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SETTLEMENTS AND ECONOMY OF THE FUNNEL BEAKER CULTURE COMMUNITIES. ARCHAEOLOGICAL AND PALYNOLOGICAL EVIDENCE FROM THE ANNUALLY LAMINATED LAKE BOTTOM SEDIMENTS (GOSTYNIN LAKE DISTRICT, CENTRAL POLAND)

ABSTRACT

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Palynological information preserved in pollen diagrams is of key importance for investigating prehistoric human activity. According to M. Ralska-Jasiewiczowa (2012, 9), the results of the multidisciplinary research of annually laminated lake sediments carried out in Lake Gościąż and its surroundings in the Gostynin Lake District are of particular importance for assessing anthropopressure in the past. In light of the results of human-environment analyses, the environmental disturbances recorded in laminated bottom sediments from Lake Gościąż can be described as reflecting pollen being to some extent "a report from afar". In the analysed case, the pollen fallout may have originated from longer distances, and the recorded transformations of plant assemblages, both with respect to phase 5 and phase 6 from Gościąż, can be attributed to humans inhabiting up to 10 km from Lake Gościąż. On the other hand, the observations made in the palynological sites of Białe, Lucieńskie, and Gąsak are well-correlated with the archaeological evidence of human activity.

Keywords: pollen diagrams, Funnel Beaker Culture, economy, annually laminated sediments
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INTRODUCTION

The basis and starting point of idea of this paper is threefold: (1) human impact recorded in the annually laminated bottom sediments of Lake Gościąż (Ralska-Jasiewiczowa, van Geel 1992; 1998a; 1998b; Pelisiak and Rybicka 1998; Ralska-Jasiewiczowa *et al.* 1998; Ralska-Jasiewiczowa 2012); (2) results of palynological research on the bottom sediments of lakes Lucińskie and Białe, and the Gąsak peat bog and the human impact recorded there (Rybicka and Wacnik 2012; Wacnik and Rybicka 2012); (3) archaeological investigations, including excavations of several sites, carried out by the authors of this paper around the lakes Gościąż, Białe, Lucieńskie and the Gąsak peat bog (Pelisiak and Rybicka 1998; Pelisiak *et al.* 1994; 2006; Rybicka 2004; 2005; 2011; 2012). All these lakes and the area of archaeological research are located in the Gostynin Lake District in Central Poland. The goal of our considerations is to compare palynological and archaeological evidence of human activity. We focused on the period between 3900 and 3300 cal BC and on the settlement system, economy and impact on the landscape of the Funnel Beaker Culture (FBC) communities on the area in question.

POLLEN DIAGRAMS – CREDIBILITY OF PALYNOLOGICAL DATA

Palynological information preserved in pollen diagrams is of key importance for investigating prehistoric human activity (*e.g.* Kruk 1980; 1994; Pelisiak and Rybicka 1998; Pelisiak *et al.* 1994; 2006; Ralska-Jasiewiczowa and van Geel 1992; 1998a; 1998b; Makohonienko 2004). While generally accepted in studies on the activity of prehistoric peoples, this statement must each time be followed by numerous caveats stemming from the nature of the palynological sources themselves, the nature of the sediment from which the analysed samples were collected, the lay of the land, the prevailing wind direction, *etc.* (Makohonienko 2004, 235). The first analytical review of pollen diagrams from the territory of Poland from the perspective of their suitability for investigating the interactions between humans and the natural environment, the anthropogenic changes in the environment, and the mechanisms (land-use patterns) behind these processes was presented by Janusz Kruk (Kruk 1980, 145-173). Since pollen diagrams can be expected to contain unambiguous palynological indicators of human settlement and to record events caused by humans but also indicators reflecting a variety of natural processes, Kruk distinguished several groups of indicators of Neolithic settlement, beginning from those most ambiguous (Kruk 1980, 149).

Analyses of palynological sources for traces of human settlement should always take into account the geographic characteristics of the region and therefore all factors potentially disturbing the picture of the plant cover as emerging from the frequencies of pollens of particular species in subsequent horizons of palynological diagrams. This is particularly important with respect to areas with varied topography. The plant species structure reflected in the quantities of pollens belonging to various taxa in sediment levels corresponding to horizons of the pollen diagram is affected by both the characteristics of pollen grains of particular species (different susceptibility to wind transportation depending on size, weight, and shape) and a range of external factors. Another important factor is the difference in the amount of pollen generated by particular species, which may lead to overrepresentation of some taxa and underrepresentation of others. In the context of research on Neolithic settlement in mountainous areas (here: the Central Uplands of Germany), these factors were analysed by Paweł Valde-Nowak, who used observations made by other researchers as well (Valde-Nowak 1995). In fact, Valde-Nowak's observations remain valid for all landscapes, and call for a critical approach to palynological data and, by implication, to caution in formulating conclusions concerning human activity based on this category of evidence (*cf.* Makohonienko 2004, 236). The measurements of contemporary pollen fallout above the upper forest limit, carried out in the Alps by Maren Jochimsen, have produced interesting, and surprising, results (Jochimsen 1986; Valde-Nowak 1995, 62). Measurements taken in the same place in different years produced completely different results in terms of proportions of AP and NAP. A separate issue was the recorded inversion of the pollen picture in relation to the actual vegetation – AP values exceeding 82% were recorded in areas devoid of forest, while forested areas produced NAP values exceeding 73% (Jochimsen 1986, 219, table 3). These data, cited by Valde-Nowak (Valde-Nowak 1995, 62), demonstrate how topography, wind direction, forest cover, and weather can disturb the picture of plant cover reconstructed on the basis of pollen frequencies of various plant species.

