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RECORDS ON ANTHROPOGENIC ENVIRONMENTAL CHANGES IN SMALL RIVER VALLEYS IN THE VICINITY OF ŁÓWICZ (CENTRAL POLAND): THEIR SIGNIFICANCE FOR THE RECONSTRUCTION OF LATE HOLOCENE SETTLEMENT TENDENCIES

Abstract: Based on palaeobotanical analyses of organic deposits, as well as geomorphological and geological studies at four sites in various geomorphological locations in relation to tributaries of the Bzura River, the presence of traces of human activity, its intensiveness, and classification to cultural levels were analysed. A pattern of later and later settlement in areas remote from the axis of the Warsaw–Berlin streamway was observed along with the gradual introduction of settlement from river valley bottoms to watershed zones.

Key words: Central Poland, river valley, human activity, organic deposits

Introduction

The zone of the northern slopes of the Łódź Hills and its transition to the Warsaw–Berlin streamway includes a system of small tributary river valleys of the Bzura River, at the streamway bed level. The geological construction of the area and development of its land relief are relatively well known, particularly in relation to the Holocene period (Jewtuchowicz 1970, Kamiński 1993; Kobojek 2000, 2009; Twardy, Forysiak 2006, Twardy 2008). In the described section of the streamway, organic deposits occur, but with no continuous record of environmental changes in the postglacial period. Within the last two decades, documentation and analysis have been carried out on Holocene organic deposits found in various valley land forms at various distances from the streamway axis, and at various latitudes within the river valleys in question (Fig. 1).

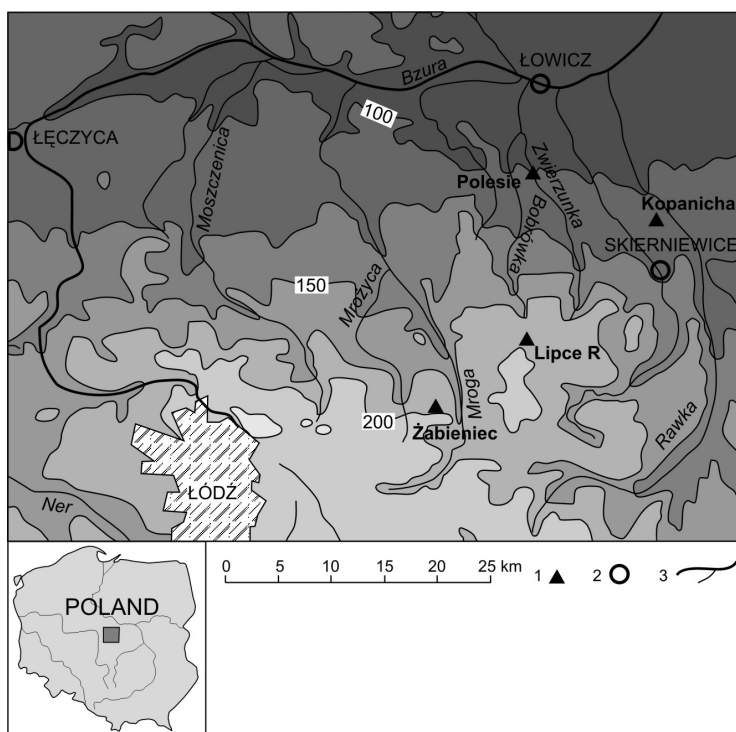


Fig. 1. Location of study sites in relation to land relief.

Explanations: 1 – location of sites, 2 – cities, 3 – rivers

This paper is based on analyses of organic and mineral deposits of small river valleys, and their record of anthropogenic changes in the natural environment of three sites: organogenic material filling an oxbow in Polesie village (in the Zwierzynka River valley), the Kopanicha fen peatland (in the Rawka River valley), and buried soil in Lipce Reymontowskie (in the Bobrówka River valley). The Polesie and Kopanicha sites are located in the southern part of the Łowicko-Błońska Plain, and are related to the lower/middle courses of right-bank tributaries of the Bzura River. The Lipce Reymontowskie site is located in the upper part of the system of the small Bobrówka River, in a denudation dry valley constituting the origin of the Bobrówka River valley. The results were also compared with the Żabieniec mire site, located in a closed-drainage cavity in the watershed zone (between the Mroga and Mrożyca River valleys). Due to the geographical location of the sites selected, it is possible to trace changes in the human activity record as well as the shift of the lower courses of the river valleys towards the upper parts of the fluvial system, up to and including the watershed.

