoned areas were next partly colonized by Poles.

An outline of settlement development presented above clearly proves an early interest shown by man in this region. Its penetration has continued starting from the Neolithic in connection with the development of contacts between the populations inhabiting the southern and northern forelands of the Beskids; later, the economic activities extended in whole area. This process has been going on, varying in extent and intensity, since the late Neolithic till the present time.

DESCRIPTION OF DIAGRAM

Five pollen assemblage zones have been distinguished in the pollen diagram (Fig. 4); each

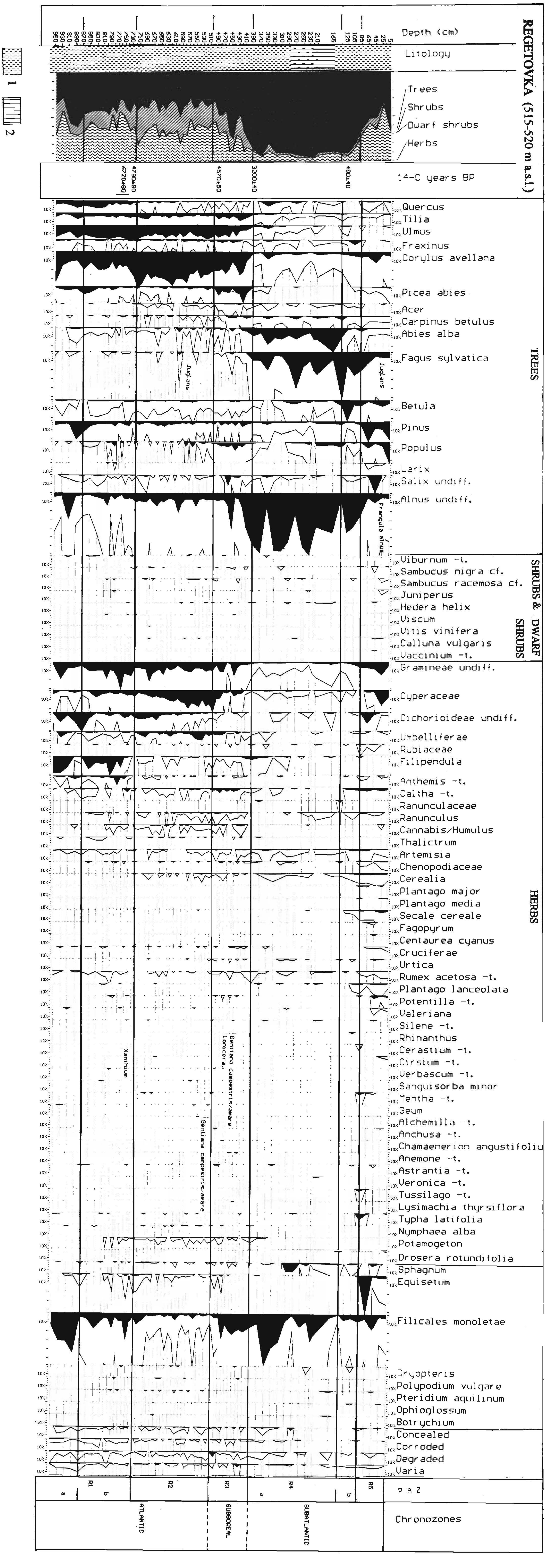

Fig. 4. Percentage pollen diagram of the profile from Regetovka mire. Lithologic symbols, 1 – peat, 2 – fragments of wood

of them includes spectra of a similar nature i. e. of the same taxonomic composition and similar percentage values (Janczyk-Kopikowa 1987).

Zone R1

The characteristic feature of this zone is a codominance of pollen taxa representing mixed deciduous forests typical of the climatic optimum: *Ulmus, Tilia, Quercus* and *Corylus*, and the significant curves with marked single peaks of *Pinus* (max 20%), *Alnus* (max 30%) and *Picea*. The low-percentage, continuous curves of *Fraxinus* and *Salix*, and frequent grains of *Abies* have also been found starting from a depth of 910 cm. Shrubs are represented by a high though fluctuating proportion of *Corylus* (35% in the bottom sample), and single pollen of *Viburnum, Sambucus racemosa* cf., *Juniperus, Hedera helix* and *Viscum.*

The sporadic occurrence of *Carpinus, Fagus, Acer* and *Populus* has been recorded. The high NAP curve is composed in particular of *Anthemis* t., Cichorioideae, Cyperaceae, *Filipendula*, Gramineae and Umbelliferae. The aquatic vegetation is represented by sporadic pollen of *Nymphaea alba, Typha latifolia* and, in the top samples, also *Potamogeton*. Spores, chiefly of Filicales monolete, but also *Equisetum* and *Sphagnum* were present. In the concentration of sporomorphs decreases towards the top of the zone with the exception of the samples at 760 and 740 cm, where is the higest concentration of the whole profile (Fig. 5). The zone has been divided into two subzones:

Subzone R1a

This subzone is characterized by a single peak of *Alnus* (max 33%) preceding almost simultaneous culminations of *Quercus, Tilia, Ulmus* and *Pinus*. A high NAP frequency (25–48%) and high proportions of Filicales monolete (max 42%) were noted.

Subzone R1b

The lower boundary is placed at the distinct, fall in pollen curves of *Betula, Fraxinus, Quercus, Tilia, Ulmus*, Cyperaceae, *Filipendula*, Filicales monolete and Cichorioideae (absolute max 23%). The highest percentage values throughout the profile were recorded for Gramineae (max 32%), *Filipendula* (max 23%) and *Anthemis* t. (max 10%). Single *Plantago lanceolata* pollen at 810, 800 and 760 cm) and of Chenopodiaceae, and *Ranunculus* pollen were noted. The top of zone was dated at 6720±80 BP.

Zone R2

The lower boundary of this zone is defined in the drop *Ulmus* curve, the simultaneous rise of *Corylus* and the appearance of Cerealia. The zone bottom was dated at 4790±90BP (probably made too young). The minimum concentration of sporomorphs for whole the profile is the characteristic feature of the zone. The proportions of *Ulmus, Alnus, Tilia* and *Corylus* are high. The contributions of *Abies* and *Populus* grow gradually. A single *Juglans* pollen grain was found at 580 cm. Pollen grains of *Hedera helix, Viscum, Sambucus nigra* cf., *Sambucus racemosa* cf. and *Vitis* were recorded sporadically. The relatively high proportion of NAP includes Cyperaceae, Gramineae, Umbelliferae and Cichorioideae as dominant taxa. The appearance of first *Urtica* pollen was observed at the same moment as Cerealia. Cerealia (among them also rye) occur in the whole zone, starting from its first sample at 720 cm; forming a continous curve at the top of zone. The appearance of corn precedes somewhat a rise in the curves of the herbs Cichorioideae, Gramineae, Umbelliferae and *Ranunculus* and *Rumex acetosa* t.. Single pollen grains of *Anthemis* t., Chenopodiaceae, Cruciferae, *Filipendula*, Rubiaceae and *Thalictrum* are also present throughout the zone. The contribution of aquatic (*Nymphaea alba, Typha latifolia, Potamogeton*) and cryptogamics (*Equisetum, Sphagnum, Dryopteris, Polypodium vulgare, Pteridium aquilinum* and Filicales monolete (max 3–10%)) is significant. The regular occurrence of *Pteridium* is restricted only to this zone and the top portion of R1b.

