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We dedicate this paper
to the Memory of Jerzy Mamak (1929–2005)

The interglacial from Korchevo in Belarus in the light of new palaeobotanical studies

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ABSTRACT. Within the present study of the Korchevian deposits there were examined two profiles from the eastern wall of the exposure in an open clay-mine. The methods used were pollen and macrofossil analyses. Altogether 215 taxa of different rank have been determined. The results of studies are presented graphically in diagrams and as a floristic list. Studies based on pollen analysis were performed using two different techniques, which were conventionally named the Polish and Belarusian methods. Pollen succession suggests that the Korchevo deposits have been disturbed. One may distinguish five basic biostratigraphic units (Kr-1 – Kr-5) in the rank of local pollen zones (L PAZ) and three zones (Kr-2 bis, Kr-4 bis, Kr-5 bis), very similar to local pollen zones Kr-2, Kr-4 and Kr-5, recognized as repeated zones (bis) in periglacial processes. It is difficult to correlate macrofossils diagrams with pollen diagrams because the analysed macrofossil samples were too thick. The presented history of vegetation is based on local pollen and macrofossil zones of the undisturbed part of the profiles. That part of the profiles is also a basis for stratigraphic conclusions. It has been accepted that the interglacial pollen succession from Korchevo represents either Korchevian interglacial in stratigraphic position between the Narevian and Jasieldian glaciations, or the Mogilevian interglacial, located between Nizhninsky and Berezynsky glacials. In Poland it may be correlated with either younger interglacial in the Augustovian succession, or younger interglacial in the Ferdynandovian succession. The results of studies on macrofossil remains suggest that these deposits exhibit features indicating rather the Korchevian interglacial in stratigraphic position between the Narevian and Jasieldian glaciations.

Studies based on pollen analysis, carried out using two different laboratory techniques, allowed to draw some important methodological conclusions.

KEY WORDS: pollen analysis, plant macrofossils, vegetation history, methodical remarks, Pleistocene, Korchevian interglacial, Mogilevian interglacial, Belarus

CONTENS

INTRODUCTION

The deposits from the Korchevo site were recognized as the stratotype for the Korchevian interglacial, the oldest and the most discussable interglacial in Belarus. Since the 1970s there have been a divergence in opinion among Belarusian scientists concerning its stratigraphic position and correlation with interglacials in other countries.

The present palaeobotanical studies at Korchevo were made in the frame of scientific cooperation of the Władysław Szafer Institute of Botany, Polish Academy of Sciences, in Kraków and the Institute of Geochemistry and Geophysics, National Academy of Sciences of Belarus, in Minsk.

Various aims were pursued in this study:

1. Sediment description by means of pollen and macroscopic plant remains analyses.

2. An attempt to solve certain stratigraphic problems concerning, among others, the correlation by many scientists the Korchevian deposits with the deposits from Przasnysz in Poland and those within the range of the Cromerian complex.

3. Grasping and describing various methodical problems which have been making it difficult for years to compare the results of pollen analysis carried out in Poland to those from Belarus. They concern:

– different ways of taking samples for pollen and macroscopic analyses;

– different techniques applied for the laboratory preparation of samples for pollen analysis;

– different methods of counting pollen spectra;

– different manners of the presentation of pollen analysis results.

DESCRIPTION OF THE SITE AND THE GEOLOGICAL STRUCTURE OF DEPOSITS

The Korchevian site (Fig. 1) exposure is situated in the south-eastern part of the Novogrudok Upland (53°21′10″ N, 26°6′ E). The site occurs in an open clay-mine on the left bank of the river Servech, a left-hand tributary of the river Neman, between the Korchevo and Yelizarovshchina villages (Baranovichi District, Brest Province). The profiles have been derived from the exposure.

Fig. 1. Location of the investigated site

The deposits from Korchevo were first described as a new Pleistocene interglacial stage by Voznyachuk (Voznyachuk et al. 1977, 1978, Vaznyachuk et al. 1978). In keeping with his findings interglacial lacustrine sediments are represented alternately by clayey and peaty gyttja with dark-grey humic silts. This horizon occurs between two tills, a green-grey till underneath and a red-brown above. It is broken into scales dipping in various directions.

The lake deposits and the green-grey till underlying them constitute according to Voznyachuk an enormous detached block, 1.5 × 0.5 km in area and up to 40 m high which has a complicated glaciogenic structure of scales overlapping one another. This detached block is forced into the Dnieper till (= Odranian, Saalenian).

Five stages were primarily distinguished in the detached block: Narevian glaciation, Yelizarovian interglacial, Nowogrudok glaciation, Korchevian interglacial and Servechian glaciation (Voznyachuk et al. 1977, 1978, Vaznyachuk et al. 1978). Later on, after more close investigation, Voznyachuk (1981, 1985) revised his view and acknowledged that the Korchevian detached block was composed of only three stages: Narevian glaciation, Korchevian interglacial and Servechian glaciation. At the same time he asserted that the Korchevian detached block was composed of several large, 7–10 m thick sheets thrust upon each other. Each of these sheets is divided into thinner scales, 0.1–3.0 m thick. According to Voznyachuk (1981) they were shuffled by the glacier and fragmented by a dense network of fissures into small blocks. Scaly layers split off from the interglacial deposits were frequently observed wedged into periglacial deposits and the other way round.

Zus (1980, 1991) took a different standpoint. Basing himself on geological studies in the area of Korchevian glaciodislocations and materials from many boreholes in this region, he questioned the detached-block nature of the Korchevian interglacial deposits. He suggested that the Korchevian interglacial deposits and the Narevian till underlying them were involved in a great glaciodislocation, which considerably affected the depth of their occurrence and the angles of inclination of the layers, but probably did not shift the interglacial layers from the place of their original deposition.

The interglacial sediments from Korchevo were studied by palynological, carpological, teriofaunistic, malacological and entomological methods.

HISTORY OF PALAEOBOTANICAL STUDIES

The earliest palynological studies of the Korchevian deposits exposed in the south-eastern wall of an open mine were conducted by Makhnach (Voznyachuk et al. 1977). The deposits in the northern wall were analysed by Kondratiene (Vaznyachuk et al. 1978).

Pollen diagram presented by Makhnach covers three layers: – 4, 5 and 6. Layer 6 is divided into 5 pollen zones, described by Makhnach as: K1+2 (birch + pine), K3 (oak up to 10–12% and elm 6–8%), K4 (alder up to 31%, *Quercetum mixtum* 16%, hornbeam 10% and hazel 8%), K5 (pine and birch). The pollen spectra obtained from layers 4 and 5 are periglacial in nature. On the basis of this sequence layer 6 with pollen zones K1 – K5 has been recognized as interglacial and named Korchevian interglacial.

The diagram obtained from the northern wall has been divided by Kondratiene into three parts: the lower – referred to the Narevian glaciation, the middle – to the Korchevian interglacial proper, and the upper – to the Servechian glaciation.

Palynological studies carried out by Kondratiene showed that the deposits of both Narevian and Servechian stages contained, in addition to the autochthonous pollen, numerous sporomorphs redeposited from older sediments. Pollen was considerably worser preserved in these layers than in the deposits of the Korchevian interglacial.

A climatic optimum in the profile studied by Kondratiene is characterized by a nearly simultaneous appearance and increase in the pollen values of thermophilous broad-leaved trees, with dominant *Quercus* (up to 18%). As for the other taxa, *Corylus* pollen reaches 6% and *Alnus* 21%. The culmination of *Alnus* and *Corylus* curves coincides with that of *Quercus*, *Ulmus*, *Tilia*, and *Carpinus* curves. All percentage values, cited after Machnach and Kondratiene (Voznyachuk et al. 1977, 1978), are based on the Belarusian method of percentage calculation.

According to Vaznyachuk et al. (1978), the pollen occurrence of *Pinus* sect. *Cembrae* Spach., *Pinus* sect. *Strobus* Shaw., *Picea* sect. *Omorica* Willkm., ?*Celtis*, ?*Vitis*, and *Ilex* as well as spores of *Selaginella* sp. 1, *Azolla* sp. etc. corroborates the assignment of the Korchevian stage to the early Pleistocene. In the opinion of the above authors, the composition and succession of the vegetation of this interglacial allow its correlation with the Cromerian interglacial in the wide expression, just as it was correlated by Makhnach (1971, tab. 1).

Plant macrofossils from the intermorainic layers were studied by Velichkevich and Yakubovskaya (Voznyachuk et al. 1977, Vaznyachuk et al. 1978, Velichkevich 1986, Yakubovskaya 1978, 1991).

According to Velichkevich (1986) macrofossils represent a numerous group of extinct species, which may be divided into:

– Pliocene-Pleistocene species: *Azolla interglacialis* Nikit. (= *A. filiculoides* Lam. foss.), *Potamogeton perforatus* Wieliczk., *Stratiotes goretskyi* Wieliczk., *Carex paucifloroides* Wieliczk., *C.* cf. *rostrata-pliocenica* Nikit., *Alisma plantago-minima* Nikit., *Ranunculus gailensis* M.E. Reid (= *R.* ex gr. *sceleratoides* Nikit.);

– Early-Middle Pleistocene species proper: *Pilularia* cf. *borysthenica* Wieliczk., *Potamogeton dvinensis* Wieliczk., *Caulinia antiqua* Jakub., and *Aldrovanda borysthenica* Wieliczk.;

– specific Korchevian species: *Scirpus kreczetoviczii* Wieliczk. and archaic *Nymphaea* and evidently alien and perhaps extinct *Lycopus*, differing in the size and shape of nuts from the contemporary European species of this genus.

On this basis Velichkevich asserted that in terms of the number of extinct species the carpological flora seems more exotic than the flora of the Shklov interglacial (= Belovezhian and Mogilevian interglacials in a new approach, Velichkevich et al. 1996) and it is clearly similar to the late Pliocene floras. At the same time, however, Velichkevich 1986 stated that this flora had still more features in common with the pre-Likhvinian (= pre-Alexandrovian, pre-Mazovian, pre-Holsteinian) floras.

Later *Aldrovanda zussii* Jakub. was included in the group of extinct species in the flora from Korchevo (Yakubovskaya 1991).

OTHER PALAEONTOLOGICAL STUDIES

From the Korchevo exposures there were also studied mammals, molluscs and insects. Basing himself on the theriofauna, Motuzko (1977, 1985) recognized this layer as Early-Pleistocene, which opinion was later confirmed by Kalinovsky (1979, 1986).

The numerous mammals have been identified among the bony remains. The whole of this group has been assigned with a certainty to the Tyraspol faunal complex. The extinct field mouse *Mimomys intermedius* New. is a particularly important species in the composition of this fauna. According to most palaeontologists, the late form of *M. intermedius* New. was replaced by *Arvicola mosbachensis* Schm. on the boundary between the early and the middle Pleistocene.

According to previous investigations (Voznyachuk et al. 1977, Voznyachuk 1985) the age of the upper boundary of the Korchevian fauna was fixed on the basis of the presence of various field mice of the genus *Mimomys* and the beaver *Trogontherium* sp., which did not pass over to the middle Pleistocene, and the lower boundary was based on the occurrence and diversity of mice from the genus *Microtus*, which spread in abundance only in the Pleistocene.

The malacofauna found by San'ko (1993) in the dark-grey gyttja corresponds to the climatic optimum of the Korchevo interglacial. It comprises 32 taxa, among them is the thermophilous Ponto-Kaspian species *Valvata naticina* Menke, along with the common interglacial species: *Limax* sp. and *Planorbaris corneus* L. The extinct species *Pisidium astartoides* Sandberger, the regional exotic taxon *Lithoglyphus* cf. *piramidatus* Moellendorff as well as *Gyraulus albus* Müller and *Valvata cristata* Müller are also included in this group.

According to San'ko (1993) the antiquity of the Korchevian malacofauna is indicated by the occurrence of a great many excentric opercula in *Bithynia labiata* Neumayer, the species characteristic of the Eopleistocene malacofauna of the European part of Russia and of the Ukraine, and probably from the paludal layers of eastern Germany. This species has not been found till now in the Belovezhian interglacial and the interglacials correlated with it, Cromer Forest Bed inclusive.

Fossil insects were studied in Korchevo by Nazarov (pers. comm.). In his opinion the thermal maximum of this interglacial is characterized by the presence of the relatively thermophilous species *Chlaenius tristis* Schall. and *Odocantha melanura* L., suggesting a milder climate than the present one. The antiquity of these deposits is indicated by the presence of the exotics Anthicidae, Rhysophagidae, and *Aridius nodifev* West. (Lathridiidae), now living in south-eastern Asia and also by the preservation of microsculpture only along the grooves in the wing-cases of *Epaphius rivularis.*

SEDIMENT DESCRIPTION IN THE ACTUAL OUTCROP

Our present investigation in the open claymine at Korchevo was conducted on its eastern wall. It is about 3.0–3.5 m high and exposes the following layers (described from the top to bottom):

Depth in m	Layers (Ps = Pollen samples, Ms = Macrofossil samples)
0–1.20	Sandy-gravel deposits with small boulders and inclusions of greenish-grey clay
1.20–1.30	Fine, plastic clay, grey with greenish and brownish hues
1.30–1.50	Dark-brown, horizontally bedded, peaty, calcareous, clayey sand splitted by cleavage, contacts sharp (Ps 32–29, Ms 8)
1.50–1.70	Brownish-grey to dark-brown, compact, horizontally bedded calcareous, clayey sand (Ps 28–25, Ms 7)
1.70–1.90	Brownish-grey, compact, slightly calcareous, horizontally bedded clayey sand (Ps 24–21, Ms 6)
1.90–2.05	Brownish-grey, compact, not-laminated calcareous clay (Ps 20–18, Ms 5)

2.05–2.25	Brownish-grey, compact, calcareous clay with a peat layer up to 10 cm thick at the bottom (Ps 17–14, Ms 4)
2.25–2.45	Brownish-greenish-grey, compact calcareous clay with peaty intercalations (Ps 13–10, Ms 3)
2.45–2.60	Brownish-grey, dark, layered, calcareous clay with thin laminae (Ps 9–7, Ms 2)
2.60–2.90	Bluish-grey, homogeneous, fine, compact calcareous clay (Ps 6–1, Ms 1).

METHODS

SAMPLING FOR PALAEOBOTANICAL STUDIES

In order to solve the problems posed in the introduction, two profiles were taken for studies by the pollen and macrofossil analyses. They were taken 1 m apart. The profile for study by T. Rylova in Minsk was designated as Korchevo I (Kr I) and that for study by M. Mamakowa in Kraków as Korchevo II (Kr II).

Fig. 2. Correlation of pollen (PS) and macrofossil (MS) samples of the profiles Korchevo I and II

From the Korchevo I profile samples for pollen analysis were taken by the method applied in Belarus, i.e. in a continuous manner. In this case a five-centimetre-long segment was treated as one sample. From samples collected in that manner there were calculated percentage values of sporomorphs. In the diagrams they were shown at the lower limit of a sample.

The Korchevo II profile was sampled point wise at definite depths in the manner usually applied in Poland. Samples obtained in this way correspond only to the lower part of deposit in the parallel samples from Korchevo I profile.

