



DISTURBANCES OF THE HOLOCENE LAKE-BOG SEDIMENT SUCCESSION AS REVEALED BY POLLEN RECORD FROM WIETRZYCHOWICE (SOUTHEASTERN KUJAWY, CENTRAL POLAND)

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Abstract

Results of geological and pollen investigations of the lake-bog sediments from the section Wietrzychowice W5, located nearby the Neolithic Funnel Beaker Culture (FBC) megaliths, are presented. The pollen data reveal that sedimentation at Wietrzychowice has begun at the beginning of the Holocene (Preboreal). Pollen analysis was used to determine stratigraphy with regard to sediment characteristics. The pollen spectrum was divided into 8 LPAZes (1-7Xa, 7Xb) which were also, where possible, stratigraphically classified. Radiocarbon dating of $6\,730 \pm 90$ BP (5 730–5 480 BC, MKL-702) at depth of 1.20 m confirmed the pollen analysis age estimation. Five settlement episodes were found in organic sediments in the upper part of the W5 core. The first was presumably during the Preboreal, the second in the early Atlantic, the third in the late Atlantic (probably Neolithic FBC), the fourth in the early Middle Ages and the last one in the late Middle Ages. The pollen analysis was useful to point irregularities in sediment succession. Such a situation made palaeoenvironmental interpretation difficult, but further research is still needed to enable an accurate reconstruction.

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Key words: pollen analysis, geoarchaeology, post-depositional disturbances, human activity, Holocene, central Poland.

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INTRODUCTION

The vegetation is visually the most distinct component in the landscape and its composition is a result of both abiotic and biotic factors. Based on vegetation composition, deductions can be made concerning other factors, including climate, pedology, geomorphology and even a time of human colonisation of the region and a scope and quality of human activities. Pollen analysis is a basic method for reconstruction of the past vegetation development during the Pleistocene and Holocene.

Palynological investigations of biogenic deposits in archaeology are used to express man and environment interactions and to correlate phenomena derived from pollen analysis and archaeological investigations. Using floral indices of husbandry, phases of man's extensive activity can be extrapolated. Considering the entirety of past vegetation, it is possible to determine environmental conditions, in which consecutive communities existed. Radiocarbon dating is of significant value in this respect.

The southeastern Kujawy region in central Poland has been intensively used for farming since early Neolithic due to

its fertile soils (Jażdżewski, 1938; Grygiel and Bogucki 1997). A number of sites were documented in this area, in which artifacts of the Neolithic Funnel Beaker culture (FBC), i.e. ceramics, stone and flint tools as well as megalithic tombs, were found. The people producing such ceramics and constructing massive stone structures inhabited southeastern Kujawy between mid-IV and mid-III millennium BC. Huge megaliths nearby Wietrzychowice, the most magnificent of them reaching 115 m in length, were well recognized by Professor Konrad Jażdżewski in the 1930s and 1960s (Jażdżewski, 1938; Jadczykova, 1970, 1971).

During the last few years geological (Roman, 2010) and notably archaeological investigations at Wietrzychowice have been taken up once again and revealed numerous remains of the FBC husbandry in several sites in the megaliths vicinity (Břízová *et al.*, 2014). Noteworthy are three sites, which can be interpreted as settlements, 3 to 5 ha each. The largest of them was located at Osiecz Mały, ca 1 km NE from the Wietrzychowice site (Fig. 1) where abundant material has been excavated, indicating long-term (several centuries) residency of the FBC community during the IV millennium