Zone R3

The lower zone boundary was marked at 500 cm, where the frequency of *Picea* and also of *Tilia* and *Populus* pollen begin to increase. The zone bottom was dated at 4570±50 BP. The AP curve grows up to about 80% in the top sample. The considerable proportions of *Ulmus, Tilia* and *Corylus* in the older part of the zone decrease towards the top of the zone. The *Quercus* curve dissappeares. The two peaks of *Picea* coincident with those of *Tilia,* are characteristic of this zone. The curves of *Abies, Carpinus* and *Fagus* rise and a particularly rapid increase of *Alnus* occurs in the upper part of the zone. *Populus* pollen forms a single peak with a maximum of 10%. The pollen concentration grows above the bottom

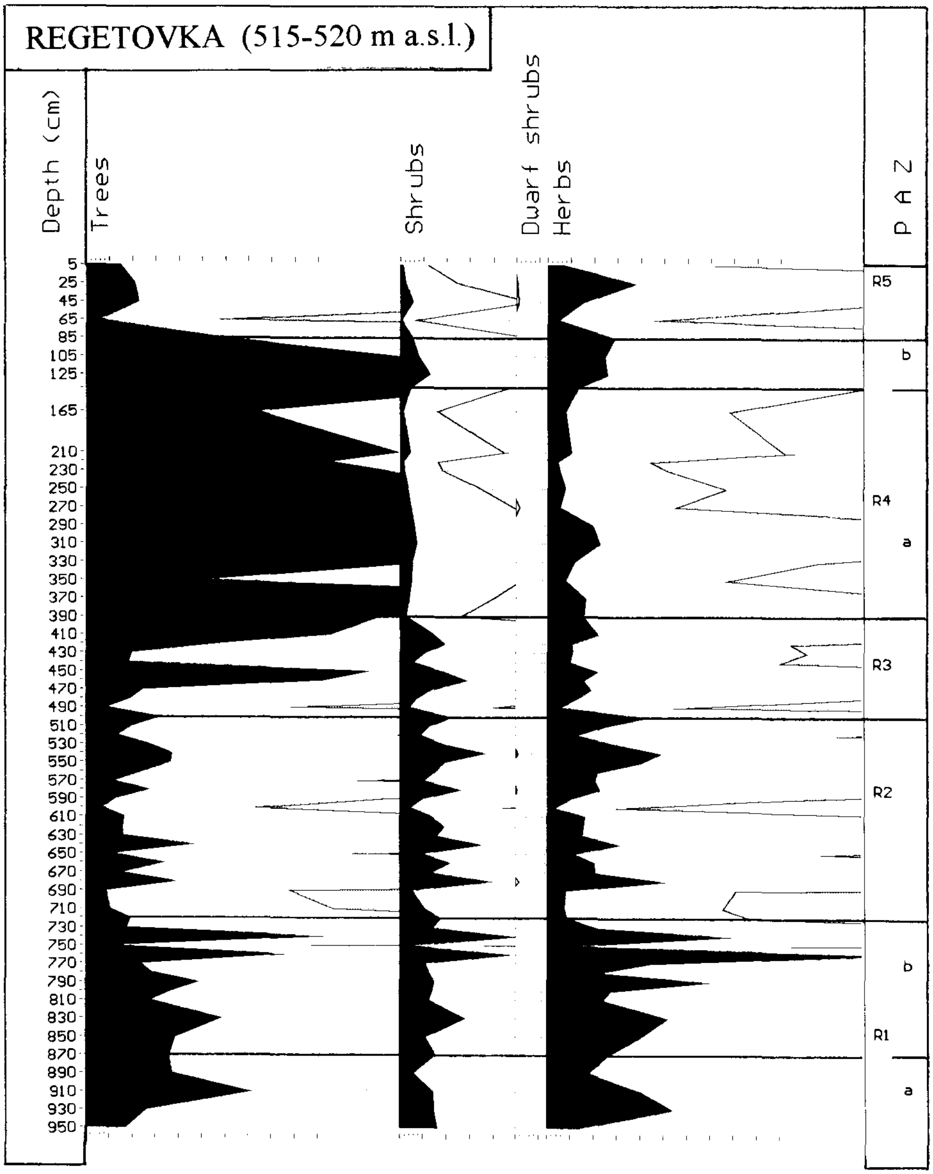

Fig. 5. Summary pollen concentration diagram for trees, shrubs, dwarf shrubs and herbs

samples. The NAP curve decreases. The abundance of herb taxa-Cyperaceae, Gramineae, *Artemisia* and Umbelliferae – undergoes a reduction.The frequency of aquatic plants and of cryptogamic (*Sphagnum, Dryopteris* (single spores), *Equisetum,* Filicales monolete) maintain relatively high level. A distinct clay layer occurs in the peat at a depth of 420 cm.

Zone R4

The lower boundary, at a depth of 390 cm, was marked at the definite fall of the components of mixed deciduous forest and of *Picea,* correlated with decreasing curves of some herbs, like Cyperaceae, Gramineae, Umbelliferae and *Caltha.* The date of the zone bottom is 3200±40 BP. This is a phase of the distinct dominance of trees (96% of the total sum). *Abies alba* and *Fagus,* the species of the lower mountain forest zone had particular forest-forming significance, whereas *Alnus* (absolute max 72%) must have abounded on the peatbog and/or in its direct surroundings. *Betula, Carpinus, Pinus, Tilia* and *Corylus,* forming low continuous curves, constituted an admixture in the beech-fir forests. The proportion of shrubs pollen is low, up to 4 %. Besides *Corylus,* single grains of *Sambucus, Viburnum, Juniperus* and *Hedera helix* are present. *Artemisia,* Cerealia, Cyperaceae, Gramineae, Cichorioideae and *Rumex acetosa* t. pollen make together the low- percentage NAP curve (below 10%), but only grasses occur continuously.

Plantago lanceolata appears relatively frequently in the whole phase. Cryptogamics are represented by considerable proportions of *Sphagnum* (max 10%) and Filicales monolete (max 56%). The zone is characterized by the highest concentration of sporomorphs in the profile. The proportion of wood in the peat grows towards the top of zone where it fills the core utterly.