Study results

The sites selected for analysis are located at a distance of approximately 15 km from each other. Land relief in the direct vicinity of individual sites increases in diversification the further they lie from the Warsaw–Berlin streamway axis. The lowest relative heights occur in the vicinity of the Polesie site, located in the lower course of the Zwierzynka River valley, in the zone classified as a streamway terrace. The Kopanicha fen peatland is located in the middle course of the Rawka River valley, adjacent to a high (8–10 m) erosional scarp. The highest located site (Lipce Reymontowskie) is situated in the north-eastern part of the Łódź Hills, at the riverheads of the small Bobrówka River valley, in a densely inhabited area.

Polesie. The analysis concerned an oxbow of the Zwierzynka River in Polesie, located at the eastern valley bed scarp. It originated in the Late Vistulian. It was filled with organic deposits, which accumulated in the Holocene as a periodically inundated or flooded peatland (Balwierz et al. 2009; Twardy and Forsyśiak 2011). It is located in the direct vicinity of the Polesie and Dzierzgówek archaeological sites, where traces of intensive settlement from the Neolithic Age until the end of the Iron Age have been

documented. Settlement phases are recorded both in the pollen spectrum and in the lithology of sediments filling the oxbow (Fig. 2).

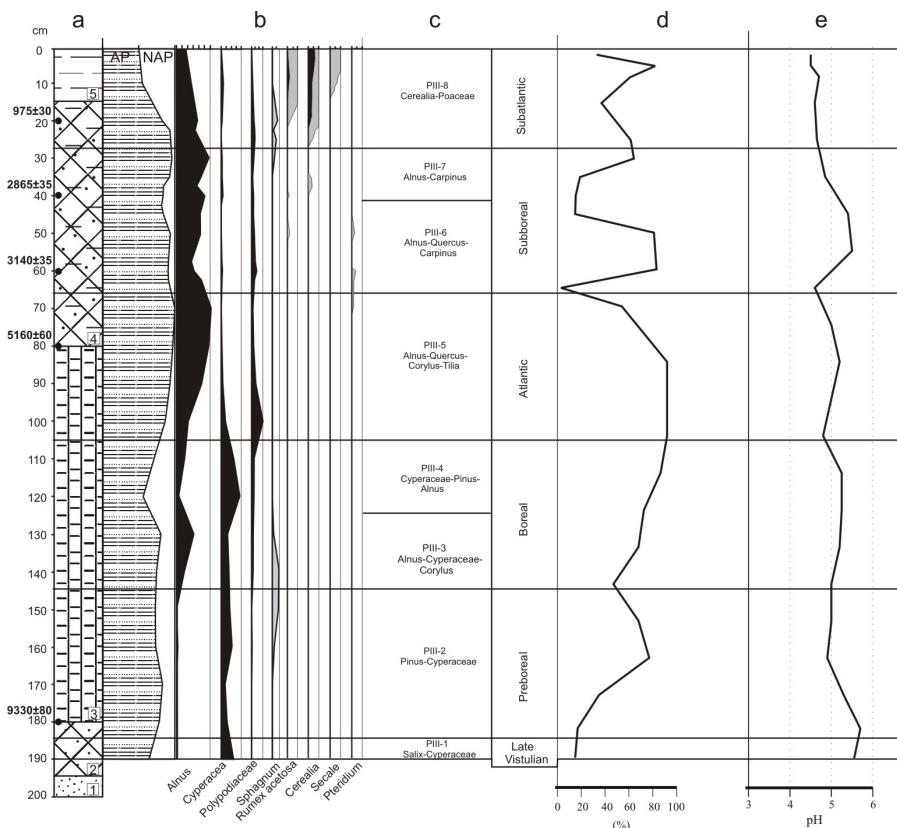


Fig. 2. Polesie region. Results of analysis of core P-III

Explanations: a – lithology: 1 – fine sands with organic interlayers, 2 – gyttja with large amounts of sand, 3 – herbaceous peat, 4 – herbaceous peat with inserts of coarse detritus gyttja, 5 – peaty formation, strongly decomposed; b – selected results of pollen analysis (Balwierz et al. 2009); c – local pollen assemblage zones and distinguished chronozones (Balwierz et al. 2009); d – content of organic matter; e – reaction