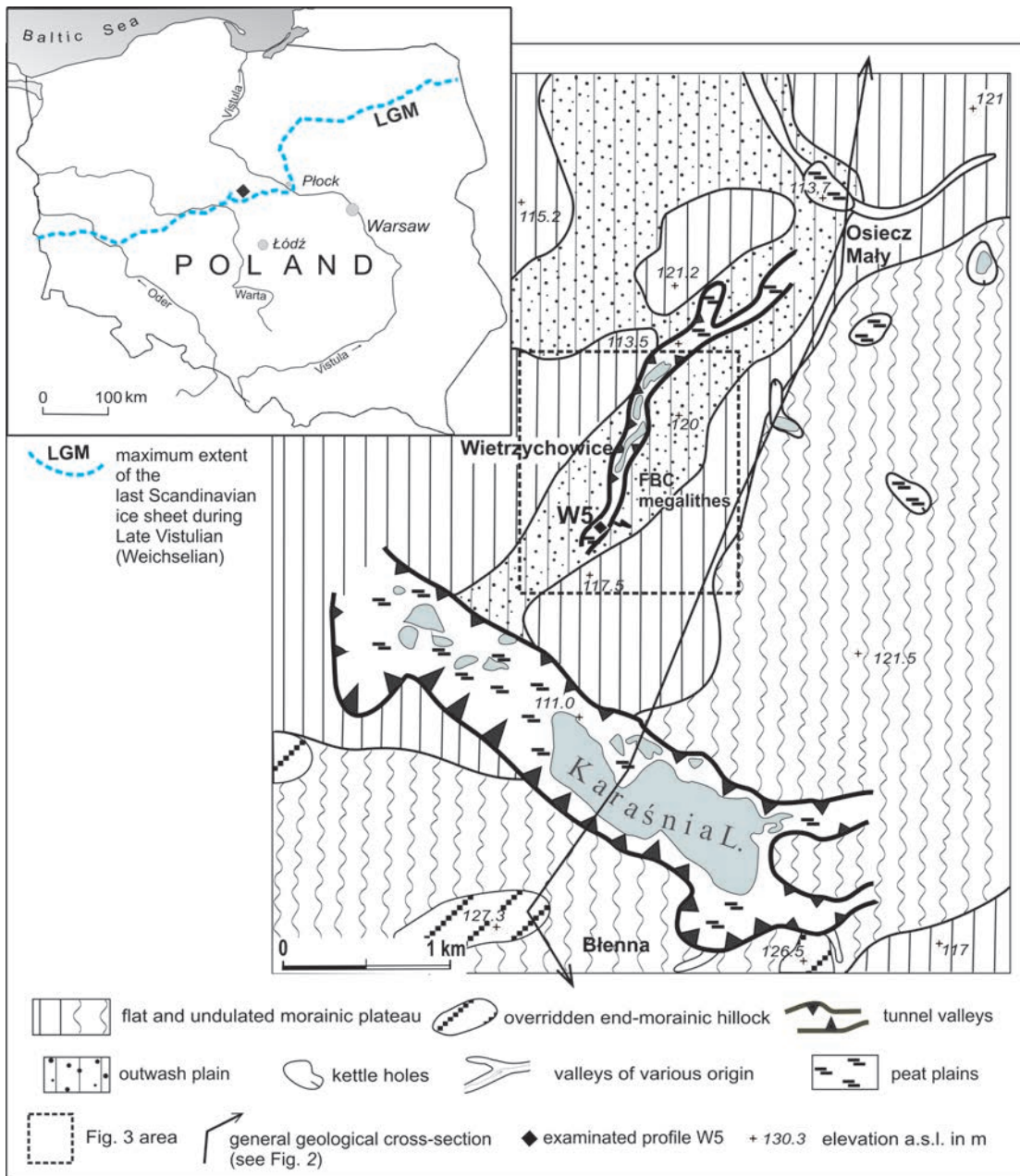


Fig. 1. Location of the Wietrzychowice site and geomorphological outline of its environs.

BC. Neolithic FBC settlements are spread at a morainic plain and also in nearby tunnel valleys, bottoms of which are featured by lakes, peat-bogs and slight tributaries. In contrast to abundant archaeological findings evidence of human activities in pollen record at the Wietrzychowice vicinity remains open and the one presented in this paper, is the first.

The aim of the work was to present anthropogenic traces and climatic features in the Holocene lake-bog sediment succession, using plant indicators to trace activities of prehistoric people and also to point out how seemingly intact deposits, in macroscopic taxation, could be found disturbed as seen in results of palynological investigations.

REGIONAL SETTING AND STUDY SITE

The Wietrzychowice site is located in the southeastern

part of the Kujawy Lakeland, within an area embraced by the Płock ice-lobe during the late Weichselian maximum (19–18 ka BP) related to the Poznań (Frankfurt) Phase (Roman, 2010, Fig. 1). An undulant morainic plateau at 115–123 m a.s.l. is the predominant landform in the area. It is composed mainly of till, locally covered by glaciofluvial sand with gravel, 0.5–1.5 m thick and increasing up to 4 m alongside the glacial tunnel valleys. The morainic plateau is cut by numerous tunnel valleys of various ranges with NW–SE and NE–SW orientations. Among the noticeable landforms, there are overridden end moraines near Boniewo and Błenna (Figs 1, 2), marking pre-maximum short ice sheet standstills (Roman, 2010) and kettle holes, commonly filled with deluvial sands and boggy deposits.