Subzone R4a

This subzone is marked by the codominance of *Abies* (max 28%) and *Fagus* (max 38%), their curves showing high fluctuations. The proportion of *Alnus* is particularly high (absolute max 72%). The high frequency of *Sphagnum* and Filicales monolete spores is characteristic of this subzone.

Subzone R4b

The lower boundary is marked at 140 cm, where the pollen frequency of pioneer trees (*Betula, Alnus* and *Corylus*) rise. The pioneer species and *Fagus* are distinctly dominant, *Abies* pollen shows a definitive fall, *Fraxinus* pollen makes a single small peak (max 6%). Though the herb pollen curve is low, the curves of Gramineae, Cerealia, *Artemisia, Caltha* and *Ranunculus* show some increase. *Secale cereale* reappears in the middle of the subzone and forms a continuous curve. After an initial rise, the pollen concentration begins to decrease.

Zone R5

Zone R5 comprises the uppermost fragment of the profile, showing particularly dominant and diverse herb taxa, which make about 55% of the sum in the sample at 25 cm. The NAP curve is built of Gramineae, Cyperaceae, Cichorioideae, *Artemisia, Caltha,* Cerealia, *Secale, Plantago lanceolata* and Chenopodiaceae, most of which increase towards the profile top. The occurrence of *Fagopyrum* pollen was recorded from two spectra. The presence of charcoal was observed from a depth of 65 cm upwards. Connected with this fact might be a rapid fall in the frequency of trees: *Abies, Fagus, Alnus* and a rise of *Pinus, Populus, Salix, Corylus*, and a decrease in the general pollen concentration. There occur single *Juglans* pollen grains.

VEGETATIONAL HISTORY OF THE REGETOVKA REGION

Zone R1

The high proportion of elm, lime, oak and hazel, indicates the dominance of humid mixed forest communities on moderately moist soils around the peatbog. It may be supposed that the forest with dominant elm and lime occupied more fertile habtats than did the oak-lime stands (Ralska-Jasiewiczowa 1966, Latałowa 1982). The undergrowth in those forests consisted mainly of hanzel (up to 32% AP), and of smaller proportions of *Viburnum* or *Sambucus racemosa* (single grains). It should, however, be kept in mind that *Corylus* is an anemophilous species and its pollen production is very high. The peatbog margins and areas along the streams supported the development of carr communities with elm, ash and alder or wet alder woods with black alder, ash, birch, spruce and willows on periodically inundated soils (Medwecka-Kornaś 1977). Single *Acer, Fagus* and *Carpinus* pollen found in this zone may have come from short-distance transport or were redeposited. The fairly high percentages of spruce pollen (max 8%) point to the presence of this tree in the surroundings of the site. *Picea* requres a suitable level of humidity both in the air and in the soil and probably for this reason it occupied land depressions, places lying close to streams, margins of the peatbog and north-facing slopes. It finds optimal conditions on moderately rich soils, whereas on fertile soils it suffers from competitive pressure of other species (Jaworski 1994). The early appearance of *Abies alba* pollen might probably by due to the contamination with younger deposits. Its curve is almost continuous. Rybničkova (1985) evidences the presence of *Abies alba* pollen in Slovakia from about 7000 BP, although this species spread over the whole area, proceeding from the south-west, only about 4000 BP. The occurence of its pollen is traced at Vihorlat, east of Regetovka from the Pre-Boreal period onward (Krippel 1971) and in the Poprad region from older part of the Atlantic (Jankovska 1988). However, taking into consideration the primitive boring equipment used by those investigators (Hiller borer), we may suppose that contamination was also responsible for the presence of *Abies* pollen in the deposits from the sites. Nevertheless, we cannot exclude the occurrence of single trees in the region of Regetovka as early as the Atlantic. The first *Abies* isopollen map for the territory of Poland was performed for 5000 BP (Ralska-Jasiewiczowa 1983) and single pollen grains from Atlantic deposits are recorded from Besko (Koperowa 1970), Szymbark (Gil et al. 1974) and Tarnowiec (Harmata 1987, 1995 a).

Forests around Regetovka were characterized by some degree of openness. The openings and forest edges were overgrown by heliophilous herbs, as indicated by the high curves of *Anthemis* t., Cichorioideae, Gramineae, *Artemisia*, Umbelliferae and *Rumex acetosa* t.. Among the taxa representing the forest herb layer Filicales monolete draw special attention by its very high frequency, chiefly in the older part of the zone. The humidity of the environment is evidenced by the percentages of *Caltha,* Cyperaceae, *Thalictrum, Valeriana,* Rubiaceae, *Sphagnum, Equisetum* and, above all, the high frequency of *Filipendula.* This was probably *Filipendula ulmaria,* witch occurs on the peatbog also at the present time (Dostal 1974). It points at the habitat of wet decidous forests, with humic soils and oscillating groundwater level. The presence of *Typha latifolia* and *Nymphaea alba* suggests places with an open water body. This zone presumably corresponds with the older part of the Atlantic. It has been divided into two subzones.

Subzone R1a evidences rather stable plant composition. The peak of *Alnus* pollen in a single spectrum may be associated with a short-lived expansion of this genus, perhaps resulting from a decrease of ground water level. It can also be explained by the disturbance of the real proportion of *Alnus* pollen caused by a fragment of an inflorescence getting directly into the deposit. The culmination of *Pinus* pollen (max 22%) proves that this intensely pollen producting genus constituted an admixture in the tree stand in places of poorer edaphic conditions. Part of that pollen may also come from some distance in connection with a considerable exposure of the area.

Subzone R1b is a phase of further dominance of the components of mixed deciduous forests, among them chiefly of *Ulmus.* The role of *Quercus* as shown by the record from a depth of 810 cm, decreases, perhaps because of the rise of groundwater level following an increase in rainfall. Single *Plantago lanceolata* pollen and the coincident increase of NAP (*Anthemis* t., Cichorioideae, Gramineae, *Ranunculus, Rumex acetosa* t., *Artemisia* and *Filipendula)* may certainly be connected with the further opening of forest stands and the extension of heliophilous vegetation, perhaps owing to man's pastoral activities.