In the pollen zone of *Alnus-Quercus-Carpinus*, correlated with the older part of the Sub-boreal period (Balwierz et al. 2009), curves of *Rumex acetosa*, *Plantago lanceolata*, and *Artemisia* appear. A cereal pollen curve also appears, and *Pteridium* has the largest presence in the profile. In the above identified *Alnus-Carpinus* zone, assigned to the younger part

of the Sub-boreal period (Balwierz et al. 2009), pollen of cereals and ruderals and meadow assemblages appears again, and are reflected in a significant decrease in total NAP. Remains of macrophytes from a depth of 40 cm were dated at 2865 ± 35 years BP. Higher in the diagram, a decrease in participation of ruderals and pastures is observed, along with a lack of cereal pollen, and the total AP curve again exceeds 90%. The consecutive, uppermost *Cerealia-Poaceae* pollen zone is distinguished by a significant decrease in presence of tree and shrub pollens (Balwierz et al. 2009) and a gradual increase in presence of cereal pollens (more than 10%) and other plants typical of agricultural fields and ruderal assemblages. Additionally, the lithological features of sediments deposited in the oxbow, described in detail in another publication (Twardy and Forysiak 2011), correspond with the changes in the pollen spectrum.

Kopanicha. The peatland is currently located within the Puszcza Bolimowska forest. It occupies the western part of the lower terrace in the Rawka River valley, and is separated from the valley bed by a somewhat higher zone of the lower terrace composed of mineral formations (Kobojek, Forysiak 2011). Peatland occupies the palaeochannel. In the bed overdeepening series containing organic deposits, a core was sampled for palaeoecological analyses. In the core analysed, a record from the Atlantic period to modern times was documented (interrupted in the older part of the Sub atlantic period). The study results have already been partially presented (Pawłowski et al, in press).

In the middle course of the Rawka River valley and adjacent areas, traces of settlement were recorded from the Neolithic Age to Early Middle Ages. This is confirmed by the pollen spectrum of the profile of sediments from the Kopanicha fen peatland (Fig. 3).

Sediments of the Kopanicha fen peatland were strongly decomposed in a major part of the profile. Due to this, the degree of preservation of palynomorphs was very low, as evidenced by their very low concentrations in sections: 350–380 cm, 120–180 cm, and 20–80 cm. In samples from a depth of 220 cm, 230 cm, 300 cm, 310 cm, and 320 cm, no pollen grains were found. Due to this, interpretation of the results may involve a large margin of error. The varying resistance of pollen grains of individual taxa to unfavourable conditions and oxidation results in qualitative and quantitative disturbances. The type of deformation of polymorphs under the influence of oxidation is dependent on the character of the vegetation.

The AP/NAP ratio is overvalued in favour of AP components (Lebreton et al. 2010).