At Wietrzychowice a small tunnel valley is found, ca 2 km long and 40–150 m wide, running NW–SE (Figs 1, 3). A nar-

row lake 300 m long as well as peat plains and bogs form the present bottom of the valley. Within the peat plain tilted to the lake from the south and located in a close vicinity of the megaliths, 30 boreholes were done. A log with thickest biogenic deposit (section W5, Fig. 3) was chosen for palynological analysis (Table 1).

METHODS

Geological mapping was done in the area of 6 km² around the Wietrzychowice FBC site and notably, the peat plain situated close to the megalith tombs and within the foot of a tunnel valley, was examined in detail. 30 boreholes fixed along 3 sections cross-wise to the tunnel valley axis were done. Lacustrine and peat deposits from the core W5 (Fig. 3) were pollen analyzed (whereupon the lowermost part of a peat layer above lake deposits was radiocarbon dated. Radiocarbon analysis was performed and calibrated at the Cianowice Radiocarbon Laboratory in Poland. The age of 6 730 ± 90 BP (5 730–5 480 cal yrs BC, MKL-702) at the depth of 1.20 m was auspicious to take up consecutive tedious palynological examination.

31 samples were pollen analyzed (1 cm³ each). They were collected from the depth 2.05–0.30 m (Fig. 3) at every 5 cm and analyzed at every 5–10 cm. Decomposition of inorganic component was carried out by HF maceration for ca 24 hours (Faegri and Iversen, 1964). An organic part, mainly cellulose, was removed by Erdtman’s acetylation (Erdtman, 1954). The sporomorphs were preserved in a mixture of ethyl alcohol, glycerine and distilled water.

Microscopic treatment included calculation of individual objects and was carried on the cover glass 22×22 mm. With a low frequency of pollen grains of woody plants, AP (an amount of AP above 100 was taken for statistical evaluation), only 1–10a preparations were done for individual samples. Raw counts of palynomorphs (AP+NAP = 100 %) were the basis for a pollen diagram with a use of the POLPAL program (Walanus and Nalepka, 1999, 2010; Nalepka and Walanus, 2003). Among pollen grains and spores, a number of plant tissues