Zone R2

The composition of the forests did not change significantly, but typical for this phase is the maximum expansion of *Corylus* (up to 40% of AP) resulting from the progressive thinning of the woods. This is evidenced by a decreasing abudance of elm. At that time the individual hazel thickets on the edges of forests were formed. In the forest undergrowth hazel was accompanied by *Sambucus nigra* , *Sambucus racemosa.*, *Viburnum* and the indicators of climatic optimum *Hedera helix, Viscum* and perhaps *Vitis. Vitis* pollen from the older phase of the Atlantic were identified in the diagrams from the Bieszczady region, where probably its natural sites occured in the communities of Fraxino pannonicae-Ulmetum up to the Sub-Boreal (Ralska-Jasiewiczowa 1980). Towards the close of the phase the number of the so far sporadical pollen of *Acer, Carpinus* and *Fagus* increases. It seems that single specimens of these trees may have been growing at a short distance, though they were still absent from the neighbourhood of the peatbog. In the top part of zone *Populus* forms a continuous curve. Interpretation of its role is difficult, for we may be concerned with the *Populus* species connected with carr communities, overgrowing the temporarily waterlogged peatbog edges and other places with oscillating groundwater level, or aspen (*Populus tremula*), which may be a component of forests from the alliance Quercion robori-petraea or Dicrano-Pinion. Interesting and hard to interpret is the early occurrence of single *Juglans* pollen at about 4650 BP. It was probably derived from long distance transport. The pollen records show that *Juglans regia* was present in Syria from 10080±55 BP, in northern Turkey from about 6000–5000 BP but not before 4000–3000 BP on the Balkans (Filipovich 1977). The archaeobotanic evidence of its cultivation in Poland comes from the Roman age (Wasylikowa 1984). Pollen grains of cereals, including *Secale cereale*, are present from the very beginning of the zone. The contribution of such synanthropic plants as *Artemisia,* Chenopodiaceae, *Rumex acetosa* t. and *Urtica* increases. At open sites and in forest herb layer species from the families: Gramineae, Compositeae (Cichorioideae), Umbelliferae, and the genera *Ranunculus* and *Humulus/Cannabis* were dominant. The peatbog surface was owergrown by Cyperaceae, Rubiaceae, *Caltha, Filipendula, Thalictrum, Valeriana, Sphagnum* and *Equisetum*. The rice of ground water level led to the formation of small shallow ponds, soon over grown by aquatic plants, first by algae (*Botriococcus brauni* and diatoms) and *Potamogeton*; next by *Nymphaea alba* and *Typha latifolia*. The accumulation of deposit was very intense; hence, the concentration of sporomorphs in the peat was low.

Zone R3

Through the greater part of the phase (corresponding with the Sub-Boreal chronozone) the Atlantic components of mixed deciduous forests were still dominant on soils covering the hills around the peatbog and contained only small admixture of new tree genera.The forest undergrowth consisted of *Sambucus nigra, Sambucus racemosa, Viburnum, Lonicera, Hedera helix* and *Corylus* which had also good conditions to spread and form thickets on places deforested by man. Filicales monolete dominated in the herb layer. The characteristic feature of the phase in the expansion of spruce, *Picea* pollen reaches 10% of total sum. A similar phenomenon is observed in the diagrams from the neighbouring regions, eg. from the Low Beskids (Szymbark – Gil et al. 1974) and the Jasło-Sanok Depression (Tarnowiec – Harmata 1987, 1995 a). The spread of spruce may have been connected with an increase in the areas of wet soils providing a favourable habitat for this tree, and also with the migration processes of this tree (Ralska-Jasiewiczowa 1983). The low-lying places and the surface of the mire itself were gradually overgrown by trees (alder, spruce, poplar, aspen, birch and willow), as evidenced by wood pieces present in the peat. The climate became cooler and somewhat more humid. It may be evidenced by the occurrence of a clay interbedding formed in the peat layer (at the depth of 420–415 cm) during a temporary inundation of the site, by the accumulation of clay material from the slopes. It is also suggested by pollen of plants indicating high ground water level, including those typical of small open pools (*Potamogeton, Nymphaea alba, Sphagnum, Equisetum, Caltha, Filipendula* and Cyperaceae). From the beginning of the zone the contribution of *Abies, Fagus* and *Alnus* in the forest communities grew consistently. At the same time the role of the previously dominant species, like *Ulmus, Corylus, Tilia* and *Picea* was decreasing. From that time onward they constituted only an admixture, just as did *Carpinus, Fraxinus* and *Quercus*. The synchroneity of these phenomena can be traced in various diagrams from the Carpathians, eg. from Szymbark (Gil et al. 1974), Tarnowiec (Harmata 1987, 1995 a) and the Bieszczady Mts. (Ralska-Jasiewiczowa 1980). This was the beginning of the formation of beech-fir mounthain forest zone at an altitude of 500–900 m in the Carpathians (Rybničkova 1985). The composition of herb vegetation with high proportions of Gramineae, Cyperaceae, Umbelliferae, *Artemisia*, Chenopodiaceae, *Potentilla* t., *Ranunculus, Rumex acetosa* t., *Urtica* and Cerealia indicates a progressive intensification of human activity including land cultivation and pasturage. The increasing human ipmact together with the climatic changes, biotopic changes and competition pressure from comer species, were conducive to drastic vegetational changes.

Zone R4

The next phase is characterized by a particularly high frequency of alder. Its curve represents the local situation on the fen surface and so it makes it difficult to reconstruct the composition of forest communities in the region of the reservoir. In order to better illustrate the changes occurring in this zone a diagram was performed in with *Alnus* pollen was excluded from the total sum (Fig. 6). The trees tolerating light and periodical inundation, notably *Alnus, Betula* and also *Fraxinus, Populus* and *Salix* formed thickets on the surface of the site, what is corroborated by wood pieces found in the peat throughout the zone, including a twig identified as *Betula* sp. At a depth of 195–167 cm the whole core was filled with wood, coming probably from an overthrown tree trunk. The encroachment of trees upon the mire became possible probably owing to the lowering of ground water table, initially in consequence of some decrease of precipitation and next as a result of the increasing transpiration of trees, whose root system were capable of penetrating through heavy, moist and poorly aerated soils (Jaworski 1994). The other AP