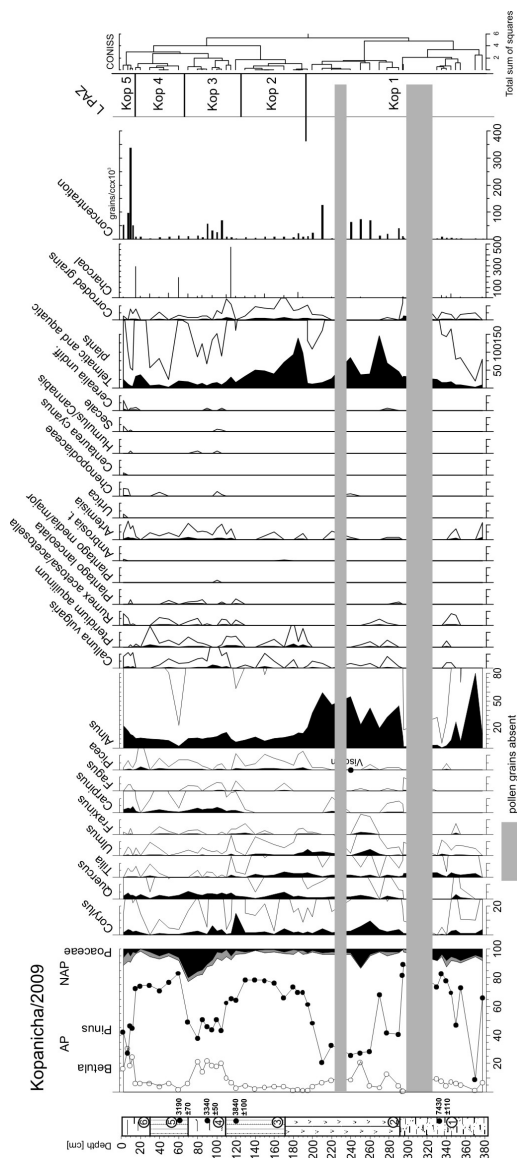


Fig. 3. Kopanicha. Simplified palynological diagram.

Explanations of lithological profile: 1 – fine sands with organic interlayers, 2 – alder swamp peat with wood, 3 – sedge peat, 4 – brown moss peat, 5 – sedge-moss peat, 6 – willow peat.

Based on the results obtained, 5 L PAZ were determined. Pollen grains of plant anthropogenic indicators are present in sediments from horizon Kop-3. An increase in the participation of AP is also observed. A low number of identified taxa, and their very low participation probably result mainly from material destruction. Horizon Kop-3 includes pollen of pasture and ruderal species (*Rumex acetosa/acetosella*, *Plantago media/major*, *Plantago lanceolata*, *Artemisia*, and *Chenopodiaceae*) and single grains of cereal pollens (*Secale* and *Cerealia* undiff.). L PAZ Kop-4 is entirely devoid of any occurrence of cereals. In sediments of L PAZ Kop-5, in addition to the aforementioned ruderals and cereals, single grains of pollen of cornflower (*Centaurea cyanaus*), nettle (*Urtica*), and *Ambrosia* were preserved.

Lipce Reymontowskie. The site in Lipce Reymontowskie is located at the riverheads of the Bobrówka River (right-bank tributary of the Bzura River), where a system of large denudational valleys developed. Some of those are dissected by impressive gullies. At the site in Lipce Reymontowskie, on sediments of the silty-sandy series from the Plenivistulian, which fill the denudation valley (Twardy 2008), a topsoil of buried black earth soil (Mollic gleysol) was recorded, with the uppermost layer dated at 1830 ± 60 years BP (LOD 877) (Fig. 4).

Buried soil underlies the sand series with an admixture of gravels, constituting a part of the accumulative fan of the gully (Twardy 2008). Pollen analysis of the buried soil horizon (Balwierz 2000) was performed on a layer with a thickness of 17 cm. The pollen material was badly corroded, and the high proportion of pollen grains which were impossible to identify decreased the interpretative value of the profile. However, the pollen spectrum shows a general trend of decreasing presence of total tree and shrub pollens, indicating that forests were gradually replaced by grass assemblages and cereal cultivation fields. The initial relatively high presence of AP (92.2%) quickly decreased to 52.2%. The bottom samples indicate an insignificant presence of cereal pollens, but in the uppermost samples it grows from 2 to 20%. In sample No. 2, rye is higher, while in the uppermost sample it is barley that has the greater presence. An increase in *Cerealia* pollen is accompanied by the presence of pollen of cornflower *Centaurea cyanaus* and single pollen grains of *Spergularia* and *Urtica*. The incidence *Artemisia* pollen gradually increases. Single spores of *Botrychium*, *Lycopodium annotinum*, *L. clavatum*, and *Pteridium* were found, with the latter reaching 0.8% (Balwierz 2000) in sample 1.