Samples for macrofossil analysis were taken in both profiles so that one sample comprised several samples for pollen analysis and their volumes were about 5 litres. The correlation of pollen and macrofossil samples is presented in the description of deposits and in Figure 2.

PREPARATION OF SAMPLES FOR POLLEN ANALYSIS

According to the maceration method applied in Belarus the samples from the Korchevo I profile were large, 40–50 g in weight. Therefore the first stage of maceration was performed – as usual in large beakers. As the deposit contained carbonate, first it was treated with cold hydrochloric acid and then washed with tap water until it became neutral. Next it was boiled with 10% KOH about 1–2 min and washed with tap water again until it became neutral, and it was sieved on a sieve with 0.5 mm in meshes in order to remove coarse detritus and sand. After applying each liquid (HCL, water, KOH) a sample was left in a beaker during 24 hours for sedimentation and then liquid was poured out very carefully, without rotation centrifuging. Further stages of maceration were carried out in test tubes and then centrifuging was applied. The deposit was subjected to flotation with heavy liquid $KJ+CdJ_2$ 2.21–2.25 in weight and then to a one minute Erdtman's acetolysis (Erdtman 1960). The samples were stored and counted in glycerine.

The samples from the Korchevo II profile were small, 0.5 cm^3 in volume. All stages of maceration were performed in test tubes and after each operation samples were centrifuged. As the deposit contained carbonate it was pre-treated with cold hydrochloric acid. Next the deposit was washed with distilled water and then it was boiled with 10% KOH about 1–3 min. After boiling it was sieved in a sieve with 0.5 mm meshes in order to remove coarse detritus and sand. Next the deposit was treated with hot hydrofluoric acid about 10 min. and with hot hydrochloric acid. Then the deposit was subjected to Erdtman's acetolysis (Erdtman 1960). The samples were stored and counted in thickened glycerine.

COUNTING OF SPOROMORPHS

Samples from Korchevo I profile were analysed under an Ergaval-Zeiss microscope with 40× and 100× planachromatic objectives, and samples from Korchevo II profile under an Amplival-Zeiss microscope with 16×, 40× and 100× apochromatic objectives and a phase-contrast objective 100× HI.

It was initially established that the basic pollen spectrum would be counted up to 500 tree and shrub pollen grains (AP). Pollen of terrestrial herbs, dwarf shrubs, reed swamp and aquatic plants, spores of Pteridophyta and Bryophyta, *Pediastrum* and pre-Quaternary sporomorphs were counted apart from this sum. However, observing these principles, we managed to count only samples 7–32 in both profiles. In the bottom samples, 1–6, we failed to obtain such basic AP sums because of a low frequency.

In the samples 1–6 from the Korchevo I profile, the amount of material remaining after Belarusian laboratory treatment was so meagre that all the material used for counting gave too low pollen sums to be used as the basis for percentage calculations. These spectra are not presented in the diagrams.

In the samples from Korchevo II, treated with hot hydrofluoric acid, the number of sporomorphs was considerably greater, which made it possible to count 100 AP grains in samples 1 and 3–6. Only sample 2 was very poor in pollen and this spectrum is not presented in these diagrams.

Samples from Korchevo I were counted by T. Rylova using the method applied in Belarus, that is, counting pollen on successive traverses extending side by side until the predetermined number of AP had been reached. If this number was obtained in a part of one slide, its remaining part was only looked over and the sporomorphs not encountered earlier were marked with the sign + (out of the AP + NAP sum).

Samples from Korchevo II were counted by the method applied by K. Mamakowa, that is, always on at least two slides. The traverses on which the predetermined number of AP grains was counted were always extending right across the slide. The remaining area of the slides was looked over and sporadic sporomorphs found in it were marked with the sign + (out of the AP + NAP sum).

Differences between the results of pollen analysis attributed by the authors to different laboratory methods and the methods of counting, are discussed separately (see pages 448–450).

PRINCIPLES OF PERCENTAGE CALCULATIONS AND THE CONSTRUCTION OF POLLEN DIAGRAMS

As can be seen from numerous discussions, the mode of counting, percentage calculation and presentation of the pollen analysis results applied by the palaeobotanists from the countries of the former USSR are not clear to many palaeobotanists from outside that area. We wish to make these techniques more widely known and to compare them with the methods commonly applied in Poland and Western European countries, and with diagrams from Korchevo, elaborated by N.A. Makhnach and Kondratiene (Woznyachuk et al. 1977, 1978), has made us to present the results of pollen analyses for both profiles (Korchevo I and II) by the two methods, here conventionally referred to as the "Polish method" and the "Belarusian method". These methods differ from each other in an essential manner.

In the "Polish method" pollen spectra are being obtained until the determined AP sum has been reached. The remaining groups of pollen, spores and other microfossils are counted parallel with the achievement of the determined AP sum, and their sums close with the numbers reached simultaneously. The pollen sum of terrestrial herbs and dwarf shrubs is separated as the NAP sum. The basic sum for percentage calculations is $\Sigma AP+\Sigma NAP = \Sigma P$. The construction of the entire pollen diagram contains:

a – a total diagram showing proportions of AP and NAP in the total pollen sum ΣP;

b – a resolved diagram of taxa making up ΣP, divided into trees, shrubs, and terrestrial herbs and dwarf shrubs; the percentage proportion of each taxon in this diagram is calculated on the basis of $\Sigma AP+NAP$;

c – other plant groups not included in $\Sigma(AP+NAP)$ are divided into swamp and aquatic plants, Pteridophyta, Bryophyta, indeterminable because of deterioration, redeposited and other microfossils, whose proportions are calculated on the basis of the sum: AP+NAP + the given taxon or + the sum of a definite group of taxa.

In the method which was generally used in Belarus, conventionally named here "Belarusian", the counting of the basic pollen spectrum is accomplished on the basis of the same criteria as in the "Polish method". Until the predetermined sum of tree and shrub pollen has been reached (ΣAP), pollen and spores of all the other plant groups are counted simultaneously. However, NAP sum is accepted not only as pollen of terrestrial herbs and dwarf shrubs but also as pollen of reed swamp and aquatic plants.

The completion of the counting of this basic spectrum may be followed by a second stage, the so-called "additional count" involving the NAP group and the group of Pteridophyta and Bryophyta. Additional counting in these groups is continued if they have not reached at least 75 specimens while counting basic spectrum. As a result, three different sums can be obtained in each sample:

a – a sum comprising AP, NAP and spores – obtained from the first stage of the basic count (ΣAP+NAP+spores);

b – a sum of NAP, which may be derived from the first basic count or includes also additional counts if these have been made;

c – a sum of spores (Pteridophyta + Bryophyta) which may also be identical with the sum from the basic count or contains the results of additional counts.

The construction of the complete diagram and percentage calculations in the "Belarusian method" are as follows:

a – the total column which shows a division of the sporomorph sum obtained from the primary count (ΣAP+NAP+spores) into percentage proportions of these three groups;

b – the resolved diagram of trees and shrubs which is divided into three parts: coniferous trees and shrubs, broad-leaved trees and broad-leaved shrubs. The basis for the percentage calculation is here the tree pollen sum. The proportions of shrub taxa are calculated in relation to the tree pollen sum, without adding to it the sum of shrubs or the given shrub taxon. In such a situation this part of the diagram is not related to the AP part in the total diagram;

c – the resolved NAP diagram which is divided into three groups: dwarf shrubs, terrestrial herbs, and reed swamp and aquatic plants. The pollen sum of these three groups – together with the pollen and *Salvinia* and *Azolla* sporangia from additional counts – if these have been made – constitutes the basis for calculation. In the NAP diagram the percentage curves exhibit the mutual relations of taxa exclusively inside their own group and are not related to the NAP part of the total column, which does not include the "additional counts";

d – the resolved Bryophyta and Pteridophyta diagram which includes Musci excl. *Sphagnum*, *Sphagnum* and Pteridophyta. The calculation basis is the sum of Bryophyta and Pteridophyta spores together with the "additional counts". In this diagram the curves represent, as in the NAP diagram, only the proportions of particular taxa in this group of plants and, similarly, are not related to the part "Spores" of the total column, which does not include the "additional counts" of spores;

e – the diagram covering remaining taxa. The calculation basis is here the AP+NAP sum (including pollen of reed swamp and aquatic plants) obtained at the first stage of counting, that is, without "additional counts"; the calculation sum is not increased by adding the taxon whose percentage is being calculated.

As can be seen the differences between the "Polish" and "Belarusian" methods are significant in the counting, percentage calculations and construction of diagrams. It may be generally said that the "Polish method" renders it possible to watch changes in the percentage proportion of particular taxa making up the total sum AP+NAP parallel with the changing relations of these two plant groups. In the "Belarusian method" the resolved parts of diagram present exclusively the mutual relations inside a definite group of plants and there are no percentage connections in them with the changing relations of these plant groups in the total column.

In both types of diagrams – drawn in "Polish" as well as in "Belarusian" methods – taxa within the ranges of particular groups of plants are, as far as possible, presented in the stratigraphical immigration order. The silhouette curves are drawn applying a 10× enlargement, which is not used in the original Belarusian method.

For drawing pollen diagrams the POLPAL method (Walanus & Nalepka 1999, Nalepka & Walanus 2003) has been used.

MACROFOSSIL ANALYSIS

Samples taken for macrofossil plant analysis from both profiles were preliminarily washed with cold water on a sieve with 0.25 mm meshes and air-dried in the field. Next, in the laboratories samples were again submerged and washed.

Samples from the Korchevo I profile were washed in the Geological Laboratory of Anthropogen at the Institute of Geochemistry and Geophysics, National Academy of Sciences of Belarus, in Minsk. A sieve with 0.25 mm meshes was used. Remains were picked out under a binocular microscope MBS-10/SSSR.

Samples from Korchevo II were washed in the Department of Palaeobotany of the Władysław Szafer Institute of Botany, Polish Academy of Sciences, in Kraków. A sieve with 0.2 mm meshes was used. Remains were picked out using a Zeiss binocular microscope. Preliminarily segregated macrofossils were delivered to the Institute of Geochemistry and Geophysics, National Academy of Sciences of Belarus, in Minsk.

Remains from both profiles were identified by G.I. Litvinyuk. His identifications were in the profile Korchevo II additionally verified by F. Yu.Velichkevich. An MBS-10/SSSR binocular microscope with 14×, 28× and 56× magnifications was used to identify the remains.

LOCAL POLLEN STRATIGRAPHY

Although the results of pollen analysis are presented in the diagrams by two methods – Polish (Figs 3, 5,) and Belarusian (Figs 4, 6) – it has been decided to base the description of the pollen zones on the percentage data obtained in the Polish method.

The pollen zones distinguished in both profiles have been described jointly. They are designated with the letters Kr and numbers growing from the bottom upwards (1–5). Zones Kr-2 bis, Kr-4 bis and Kr-5 bis are regarded as repeated in consequence of the superposition of layers caused by the folding of the bed.

L PAZ Kr-1 – *Artemisia*-Poaceae-*Salix*

Profile Korchevo II: samples 1–6

Zone Kr-1 is well developed only in Korchevo II, on which its description is based. In Korchevo I numbers of sporomorphs in samples 1–6 were too low for percentage calculations.

In the Korchevo II NAP values in zone Kr-1 are 41.2–47.6%, those of AP being 52.4–58.8%. The zone is characterized by high pollen values of Poaceae undiff. (up to 19.4%) and *Artemisia* (up to 15.2%) and somewhat lower values of Cyperaceae (up to 9.4%). The diversity of other herb taxa is fairly great but they are represented by sporadic pollen grains or have low values (up to about 1%). From shrubs characteristic of the zone are the high pollen values of *Salix glauca* type (up to 7.2%), not very high values of *Betula nana* (up to 1.8%) and the sporadic occurrence of *Hippophaë*, *Ephedra distachya* type, and *E. fragilis* type. Among trees *Pinus sylvestris* type and *Betula alba* type have high values. Values of *Sphagnum* and other mosses are low.

Noteworthy is the occurrence of very numerous redeposited pre-Quaternary sporomorphs, fairly frequent cysts of Dinoflagellata and high values of indeterminable, chiefly amorphous, crumpled and broken sporomorphs.

The upper boundary of the zone is placed at the decline of herb and *Salix glauca* type pollen values and the rise of *Betula alba* type and *Pinus sylvestris* type. The redeposited pre-Quaternary sporomorphs, Dinoflagellata cysts and marine plankton disappear at this level and the values of deteriorated sporomorphs are lowered.

L PAZ Kr-2 – *Betula* - *Pinus* -NAP

Korchevo I: samples 7–10; Korchevo II: samples 7–11

In Korchevo I tree and shrub pollen values (AP) lie within the range of 76.8–93.8% and that of herbs (NAP) between 6.2 and 23.2%. In Korchevo II these proportions are, respectively, AP 49.7–80.3% and NAP 19.7–50.3%. In both profiles the characteristic features of this zone include high values of *Betula alba* type with a culmination in the upper part of the zone and *Pinus sylvestris* type with a somewhat smaller rise in its lower part. The presence of *Larix* pollen deserves special attention. NAP values are still relatively high and increase in the upper part of the zone. This increase is conditioned in both profiles by the rise of Chenopodiaceae and *Artemisia*. In Korchewo II there are also relatively high Poaceae and Cyperaceae values. The variety of other herb taxa is considerable but their percentage values are low. Noteworthy are the high values of mosses (Musci excl. *Sphagnum*) and *Pediastrum*. The redeposited pre-Quaternary sporomorphs are sporadic in Korchevo II and their curve in Korchevo I is low but continuous.

The upper boundary is marked by the rapid fall of *Betula alba* type and NAP values, and the almost simultaneous increase in pollen values of all thermophilous trees, *Corylus* and *Alnus glutinosa* type.

N o t e. A problem concerning a higher proportion of Poaceae undiff., Cyperaceae and Chenopodiaceae pollen and a lower proportion of *Artemisia* in profile Korchevo II is discussed on pages 448–450.

L PAZ Kr-3 – *Ulmus-Quercus-Carpinus-Alnus*

Korchevo I: samples 11–14; Korchevo II: samples 12–14

AP percentage values exceed 90% in both profiles. The almost simultaneous appearance and increase in pollen values of all thermophilous trees, *Alnus glutinosa* type and *Corylus* are a characteristic feature of this zone. Pollen values of *Betula alba* type fall rapidly to 5.0% (Korchevo I) and 6.3% (Korchevo II), and those of *Pinus sylvestris* type decrease slightly. The proportion of Filicales monolete rises, while that of mosses (Musci excl. *Sphagnum*) and of *Pediastrium* decreases. Only one pre-Quaternary spore was noted in Korchevo II.

The upper boundary is marked by the fall in pollen values of thermophilous trees with the exception of *Quercus*, and also by the fall of *Alnus glutinosa* type and *Corylus*, as well as the rise of *Quercus* and *Pinus sylvestris* type.

N o t e. Korchevo I profile provides higher *Tilia* values (max. 8.9%) than Korchevo II (max. 1.9%), whereas *Carpinus* values are lower in Korchevo I (max. 2.4%) than in Korchevo II (max. 12.3%). Values of Filicales monolete also show considerable differences (for discussion see pp. 448–450.