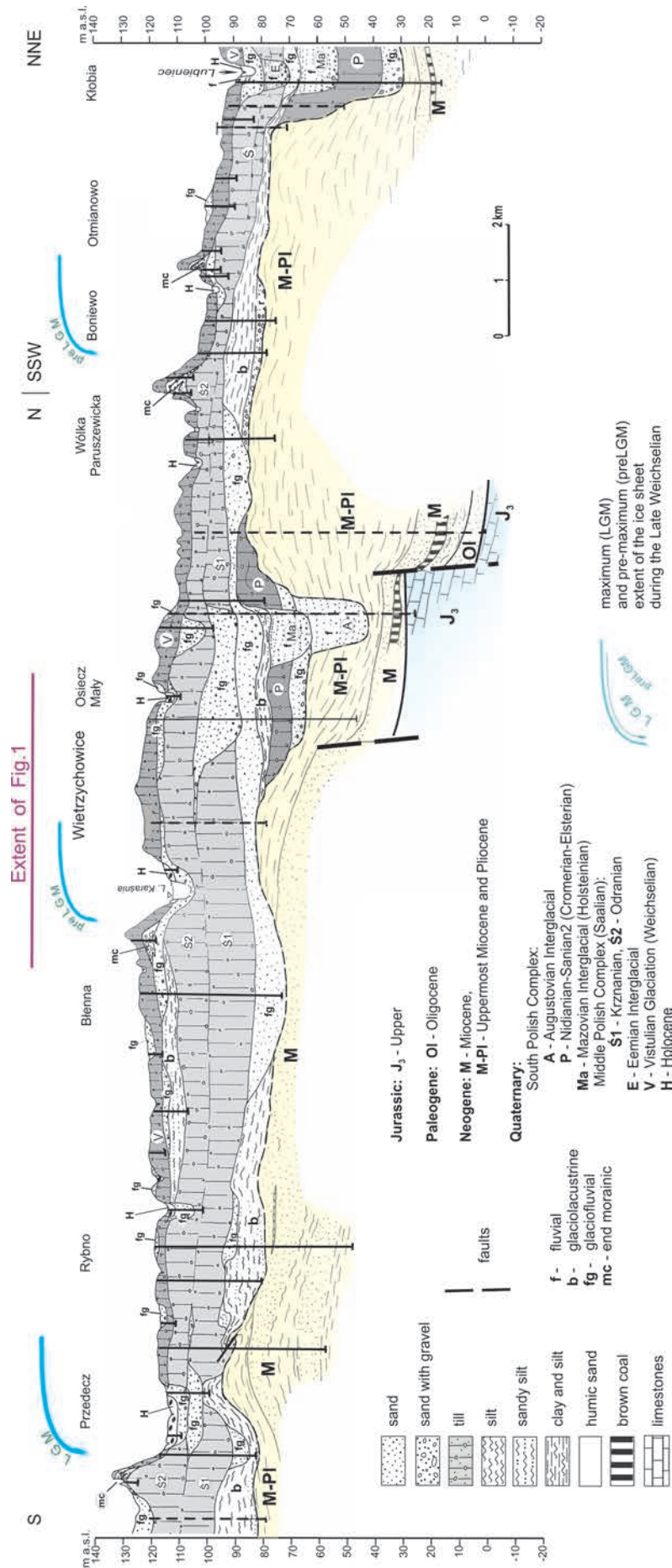


Fig. 2. General geological cross-section Przedecz-Wietrzychowice-Klobia (after Roman 2010, modified).

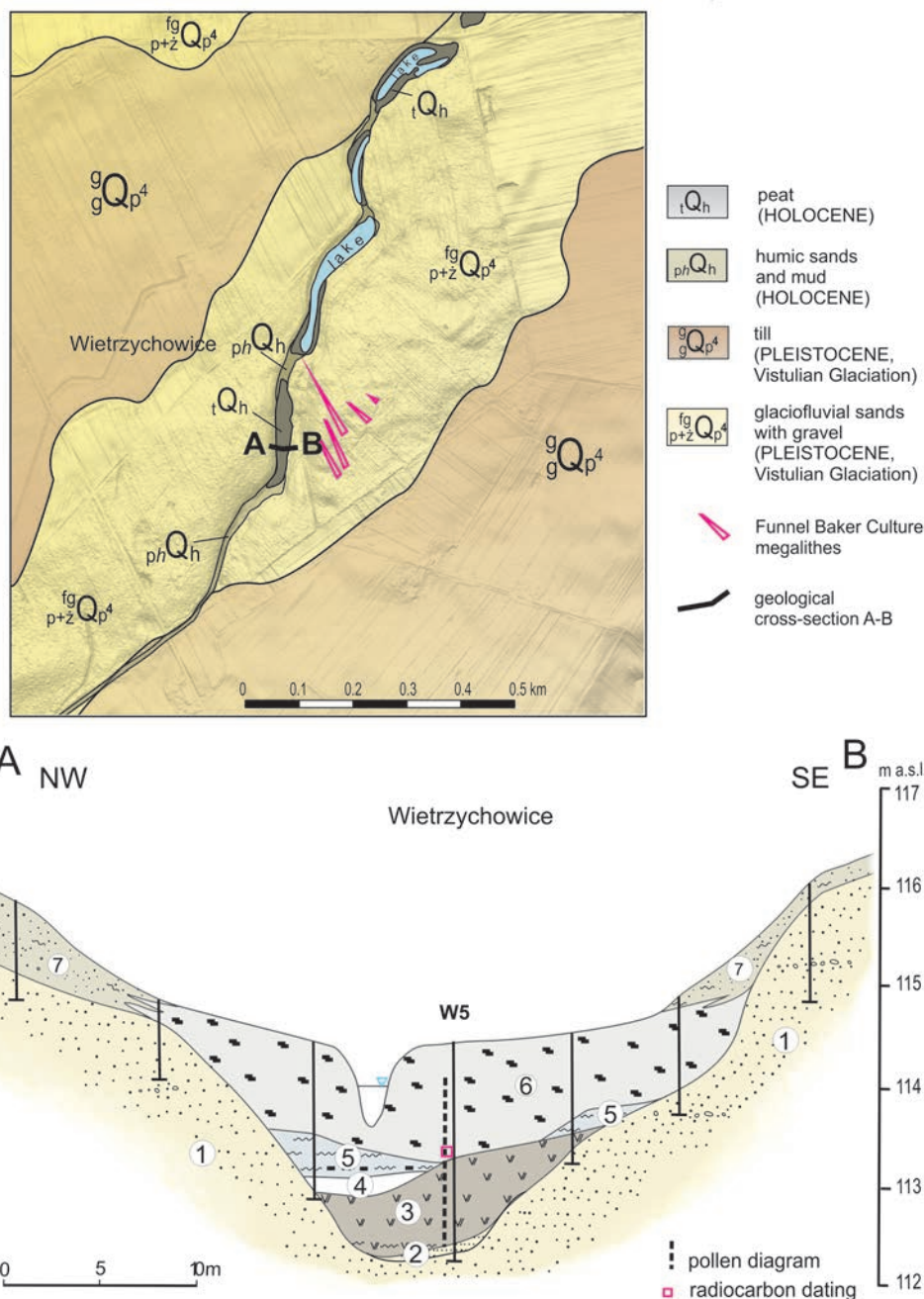


Fig. 3. Surface geology of the Wietrzychowice vicinity and geological cross-section A–B throughout a tunnel valley runs nearby Funnel Baker culture megaliths. Pleistocene: 1 – glaciofluvial sands and sands with gravel; Holocene: 2 – lacustrine fine sands with organic matter, 3 – gyttja, 4 – lake chalk, 5 – lacustrine silt and organic silt, 6 – peat, 7 – deluvial sands and humic sands.