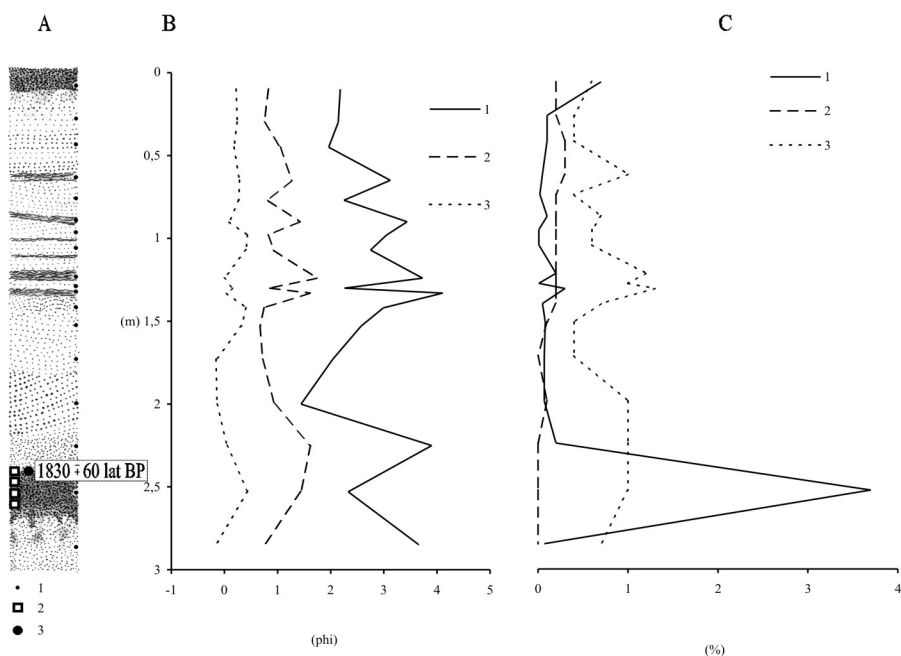


Fig. 4. Lipce Reymontowskie. A – lithological profile, B – grain size coefficients (by Folk and Ward): 1 – mean size, 2 – standard deviation, 3 – skewness, C – selected chemical properties of sediments: 1 – C (organic), 2 – CaCO₃, 3 – Fe₂O₃

Record interpretation

The Warsaw–Berlin streamway (Łowicko-Błońska Plain) zone reveals traces of settlement dating back to the older part of the Neo- and Mesolithic Periods, and even the Late Palaeolithic Age. In the area discussed, remains of settlement ascribed to the Funnel Beaker Culture are archaeologically well-documented (Balwierz et al 2009) at the Polesie 1 site. Their record in the analysed sediments of the oxbow of the Zwierzynka River is very poor, however.

The first settlement phase distinctly recorded in the environment was the period of functioning of the Trzciniec Culture. Its record in deposits in the Zwierzynka River valley constitutes laminae of overbank deposits in the analysed oxbow (a decrease in presence of organic matter to only 3%). Floods on the Zwierzynka River were caused by changes in the streamflow hydrological conditions and the unblocking of the surface run-

off on slopes, resulting in an increase in surface-water supply to the river, which in turn resulted in a higher changeability of the river stage and more frequent overbank flow. These changes were caused by the transformation or at least significant thinning of vegetation by man as confirmed in the pollen spectrum by a decrease in total NAP and the appearance of pollen of economy-related taxa.

Between 3140 ± 35 and 2865 ± 35 years BP, the peatland in the oxbow of the Zwierzynka River in Polesie was partially regenerated. Further, an increase in the flood activity of the river is recorded again, maintained throughout the periods of development in the valley of the Lusation, Pomeranian, and Przeworsk Cultures, which are documented at the Polesie and Dzieżgówek sites. The construction of the overbank deposits series of the Zwierzynka River valley bed reveals an increase in the presence of silt and clay in its grain-size composition. The source of the fine-grained material must have been glacial tills from the Wartian Glaciation, uncovered within slopes south of the site. The exposure of this heavy material to surface wash and its subsequent supply to the valley bed may have been related to the clearing of dry ground forests.