L PAZ Kr-4 – *Quercus-Pinus*

Korchevo I: samples 15–18; Korchevo II: samples 15–17

AP values exceed 90% in both profiles. The characteristic features are the high pollen values of *Quercus* and *Pinus sylvestris* type and the almost complete disappearance of the remaining thermophilous trees as well as *Corylus* and *Alnus glutinosa* type. Musci and *Pediastrum* play hardly any role.

The upper boundary is marked by a decrease in pollen values of *Pinus sylvestris* type and *Quercus* and the rise of other thermophilous trees as well as *Corylus* and *Alnus glutinosa* type.

N o t e. The values of *Pinus sylvestris* type are higher in profile Korchevo I (max. 71.1%) than in Korchevo II (max. 41.7%). *Quercus* behaves in the opposite way, its values being lower in Korchevo I (max. 23.4%) and higher in Korchevo II (max. 42.3%). In Korchevo I Filicales monolete values are also higher (max. 36.1%)

than in Korchevo II (max. 9.6%); (for discussion see pp. 448–450).

L PAZ Kr-5 – *Ulmus-Quercus-Tilia-Carpinus*

Korchevo I: samples 19–21; Korchevo II: samples 18–20

As in the preceding two zones AP values reach above 90%. The zone is again characterized by somewhat higher values of thermophilous trees in which *Carpinus* is important, as well as of *Corylus* and *Alnus glutinosa* type, while the values of *Pinus sylvestris* type and *Quercus* are lower than in zone Kr-4. The values of Musci and *Pediastrum* are higher than in the previous zone.

The upper boundary of the zone is placed where the pollen values of thermophilous trees, *Corylus* and *Alnus glutinosa* type fall and *Betula alba* type and NAP rise steeply.

N o t e. The pollen values of *Tilia* are higher in profile Korchevo I (max. 7.6%) than in Korchevo II (max. 2.3%). On the other hand, *Carpinus* has lower values in Korchevo I (max. 1.3%) than in Korchevo II (max. 5.3%, for discussion see pp. 448–450).

Parts of diagrams above L PAZ Kr-5 *Ulmus-Quercus-Tilia-Carpinus* can be divided into three zones. The lower zone is characterized by the same features as these in L PAZ Kr-2 *Betula-Pinus*-NAP, the next zone is similar to L PAZ Kr-4 *Quercus-Pinus* and the top zone is similar to L PAZ Kr-5 *Ulmus-Quercus-Tilia-Carpinus*. These three zones are the repetition of the same zones which occur in the lower part of the profile. The results are fully consistent with Voznyachuk's opinion (1985), that primeval interglacial deposits in Korchevo were disturbed by glacial processes which split them into different scales and threw them into disarray.

In view of this opinion the upper pollen zones are considered to be the repetition of the lower ones and they are marked as zones "bis", and not redescribed.

Zone Kr-2 bis – *Betula-Pinus*-NAP

Korchevo I: samples 22–26; Korchevo II: samples 21–27

Zone Kr-4 bis – *Quercus-Pinus*

Korchevo I: samples 27–30; Korchevo II: samples 28–30

Zone Kr-5 bis – *Ulmus-Quercus-Tilia-Carpinus*

Korchevo I: samples 27–32; Korchevo II: samples 28–32

LOCAL MACROFOSSIL STRATIGRAPHY

The results of the bottom macrofossil analysis are presented separately for each profile (Figs 7, 8). The macroscopic sample Ms1 corresponding to the local pollen zone Kr-1 *Artemisia*-Poaceae-*Salix* contained no macrofossils. In the remaining samples data of many taxa are similar in both profiles although surprising differences also occur here.

Similar results refer to the occurrence of *Ranunculus sceleratus, R. gailensis* (=*R. sceleratoides*), *Lycopus*, *Menyanthes trifoliata*, *Alisma plantago-minima*, *Potamogeton crispus*, and several other taxa. Essential differences are in the numbers of *Zannichellia palustris* fruits and *Typha* seeds. They are very numerous in the Korchevo II profile while in the Korchevo I they are scarce. Some disparities in numbers of *Salvinia natans* macrospores also occur. There are also taxa represented by not numerous or sporadic specimens only in one of the profiles.

The connection of such considerable disparities in the numbers of *Typha* and *Zannichellia palustris* specimens with different habitats does not seem probable as profiles are only 1 m apart. It is more probable that in the place of profile II, local lake conditions favoured the accumulation of macroscopic remains.

The close correlation between the results of the macrofossil and pollen analyses is difficult because of the methodical mistake which was made in taking samples for macrofossil analysis. Their thickness appeared too big, which resulted in mixed material regarding distinguished local pollen zones.

In connection with this heterogeneity of macroscopic samples the boundary between the initial part of succession and climatic optimum is not clear. It refers to both the lower part of the profile represented by pollen zones Kr-2 – Kr-5 and the upper part ("bis") represented by zones Kr-2 bis, Kr-4 bis and Kr-5 bis.

For instance in the lower part of both profiles the macrofossil sample Ms3 contains the upper part of the late glacial local pollen

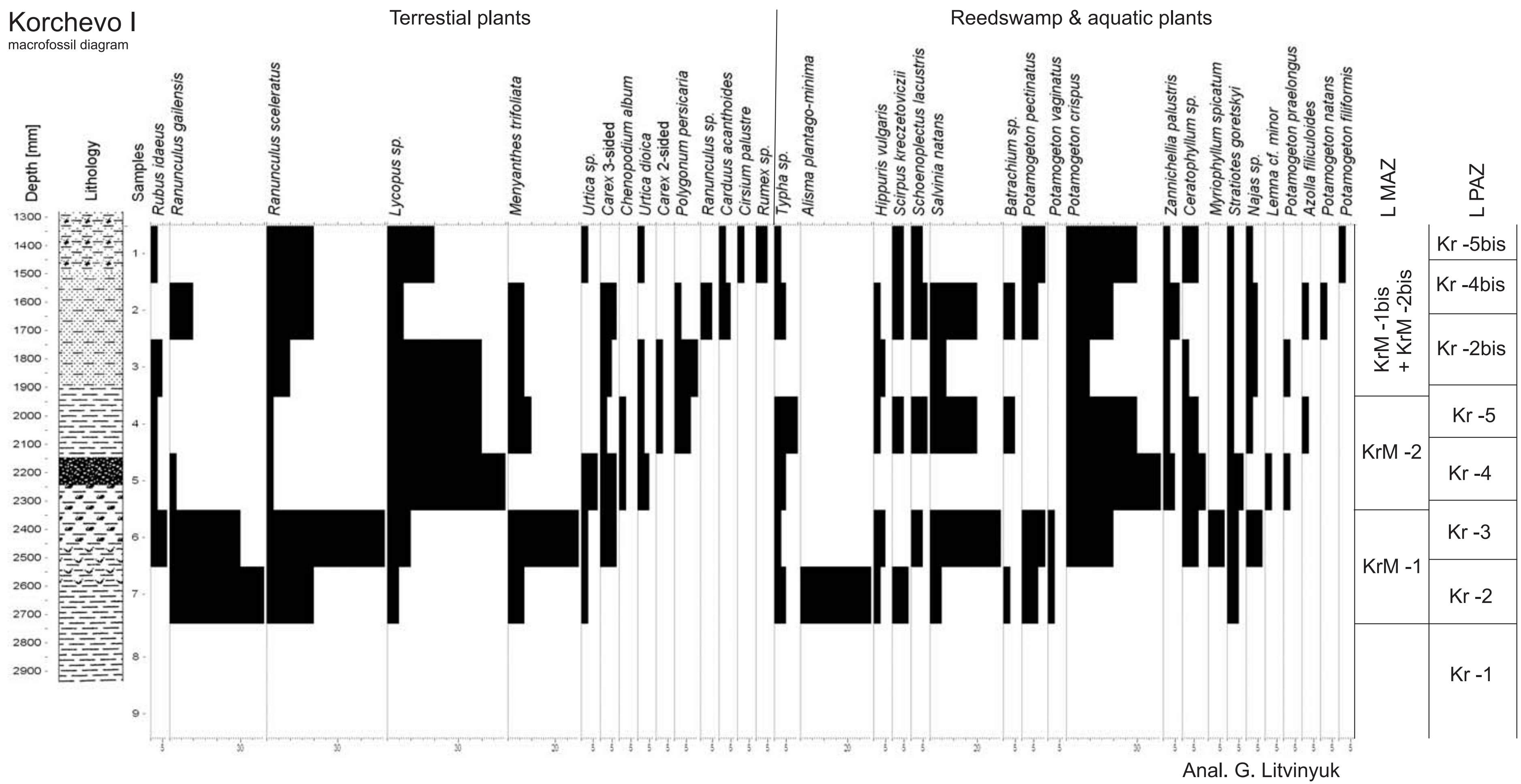

Fig. 7. Plant macrofossil diagram of Korchevo I, lithology see Fig. 3

zone Kr-2 – *Betula-Pinus*-NAP and almost the whole local pollen zone Kr-3 – *Ulmus-Quercus-Carpinus-Alnus* which represents already the beginning of climatic optimum. In the upper part of the profiles the macrofossil sample Ms6 contains the upper part of pollen zone from the climatic optimum i.e. L PAZ Kr-5 – *Ulmus-Quercus-Tilia-Carpinus* and the lower part of L PAZ Kr-2 bis – *Betula-Pinus*-NAP which is considered to be the repetition of the late glacial zone Kr-2 – *Betula-Pinus*-NAP.

It is difficult to distinguish precisely the macrofossil zones. However, on the basis of some similarities of data, two macrofossil zones (KrM-1 and KrM-2) have been distinguished in the lower part of both profiles which correspond to local pollen zones Kr-2 – Kr-5.

Zone KrM-1

Macroscopic samples Ms2 and Ms3

In both profiles macrofossils of *Ranunculus galiensis*, *R. sceleratus*, *Alisma plantago-minima* (only in the sample Ms2), and *Menyanthes trifoliata* occur abundantly whereas *Potamogeton pectinatus*, *P. crispus* somewhat less numerously, and *Hippuris vulgaris* and *Myriophyllum spicatum* occur rarely. Only in the Korchevo II relatively frequent are *Alisma plantago-aquatica* and *Sagittaria sagittifolia*.

Hundreds of *Typha* specimens occurred unexpectedly in the Korchevo II while in the Korchevo I profile three seeds only were found. *Salvinia natans* macrospores occur in great number in Korchevo I whereas in Korchevo II there occur only 5 specimens. Other taxa are in small numbers and not all of them occur in both profiles.

The upper zone boundary was marked out in both profiles above abundant occurrence of *Ranunculus sceleratus* and *R. galiensis* and below abundant occurrence of *Potamogeton crispus* and of *Lycopus* sp.

Zone KrM-2

Macroscopic samples Ms4 and Ms5

In both profiles *Potamogeton crispus* and *Lycopus* sp. are numerous. *Zannichellia palustris* is numerous only in Korchevo II while in Korchevo I only single specimens occur. Other taxa do not present a significant coincidence of occurrence in both profiles.

The upper boundary of the zone is not clearly marked. It is caused by the heterogeneous deposit in the samples Ms6. The only trace that the sample Ms6 is a boundary sample for this zone is reappearance of *Ranunculus sceleratus* fruits in the Korchevo I and *R. galiensis* in the Korchevo II profiles. These fruits, occurring in the bottom part of the profile as well as in the sample Ms6, have been derived from the deposit which corresponds to pollen zones Kr-2 *Betula-Pinus*-NAP and Kr-2 bis *Betula-Pinus*-NAP.

In macroscopic samples Ms6–8 in the upper parts of both profiles which correspond to repeated pollen zones Kr-2 bis, Kr-4 bis and Kr-5 bis, separate macrofossil zones were not distinguished. There are more or less the same macrofossils as in the lower parts of the profiles. These upper parts of both profiles are therefore acknowledged jointly as KrM-1 bis + KrM-2 bis and not described separately.

To sum up, it should be stated that the results of macrofossil analysis, in comparison with results of pollen analysis, give a little weaker basis, for an assumption that profiles Korchevo I and II represent the same two macroscopic sequences overlying each other.

FLORISTIC LIST

The flora of Korchevo comprises 215 taxa identified on the basis of pollen, spores, macrospores, microsporangia, fruits, seeds, and vegetative remains. Among the macroremains there are several extinct taxa which in the floristic list (Tab. 1) are marked with the symbol †. Both pollen and macrofossil taxa are determined to different units: species, genus, family, and in the case of pollen and spores, also to the type.

VEGETATION HISTORY

The results of pollen analysis allow one to assume that local pollen zones Kr-1 – *Artemisia*-Poaceae-*Salix* and Kr-2 – *Betula-Pinus*-NAP represent the late-glacial succession of certain glacial, while local pollen zones Kr-3 – *Ulmus-Quercus-Carpinus-Alnus*, Kr-4 – *Quercus-Pinus*, and Kr-5 – *Ulmus-Quercus-Tilia-Carpinus* – an interglacial climatic optimum. Top pollen zones Kr-2 bis, Kr-4 bis and Kr-5 bis exhibit similar features as L PAZ-es Kr-2, Kr-4 and Kr-5, and for that reason they have been recognized as repeated zones, connected

Table 1. Floristic list of the Korchevo flora. Abbreviations: **p** – pollen, **f** – fruit, seed, **s** – spore, **m** – macrospore, **mg** – microsporangium, sporangium, **o** – oospore, oogonium, **w** – wood, **ch** – charcoal, **h** – hairs, **st** – sclerotia, **x** – other remains, **„undiff."** indicates that some taxa belonging to the same family/genus have been determined. The term **„type"** is used when more than two species or genera have sporomorphs of the same morphological type. Asterisk * means the single occurrence of that taxon in a given profile, ✝ extinct taxa

Taxon	Korchevo I	Korchevo II
CHLOROPHYTA		
Hydrodictyaceae		
Pediastrum Meyen	x	x
CHAROPHYTA		
Characeae		
Chara Vaillant	–	o
MYCOTA		
Hyphomycetes		
Cenococcum geophilum Fr.	–	st
BRYOPHYTA		
Bryales		
Musci (excl. *Sphagnum* L.)	s	s
Sphagnaceae		
Sphagnum L.	s	s
PTERIDOPHYTA		
Azollaceae		
Azolla filiculoides Lam. foss.	m	m
Azolla Lam.	–	mg*
Dennstaedtiaceae		
Pteridium aquilinum (L.) Kuhn	s	s
Equisetaceae		
Equisetum L.	s*	s
Lycopodiaceae		
Diphasiastrum complanatum (L.) Holub/ *D. tristachyum* (Pursh) Holub	–	s
Lycopodiella inundata (L.) Holub	s	–
Lycopodium annotinum L.	–	s
Lycopodium clavatum L.	s	s
Marsileaceae		
cf. *Pilularia* L.	–	s*
Ophioglossaceae		
Botrychium lunaria (L.) Sw. type	–	s*
Botrychium Sw.	s	–
Botrychium Sw. undiff.	–	s*
Osmundaceae		
Osmunda cf. *cinnamomea* L.	–	s*
Osmunda regalis L./*O. claytoniana* L.	–	s
Polypodiaceae		
Polypodium vulgare L.	–	s
Polypodiaceae s.l. (= Filicales monolete)	s	s, mg
Salviniaceae		
Salvinia natans (L.) All.	m	m
Salvinia Ség.	g	g
Selaginellaceae		
Selaginella cf. *sibirica* Hieron	s	–
Selaginella helvetica (L.) Spring	–	s*
Thelypteridaceae		
Thelypteris palustris Schott	s	s
SPERMATOPHYTA		
CONIFEROPHYTINA (GYMNOSPERMAE)		
Cupressaceae		
Juniperus L.	p	p
Ephedraceae		
Ephedra distachya L. type	–	p