and microscopic animal remains were found during the microscopic analysis. Stratigraphy of the pollen succession was proposed and reconstruction of vegetation phases was produced using Firbas' (1949, 1952) division, modified by Mangerud (Mangerud *et al.*, 1974; Walanus and Nalepka, 2010) (Table 2).

RESULTS

The main task of the carried out pollen analysis, besides the information about the vegetation, was a finding of natural sedimentary conditions and age determination. The pollen spectrum covers climatic-plant zones of the whole Holocene

(IV–X, Preboreal to late Subatlantic) and certain facts were discovered (Fig. 4) that will be described hereafter.

Local pollen assemblage zones

L PAZ WIE 1: Preboreal, depth 1.7 – 2.05 m, Pinus – Betula – Alnus – Salix

The pollen spectrum corresponds most probably to the Preboreal (IV, 10 250–9 100 yrs BP). High frequency of AP pollen, mostly pine (*Pinus*) and birch (*Betula*), was found. More pollen grains of alder (*Alnus*), but less willow (*Salix*), were also present. *Vitis*-type and *Viscum* (semi-parasite most

often on pine), *Quercus*, *Ulmus*, *Tilia cordata*, *Picea*, *Picea* and *Carpinus* represented a fairly thermophilic vegetation. In this phase, expansion of aqueous flora (*Potamogeton*, *Lemna minor*, *Myriophyllum*, *Nuphar*, *Botryococcus*, Cladocera) as well as of other wetland vegetation (Cyperaceae, *Menyanthes trifoliata*, *Caltha*-type, *Sparganium*/*Typha angustifolia*, *Typha latifolia*, *Phragmites*) took place. A small lake was surrounded by alderwoods, willows and poplars. A green alga of the genus *Botryococcus* appeared together with mosses (Bryales) of the genus *Sphagnum*. *Pinus cembra*, *Juniperus* and *Ephedra fragilis* were characteristic pollen of the cold Late Glacial and the early Holocene climate and have been therefore enduring until the beginning of the Holocene. The cereal *Triticum* (maybe redeposited) was a characteristic pollen of the late Holocene and is improbable in the Preboreal.

L PAZ WIE 2: Boreal, depth 1.5–1.7 m, Pinus – Betula – Salix – Corylus

This part of the section belongs to the Boreal (V, 9 100 - 7 700 yrs BP). In the pollen spectrum a larger content of pollen grains of pine (*Pinus*) and birch (*Betula*) appeared, with a continuous record of willow (*Salix*), poplar (*Populus*) and hazel (*Corylus*). In organic sediments the spores without the upper layer, which would have enabled a more precise determination, were common. They were classified into a morphological type of Polypodiaceae (*Filicales monolete*) and occurred together with spruce (*Picea*). There were some algae of the genera *Botryococcus* and *Pediastrum*, accompanied by a moss (Bryales) *Sphagnum*.

L PAZ WIE 3: early Atlantic, depth 1.2–1.5 m, Pinus – Quercetum mixtum (QM, Ulmus, Quercus, Tilia) – Cerealia

This segment belongs to the early Atlantic (VI, 7 700–6 000 BP). The studied zone represented rather a small time stage covering a climatic optimum. The succession illustrated most an invasion of pine (*Pinus*) and alder (*Alnus*), less spruce (*Picea*), fir (*Abies*) and hornbeam (*Carpinus*). Cereals – Cerealia sp., Cerealia T. *triticum* and also a buckwheat (*Fagopyrum*) and other anthropogenic indicators (*Artemisia*, *Centaurea cyanus*, Chenopodiaceae, Brassicaceae, Apiaceae, *Rumex*, Asteraceae Liguliflorae, A. Tubuliflorae, *Trifolium*, *Symphytum*) characteristic for farming. The green algae were represented by the genus *Botryococcus* only. Quite a high content of pine pollen (*Pinus*) and radiocarbon dating 6 730 ± 90 yrs BP (5 730–5 480 yrs BC, MKL-702) in the upper part of the section indicates the Atlantic age. Some pollen grains in the Czech Republic such as *Fagopyrum*, *Centaurea cyanus* indicated the Middle Ages. Pollen grains of synanthropic plants (*Artemisia*, Chenopodiaceae, Asteraceae Liguliflorae) and cereals (Cerealia sp., C. T. *triticum*) may appear in the Neolithic, but a buckwheat (*Fagopyrum*), found out in these sediments, was characteristic for the Middle Ages in the Czech Republic and was probably introduced by a man from its homeland in the Middle East (Břizová, 1998, 1999). In the territory of Poland pollen grains of *Centaurea cyanus* were found in the Atlantic sediments (see Nalepka, 2005; Ralska-Jasiewiczowa et al., 2004).