The collapse of the Przeworsk Culture settlement and the following Migration Period, during which the Łódź region became depopulated, to a large degree enabled the regeneration of the peatland in the oxbow in Polesie. The consecutive settlement phase recorded both in the pollen spectrum and in mineral deposits is correlated with the Early Middle Ages (Twardy, Forysiak 2011).

In the pollen profile from the Kopanicha fen peatland, in pollen zone Kop-1, correlated with the Atlantic period, the presence of pollen of plants related to human economy is still scarce. In the consecutive pollen zone (Kop-2), correlated with the older part of the Sub-boreal, a small share of pollen of plants indicative of human activity is already observed. A clear increase in the presence of plants related to human activity is recorded at a depth of approximately 125 cm. In the sample from a depth of 120 cm, a significant decrease in total tree pollen is observed in spite of a rapid and short increase in the presence of hazel. The local pollen zone Kop-3, at a depth between 120 cm and 60 cm, between the radiocarbon dates 3840 ± 100 years BP (MKL-554) and 3190 ± 70 years BP (MKL-618), is correlated with the period of influences of the Trzciniec Culture. Throughout the period, the high presence of pollen of economy-related plants is recorded.

In the middle part of the zone, cereal pollens are found. Zone Kop-4 reveals an initial increase in the presence of trees, and then a decrease occurring in conjunction with a higher presence of plants suggestive of human impact, but with no cereals. The low degree of preservation of palynomorphs, and the low concentration of pollen, including L PAZ, do not provide the basis for attempts to reconstruct the human activity type. This zone is correlated with the end of the Sub-boreal period, and can be related to the functioning of the Lusation Culture. The profile includes no record of the Sub-atlantic period, apart from modern times.

Although settlement in the period under discussion occurred in the Rawka River valley, the analysed deposits of the Kopanicha fen peatland include no traces of direct influence of fluvial activity or floods in the form of presence of mineral material. This is due to the location of the peatland being above the zone of that period's fluvial activity.

The profile from Lipce Reymontowskie documents flora related to the Younger Holocene, and more specifically to the Sub-atlantic (Balwierz 2000). During that time, poor forests predominated in the vicinity of Lipce, with pine, birch and alder, and significantly lower presences of hazel, lime, oak, spruce and fir. In a sample from the uppermost buried soil layer, the cereals curve reached the value of 20.4%, which is rarely observed in palynological diagrams from the period of influence of the Roman Culture from the Iron Age. The uppermost buried soil layer has been radiocarbon dated to 1830 ± 60 years BP. Under intensive deforestation by representatives of the Przeworsk Culture, soil erosion and gully processes in denudational valleys intensified.

The site on the Żabieniec mire, mentioned at the beginning of this paper, located outside river valleys and at a significant distance from the Warsaw–Berlin streamway axis, constitutes a reliable palaeoecological benchmark for the Holocene. The complex studies carried out (Twardy et al. 2010 (ed.)) reveal a continuous record of environmental development up to modern times (Fig. 5), and late (dated to the end of the 14th century) direct economic interference in the catchment of the peatland (Lamentowicz et al. 2009).

Due to this, it is possible to reconstruct features of the local natural environment with no anthropogenic influence. The site shows very late, medieval economic interference in watershed zones, particularly in the higher parts of the Łódź Hills. While it is true that the Mroga and Mrożyca River valleys (located in the vicinity of Żabieniec) already show traces

of settlement from the end of the Bronze Age, and later from the Iron Age (Kittel, Sygulski 2010), as marked in the pollen diagram by a decrease in long distance transport (Balwierz 2010), it should be stressed that, despite this fact, watershed zones remained unaffected by direct human activity.