Table 1. Continued

Taxon	Korchevo I	Korchevo II
Ephedra fragilis Desf. type	–	p
Ephedra L.	p*	–
Pinaceae		
Abies Mill.	P*	p
Larix Mill.	p	p
Picea abies (L.) Karsten	p	p
Picea omorica (Pančić) Purkyně type	p*	–
Pinus cembra L. type	p	p
Pinus diploxylon type	p	–
Pinus cf. *strobus* L.	p	–
Pinus sylvestris L. type	p	p
Pinus L.	–	w
Taxaceae		
Taxus L.	p	p
MAGNOLIOPHYTINA (ANGIOSPERMAE)		
Aceraceae		
Acer L.	p	p
Alismataceae		
Alisma plantago-aquatica L.	–	p, f
✝ *Alisma plantago-minima* Nikit.	f	f
Alisma L.	p	–
Sagittaria sagittifolia L.	–	f
Sagittaria L.	–	p
Apiaceae	p	–
Bupleurum L.	–	p
Hydrocotyle L.	–	p*
Apiaceae undiff.	–	p
Asteraceae		
Anthemis L. type	–	p
Artemisia L.	p	p
Aster L. type	p*	p
Carduus acanthoides L.	f	–
Carduus L.	–	f
Centaurea L.	p*	–
Cirsium palustre (L.) Scop.	F*	–
Cirsium Mill.	p*	p
Cirsium Mill./*Carduus* L.	–	p
Asteraceae undiff.	p	p
Betulaceae		
Alnus glutinosa (L.) Gaertn. type	p	p
Alnus viridis (Chaix) DC.	P*	p*
Betula sect. *Albae*	–	f
Betula alba L. type	p	p
Betula nana L.	–	p
Betula cf. *nana* L.	p	–
Betula L.	–	ch
Brassicaceae	p	p
Bunias cochlearioides Murr.	–	f*
Rorippa palustris (L.) Bess.	–	f
Cannabaceae		
Humulus L.	–	p
Caprifoliaceae		
Lonicera xylosteum L. type	–	p*
Sambucus nigra L.	–	p
Sambucus cf. *racemosa* L.	–	p
Sambucus L.	–	f*
Viburnum L.	p	p

Table 1. Continued

Taxon	Korchevo I	Korchevo II
Caryophyllaceae	p	f
Cerastium L. type	–	p
Dianthus L. type	–	p
cf. *Lychnis* L.	–	p*
Silene L. type	–	p
Caryophyllaceae undiff.	–	p*
Ceratophyllaceae		
Ceratophyllum L.	f, h*	f, h
Chenopodiaceae	p	p
Chenopodium album L.	f	–
Chenopodium cf. *album* L.	–	f*
Chenopodium L.	–	f
Cichoriaceae	p	p
Cistaceae		
Helianthemum nummularium (L.) Mill. type	–	p*
Convolvulaceae		
Calystegia R. Br.	–	p*
Corylaceae		
Carpinus L.	p	p
Corylus L.	p	p
Cyperaceae	p	p
Carex 3-sided	f	f
Carex 2-sided	f	f
† *Carex paucifloroides* Wieliczk.	–	f
Cyperus glomeratus L.	–	f*
Eleocharis palustris (L.) Roem. & Schult.	–	f
Schoenoplectus lacustris (L.) Palla	f	f
† *Scirpus kreczetoviczii* Wieliczk.	f	f
Scirpus sylvaticus L.	–	f*
Droseraceae		
† *Aldrovanda zussii* Yakub.	–	f*
Elaeagnaceae		
Hippophaë rhamnoides L.	–	p
Ericaceae	p	–
Calluna Salisb.	–	p
Ledum L.	–	p
Ericaceae undiff.	–	p
Euphorbiaceae	p	–
Fabaceae	p	–
Lotus L.	–	p
Trifolium medium L. type	–	p*
Vicia cracca L type	–	p*
Fabaceae undiff.	–	p*
Fagaceae		
Quercus L.	p	p
Haloragaceae		
Myriophyllum spicatum L.	p, f	p, f
Myriophyllum verticillatum L.	–	p*
Hippuridaceae		
Hippuris vulgaris L.	f	f
Hydrocharitaceae		
† *Stratiotes goretskyi* Wieliczk.	f	f*
Stratiotes L.	–	p, f
Juncaceae		
Juncus L	–	f
Lamiaceae	p	–
Lycopus L.	f	f
Lycopus L. type	–	p

Table 1. Continued

Taxon	Korchevo I	Korchevo II
Mentha L.	–	f*
Mentha L. type	–	p*
cf. *Stachys* L.	–	p*
Lemnaceae		
Lemna cf. *minor* L.	f*	–
Lemna trisulca L.	–	f
Lemna L.	–	p
Lentibulariaceae		
Utricularia L.	–	p*
Liliaceae		
Allium ursinum L. type	–	p*
Gagea lutea (L.) Ker Gawl. type	p	p*
Lythraceae		
Lythrum L.	p	p*
Menyanthaceae		
Menyanthes trifoliata L.	f	f
Menyanthes L.	p*	p
Najadaceae		
✝ *Caulinia antiqua* Yakub.	–	f*
✝ *Caulinia* cf. *goretskyi* (Dorof.) Dorof.	–	f*
Caulinia minor (All.) Coss. & Germ. (= *Najas minor* All.)	–	f
Najas L.	f	f
Nymphaeaceae		
Nuphar cf. *lutea* (L.) Sm.	–	p
Nymphaea alba L. type	–	p
Oleaceae		
Fraxinus L.	p	p
Ligustrum L.	–	p*
Onagraceae		
Epilobium L.	p*	p*
Ludwigia palustris (L.) Elliott	–	f*
Plantaginaceae	p	–
Plantago major L.	–	p
Plantago media L.	–	p
Poaceae	p	–
Elymus L. type	–	p
Phragmites Adans. type	–	p
Poaceae undiff.	–	p
Polemoniaceae		
Polemonium L.	p	–
Polygonaceae		
Polygonum amphibium L.	P*	–
Polygonum aviculare L. type	–	p
Polygonum bistorta L./*P. viviparum* L.	p	p
Polygonum persicaria L.	f	–
Polygonum persicaria L. type	p	p
Polygonum L.	–	f
Polygonum undiff.	p	–
Rumex acetosa L. type	–	p
Rumex acetosella L. type	–	p
Rumex aquaticus L./*R. hydrolapathum* Huds.	–	p*
Rumex crispus L. type	–	p
Rumex sect. *Acetosa*	–	p
Rumex L.	p*, f	f
Potamogetonaceae		
Potamogeton crispus L.	f	f
Potamogeton filiformis Pers.	F*	f

Table 1. Continued

Taxon	Korchevo I	Korchevo II
Potamogeton natans L.	f*	–
Potamogeton obtusifolius Mert. & Koch	–	f*
Potamogeton pectinatus L.	f	f
Potamogeton praelongus Wulf.	f	–
Potamogeton cf. *praelongus* Wulf.	–	f*
Potamogeton cf. *pusillus* L.	–	f
Potamogeton rutilus Wolfg.	–	f
Potamogeton vaginatus Turcz.	f	–
Potamogeton sect. *Coleogeton*	–	p
Potamogeton sect. *Eupotamogeton*	–	p
Potamogeton L.	p	f
Primulaceae		
Lysimachia thyrsiflora L.	–	p
Pyrolaceae	p*	–
Ranunculaceae		
Batrachium (DC.) Gray	f	f
Caltha L. type	p*	p
Ranunculus acris L. type	–	p
Ranunculus flammula L. type	–	p
† *Ranunculus gailensis* E.M. Reid (= *R. sceleratoides* Nikit.)	f	f
Ranunculus lingua L.	–	f
Ranunculus sceleratus L.	f	f
Ranunculus trichophyllus Chaix type	–	p*
Ranunculus L.	p, f	f*
Thalictrum L.	p	p
Trollius L.	–	p*
Rhamnaceae		
Frangula Mill.	P*	p
Rosaceae	p	–
Comarum L. type	–	p
Filipendula Mill.	–	p
Potentilla anserina L.	–	f
Potentilla L.	–	f*
Potentilla L. type	–	p
Rubus idaeus L.	f	f
Sanguisorba officinalis L. 2n=56	–	p
Rosaceae undiff.	–	p
Rubiaceae	–	p
Salicaceae		
Populus tremula L.	–	p
Salix glauca L. type	–	p
Salix pentandra L. type	–	p
Salix L.	p	–
Saxifragaceae		
Chrysosplenium L.	–	p*
Saxifraga granulata L. type	–	p*
Saxifraga L.	P*	–
Scrophulariaceae	p	–
Rhinanthus L. type	–	p
Solanaceae		
Hyoscyamus niger L.	–	f*
Sparganiaceae		
Sparganium L. type	p	p
Tiliaceae		
Tilia cordata Mill. type	–	p
Tilia platyphyllos Scop. type	–	p
Tilia L.	p	–

Table 1. Continued

Taxon	Korchevo I	Korchevo II
Typhaceae		
Typha latifolia L.	p	p
Typha L.	f	f
Ulmaceae		
Ulmus L.	p	p
Urticaceae		
Urtica dioica L.	f	p*, f
Urtica L.	f	f
Valerianaceae		
Valeriana officinalis L.	–	p
Vitaceae		
Vitis L.	p	–
Zannichelliaceae		
Zannichellia palustris L	f	f

with disturbance of deposits (see Voznyachuk 1985) and named „bis".

The results of plant macrofossil analyses are less suggestive of the disturbance of deposits, which was discussed in chapter on local macrofossil stratigraphy. In the light of this it is very difficult to establish boundaries: late glacial/interglacial/disturbed zones „bis" in the succession of macrofossils.

LATE GLACIAL VEGETATION

Kr-1 – *Artemisia-Poaceae-Salix* L PAZ (Korchevo II)

Very high values of pre-Quaternary and undeterminable sporomorphs due to their poor state of preservation, as well as the presence of Dinoflagellata cysts indicate intensive erosion of clay deposits. Very low frequency of sporomorphs along with a high proportion of herbaceous plants pollen and presence of such shrubs as *Salix*, *Betula nana*, *Ephedra*, and *Hippophaë rhamnoides* suggest that in the open landscape, pollen of *Pinus sylvestris* type and *Betula alba* type may in a considerable part have originated from the long-distance transport. The presence of pollen of thermophilous trees and *Corylus* should most probably be attributed to redeposition of Tertiary deposits.

In that period, vegetation in the surroundings of the lake had a very open character. Wet habitats were occupied by patches of sedge communities and shrubby tundra with numerous *Salix* and relatively numerous *Betula nana*. The presence of *Ledum*, *Chrysosplenium*, *Comarum* type, *Rumex acetosa* type, and *Mentha* type pollen may certainly be attributed to these habitats. Dry habitats were occupied by steppe-like communities with a large proportion of *Artemisia* and a relatively large of Chenopodiaceae. Pollen of *Helianthemum nummularium* type, *Plantago media*, cf. *Stachys*, *Elymus* type, and *Polygonum aviculare* type have surely originated from these communities. Spores of *Polypodium vulgare* may also be attributed to them. Despite the dominance of herbaceous plant communities, the presence of few *Pinus sylvestris* trees, or tree birches (*Betula alba* type), and perhaps also *Picea abies* and *Pinus cembra* is not unlikely.

Water and reed swamp vegetation was very poorly developed. Macrofossils are almost completely lacking in that part of the profile but the occurrence of *Phragmites* type, *Sparganium* type, *Batrachium* type, *Potamogeton* sect. *Coleogeton*, and also *Myriophyllum spicatum* pollen may indicate that water in a lake was too cold to provide sufficiently good conditions for fruiting of water and reed swamp plants, but climatic conditions were already enough favourable to allow them to flower.

Kr-2 – *Betula-Pinus*-NAP L PAZ; older part of KrM-1 (Korchevo I and II)

This zone is characterized by almost complete absence of pre-Quaternary and unidentifiable sporomorphs due to their poor state of preservation, and Dinoflagellata cysts which indicates considerable stabilization of erosion processes in that time.

An increase in pollen frequency along with a simultaneous growth of percentage values of

Pinus sylvestris type and *Betula alba* type, as well as the occurrence of *Larix*, *Picea abies*, and *Populus tremula* pollen suggest a higher proportion of pine-birch communities with larch, spruce and aspen. These were probably forest communities of the taiga character. It is, however, difficult to explain the almost simultaneous growth of the pollen curves of *Alnus glutinosa* type, *Corylus* and thermophilous trees in profile Korchevo II and the presence of these taxa in the bottom of zone Kr-2 in profile Korchevo I. A complete lack of redeposited pre-Quaternary sporomorphs in profile Korchevo II and their low values in profile Korchevo I makes the relevance of termophilous trees pollen to the redeposited material rather unlikely. It is more probable that simultaneously with the development of forest patches of the taiga type, thermophilous trees and *Corylus* also appeared sporadically in that region.

Despite an increase in the proportion of forest communities in the surroundings of the Korchevo lake, vegetation of open habitats still played a very important role. The presence of *Betula nana*, *Salix glauca* type, and *Alnus viridis* pollen, still relatively high values of Poaceae, *Artemisia*, and Chenopodiaceae pollen, very abundant spores of mosses (Musci excl. *Sphagnum*), and in Korchevo II also numerous pollen grains of Cyperaceae suggest the occurrence of both: communities of the tundra character and the steppe-like vegetation in the surroundings of the lake.

In the bottom part of that pollen zone, a rapid increase in the proportion of Chenopodiaceae and *Artemisia* pollen in both profiles and a growth of the pollen diversity of herbaceous plants representing both wet and dry habitats is a surprising phenomenon. It seems probable that this phenomenon reflects the continentalization of climate and an increased importance of the steppe-like vegetation with numerous occurrence of Poaceae, *Artemisia* and Chenopodiaceae. Pollen of *Elymus* type also originates from these habitats. Fires may be also an indication of the continentalization of climate; the presence of charred remains of *Betula* sp. in Korchevo II may testify to their occurrence.

The presence of *Polygonum persicaria* type, *Rumex acetosa* type, *Plantago major*, and *Caltha* type pollen is attributed to wet habitats. Macrofossil remains allow to assume that in the environs of the lake there were growing abundantly such plants as: *Ranunculus gailensis* and *R. sceleratus*, fairly numerously *Lycopus*, *Menyanthes trifoliata*, and sporadically *Ludwigia palustris* and *Urtica dioica.* To these habitats one may surely attribute also the presence of *Carex* sp. fruits. Pollen of *Rumex acetosella* type, *Calluna*, and *Polygonum aviculare* type has originated from the communities of dry habitats.