Table 1

Lithology of the examined log Wietrzychowice W5

Depth (m)	Sediments	Sedimentary environment
0.00–0.50	peat, slightly decayed, brown	boggy
0.50–1.23	moss-sedge peat, brown	boggy
1.23–2.05	gyttja with calcareous coarse-detritus, dark grey	lacustrine
2.05–2.10	fine sand with organic matter, laminated, blue-grey	lacustrine
2.10–2.30	sands, various grain size	glaciofluvial

Table 2

Stratigraphy of the Holocene

HOLOCENE	Modified stratigraphy by Břizová (Dreslerová et al. 2004), uncal. yrs BP	Modified stratigraphy by Mangerud (Walanus and Nalepka 2010), conv. yrs BP	Modified stratigraphy by Mangerud (Walanus and Nalepka 2010), cal. yrs BC
SUBATLANTIC IX, X	2 800 – recent	2 500 – recent	600 – recent
SUBBOREAL VIII	5 100/4 500–2 300	5 000–2 500	3 800–600
ATLANTIC VI, VII	7 700–5 100/4 500	8 000–5 000	7 000–3 800
BOREAL V	9 100–7 700	9 000–8 000	8 200–7 000
PREBOREAL IV	10 250–9 100	10 000–9 000	9 500–8 200

L PAZ WIE 4: late Atlantic, depth 1.2–0.8 m, Pinus – Quercetum mixtum – Cyperaceae – Poaceae

The pollen spectrum corresponds to the late Atlantic (VII, 6 000–5 100/4 500 BP). There is a high fraction of pollen grains of woody species (AP), primarily pine (*Pinus*). The individual pollen grains of herbs (NAP: Asteraceae Liguliflorae, *Plantago major-media*, *Artemisia*, Chenopodiaceae), cereals (Cerealia T. *triticum*) and *Centaurea cyanus* represent the farming, but not to a greater extent. A still dominating fraction is formed by wetland plants (*Salix*, *Alnus*, *Populus*, Cyperaceae, *Sparganium*/*Typha angustifolia*) and Polypodiaceae type. A high fraction of woody species (*Pinus*) is accompanied by a smaller amount of other AP (*Betula*, *Tilia*, *Quercus*, *Ulmus*, *Populus*) and also a small number of herbs (NAP). The shrub layer is relatively rich (*Cornus sanguinea*, *Lonicera*, *Prunus*-typ, *Vitis*). It is probable that there might have been Neolithic settlements.

L PAZ WIE 5: depth 0.8–0.7 m, Pinus – Picea – (Polypodiaceae)

The pollen spectrum corresponds most probably to the Subboreal (VIII, 5 100–2 300 yrs BP). There is still a high frequency of woody species (AP), again mostly pine (*Pinus*), substantially less other woody species such as *Picea*, *Betula*, *Alnus*, *Tilia*, *Quercus*, *Ulmus* and *Populus* and there is also a small amount of herbs (NAP). In the sediments there are abundant ferns, represented by spores without perina (upper cover), which were classified as a morphological type of

Polypodiaceae (Filicales monolete). Without the upper cover their more detailed determination is impossible.

L PAZ WIE 6: depth 0.7–0.55 m, *Pinus* – *Betula* – *Alnus* – *Cyperaceae* – aquatic plants

A high fraction of alder (*Alnus*), which is characteristic for this place, alderwood and Cyperaceae predominate; moreover it is a period of expansion of aquatic flora (*Potamogeton*, *Lemna minor*, *Myriophyllum*, *Utricularia*, *Botryococcus*, Cladocera) and consequently marsh plants (Cyperaceae, *Menyanthes trifoliata*, *Sparganium/Typha angustifolia*, *Typha latifolia*). A mutual occurrence of juniper (*Juniperus*), stinging nettle (*Urtica*) and heather (*Calluna vulgaris*) may indicate human presence, which is characteristic for a pasture directly in a forest. Greater extension of these plants might have begun just due to a pasture. Cereals did not emerge any more. According to development of the plant cover, the sediment may be classified into the early Subatlantic (IX, 2 800 yrs BP–500/700 AD).