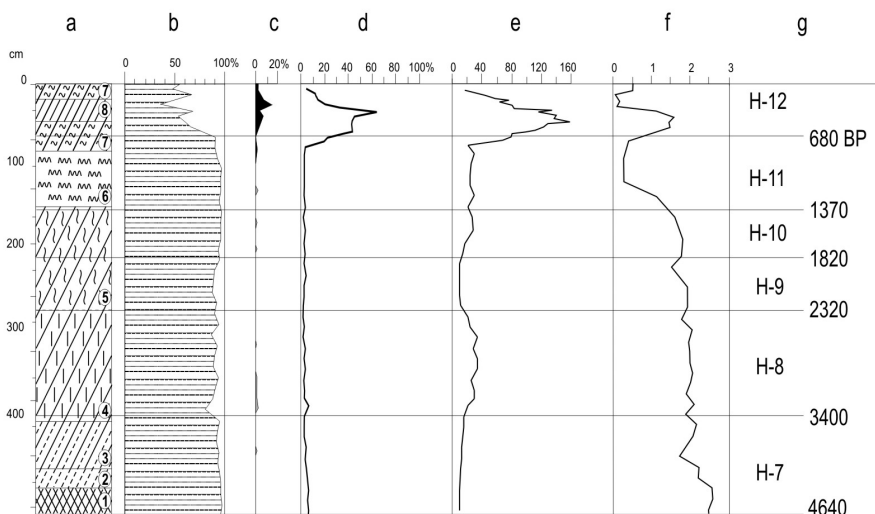


Fig. 5. Żabieniec. Selected results of analyses of core Z-2.

a – lithological profile: 1 – detrital gyttja, 2 – brown moss peat, 3 – sedge-moss peat, 4 – bog-moss peat, 5 – moss peat; 6 – sedge peat 7 – sedge-moss-bog peat; pollen analysis: b – AP/NAP ratio, c – presence of pollen of cereals; geochemical analysis: d – content of mineral matter, e – Fe/Mn ratio; f – Chironomidae analysis; g – peatland development phases and their age.

Conclusions

In the Warsaw–Berlin streamway axis zone, settlement is recorded from the beginning of the Sub-boreal (Fig. 6), and first occurred at the higher levels of the streamway in the younger part of the period. In the upper courses of small river valleys located in the Łódź Hills, it appears in the Sub-Atlantic, and in the vast watershed areas as late as the Middle Ages (Fig. 6).

The scope of the anthropogenic changes in vegetation recorded in the cores presented illustrates the process of primeval colonisation of the Łódź Hills, proceeding from the Warsaw–Berlin streamway along river valleys to their riverheads.

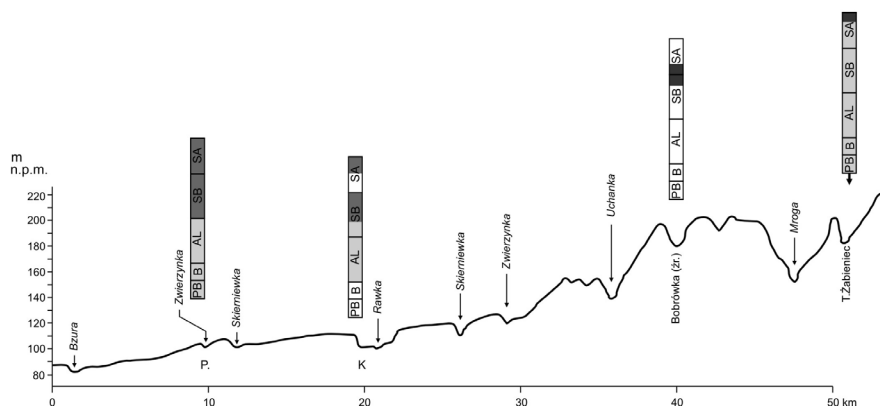


Fig. 6. Hypsometric profile with stratigraphic diagrams of sediment cores described (black – record of human activity, grey – lack record of human activity, white – lack of sediment).

Human activity recorded in the cores discussed is reflected in a decrease in the presence of AP, the appearance of species indicative of human activity, an increase in mineral matter in organic deposits, a decrease in pH, an increase in presence of elements activated by mechanical denudation, and in the results of other palaeoecological analyses.