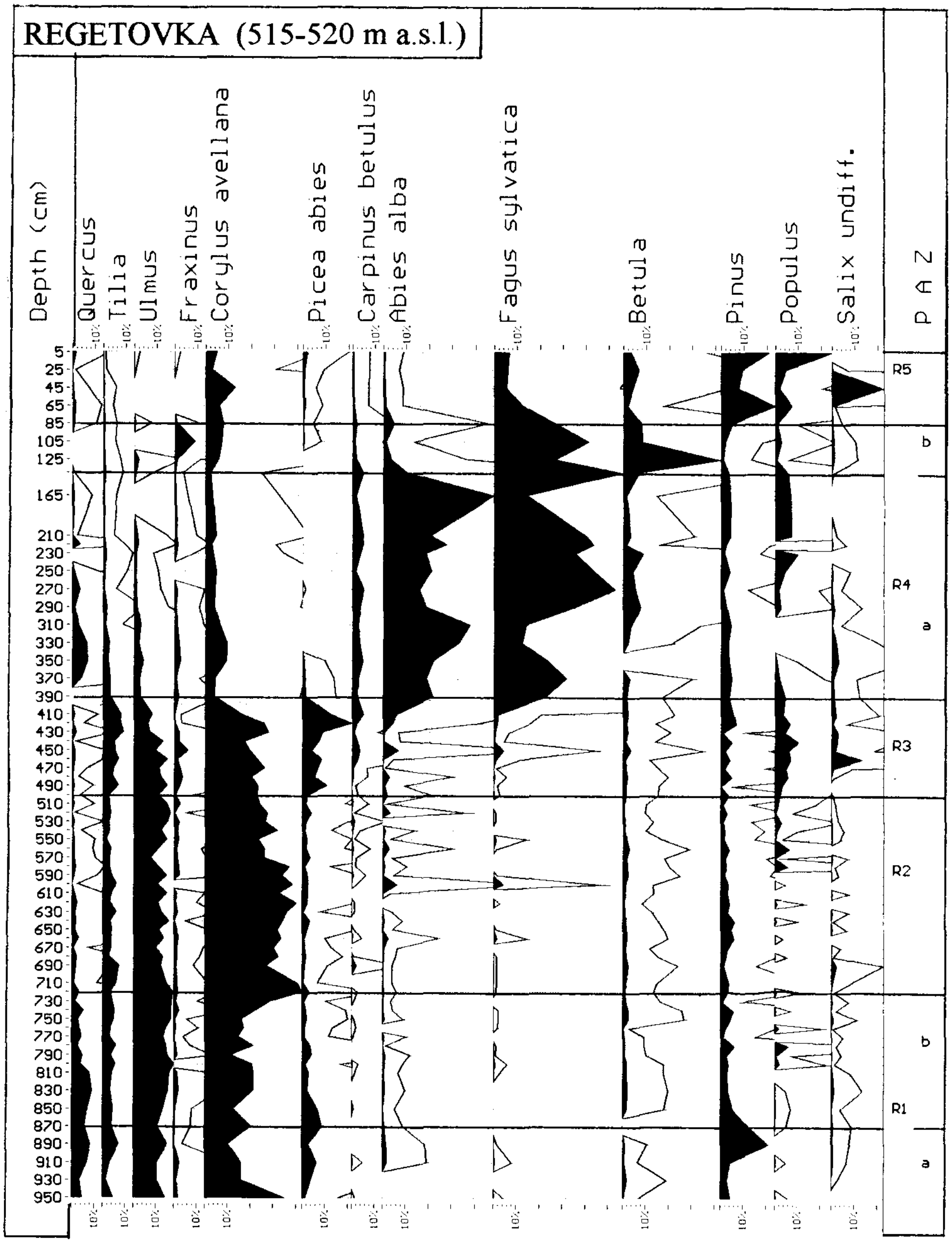

Fig. 6. Percentage pollen diagram of selected tree taxa, with *Alnus* excluded from the total sum

curves indicate the spread of communities with fir and beech, forming dense, shady tree stands on the hills round the fen. From the beginning of this zone a distinct connection appears between the maxima of *Abies* and minima of *Fagus* curves. A similar correlation was observed in other diagrams and it is particularly well seen in the pollen diagram from Smerek mire in the Bieszczady Mts. (Ralska-Jasiewiczowa 1980). Some contribution to the forest communities was formed by Carpinus, its low-percentage curve reflecting distinctly the fluctuations of the beech curve. The other trees of minor importance were *Pinus, Quercus, Tilia* and *Ulmus*, connected with lower-lying places overgrown by more open woods with undergrowth dominated by hanzel, as in the preceding zone. The poor herb layer of shady forests was to mostly composed of ferns (indeterminable species). The subsisting stands of heliophilous herbs were probably too small to become conspicuous in pollen spectra. Among NAP occurring in limited proportions, dominant were agriculture, pasture and settlement indicators, like Cerealia, *Artemisia, Plantago lanceolata, Rumex acetosa* t., *Ranunculus, Urtica,* Cichorioideae and Gramineae. The continuous curve of *Secale cereale* begins in this phase.

The dominance of alder on the fen, and of fir and beech in its close vicinity are characteristic features of subzone R4a.

A retreat of *Abies*, which was replaced by expanding beech (max 54%), took place in younger subzone, R4b. The pioneer *Betula* developed quickly in open areas that appeared after forest clearance; their presence is also confirmed by the gradual increase in the significance of herbs.

Zone R5

The phase of rapid changes in the composition of the pollen spectra recording a consistent reduction in the proportion of tree pollen in the total sum, is the effect of the far-gone devastation of forests by man; its first signs were already observed in the previous zone. The presence of charcoal in the peat (samples from 65–5 cm, about 300 last years BP) indicates frequent fires in the site region. Became pollen analyses were performed every 20 cm, it was impossible to determine the frequency of fires. The starting of fires by natural agents seems hardly probable, mainly on account of the type of tree stand. Moist mixed forests, just as wet alder woods and alder carrs, very rarely catch fire, it happens only during the fires of large forest complexes, mostly with prevalent conifers (Hanak 1994). The regularity of the occurrance of charcoal over a several-ten-centimetre-long portion of the profile speaks also against the spontaneous outbreak of the fires. Most probably the felling of beech and next possibly of alder in the fen surroundings to obtain new terrains for tillage was practised first. The economicaly useless tree wastes left after felling were then burned to clear the area and, in addition, to fertilize it with ash. The devastated terrains were later overgrown by birch, aspen and, next by pine, similarly to that happens after natural forest fires (Medwecka-Kornaś 1994). The AP curves suggest the formation of an open wood of the parkland type, dominated by the above-mentioned species and beech and with small contributions of oak, lime and fir. Besides dominant hazel, both species of *Sambucus*, and *Juniperus, Hedera helix* still occurred in the wood undergrowth. Nowadays, flowering specimens of ivy can by scarcely found in the following areas of low mountains and foot-hills of southern Poland: Mt Babia Góra, Bielsko-Biała region, Krynica, Tęgoborze area and, also in the western part of the Low Beskids, on the Maślana Góra at an altitude of 650 m (Denisiuk & Pilipowicz 1984). *Hedera* is an indicator of a fairly mild climate in the phase discussed. The reduction of forests may have led to rise of ground water level, which is suggested by the development of arboreal components of carrs and wet alder woods, such as *Salix, Populus, Betula, Fraxinus* and *Picea*. After the previous reduction of *Alnus* connected lessibly with clearance, its number remains at a relatively constant level. Its frequency may have been controlled by man,who prevented its re-expansion by mowing drier patches of fen, just as it happens nowadays (Dostal 1981). The rise of the ground humidity is indicated by the rising proportions of *Sphagnum, Typha latifolia*, Cyperaceae, *Equisetum, Caltha*, Rubiaceae , *Valeriana* and *Mentha* t.. Large woodless areas utilized for grazing supported heliophytes: Compositeae, of which mainly Cichorioideae, Gramineae, *Umbelliferae, Potentilla* t. and also *Plantago lanceolata, Plantago major* and *Plantago media*. The percentages of *Artemisia*, Cerealia, Chenopodiaceae, *Rumex acetosa* t., *Secale cereale* and *Fagopyrum* evidence the intensification of land cultivation.