L PAZ WIE 7: depth 0.55–0.3 m, *Pinus* – *Salix* – *Alnus* – *Abies* – aquatic plants – anthropophytes

The pollen spectrum corresponds to the late Subatlantic of the early and late phase Xa (500–1 200 AD) and Xb (1 200 AD–recent). The examined part of the profile represented rather a small time stage covering the youngest part of the Holocene. In this period a pine (*Pinus*) was predominant, with small amounts of *Betula*, *Quercus*, *Juniperus*, *Alnus*, *Picea* and *Abies*. Herbs were represented sporadically by Cyperaceae, *Sparganium/Typha angustifolia*, *Potamogeton*, *Lemna minor*, Asteraceae Liguliflorae, A. Tubuliflorae, Chenopodiaceae, *Artemisia* and *Centaurea cyanus*. Upon the discovery of plant palynomorphs that accompanied a man (predominantly cereals), the period can be characterized as the Middle Ages without improved differentiation (early and late Middle Ages, Xa–Xb).

DISCUSSION

The pollen data confirm that the examined profile represents the Holocene, with the Preboreal (IV) at the beginning, via the following periods up to the late Subatlantic (X).

Soon afterwards, the human presence becomes visible but showing itself as questionable in the period of climatic optimum (VI, VII). In the Subboreal (VIII) man's traces did not occur, but they were noted only in the early (IX) and late Subatlantic (Xa, Xb). In the pollen diagram (Fig. 4) the human presence could not be reliably proved (improbable in the Preboreal) until the early and late Subatlantic (VI, VII, comparison Brízová and Bartošková, 1994; Brízová and Szwarzewski, 2005; Brízová, 2012a, b; Brízová *et al.*, 2012).

During the Atlantic, if the locality or its surroundings was settled, the human presence was possible but vegetation that emerged here, was characterized by the types of the Middle Ages origin (*Fagopyrum*, *Centaurea cyanus*) in the Czech Republic. In the Kujawy Region pollen grains of *Centaurea cyanus* were found in the Atlantic sediments (Nalepka, 2005). Reliable findings of human activity did not become visible in the pollen diagram until early and late Mid-

dle Ages in the upper part of the section at Wietrzychowice. There are five settlement phases in the pollen diagram, irrespective of reality. The first is only presumable in the Preboreal, the second in the early Atlantic, the third in the late Atlantic (probably Neolithic FBC), the fourth in the early Middle Ages and the last one in the late Middle Ages.

Deposition of organic material was initiated in the beginning of the Holocene during the Preboreal and possible redeposition is moreover exemplified by findings of Dinoflagellata cysts. The sediments at the bottom (1.2–2 m) and the sands below the organic part are classified as lacustrine, which is concurrently supported by pollen analysis (Fig. 4). Siltation and overgrowing of a small lake started at the beginning of the early Atlantic and corresponded to the largest warming during the Holocene and also the largest vegetation expansion (comparison e.g. Mentlík *et al.*, 2010) and continued during the whole Holocene, being exemplified by abundant wetland vegetation (*Potamogeton*, *Sparganium/Typha angustifolia*, Cyperaceae, *Lemna minor*). Open water table probably endured during the deposition (e.g. *Lemna minor*, *Potamogeton*) but periodic flooding at higher precipitation and a more humid phase of the climate may have occurred.

FINAL REMARKS

Taking into account topography, geological setting and lithology of the W5 core from the Wietrzychowice site, it could be expected to find a continuous and undisturbed sediment record. Even radiocarbon dating and pollen analysis are not in contradiction. Merely the pollen spectrum, which directly indicated a human influence, is problematic. There are 5 traces of settlements (Fig. 4), found in organic sediments of the upper segment of the W5 core and referenced probably to the Preboreal, early Atlantic, late Atlantic (presumably Neolithic FBC), early Middle Ages and late Middle Ages. It is evident that the locality might have been frequently settled and therefore sedimentation was influenced by the humans. Furthermore, it is troublesome to assess reasons why deposits found to be of Atlantic age bear traces of Medieval human activity. Such disturbance most probably has been related to human and animal-induced physical perturbations of the soft sediment surface, but no visible bed disturbances, insertions and structure changes in the peat section of the W5 core are noted.