Particular horizons of pollen diagrams provide us with a cumulated record of flora from the area immediately adjoining the place where the palynological samples were collected and, to a varying extent, with information concerning plants growing at some distance, sometimes quite a significant one, from the investigated palynological site. The crucial factor determining pollen transport is wind, with a lesser role played by water, birds, and insects. The forest cover, and the resulting zonal nature of pollen transportation within the forest and above it, is also important (Tauber 1965). The role of forest as a factor indirectly connected with pollen transportation, and therefore indirectly affecting the proportions of pollens of particular taxa in particular horizons of a diagram, is quite obvious. The findings of Henrik Tauber cited above can have a wide application in this respect.

Taking into account the various factors affecting the distribution of pollen, Herbert Straka distinguished five zones from which pollen grains recorded in settlements originate (Straka 1975, 74, 75; Valde-Nowak 1995, 62). The first zone encompasses the area of the peat bog or lake from which the sample was collected, and its shores. This area is marked by a pattern of local deposition of pollen. The second zone is the area within 500 m from the peat bog or lake, the next one extends to 10 km, another one from 10 to 100 km, and the last zone is over 100 km. As emphasised by Straka, the vast majority of pollen originates from an area within a 10 km radius, while the percentage of pollen grains transported over longer distances (long-distance transportation) is usually insignificant. However, their quantities may increase in areas devoid of forest or those where the forest cover is sparse (Valde-Nowak 1995, 62).

Pollen dispersion depends considerably on the horizontal movements of air masses (Tauber 1965; Straka 1975, 166; Valde-Nowak 1995, 63). Wind direction and strength are linked with topography, and the transportation of pollen is affected by plant cover as well. Both these factors are crucial in the dispersal of pollen grains, and as a result they affect the frequencies of particular taxa in pollen spectra. Three basic horizontal zones of pollen transportation can be distinguished for forested areas. The lowermost zone is the area among the trees. The air moves the slowest there (0.5-1.5 m/s), and the trees create a natural barrier hampering pollen dispersal. As a result, pollen spectra from woodlands contain primarily the material from the peat bog/lake and its immediate vicinity. In the second zone (immediately above the treetops), the speed of air movement is 2-6 m/s. Pollen grains can be transported over longer distances, which means that the pollen represents local vegetation. The third zone encompasses higher strata of the atmosphere, where winds can blow with a speed exceeding 4 m/s. This is a natural route for pollen to disperse over significant distances. This zone links with the regional component in pollen diagrams (Valde-Nowak 1995, 63). A separate issue is the impact of the size of the peat bog or body of water from where the samples were collected on the proportions of pollen originating from immediate, local, and regional fallout. Experimental research has revealed interesting regularities in this respect. Simply put, the respective proportions of taxa belonging to immediate, local, and regional components in small peat bogs (100-200 m in diameter) are 80%, 10%, and 10% of pollen grains, while in large peat bogs these proportions are 10%, 70%, and 20%, respectively (Valde-Nowak 1995, 63, 64). These observations are of particular importance for the lakes of the Gostynin Lake District (Fig. 1; Ralska-Jasiewiczowa *et al.* 1998; Pelisiak *et al.* 2006; Rybicka and Wacnik 2012). Using the above size categories, most of these lakes represent large water bodies (exceeding 200 m in diameter). Therefore, the structure of the pollen spectra from the Gostynin Lake District reflects above all the local pollen component, and to a much lesser extent the immediate and regional components (Pelisiak *et al.* 2006). This conclusion has significant research implications: it means that the picture recorded in the pollen diagrams should primarily be analysed in the context of and referring to the human activity in an area within a radius of 10 km from the palynological sites. In light of the above, in order to verify the credibility of information from pollen diagrams collected from the laminated sediments of Lake Gościąż, similar analyses were carried out in the surroundings of Lakes Białe and Lucieńskie and the Gąsak peat bog, situated around 10 km south of the benchmark palynological site mentioned above (Pelisiak *et al.* 2006; Rybicka and Wacnik 2012).