EVIDENCES OF HUMAN ACTIVITY IN THE POLLEN DIAGRAM

The first perceptible traces of human activity in the Regetovka region come from the spectrum at 810 cm (Fig. 7), where the first single pollen grains of *Plantago lanceolata* have been recorded. This alone is not a reliable indication of cattle breeding activity; however, several successive samples with the reduced abundance of *Ulmus* and synchronously rising curves of herbs from open places, chiefly *Anthemis* t., Gramineae, Umbelliferae, *Rumex acetosa* t., *Artemisia* and *Ranunculus*, strongly suggest changes caused by the destruction of forest, perhaps by burning, fixed next by livestock grazing. The grazing may have proceeded in natural open areas round the fen, partly in the drier parts of the fen itself, in neighbouring open forests and, above all, on surfaces newly exposed by a fire. Grazing additionally increased the area occupied by heliophilous vegetation and, induced changes in the forest communities, perhaps leading to the development of open scrub woods providing more fodder. The occurrence of fires is evidenced by

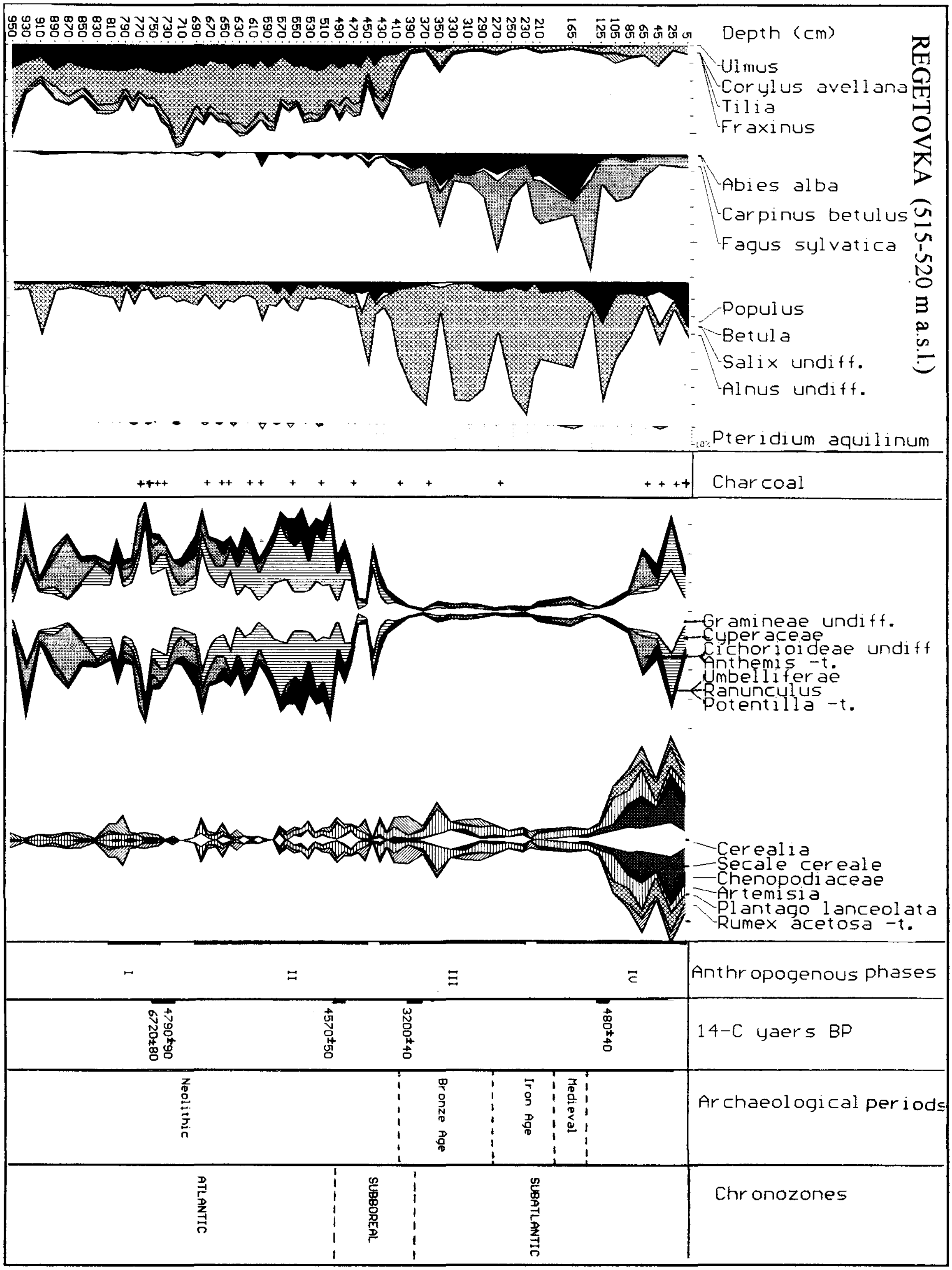

Fig. 7. Percentage diagram of the anthropogenic pollen indicators, selected tree taxa and showing local settlement phases

not numerous charcoal found in the peat at 790–730 cm and also by the changes in the vegetation detected at that time, such as an increase in the proportion of *Populus* pollen and the appearance of *Pteridium aquilinum* spores.