A significance of the pollen record for our understanding of the Neolithic time, when farming groups of Funnel Beaker culture appeared in the Kujawy region, is obvious from a high proportion of published contributions from archaeologists (i.a. Czerniak, 1994; Rzepecki, 2004). In the presented case, a pollen analysis was useful to indicate irregularities in sediment succession, although such a situation makes palaeoenvironmental interpretation difficult and further research is needed to enable accurate reconstruction.

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Wietrzychowice 5, Poland

52°24'45" N

18°52'32" E

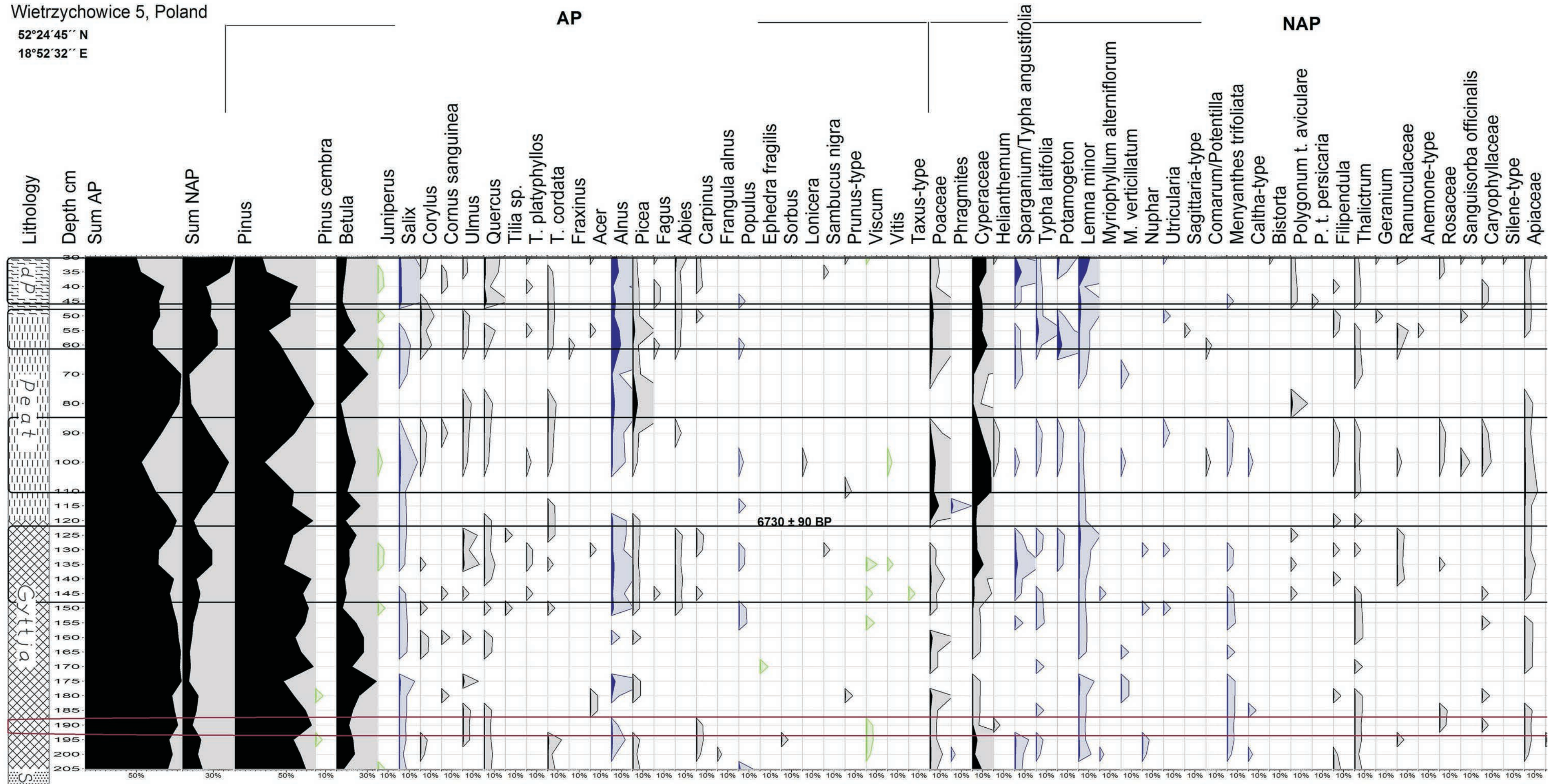


Fig. 4. Pollen diagram of the Wietrzychowice W5 profile (analyzed by Eva Brizová).

NAP

PTERIDOPHYTA

BRYOPHYTA ALGAE FUNGI