Climate warming in the younger part of the late glacial caused an expansion of reed swamps and aquatic vegetation. The development of a wide belt of reed swamps is indicated by large amounts of macrofossils of *Typha* sp. (Korchevo II), *Alisma plantago-minima*, *Alisma plantago-aquatica*, *Sagittaria sagittifolia* (Korchevo II), and presence of *Eleocharis palustris*, *Scirpus kreczetowiczii*, *Hippuris vulgaris*, *Schoenoplectus palustris*, and also pollen of *Phragmites* type, *Typha latifolia*, and *Sparganium* type. Pleuston communities with *Salvinia natans*, *Lemna trisulca*, and *L. minor* developed on the lake surface. Its deeper parts were colonized by different species of *Potamogeton* (*P. crispus*, *P. pectinatus*, *P. obtusifolius*, *P. vaginatus*), and *Zannichellia palustris, Stratiotes goretskyi*, and *Myriophyllum spicatum.* Shallower places were occupied by among others *Nuphar luteum* and *Utricularia* (represented by pollen). The abundant occurrence of *Pediastrum* suggests an improvement in trophy of water and good light conditions in the water.

INTERGLACIAL VEGETATION

Kr-3 – *Ulmus-Quercus-Carpinus-Alnus* L PAZ; younger part of KrM-1 (Korchevo I and II)

Low pollen values of herbaceous plants and a small diversity of their taxa indicate that dense forests occurred in the proximity to the lake. Certain differences between profiles Korchevo I and II as to the pollen values of *Pinus sylvestris* type and other trees are undoubtedly connected with different laboratory methods. Despite these differences one may assume that pine communities were still of great importance in that time but tree birches had already retreated from the majority of localities. Different forest communities, characteristic of a climatic optimum, were developing very quickly. Pollen data allow to accept that birch had withdrawn from the pine-birch communities and was replaced by oak which formed pine-oak communities. On fertile habitats there spread multispecies oak-hornbeam forests with elm and lime, and an admixture of maple and yew, and on wetter habitats – elm-ash communities with alder. Alder (surely mostly *Alnus glutinosa*) supplanted birch (most probably *Betula pubescens*) from wet habitats around the lake.

On very wet habitats, in reed swamps and in the lake there survived those communities which occurred already in the younger part of the late glacial. *Ranunculus sceleratus* and the extinct species *R. gailensis* occurred numerously, while *Schoenoplectus lacustris* sporadically. In the lake *Potamogeton crispus* and *P. pectinatus*, *Salvinia natans* (Korchevo I), *Ceratophyllum* sp., *Myriophyllum spicatum*, and *Stratiotes goretskyi* (extinct species) occurred also only sporadically. A declining tendency in the proportion of *Pediastrum* may indicate worse light conditions in the lake.

Kr-4 – *Quercus-Pinus* L PAZ; older part of KrM-2 (Korchevo I and II)

A picture presented by both pollen diagrams indicate the transformation of forest communities, consisting in the dominance of pine-oak forests and a decrease in proportion of the multispecies deciduous forests with *Alnus glutinosa* type, *Ulmus*, *Tilia* (*T. cordata* type and *T. platyphyllos* type), *Carpinus*, and *Corylus*. That change suggests an episode of more continental climate. It did not caused, however, an increase in the proportion of herbaceous plant communities. The lake was probably becoming shallow, as shown by a rapid decrease in the proportion of *Pediastrum*.

The proportion of *Potamogeton crispus* and *Zannichellia palustris* had increased in water plant communities. They were also enriched in two new species: *Azolla filiculoides* foss. and extinct *Aldrovanda zussii*. A rapid decrease in the value of *Pediastrum* suggests a considerable worsening of light conditions in the water.

Kr-5 – *Ulmus-Quercus-Tilia-Carpinus* L PAZ; younger part of KrM-2

That part of the profile which is represented by pollen zone Kr-5 is very difficult to be interpreted because it indicates a change in vegetation towards the vegetation which prevailed during zone Kr-3 – *Ulmus-Quercus-Carpinus-Alnus*. After a period of the marked dominance of pine-oak communities, the area was colonized anew by multispecies deciduous oak-hornbeam forests with lime (mostly *Tilia cordata*). An increase in pollen value of *Alnus glutinosa* type suggests that alder forests had spread again. Pine-oak and pine-birch forests still occupied many habitats. Forests were dense, as indicated by a minute proportion of herbaceous pollen.

Macrofossils indicate still numerous occurrence of *Lycopus* sp. and sporadic occurrence of *Ranunculus sceleratus* and *R. gailensis*, *Menyanthes trifoliata* in wet areas around the lake and *Urtica dioica* and *Polygonum persicaria* in slightly drier areas. Macrofossils of aquatic plants do not show any clear signs of changes in water and reed swamp vegetation in that time.

Kr-2 bis – *Betula-Pinus*-NAP, Kr-4 bis – *Quercus-Pinus*, Kr-5 bis – *Ulmus-Quercus-Tilia-Carpinus* L PAZ-es; macrofossil samples Ms 6–8.

Pollen spectra of the above zones allow to assume that they have originated from a broken fold of the deposit, which superimposed a scale representing zones Kr-2, Kr-4 and Kr-5.

In macrofossil diagrams it is much more difficult to find evidence that the upper part of the diagram represents anew the same period as the bottom part. A relatively clear indication of this repetition is the repeated numerous occurrence of *Salvinia natans* macrospores (Korchevo II) and fruits of *Ranunculus sceleratus* and *R. gailensis* in both profiles.

Assuming that the upper parts of both profiles are a new scale of the deposit, superimposed during the glaciodislocation processes, the authors did not undertake a repeated description of the vegetation history on the basis of the upper parts of the pollen and macrofossil diagrams. Of the hitherto described, by the method of pollen analysis, profiles from Korchevo, i.e. by Makhnach (Voznyachuk et al. 1977), Kondratiene (Vaznyachuk et al. 1978), and the present authors, these last yield the most reliable evidence to support the opinion by Voznyachuk (1985) about the dislocation and disarrangement of deposits in the Korchevo detached block.

COMPARISON OF PRESENT RESULTS OF POLLEN AND MACROFOSSIL ANALYSES WITH THE FORMER STUDIES

The pollen analysis results of the profiles investigated by Makhnach (Voznyachuk et al. 1977) and Kondratiene (Vaznyachuk et al. 1978) and of the present Korchevo I and II profiles have many common features but they also show some differences. There are pollen zones repeatable in all profiles but they are the same zones in particular profiles. Data from the profiles examined by N.A. Makhnach and O.P. Kondratiene can be compared only to diagrams constructed using the Belorusian method (Figs 4, 6).

In the profile performed by Kondratiene and in the present profiles the pollen succession starts with the zone in which the frequency of sporomorphs is very low. Among them redeposited pre-Quaternary sporomorphs occur numerously. In the present Korchevo II profile it is zone L PAZ Kr-1 *Artemisia*-Poaceae-*Salix*, and in the present profile Korchevo I the frequency was so low that it did not allow to obtain reliable pollen spectra for counting per cent values. Such a zone does not occur in the profile performed by Makhnach (Vaznyachuk et al. 1978.

In the present profiles above zone Kr-1 *Artemisia*-Poaceae-*Salix* occurs L PAZ Kr-2 – *Betula-Pinus*-NAP with high pollen values of tree birches, pine and herbs. A similar zone is also present in the profiles worked out by Makhnach and Kondratiene. However, the values of *Betula, Pinus* and NAP (mostly *Artemisia*, Poaceae and Cyperaceae) differ in particular profiles. The pollen contribution of thermophilous trees is also differentiated. This zone is very well developed in the present profiles.

In the climatic optimum the composition of tree pollen is similar in all the profiles but succession of curve culminations of particular trees is different.

Pollen succession in the climatic optimum is expressed best in the present profiles. In comparison with the profiles performed by Makhnach and Kondratiene it is characterized by higher proportion of *Quercus*, and *Ulmus* and in Korchevo I also by *Tilia*. The culmination of *Alnus, Tilia, Carpinus*, and *Corylus* pollen curves is somewhat earlier than *Ulmus* (L PAZ Kr – *Ulmus-Quercus-Carpinus-Alnus*), and *Quercus* is culminating as the last one (L PAZ Kr-4 *Quercus-Pinus*). In the range of *Quercus* culmination, pollen values of remaining thermophilous trees and *Corylus* and *Alnus glutinosa* type decrease, while *Pinus sylvestris* type values rise. When this oscillation is over the values of *Quercus* and *Pinus sylvestris* type redecline with an anew increase in pollen values of other thermophilous trees and also *Corylus* and *Alnus glutinosa* type (L PAZ Kr-5 *Ulmus-Quercus-Tilia-Carpinus*).

In pollen succession of the profile worked out by Makhnach *Alnus* pollen is dominant (up to about 30%), and pollen values of thermophilous trees reach maxima in the range of 5–10%. *Quercus* and *Ulmus* culminations are somewhat earlier than *Carpinus*, *Tilia*, *Corylus*, and *Alnus*.

In the profile worked out by Kondratiene the pollen values of thermophilous trees are somewhat higher than in the profile carried out by Makhnach. The culminations of curves of all thermophilous trees and *Alnus*, *Carpinus, and Corylus* occur simultaneously but *Quercus* pollen values are somewhat higher in the older part of climatic optimum than values of other thermophilous trees and *Carpinus*.

The sequence of pollen culminations of particular trees is somewhat different in the both above mentioned profiles. Some disparities are also found in the successions of the present profiles although they are situated only 1 m apart.

The next zone recognized in the succession from profiles Korchevo I and II as the repeated Kr-2 bis zone with high values of *Betula alba* type, *Pinus sylvestris* type and NAP is represented also in the succession from the profile performed by Kondratiene. In the profile worked out by Makhnach only the beginning of this zone occurs (pollen zone 5).

Above this zone in the present profiles as well as in the profile by Kondratiene the next section occurs with high pollen values of the same thermophilous trees which were found in climatic optimum. In the present profiles the similarity is so strong that this part of the diagram has been accepted as repeated zones Kr-4 bis – *Quercus-Pinus* and Kr-5 bis *Ulmus-Quercus-Tilia-Carpinus*.

In the profile worked out by Kondratiene above this warm section the next zone with high pollen values of *Betula* and *Pinus* occurs, above which the zone with high values of redeposited sporomorphs of older periods, similar to the bottom zone, is noted. These last two zones do not occur in present profiles Korchevo I and II.

In the beginning, the repetition of the similar pollen zones Voznyachuk (Vaznyachuk et al. 1978) recognized as a result of washing away deposits from the climatic optimum and their anew deposition in the periglacial period. Later on, basing himself on more accurate geological studies, Voznyachuk (1981, 1985) stated that in the deposits from Korchevo, interglacial layers quite often wedged into periglacial deposits and the other way round. It seems that the present studies confirm the his second hypothesis.

Macrofossils from Korchevo were studied by F.Yu. Velichkevich and T.V. Yakubovskaya from many outcrops. These studies resulted in identifying the abundant flora comprising about 100 taxa (Voznyachuk et al. 1977, 1978, Vaznyachuk et al. 1978, Yakubovskaya 1978, 1991, Velichkevich 1986). Among them aquatic and reed swamp plants were dominant and numerous extinct taxa occurred.

The macroscopic flora from the present profiles consists of 69 taxa. It is then scantier which is probably associated with a significantly lower volume of investigated samples and only of two profiles. This flora contains also a few extinct species (Tab. 2) and their number is lower than in the data presented by Velichkevich (1986).

EVALUATION OF THE STRATIGRAPHIC POSITION OF THE KORCHEVIAN DEPOSITS ON THE BASIS OF POLLEN ANALYSIS

The stratigraphic position of the Korchevian deposits in the Early Pleistocene (in a broad approach Günz/Mindel) has been established on the basis of palaeozoological and palaeocarpological data (Voznyachuk et al. 1977, 1978, Vaznyachuk et al. 1978). They were accepted than as the new interglacial with the name Korchevian interglacial.

In a stratigraphic approach on the basis of features mentioned above the Korchevian interglacial has been settled in the oldest part of the Middle Pleistocene between Narevian and Yaseldian glaciations (Velichkevich et al. 1996, 2001). After Mojski's stratigraphic division (Mojski 1985, 1993) the Korchevian interglacial was correlated with the Przasnysz interglacial in Poland settled between the Narevian and South Polish Glaciations (Sanian 1).

So far no attempt has been made to assess the stratigraphic position of the Korchevian deposits on the basis of pollen analysis results. Such an attempt is essential as the geological situation of the deposits from Korchevo does not rule out other stratigraphic positions.

Korchevian pollen succession has a charac-

Table 2. Macrofossils determined in the Korchevo deposits

Former profiles (Voznyachuk et al. 1977, 1978, Vazhnyachuk et al. 1978)	Current profiles (Korchevo I and II)
1/ Pliocene-Pleistocene species	
Azolla interglacialica Nikit. (= *Azolla filiculoides* Lam. foss.)	*Azolla interglacialica* Nikit. (= *Azolla filiculoides* Lam. foss.)
Potamogeton perforatus Wieliczk.	
Stratiotes goretskyi Wieliczk.	*Stratiotes goretskyi* Wieliczk.
Carex paucifloroides Wieliczk.	*Carex paucifloroides* Wieliczk.
Carex cf. *rostrata-pliocenica* Nikit.	
Alisma plantago-minima Nikit.	*Alisma plantago-minima* Nikit.
Ranunculus gailensis E.M. Reid (= R. ex gr. *sceleratoides* Nikit.	*Ranunculus gailensis* E.M. Reid (= R. ex gr. *sceleratoides* Nikit.
2/ typical early-middle-Pleistocene species	
Pilularia cf. *borysthenica* Wieliczk.	
Potamogeton dvinensis Wieliczk.	
Caulinia antiqua Jakub.	*Caulinia antiqua* Jakub.
	Caulinia goretskyi (Dorof.) Dorof.
Aldrovanda borysthenica Wieliczk.	
Aldrovanda zusii Jakub.	*Aldrovanda zusii* Jakub.
3/ specific Korchevo species	
Scirpus kreczetoviczii Wieliczk.	*Scirpus kreczetoviczii* Wieliczk.
4/ archaic	
Perhaps an extinct species of *Lycopus*	

teristic climatic optimum in spite of different disturbances observed in the diagrams of the present Korchevo I and II profiles as well as in the profiles worked out by Makhnach and Kondratiene (Voznyachuk et al. 1977, 1978, Vaznyachuk et al. 1978). The most important feature of this optimum is the occurrence of *Carpinus* simultaneously with thermophilous trees being the members of *Quercetum mixtum* and *Alnus,* as well as *Corylus*. In spite of disturbances occurring in the deposits from Korchevo this zone is represented, directly above the pine-birch zone with high proportion of herb pollen in the diagrams of all the profiles worked out so far.

The comparison of Korchevian climatic optimum with younger interglacials of Belarus rules out entirely the Muravian (= Eemian) and Alexandrian (= Mazovian, Holsteinian) interglacials. In both these interglacials *Carpinus* pollen occurs but in quite another composition. In the Muravian interglacial in the hornbeam zone values of *Quercus* and *Ulmus* are not as high as in Korchevian succession while *Picea* values are usually higher. In the Alexandrian interglacial simultaneously with *Carpinus* high pollen values of *Abies* occur while thermophilous tree pollen values are significantly lower.