Although fires were natural and relatively frequent occurrences in natural environments (Kruk 1980), started usually by lightnings during the summer when herb layer was over-dried, yet the systematic appearance of their evidences suggests man's purposeful activity. After a short-lived decline of human interference a successive episode of his economic activity reccured. In addition to the indicators of grazing, there were also evidences of cereal cultivation (Cerealia pollen). Corn was grown on small plots disforested by slash and burn technique; hence came charcoal observed in a number of samples starting from a depth of 680 cm. Fire clearance was probably applied in summer, before rain, what caused the sinking of ash into the soil, and fertilizing it. Stumps and thick tree trunks were not removed, for they did not present impediment during primitive soil tillage (Clark 1957). Extensive burning out – fallow system in plant productiom allowed for only short-lasting utilization of the field. The progressing process of soil impoverishment made the farmers abandon the plot and gain new terrains for cultivation; thus the area of forests destroyed by human activity enlarged quickly. The growing significance of livestock breeding by the pasture-cowshed system is evidenced not only by the increasing proportion of meadow vegetation and might also be connected with the first rapid fall of elm (drop by about 8%) and lime, pollen values recorded about 5000 BP. This phenomenon can be traced in quite a few European pollen diagrams in this time (Troels-Smith 1960). Leaves, young stalks and bark of these trees were probably used as fodder for animals not only in spring and famine times, as the routine haymaking did not start till the early Iron Age. That method of feeding cattle has persisted untill today in certain regions of Europe, eg. in Norway (Austed 1986). It is however unclear how widely it was applied in the Neolithic. The reduction at elm abundance is not an univocally explainable phenomenon, there are at least five theories trying to explain it (Peglar & Birks 1993). The best-grounded seems the assumption of the joint effect of man's interference by branch cutting and a pathogenic factor as such the fungus *Cerathocystis ulmi* inducing Dutch elm disease about 5000 BP (Peglar & Birks 1993). Forest with elm and lime occurred on fertile grounds good for agriculture, what in turn led to selective felling of such forests. Indicative for clearings is the presence of *Sambucus nigra* pollen. By thinning of dense primary forests, farmers contributed to the fast expansion of hazel, which reproducing efficiently from sprouts. It formed clusters in places unshaded by the forest canopy. In such situations hazel fruited intensely, becoming a source of nuts, readily utilized by man as the Neolithic (Twardowska 1983). It was not endangered by animals, because, while grazing, they avoided these relatively dense thickets (Ralska-Jasiewiczowa 1966, 1968).

After the next regression of settlement, which was reflected in the pollen diagram at a depth of 630–570 cm by the reduction of cereal and anthropogenic indicator pollen and coincident rise of tree pollen frequency, the agro-pastoral tribes resumed their economic activities. The extensive cultivation of cereals, probably on a fairly large scale, is indicated by the higher percentage of Cerealia (including a single grain of *Secale cereale*), by nitrophilous weeds; *Artemisia*, Chenopodiaceae, *Urtica* (was found at the same time when Cerealia), and the corresponding decrease in the *Ulmus* frequency. Rye, which was found in the deposits so early, may have been a weed in other cereal crops. Prevailing is the opinion that the propagation of the rye cultivation took place in the Roman Period, although some earlier sites of rye are known from the territory of Poland, including, several ones from the Neolithic (Wasylikowa 1984, Behre 1992).

The surroundings of Regetovka were exploited constantly but with variable intensity, what is well illustrated by the coincident rises and falls of the *Artemisia,* Cerealia and *Rumex acetosa* t. curves. This is the effect of different factors, chiefly the changes in the husbandry from (short lasting exploitation of the same plots), displacements of cultures, and perhaps also climatic conditions. Animal breeding based on nomadic and semi-nomadic grazing played an important role at that time, as evidenced by the proportions of Gramineae, Umbelliferae, Cyperaceae, *Ranunculus, Rumex acetosa* t. and *Potentilla* t.. In the Sub-Boreal the pollen curves of *Tilia, Ulmus, Fraxinus* and *Corylus* decrease gradually. These taxa were being replaced by new coming shade tolerant trees- fir, beech and, to a smaller extent, hornbeam; their spreading was facilitated by the clearance of forests by man. We may, therefore, treat them to a certain extent as forest communities formed under man's influence. Farmers gradually adopted more stationary ways of life and what is evidenced by remarkable pollen percentages of plants associated with settlement like Chenopodiaceae and *Urtica*. At the same time the evidences of fires decrease in number, what may indicate of giving up the fire-clearance for cultivation.

In the sample at 270 cm a fall of the human indicators may suggest a short-lived limitation of agriculture. A similar record was also found at 220 cm. The abandoned fields and meadows were successively overgrown, first by pioneer species and next by beech-fir and beech woods. Such development is clearly reflected by the summary tree curve, which attains a maximum value of 96%. However, this change in the composition of prevailing forest communities was rather unfortunable for primitive husbandry. Dense, shady forests with dominant beech and a very poor herb layer are not suitable for direct grazing, contrary to the more open oak-hornbeam forests; they are also much more difficult to be cut out (Godłowski 1983).

The last settlement phase, lasting to the present day, began with the pollen spectrum at 210 cm. At the beginning the proportion of pollen indicative of human activities was low but stable. The human indicators started increasing rapidly from the sample at 125 cm. At the same moment the rapid elimination of *Abies* and somewhat later of *Alnus* and *Fagus* was recorded in the diagram. The cleared areas were used for the cultivation of cereals: rye, wheat and probably also *Fagopyrum*, although represented only by single pollen grains. The pollen of this genus has been found in different pollen diagrams from Poland by the end of Sub-Atlantic period. It should also be kept in mind that the intensity of cultivation cannot be simple inferred from the frequency of cereal pollen. Pollen of cereals is generally present in sediments in small amounts. This is due to both their small pollen production (only *Secale cereale* is anemogamous) and pollen transported at rather short distance (Hall 1988). So it may not be found during pollen analysis, even if the counted pollen sum is 500–1000 (Edwards & McIntosh 1988). The grazing of animals in pastures is confirmed by the proportions of heliophytes: Cichorioideae, Gramineae, *Potentilla* t., *Ranunculus*, and indicators at pasturages: *Plantago lanceolata* and *Rumex acetosa* t.. The areas with poorer soils were occupied by forests with dominant pine.

Discussion

It is a difficult task to refer particular phases of increased economic activity recorded in pollen diagram to the appropriate cultural periods in the study area because the time resolution of analysed samples was to big and the number of 14 C dating was small. Correlations were based on the radiocarbon dates obtained and on comparison of the pollen curves with those in other dated diagrams, from neighbouring areas mainly from Szymbark (Gil et al. 1974). This is the nearest mire formed in a landslide niche at a comparable altitude studed by pollen analysis but, owing to its location, it provides a very poor record of prehistoric settlement

The first undistinct traces of economic activity were observed in the pollen diagram before 6700 BP. The earliest evidences of grazing in the diagram (settlement phase I) indicate a limited and short-lasting penetration of the neighbouring terrains by groups of people with livestock: cattle, goasts and sheep. Because of the unreliable chronology of this section of diagram it is imposible to correlate the recorded changes with the concrete cultural circle. The primitive cereal cultivation started somewhat later, about 5000 BP (settlement phase II) and was kept, on small plots, deforested by the fire-clearance, and situated at a certain distance from the fen.The agro-pastoral population of Funnel-Beaker Culture had to change frequently the occupied areas to gain the new grounds for crops because of extensive method of cultivation based on fire-clearance. This type of economy was probably responsible for the decreases in the culture indicators and the episodes of proportion rising of trees in pollen diagram, evidencing the overgrowing of abandoned plots occurring in the discussed and following phases such oscillations should probably be treated as local phenomena. The decline of II settlement phase comprises the period of development the Corded Ware Culture. In the mountain region the population of this culture was typically pastoral, what is suggested by an increase of *Rumex acetosa* t., Ranunculaceae and *Potentilla* t. pollen. The coicident occurrance of grazing indicators and pollen of cereals and weeds, pointing to the presence of crop cultivation or even short-lived settlement at a certain distance from the fen (regular occurrence of Chenopodiaceae, *Artemisia* and *Urtica*), seems interesting.