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References

- BALWIERZ Z., 2000, Ekspertyza palinologiczna gleby kopalnej z Lipiec Reymontowskich, Maszynopis, Uniwersytet Łódzki.
- BALWIERZ Z., 2010, Analiza pyłkowa osadów torfowiska Żabieniec, [in:] J. Twardy, S. Żurek, J. FORYSIAK (eds.), Torfowisko Żabieniec. Warunki naturalne, rozwój i zapis zmian paleoekologicznych w jego osadach. Bogucki Wyd. Nauk. Poznań, 179–188.

- BALWIERZ Z., DOMAŃSKA L., FORYSIAK J., RZEPECKI S., TWARDY J., 2009, Archeologiczne i paleośrodowiskowe badania wielokulturowego stanowiska Polesie 1, gmina Łyszkowice (centralna Polska), [in:] L. Domańska, P. Kittel, J. Forysiak, (eds.) Środowiskowe uwarunkowania lokalizacji środowiska, Środowisko–Człowiek–Cywilizacja, tom 2, Bogucki Wyd. Nauk., Poznań, 281–300.
- JEWTUCHOWICZ S., 1970, Rozwój rzeźby okolic Łęczycy po zlodowaceniu środkowopolskim, Pr. Geogr. IG PAN, 85 pp.
- KAMIŃSKI J. 1993, Późnoplejstocenska i holocenska transformacja doliny Moszczenicy. Acta Geogr. Lodz, 64 pp.
- KITTEL P., SYGULSKI M., 2010, Ślady osadnictwa pradziejowego i historycznego w otoczeniu torfowiska Żabienie, [in:] J. Twardy, S. Żurek, J. Forysiak (eds.) Torfowisko Żabieniec. Warunki naturalne, rozwój i zapis zmian paleoekologicznych w jego osadach, Bogucki Wyd. Nauk. Poznań, 97–112.
- KOBOJEK E., 2000, Morfogeneza doliny Rawki, Acta Geogr. Lodz, 77, 157 pp.
- KOBOJEK E., 2009, Naturalne uwarunkowania różnych reakcji rzek nizinnych na antropopresję na przykładzie środkowej Bzury i jej dopływów, Wyd. UŁ, Łódź, 203 pp.
- LAMENTOWICZ M., BALWIERZ Z., FORYSIAK J., PŁÓCIENNIK M., KITTEL P., KLOSS M., TWARDY J., ŻUREK S., PAWLYTA J., 2009, Multiproxy study of anthropogenic and climatic changes in the last two millennia from a small mire in central Poland. *Hydrobiologia* 631, 213–230.
- LEBRETON V., MESSEGER E., MARQUER L., RENAULT-MISKOVsky J. 2010, A neotaphonomic experiment in pollen oxidation and its implications for archaeopalynology. *Review of Palaeobotany and Palynology* 162, 29–38.
- PAWŁOWSKI D., KLOSS M., OBREMSKA M., SZYMANOWSKI M., ŻUREK S., (in press), Evolution of small valley mire in central Poland as a result of hydroclimatic oscillations.
- TWARDY J., 2008, Transformacja rzeźby centralnej części Polski Środkowej w warunkach antropopresji, Wyd. UŁ, Łódź, 292 pp.
- TWARDY J., FORYSIAK J., 2006. Charakterystyka środowiska geograficznego stanowiska archeologicznego Polesie 1 i jego najbliższego otoczenia, [in:] II Sympozjum Archeologii Środowiskowej „Środowiskowe uwarunkowania lokalizacji osadnictwa”, Przewodnik terenowy, Łódź, 51–61.
- TWARDY J., FORYSIAK J., (2011). Charakterystyka środowiska geograficznego okolic stanowiska archeologicznego Polesie 1 oraz neholoceńskie zmiany jego budowy geologicznej i rzeźby. [in:] J. Górski, P. Makarowicz, A. Wawrusiewicz

(eds.), Osady i cmentarzyska społeczności trzcinieckiego kręgu kulturowego w Polesiu. T. 1. 227–245.

TWARDY J., ŻUREK S., FORYSIAK J., 2010, (eds.), Torfowisko Żabieniec. Warunki naturalne, rozwój i zapis zmian paleoekologicznych w jego osadach, Bogucki Wyd. Nauk. Poznań, 214 pp.