The comparison of pollen succession from Korchevo with succession of the Belovezhian interglacial (sensu Velichkevich et al. 1992, 1996, 2001) of which holostratotype is the Borki site in the Belovezha Primeval Forest (Voznyachuk 1961, 1981, 1985), and with other sites recognized as Belovezhian interglacial in the lower part of the profiles Nizhninsky Rov (Kondratiene & San'ko 1985, Goretsky et al. 1987) and Krasnaya Dubrava from the Kholmech region (Makhnach et al. 1982, Makhnach & Rylova 1986), excludes entirely the possibility of their correlation. The Belovezhian interglacial and its counterpart in Ferdynandovian succession in Poland recognized by Janczyk-Kopikowa (1991a, b) and Janczyk-Kopikowa et al. (1981) as lower climatic optimum, and by Mamakowa (2003) as Interglacial I in the Ferdynandovian succession, are characterized by absence of *Carpinus* or presence of only its sporadic pollen grains and by the presence of *Abies* in Poland and western Belarus.

Essential for evaluation of the stratigraphic position of the Korchevo deposits is the comparison of Korchevian climatic optimum to climatic optimum of the Mogilevian interglacial sensu Velichkevich et al. (2001). of which holostratotype is the upper peat from the Nizhninsky Rov site, situated on the left bank of the Dnepr river near Shklov in the Mogilevian region (Voznyachuk 1981). Other important stands of the Mogilevian interglacial are Krasnaya Dubrava from the Gomel region (Makhnach et al. 1982, Makhnach & Rylova 1986) and Smolarka from the Brest region (Velichkevich et al. 1997).

Characteristic features of the Mogilevian interglacial climatic optimum are as follows:

a – almost simultaneous occurrence of relatively high pollen values of *Carpinus* and *Alnus* with thermophilous trees – *Quercus*, *Ulmus*, *Tilia*, and *Corylus*. In some profiles the beginning of the curves of *Quercus*, and sometimes also *Ulmus* and *Tilia* occurs somewhat earlier

b – higher pollen values of *Quercus* and *Carpinus* than other termophilous trees

c – low proportion of *Tilia* and *Corylus* pollen

d – completely sporadic pollen grains of *Abies* and *Taxus*

e – occurrence in some profiles of single pollen grains of *Vitis*, cf. *Celtis*, *Pterocarya* (Kondratiene & San'ko 1985, Velichkevich et al. 1997), and *Ostrya* (Yelovichova, in Goretsky et al. 1987).

The comparison of pollen succession from the Mogilevian interglacial climatic optimum with pollen succession from the Korchevian climatic optimum leads to a conclusion that these two successions have identical features. It permits to suggest that the Korchevian deposits maybe do not represent the separate Korchevian interglacial, but they can be assigned to the Mogilevian interglacial.

Pollen succession features of the Mogilevian interglacial are very similar, as a matter of fact identical with features of the so called "second climatic optimum" of Ferdynandovian succession (sensu Janczyk-Kopikowa et al. 1981, Janczyk-Kopikowa 1991a, b).

In view of the pollen analysis results from the Podgórze site (profile B1), Mamakowa (1996) recognized the "second climatic optimum" as "imperfect interglacial" or very warm interstadial which she correlated with the Dutch Cromer III. This opinion is concurrent with Voznyachuk's opinion in his first publications regarding the Korchevian deposits (Voznyachuk et al. 1977, 1978, Vaznyachuk et al 1978). Interpreting the Ferdynandovian succession Mamakowa (2003) accepted that it consisted of two interglacials separated by a glacial.

The correlation of the Korchevian pollen succession with the Mogilevian interglacial succession and with the second warm unit of the Ferdynandovian succession enables to formulate a hypothesis that the Korchevian deposits can correspond to the Dutch Cromer III. Such a correlation, on the basis of the comparison of pollen succession from Korchevo with pollen succession from Dutch sites Rosmalen 45B/12 and Het Zwinkel seems to be fully reasonable (see also Zagwijn 1996).

The comparison of pollen succession from Korchevo with other pollen successions from Belarus and Poland requires also an attitude towards the recently distinguished new interglacial called Augustovian in north-eastern Poland (Janczyk-Kopikowa 1996, Ber 1996, 2000, Ber et al. 1998, Winter 2001, Lisicki & Winter 2004). This interglacial is referred to the position between Narevian and Nidanian glaciations.

The basic features of the second warm unit of the Augustovian interglacial (II interglacial in Mamakova 2003) are very similar as those characteristic for the climatic optimum of Korchevian succession and also for the climatic optimum of the Mogilevian interglacial in Belarus, and for the second warm unit of Ferdynandovian succession. Janczyk-Kopikowa (1996) excluded, however, the possibility of referring the pollen succession from Szczebra to Ferdynandovian succession. Her main argument from the palynological point of view, that these deposits are older than Ferdynandovian, is the presence in climatic optimum of the interglacial from Szczebra, sporadic pollen grains of exotic taxa such as *Juglans*, *Carya*, *Celtis*, *Tsuga*, *Eucommia*, and microsporangia of *Azolla filiculoides* which she accepted as autochthonous for the flora from Szczebra. However, the fact that the redeposited sporomorphs occur almost in the whole profile from Szczebra does not permit to exclude the possibility that the above mentioned taxa can also be redeposited. What more, several of these exotic taxa were found in some profiles of the Mogilevian interglacial.

The next problem to discuss is the correlation, by many authors, of the Korchevian interglacial with the Przasnysz interglacial in Poland (Mojski 1985, Lindner 1988, 1992, Velichkevich et al. 1996, and others).

The results of palynological studies univocally exclude the acceptance of the same stratigraphic position for organic deposits from Korchevo and from Przasnysz. Although the deposits are disturbed, and the pollen succession from Korchevo, is completely different from that of the profile from Przasnysz. The pollen succession from Przasnysz (Bałuk & Mamakowa 1991, Mamakowa 1998), in spite of disturbances associated with the redeposited pre-Quaternary pollen, has typical features for the Mazovian interglacial (= Alexandrian, Holsteinian). It has the distinct *Picea-Alnus* zone with *Taxus* and *Carpinus-Abies* zone with *Pterocarya*. High pollen values of *Abies* in Przasnysz reaching 20% of the total sum indicate that these deposits may have not be formed in the same interglacial as the Korchevian deposits in which single *Abies* pollen grains are found at most.

Concluding, it ought to be acknowledged that chronostratigraphic position of the Korchevian deposits, based on the pollen analysis results, is inconsistent with the position postulated on the basis of macrofossils by Velichkevich and Yakubovskaya (Voznyachuk et al. 1977, 1978, Vaznyachuk et al. 1978, Yakubovskaya 1978, 1991, Velichkevich 1986, Velichkevich et al. 1996).

In our opinion the majority of exotic macrofossil taxa found in Korchevo occurs also in younger interglacials, i.e. Belovezhian, Mogilevian and Alexandrian, which is noted also by Velichkevich (1986). As regards the exotic taxa specific, in our opinion, for flora from Korchevo, i.e. *Scirpus kreczetoviczii* and *Aldrovanda zussii*, we assume *S. kreczetoviczii* is not specific only for Korchevo, as Velichkevich (1982) reports it in the younger deposits till the Dnepr glaciation (= Odra glaciation) in the Zhytomiezh Region in Ukraine. Then only *Aldrovanda zussii* identified by Yakubovskaya (1991) in the Korchevian deposits has not been found in the interglacials of other age so far.

In our opinion, the macrofossil flora from Korchevo does not deny the possibility of recognition the Korchevian deposits as the Mogilevian interglacial, which is expressed by the pollen succession characteristic for this interglacial.

METHODICAL REMARKS

Two profiles, situated 1 m apart and showing the identical layout of lithological layers, should in substance produce almost the same results, particularly when investigated by the method of pollen analysis. However, despite the general similarity of pollen diagrams as to the occurrence of main taxa, their appearance and culmination are observed rather significant differences between them.

These differences are visible beginning from pollen bottom zone Kr-1. It has appeared that in bottom samples 1–6 from profile Korchevo I, prepared for pollen analysis using the method applied in Minsk, pollen frequency was so low that it was impossible to reach 100 pollen grains of trees in no sample from the whole material remaining after the laboratory treatment. It seems that the loss of pollen may have taken place at pouring off reagents and water in that phase, of the procedure applied by the laboratory in Minsk where reagents are poured on big samples of sediment in large beakers and allowed to stand for 24 hours, and next reagents are poured off without centrifuging. In the present authors opinion, this pouring off the reagents may conduce to a loss of a small fraction of sediment with sporomorphs.

The results of pollen analysis, obtained in that part of profile Korchevo II, from small samples (0.5 cm^3 of sediment), treated in hot hydrofluoric acid in the laboratory in Kraków allowed to obtain 100 grains AP in samples 1 and 3–6 from an area similar to that where in the remaining samples 500 grains AP were counted. Only sample 2 was almost without sporomorphs. Thus, low frequency occurred also in Korchevo II but was not so drastic as in Korchevo I.

The subsequent very surprising difference consisted in a nearly complete absence of Cyperaceae pollen and lower values of Poaceae in the diagram Korchevo I (Fig. 3) and relatively high values of these taxa in the diagram Korchevo II (Fig. 6), and higher values of *Artemisia* pollen in the diagram Korchevo I (Fig. 4) as compared with the diagram from Korchevo II (Fig. 5). To determine causes of these differences, control tests/analyses of sample 10 from Korchevo I and sample 23 from Korchevo II were undertaken. Controlled were different methods of counting by the two authors and different laboratory methods.

The results of control analyses concerned with different methods of counting by the two authors produced similar pollen spectra, with differences within the limits of error limits (Fig. 9).

To check whether differences in the amounts of Cyperaceae and Poaceae are a result of different laboratory methods, sample 10 from Korchevo I was prepared using the hydrofluoric method in the laboratory in Kraków. It was counted by K. Mamakowa, using her own manner of counting and by T. Rylowa, by the method of counting used by Mamakowa and her own method. The results are shown in Figure 9. They indicate that in samples prepared by the method used in Minsk pollen values of Cyperaceae and Poaceae are lower than in the same sample prepared by the hydrofluoric method. The most pronounced difference concerns the values of Poaceae, irrespective which of the authors counted a sample and by which method it was counted. Slightly higher values were obtained by Mamakowa for Cyperaceae, using her own manner of counting in two slides, on traverses extending across the whole width of a slide.

The obtained control data from sample 10 show unequivocally that pollen values of Cyperaceae and Poaceae are lower in the diagram Korchevo I as the result of the laboratory technique used in Minsk. This is most probably connected with pouring out of these light grains during the treatment of material in large beakers. Slightly higher values of Cyperaceae may be also the result of counting of the spectra on traverses distributed uniformly over the whole slide of a preparation and in two preparations.

A difference concerning pollen values of Chenopodiaceae and *Artemisia* has shown that different methods of counting by the two authors does not influence significantly the obtained pollen values. Differences are connected only with laboratory techniques. Higher values of Chenopodiaceae than those of *Artemisia* were obtained in samples prepared by the hydrofluoric method, while higher values of *Artemisia* were in sample 23 prepared by flotation $KJ + CdJ_2$.

The subsequent difference in the results of pollen analysis concerns generally higher pollen values of *Pinus sylvestris* type and lower of *Quercus* and other thermophilous trees in the diagram from profile Korchevo I, constructed

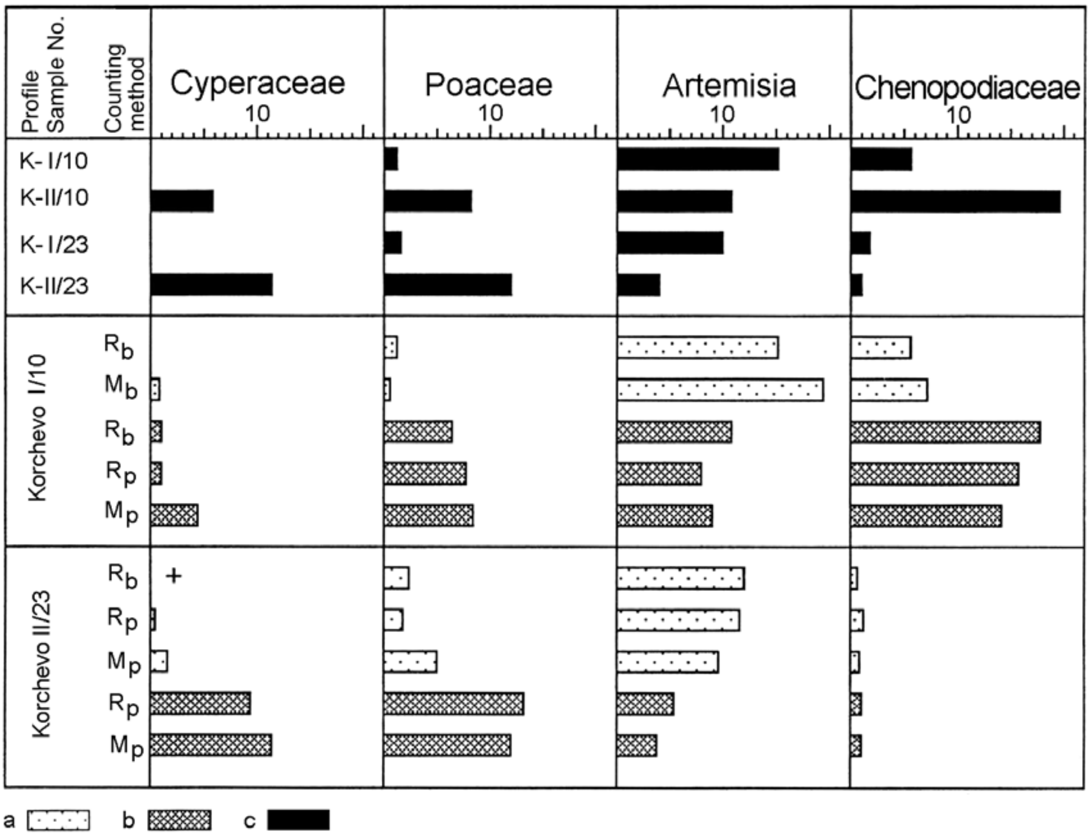

Fig. 9. Comparison the percentages of pollen spectra of two samples 10, and 23 from the both profiles Korchevo I and Korchevo II prepared and counted by two different methods; **a** – samples prepared by the flotation method; **b** – samples prepared by the HF method; **c** – mean percentage value of adequate taxon in proper pollen spectrum of both profiles Korchevo I and II; **Rb** – counted Rylova by Belarusiam method, **Rp**– counted Rylova by Polish method; **Mp** – counted Mamakowa by "Polish method"; **Mb** – counted Mamakowa by "Belarusian method"

on the basis of a flotation. In the diagram from profile Korchevo II, based on the hydrofluoric method, values of *Pinus sylvestris* type are much lower, and values of *Quercus* are higher (Fig. 10).