About 3700 BP the Corded Ware Culture vanished and the area got under the influence of the cultures of early, and next of middle and late Bronze Age and Hallstatt (III settlement phase). The agricultural activity of these communities consisted of cereal cultivation, perhaps also with the use of the fire-clearance method for gaining new terrains, and stock-breeding by direct grazing the pastures. The existence of pastures in the pollen record from the Regetovka mire is indicated by the proportions of eg. Gramineae, Umbelliferae, *Ranunculus, Rumex acetosa* t. and the regular occurrance of *Plantago lanceolata*. The next decrease of economic activities, which may have been caused by the decline of these cultures in the middle of the Sub-Atlantic, can also be connected with the change of climatic conditions. According to Godłowski (1983), the 7th-6th centuries BC were a period of a rapid increase in rainfall and a cooling of the climate, which may have brought about a disaster of poor crops and livestock pests and, as a result, a rise of tree pollen frequency occurring from a depth of 270 cm. Archaeological studies show that the symptoms of recession did not appear before 5th century BC what was possibly connected with the invasions of Scythians and next of Celts. A following short-lived disappearance of the indicators of cereal cultivation was noted at 220 cm, which might have been associated with the final decline of the Tarnobrzeg group of the Lusatian Culture in this region. The next expansion and rise of population density might have taken place in the period of Roman influences (settlement phase IV). It seems to be confirmed by the finding of a large number of pottery fragments from the late Roman Period and traces of iron slag on one of the elevations near Smilno (Machnik 1994). The increase of the population density resulted in the occupation of the unfertile terrains unpopulated or sparsely populated up to that time (Godłowski 1983). Farmers have been present in the Regetovka region ever since, though the population density probable was changing. The importans of human economy increased rapidly from about 500 BP (sample at 125 cm). The intensification of their activities is illustrated by the rising pollen curves of cultivated plants-mainly rye and of synanthropic species. The final fall of *Artemisia* pollen curve may be caused by the improvement in the cultivation techniques. The progressing devastation of the forests is recorded by the rapid fall of tree pollen sum in the diagram by nearly 50%. Animal grazing was continued on a large scale in open areas. The reduction of the crops and grazing indicators at 45 and 5 cm is difficult to explain as occuring in single samples.

COMMENTS

1. In the considerable part of the profile the samples were analysed at too large intervals, every 20 cm. In order to obtain more detailed data, it is necessary to complete analyses of samples between to get at least the same time resolution as in the part of diagram covering the Neolithic.

2. It was not possible to determine the age of the landslide and to reconstruct the vegetational succession in the arising mire because the bottom part of the profile has not been collected.

3. The small number of 14 C datings and a big differences in results between two samples (no. 4 and 5) what may caused by differences in the peat accumulation rates, does not allow us to define the exact beginning of agricultural activities and to carry out detailed correlations with the corresponding cultural circles.

ACKNOWLEDGMENTS

I wish to express my heartfelt thanks to all whose help made the completion of work possible. My special thanks are due to Prof. M. Ralska-Jasiewiczowa for her numerous remarks and discussions, help with formulating of conclusions and concern in the progress of my work. I thank her also for correcting the text of the paper. All that, as well as her lavishly sharing her knowledge with me was an additional encouragement to carry on my work.

I extend my grateful thanks to Dr K. Harmata for friendliness and substantial assistance during my study of materials, to Prof J. Machnik for initiating me into the problems concerning Neolithic settlement, discussions and corrections made in my text and to Prof Z. Woźniak for his valuable remarks on the settlement problems.

I wish to extend my gratitude to Dr J. Harcar, who gave me access to his so far unpublished material, to Prof K. Szczepanek for collecting the profile from Regetovka mire and to Ms M. Zurzycka for the laboratory preparation of the samples for pollen analysis.

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STRESZCZENIE

Historia lokalnej szaty roślinnej i ślady działalności człowieka odzwierciedlone w diagramie pyłkowym z Regetovki (NE Słowacja)

1. Uzyskane wyniki badań palinologicznych ujęte w diagramie pyłkowym posłużyły do wydzielenia pięter stratygraficznych i rekonstrukcji zmian w zbiorowiskach roślinnych, w środkowym i młodszym holocenie.

2. Profil obejmuje osady z trzech okresów: atlantyckiego, subborealnego i subatlantyckiego.

a) Okres atlantycki odznaczał się dominacją stosunkowo luźnych, wielogatunkowych lasów liściastych na żyznych glebach wokół torfowiska. Płaty o glebie okresowo podtapianej obejmowały formacje typu łęgów lub olesów. Około 5000 BP z przyczyn antropogenicznych i/lub patogenicznych ograniczony został znacznie udział wiązu w lasach, a w jego miejsce rozwinęły się światłolubne zarośla leszczynowe.

b) W okresie subborealnym doszło do jakościowych przegrupowań w składzie gatunkowym zbiorowisk. Równocześnie z ograniczeniem liczebności wiązu, lipy i leszczyny rozszerzyły się nowe gatunki lasotwórcze takie jak: *Abies, Alnus* oraz występujące dotąd sporadycznie *Fagus* i *Carpinus*. Charakterystyczna była wysoka liczebność świerka w drzewostanie.

c) W okresie subatlantyckim początkowo wytworzone zwarte, cieniste lasy jodłowo-bukowe i bukowe z powodu rosnącej degradacji drzewostanu zastąpione zostały przez rozwijające się na zrębach gatunki pionierskie.

3. Badania dostarczyły wielu informacji na temat oddziaływań osadnictwa ludzkiego na szatę roślinną w okolicy Regetovki.

a) Pierwsze wskaźniki wypasu, a co za tym idzie i hodowli zwierząt pojawiły się w środkowej fazie okresu atlantyckiego poniżej 6700 BP, kiedy to zanotowano występowanie *Plantago lanceolata,* równoczesne kulminacje *Rumex acetosa* t. i heliofilnej roślinności miejsc otwartych, oraz nieznaczny spadek ilości ziarn pyłku wiązu.

b) Świadectwa uprawy zbóż pojawiły się ok 5000 BP, równocześnie z szeregiem zjawisk związanych z działalnością człowieka m. in. wyraźnym spadkiem krzywych wiązu i lipy oraz świadectwami występowania pożarów.

c) W profilu wyróżniono kilka faz ożywienia gospodarczego rozdzielonych okresami regresu osadnictwa, oraz podjęto próbę powiązania zmian intensywności działalności rolniczej z następującymi na tym obszarze zmianami kulturowymi.