To explain these results sample 18 from profile Korchevo I was taken for a control analysis. Rylowa counted it once more by Mamakowa's system and the obtained spectrum was very similar to that counted by her own manner. Sample 18 was macerated in hydrofluoric acid and Mamakowa counted it by the two methods. These two methods of counting produced results differing only slightly; a difference was within the limits of error. On the other hand, a difference in values of *Pinus sylvestris* type was surprising; after treatment of the sample in hydrofluoric acid these values were considerably lower, while those of *Quercus* much higher. Following these controls,

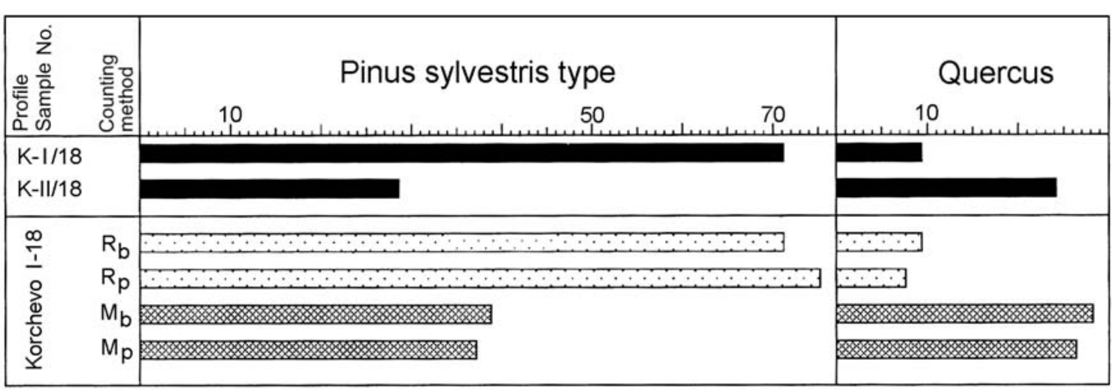

Fig. 10. Comparison of the perecentages of *Pinus sylvestris* type and *Quercus* in sample 18 from the both profiles Korchevo I and Korchevo II prepared and counted by two different methods; for explanation see Fig. 9

a question arises whether the method used in the laboratory in Minsk lowers *Quercus* values in that phase of the procedure when material is allowed to stand in large beakers for the all-night sedimentation, and next the supernatant is poured off without centrifugation, or it is hydrofluoric that destroy *Pinus* pollen grains.

A next difference concerns proportions of *Carpinus* and *Tilia* in the two profiles is shown on Figure 11. Samples 12 from both profiles were tested/controlled. In Korchevo I, in samples prepared in the laboratory by the method of flotation (with pouring off reagents in large samples without centrifuging), a pollen value for *Carpinus* was lower and that for *Tilia* higher, while in Korchevo II the situation was reverse. The results of analyses have unequivocally shown that neither a method of counting, nor a person counting spectra influences significantly pollen numbers. So another question arises: whether the method used in Minsk favours *Tilia* pollen and decreases pollen values of *Carpinus*, and whether the hydrofluoride destroys more *Tilia* pollen, which results in its lower proportions in sample 12 from both Korchevo I and Korchevo II.

One of the general conclusions is that perhaps lighter pollen grains of Cyperaceae, Poaceae, Chenopodiaceae and *Quercus* are poured off within that phase of the procedure used in the Minsk laboratory when large beakers with samples are filled with water and HCl and next, supernatant is poured off after 24 hours without centrifuging. It is not unlikely, however, that hydrofluoride destroys *Tilia* pollen and for that reason its proportion is lower in the diagram from profile Korchevo II.

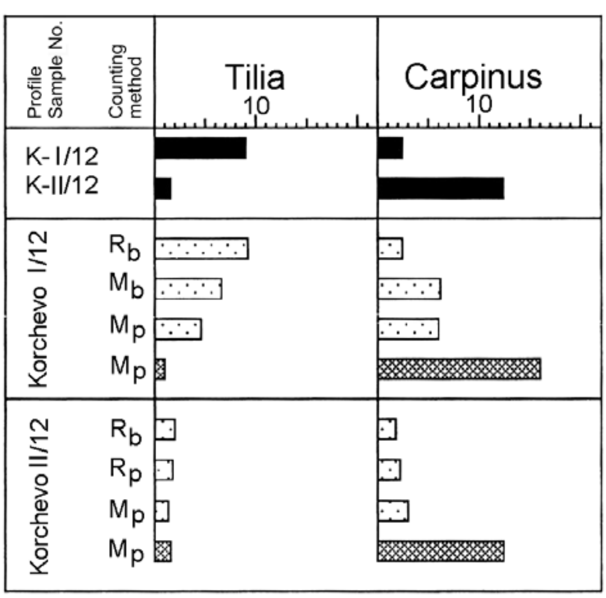

Fig. 11. Comparison of the percentages of *Tilia* and *Carpinus* in sample 12 from the both profiles Korchevo I and Korchevo II prepared and counted by two different methods; for explanation see Fig. 9

CONCLUSION

The deposits of Korchevo, as the new oldest interglacial, were for the first time distinguished and characterized by Voznyachuk on the basis of comprehensive palaeontological studies (Voznyachuk et al. 1977, 1978, Vaznyachuk et al. 1978).

The aim of the present studies was to resolve certain methodological problems which make it difficult to compare the results of studies carried out by the method of pollen analysis from Belarus and Poland and to decide certain stratigraphic questions.

These problems were discussed and illustrated on the basis of two profiles situated close to each other on the eastern wall of an exposure in the Korchevo clay-pit. In addition to pollen analysis these profiles have been examined also by the macrofossil method.

The new pollen diagrams, as well as those constructed earlier by Makhnach and Kondratiene (Voznyachuk et al. 1977, 1978, Vaznyachuk et al. 1978) exhibit the similar composition of main tree species but succession of their culminations and percentage values in the climatic optimum are slightly different. This concerns also data from the present profiles. The macroscopic flora from the present profiles is somewhat poorer than the flora from earlier described profiles but like floras from other exposures includes some extinct species (*Ranunculus gailensis*, *Carex paucifloroides*, *Alisma plantago-minima*, *Caulinia antiqua*, *Caulinia* cf. *goretskyi*, *Azolla filiculoides, Aldrovanda zussii*, and *Stratiotes goretskyi*.

A comparison of pollen succession in the climatic optimum from Korchevo with the optima of other interglacials in Belarus and Poland indicates that it can be neither Muravian interglacial (= Eemian), nor Alexandrian one (= Mazovian) and Białowiezha s.str. according to Velichkevich et al. (1996). On the other hand, such features of pollen diagrams from Korchevo, as the presence and culmination of *Carpinus* together with other thermophilous trees (sensu *Quercetum-mixtum*), with a dominance of *Quercus*, as well as high pollen values of *Alnus* and lower ones of *Corylus* are characteristic of Mogilevian interglacial sensu Velichkevich et al. (1996). That correlation allows also the correlation of pollen succession from Korchevo with a younger interglacial in the Ferdynandovian succession in Poland. The recent data from the territory of Poland allow also a correlation of Korchevian succession with a younger interglacial in the Augustovian succession (Janczyk-Kopikowa 1996, Winter 2001).

A comparison of pollen succession from Korchevo with pollen succession from Przasnysz in Poland (Bałuk & Mamakowa 1991, Mamakowa 1998) allows to state unequivocally that these are completely different pollen successions and can not represent the same stratigraphic unit, as accepted by some Polish and Belorusian geologists.

Different techniques of collecting samples for palynological studies in the two currently studied Korchevo profiles, different laboratory techniques and different manners of presentation of the results obtained by the Polish and Belorusian methods, were a basis for discussion of the influence of research methods on the results of pollen analysis.

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REFERENCES

BAŁUK A. & MAMAKOWA K. 1991. Stratigraphic position of interglacial deposits at Przasnysz. Kwart. Geol., 35(1): 1–26.

BER A. 1996. Sytuacja geologiczna jeziornych osadów piętra augustowskiego w Szczebrze koło Augustowa oraz osadów jeziornych interglacjału mazowieckiego w Krzyżewie (summary: Geological situation of Augustovian (Pastonian) Interglacial lake sediments at Szczebra near Augustów and Mazovian Interglacial organogenic sediments at Krzyżewo). Biul. Państw. Inst. Geol., 373: 35–48.

BER A. 2000. Plejstocen Polski północno-wschodniej w nawiązaniu do głębszego podłoża i obszarów sąsiednich (summary: Pleistocene of North-Eastern Poland and neighbouring areas against crystalline and sedimentary basement). Prace Państw. Inst. Geolog., 170: 1–89.

BER A., JANCZYK-KOPIKOWA Z. & KRZYSZKOWSKI D. 1998. A new interglacial stage in Poland (Augustovian) and the problem of the age of the oldest Pleistocene till. Quatern. Sci. Rev., 17: 761–773.

ERDTMAN G. 1960. The acetolysis method. Svensk. Botan. Tidskr., 54(4): 561–564.

GORETSKY G.I., GURSKY B.N., YELOVICHEVA Ya.K., VELICHKEVICH F.Yu., DROMASHKO S.G.D., NAZAROV V.I. & ZUBOVICH S.F. 1987. Nizhninsky Rov. Nauka i Tekhnika, Minsk.

JANCZYK-KOPIKOWA Z. 1991a. The Ferdynandów Interglacial in Poland. Kwart. Geol., 35(1): 71–79.

JANCZYK-KOPIKOWA Z. 1991b. Palynostratigraphy of the Pleistocene in Poland and the problem of the age of deposits from Besiekierz (Central Poland). Ann. Univ. M. Curie-Skłodowska, Ser. B, 46(6): 111–128.

JANCZYK-KOPIKOWA Z. 1996. Ciepłe okresy w mezoplejstocenie północno-wschodniej Polski (summary: Temperate stages of the Mesopleistocene in Northeastern Poland). Biul. Państw. Inst. Geol., 373: 49–66.

JANCZYK-KOPIKOWA Z., MOJSKI J.E. & RZECHOWSKI J. 1981. Position of the Ferdynandów Interglacial, Middle Poland, in the Quaternary stratigraphy of the European Plain. Biul. Inst. Geol., 335: 65–79.

KALINOVSKY P.F. 1979. Mestsaznakhodzhanni paleateryyafauny na terytory Belarusi: 54–63. In: Lyaukou E.A. & Yakubovskaya T.V. (eds) Novaye u gealogii antrapagenu Belarusi (New knowledge on the Anthropogen geology of Byelorussia). Nauka i Tekhnika, Minsk.

KALINOVSKY P.F. 1986. Melkie mlekopitayushchie antropogena Belorussii.: 106–110. In: Garetsky R.G. et al. (eds) Paleontologiya i yee rol v poznany geologicheskovo stroyeniya territorii Belorussii. Nauka i Tekhnika, Minsk. (in Belorussian).

KONDRATIENE O.P. & SAN'KO A.F. 1985. Usloviya zaleganiya i palinologicheskaya kharakteristika mezhlednikovykh otlozheny v ovrege Nizhninsky Rov.: 101–124. In: Valchik M.A. & San'ko A.F. (eds) Problemy pleystotsena. Nauka i Tekhnika, Minsk.

LINDNER L. 1988. Stratigraphy and extents of Pleistocene continental glaciations in Europe. Acta Geol. Polon., 38(1–4): 63–83.

LINDNER L. 1992. Stratygrafia (klimatostratygrafia) czwartorzędu: 441–634. In: Linder L. (ed.) Czwartorzęd. Wyd. PAE, Warszawa.

LISICKI L. & WINTER H. 2004. Rewizja pozycji stratygraficznej oasadów dolnego i środkowego plejstocenu północno-wschodniej Polski (summary: Revision of stratigraphy of the lower and middle Pleistocene sediments of north-eastern Poland): 259–283. In: Kostrzewski A. (ed.) Geneza, litologia i stratygrafia utworów czwartorzędowych, Vol. 4, Ser. Geografia, 68. Wyd. Univ. Adam Mickiewicz, Poznań.

MAKHNACH N.A. 1971. Etapy razvitiya rastitelnosty Belorussii v antropogene (Stages of the development of the vegetation of the Byelorussia during Anthropogen). Nauka i Tekhnika. (in Russian).

MAKHNACH N.A. & RYLOVA T.B. 1986. Stratigraficheskoye raschlenene drevneozernykh pleystotsenovykh otlozheny Rechitskovo Pridneprovya Belorussii (po materialam novykh palinologicheskikh issledovani).: 56–75 In: Zinova R.A. (ed.) Pleystotsen Rechitskovo Pridneprovya Belorussii. Nauka i Tekhnika, Minsk.

MAKHNACH N.A. & TSAPENKO M.M. 1966. Novye dannye o mezhlednikovykh otlozheniyakh v verkhovyakh r. Bereziny (Dneprovskoy).: 328–336 In: Golubtsov V.K. (ed.) Paleontologiya i stratigrafiya BSSR. Nauka i Tekhnika, Minsk.

MAKHNACH N.A., KHURSEVICH G.K., LOGINOVA L.P. & BOGOMOLOVA L.N. 1982. Novye paleobotanicheskie issledovaniya drevneozernykh pleystotsenovykh otlozheny razreza Krasnaya Dubrova.: 37–53. In: Azhgirevich L.F., Velichkevich F.Yu. & Zinova R.A. (eds) Neogenovye otlozheniya Belorussii. Nauka i Tekhnika, Minsk.

MAMAKOWA K. 1996 (unpubl.). Nowe dane palinologiczne z profilu Podgórze, Szczegółowa Mapa Geologiczna Polski 1:50000, ark. Białobrzegi (prof. B1). Archives Państw. Inst. Geol., Warszawa.

MAMAKOWA K. 1998. Wyniki badań paleobotanicznych profilu z Przasnysza: 71–73. In: Lisicki S., Marks L., Medek J. & Pochocka K. (eds) 5 Konferencja „Stratygrafia Plejstocenu Polski", Iznota, 1–4 września 1998 r.

MAMAKOWA K. 2003. Plejstocen: 235–273. In Dybova-Jachowicz S. & Sadowska A. (eds) Palinologia. Wyd. Inst. Bot. PAN, Kraków.

MOJSKI J.E. 1985. Geology of Poland. Vol. I. Stratigraphy. Part 3b Cainozoic. Quaternary. Wyd. Geol., Warszawa

MOJSKI J.E. 1993. Europa w plejstocenie – ewolucja środowiska przyrodniczego. Wyd. PAE, Warszawa.

MOTUZKO A.N. 1977. Pervaya nakhodka nizhnepleystotsenovoy fauny mleko-pitayushchikh v Belorussii (summary: The first find of the Lower Pleistocene fauna of mammals in Byelorussia). Vestnik Mosk. Inst. Geogr., 4: 47–53.

MOTUZKO A.N. 1985. Gryzuny antropogena Belorussii i sopredelnykh territorii: 173–188. In: Valchik M.A. & San'ko A.F. (eds) Problemy pleystotsena. Nauka i Tekhnika, Minsk.

NALEPKA D. & WALANUS A. 2003. Data processing in pollen analysis. Acta Palaeobot., 43(1): 125–134.

SAN'KO A. 1993. Malacofauna of Korchevo and its stratigraphic importance. Second Baltic Stratigraphic Conference. Vilnius, 9–14 May 1993. Abstract: 90.

VAZNYACHUK L.M., MAKHNACH N.A., ZUS M.Ya. & KONDRATIENE O.P. 1978. Novyya zvestki ab nizhnim pleystatsene Belaruskaga Panyamonnya i mestsa karchouskay mizhledavikovay toushchy syarod nizhne-pleystatsenavykh adkladau Europy: 69–81. In: Kuznyatsou U.A. (ed.) Dasledavanni antrapagenu Belarusi. Nauka i Tekhnika, Minsk.

VELICHKEVICH F.Yu. 1982. Pleystotsenovye flory lednikovykh oblastey Vostochno-Yevropeyskoy ravniny. Izd. Nauka i Tekhnika, Minsk.

VELICHKEVICH F.Yu. 1986. O rannepleystotsenovoy mezhlednikovoy flore razreza Korchevo na Novogrudskoy vozvyshennosti (summary: The Early-Pleistocene interglacial flora from the Korchevo exposure within the Novogrudok Upland). Doklady AN BSSR, 30(3): 255–258.

VELICHKEVICH F.Yu., KHURSEVICH G.K., RYLOVA T.B. & LITVINYUK G.I. 1997. K stratigrafii srednevo pleystotsena Belarusi. Stratigrafiya. Geologicheskaya Korrelyatsiya, 5(4): 68–84.

VELICHKEVICH F.Yu., SAN'KO A.F., RYLOVA T.B., NAZAROV V.I., KHURSEVICH G.K. & LITVINYUK G.I. 1996. Stratigraficheskaya skhema chetvertychnykh (antropogenovykh) otlozheny Belarusi. Stratigrafiya. Geol. Korrelatsiya, 4(6): 75–87.

VELICHKEVICH F.Yu., NAZAROV V.I., RYLOVA T.B., SAN'KO A.F., FEDENYA V.M., KHURSEVICH G.K. & LOGINOVA L.P. 1992. Sovremennye predstavleniya o stratigrafii pleystotsena Belarusi. Byull. Regional. Mezhvedomst. Statigr. Komissii po tsentru I yugu. Russkoy Platformy. Vypusk 1. C.: 149–153.

VELICHKEVICH F.Yu., DERYUGO G.V., ZERNITSKAYA V.P., ILKEVICH G.I., LEVITSKAYA R.I., LITVINYUK G.I., MATVEEV A.V., NAZAROV V.I., SAN'KO A.F., RYLOVA T.B., KHURSEVICH G.K. & YAKUBOVSKAYA T.V. 2001. Chetvertichnaya sistema (kvarter): 325–386. In: Makhnach A.S., Garetsky R.G. & Matveev A.V. (eds) Geologiya Belarusi. Institut Geologicheskikh Nauk NAN Belarusi, Minsk.

VOZNYACHUK L.N. 1961. Otlozheniya poslednevo mezhlednikovya na territorii Belorussii: 159–217. In: Lukashou K.I., Tsapenka M.M. & Vaznyachuk L.M. (eds) Materialy po antropogenu Belorussii. Izd. Akad. Nauk BSSR, Minsk.

VOZNYACHUK L.N. 1981. Osnovnye stratigraficheskie podrazdeleniya chetvertichnykh otlozheny.: 137–151. In: Golubtsov V.K. (ed.) Materialy po stratygrafii Belorussii k mezhvedomstvennomu statigraficheskomu soveshchaniyu. Nauka i Tekhnika, Minsk.

VOZNYACHUK L.N. 1985. Problemy glyatsiopleystotsena Vostochno-Evropeyckoy ravnin: 8–55. In: Valchik M.A. & San'ko A.F. (eds) Problemy pleystotsena. Nauka i Tekhnika, Minsk.

VOZNYACHUK L.N., MAKHNACH N.A., MOTUZKO A.N., VELICHKEVICH F.Yu., YAKUBOVSKAYA T.V., ZUS M.E., KALINOVSKY P.F., RUNETS E.P. & SAN'KO A.F. 1977. Nizhnepleystotsenovye otlozheniya d. Korchevo na novogrudskoy vozvyshennosti v Belorussii i ikh stratigraficheskoye paleogeograficheskoye znachenie (summary: Lower Pleistocene deposits of the village of Korchevo on the Novogrudok Hills in Byelorussia and their stratigraphic and paleogeographic significances). Doklady AN BSSR, 21(11): 1025–1028.

VOZNYACHUK L.N., MAKHNACH N.A., MOTUZKO A.N., VELICHKEVICH F.Yu., YAKUBOVSKAYA T.V., ZUS M.E., KALINOVSKY P.F., RUNETS E.P. & SAN'KO A.F. 1978. Novye dannye po paleogeografii rannevo pleystotsena lednikovoy oblasti Vostochno-Evropeyskoy ravniny (New data on the paleogeography of the Early Pleistocene of the glacial region of the East-European plain). Doklady AN SSSR, 239(1): 154–157. (in Russian).

WALANUS A. & NALEPKA D. 1999. POLPAL program for counting pollen grains, diagrams plotting and numerical analysis. Acta Palaeobot. Suppl., 2: 57–67.

WINTER H. 2001. Nowe stanowisko interglacjału augustowskiego w północno-wschodniej Polsce (summary: New profile of Augustowski Interglacial in north-eastern Poland): 439–450. In Kostrzewski A. (ed.) Geneza, litologia i stratygrafia utworów czwartorzędowych, Vol. 3, Ser. Geografia, 64. Wyd. Univ. Adam Mickiewicz, Poznań.

YAKUBOVSKAYA T.V. 1978. Ranneantrapagenavyya nasennyya flory Belaruskay grady i ikh stratygrafichnae stanovishcha: 93–105. In: Kuznyatsou U.A. (ed.) Dasledavanni antrapagenu Belarusi. Nauka i Tekhnika, Minsk.

YAKUBOVSKAYA T.V. 1991. Rod *Aldrovanda (Droseraceae)* v pleystotsene Belorussii (The genus *Aldrovanda (Droseraceae)* in Pleistocene of Byelorussia). Bot. Zhurn., 76(1): 109–118. (in Russian).

ZAGWIJN W.H. 1996. The Cromerian Complex Stage of the Netherlands and correlation with other areas in Europe: 145–172 In: Turner C. (ed.) The early Middle Pleistocene in Europe. Proceedings of the Seqs Cromer Symposium, Norwich UK, 3–7 September 1990. A.A. Balkema, Rotterdam.

ZUS M.E. 1980. Geologicheskaya situatsiya rayona Korchevskikh glyatsiodislokatsy.: 28–36. In: Gursky B.N. (ed.) Problemnye voprosy geologii antropogena i neogena Belorussii. Nauka i Tekhnika, Minsk.

ZUS M.E. 1991. Novogrudskaya vozvyshennost. Nauka i Tekhnika, Minsk.

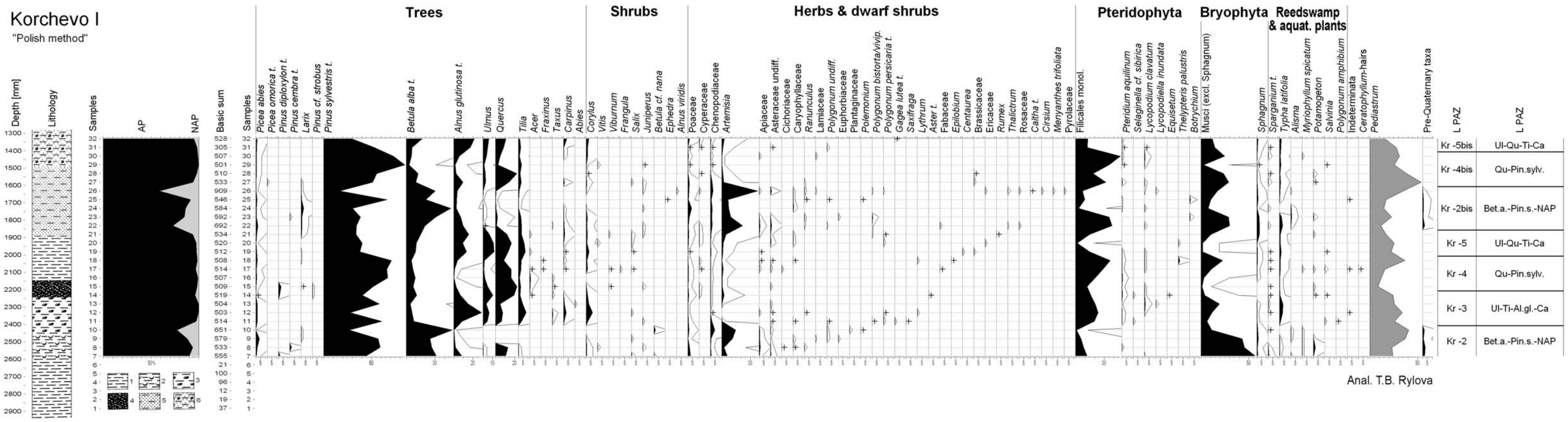

Fig. 3. Percentage pollen diagram of Korchevo I – "Polish method". **1** – brownish-grey, compact, not-laminated calcareous clay; **2** – brownish-grey, dark, layered, calcareous clay; **3** – brownish-greenish-grey, compact calcareous clay; **4** – brownish-grey, compact, calcareous clay with peat layer; **5** – brownish-grey, compact slightly calcareous clay; **6** – dark-brown, horizontally bedded, peaty, calcareous, clayey sand

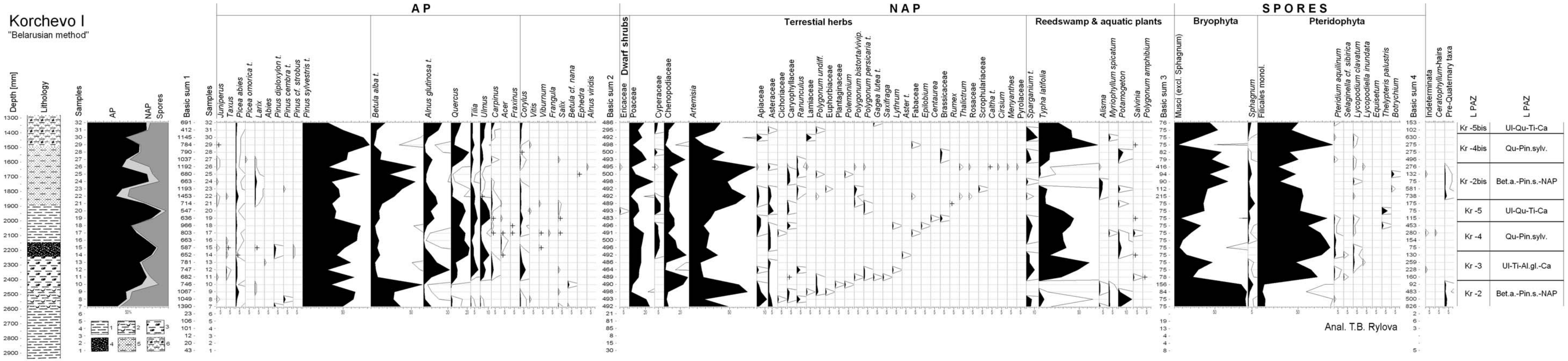

Fig. 4. Percentage pollen diagram of Korchevo I "Belorusian method", for explanation see Fig. 3

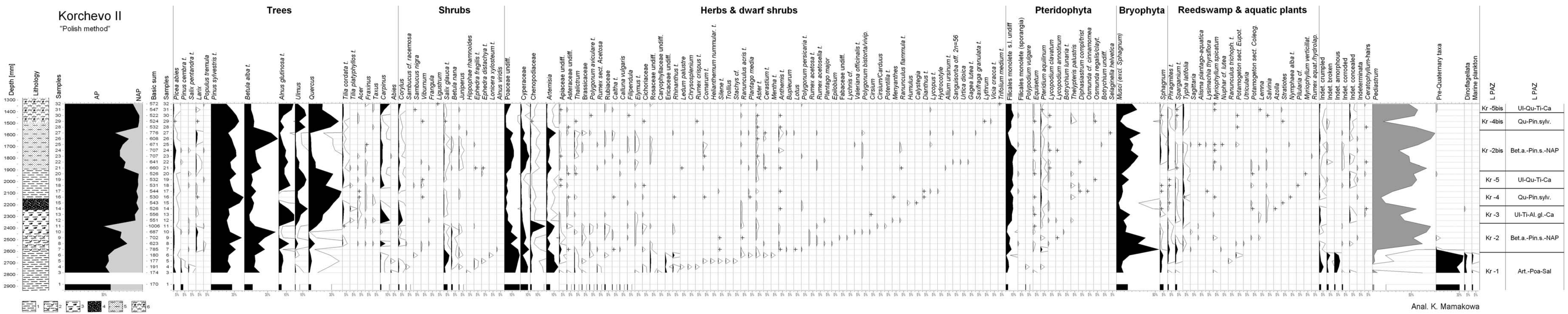

Fig. 5. Percentage pollen diagram of Korchevo II – "Polish method"; for explanation see Fig. 3

Fig. 6. Percentage pollen diagram of the profile Korchevo II – "Belarusian method"; for explanation see Fig. 3

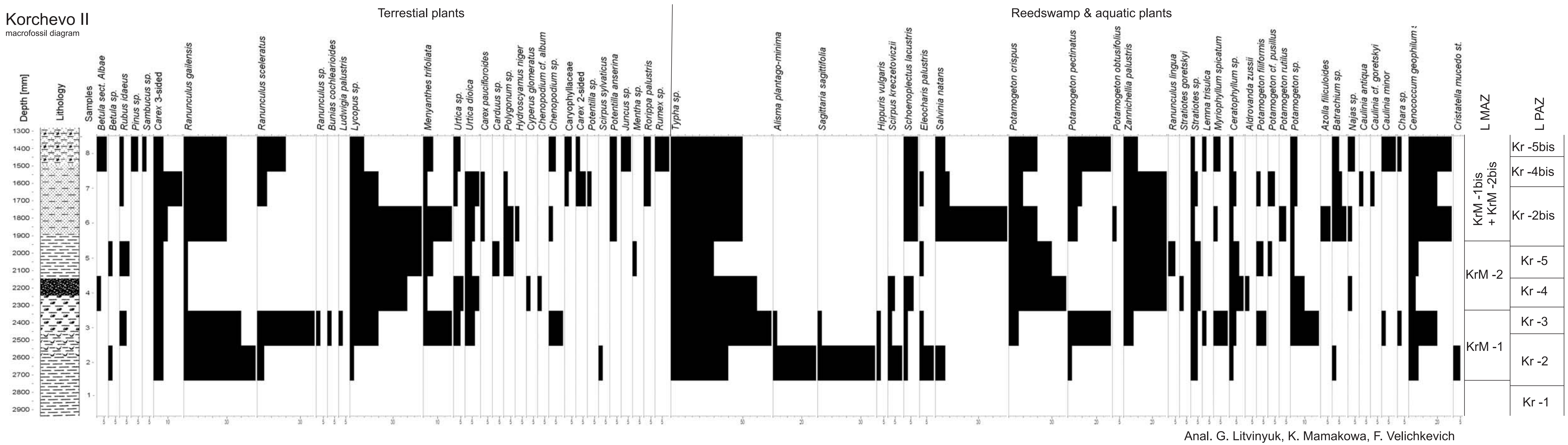

Fig. 8. Plant macrofossil diagram of Korchevo II, lithology see Fig. 3