The discussion on the interpretation of palynological diagrams can be additionally revived by information published by Mirosław Makohonienko (2004, 236) concerning two important issues: the extent to which the size of the area under cultivation is reflected in palynological diagrams and how large an area needs to be deforested for a significant decline in AP to be recorded. As demonstrated by experiments, in some cases in boreal forests even cultivated fields as large as 2500 ha may find no reflection in a pollen fallout recorded merely 250 m away, and deforestations of a range of 4100-2500 ha may not translate into a decline in AP in a diagram from a lake surrounded by forest (Makohonienko 2004, 236). As emphasised by Makohonienko (2004, 236), this is precisely why we can notice only a "weak reflection of Neolithic deforestations in pollen diagrams, with the cleared areas used as cultivated fields surrounded with forests...".

An additional factor of great importance for assessing the credibility of reconstructing human-environment relations is the state of research on settlement in the areas surrounding palynological sites.

PALYNOLOGICAL EVIDENCE OF HUMAN ACTIVITY FROM THE GOSTYNIN LAKE DISTRICT

Lake Gościąż

According to M. Ralska-Jasiewiczowa (2012, 9), the results of the multidisciplinary research of annually laminated lake sediments carried out in Lake Gościąż and its surroundings in the Gostynin Lake District (Fig. 1-2) are of particular importance for assessing anthropopressure. A monograph published in 1998 set the palynological data against the archaeological evidence uncovered during surface surveys and excavations carried out within a radius of 5 km from the lake, and against data – at that time relatively sparse – originating from more distant parts of the region (Pelisiak and Rybicka 1998). The problems with unambiguous identification of human communities responsible for the more or less evident (and very well-dated) disturbances in the natural environment discernible in the diagram from Gościąż were interpreted at that time as reflecting either the poor development of the ancient settlement network in the immediate surroundings of the lake, or its insufficient investigation (Pelisiak and Rybicka 1998). The latter argument was raised in particular with respect to the Neolithic and the Bronze Age, periods manifested in the pollen record by intensive environmental transformations, which contrasted with the archaeological data from the lake's surroundings (up to 5 km), suggesting a low intensity of occupation (Pelisiak and Rybicka 1998; Pelisiak *et al.* 2006). This gave rise to the question of whether the indicators of human activity clearly discernible in the diagram reflect a human presence in more distant areas, up to 10 km or more, or the pollen represents the third or fourth fallout zone in Straka's classification (Straka 1975, 74-75; Valde-Nowak 1995, 62).

When considering the evidence from the bottom deposits relating, to the effects on the landscape of the FBC communities on the area in question, phase 5 and 6 of human impact

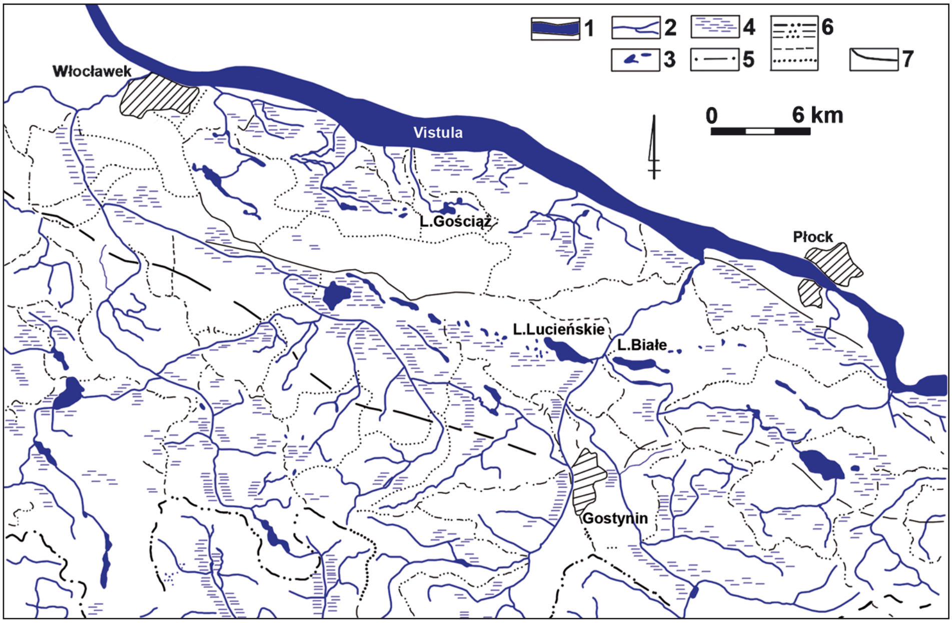


Fig. 1. Hydrology of the Gostynin Lake District (after Pelisiak *et al.* 2006):
1 – Vistula; 2 – streams; 3 – lakes; 4 – bogs; 5 – Vistula-Odra watershed; 6 – watersheds of lower orders; 7 – scarp of morainic plateau'

on vegetation are of particular importance (Ralska-Jasiewiczowa, van Geel 1998; Pelisiak *et al.* 2006).

Phase 5. What deserves particular attention are changes in plant cover dated around 3900-3600 BC, which represent phase 5 of anthropogenic disturbances distinguished in the Gościąż diagram (Fig. 2; Pelisiak *et al.* 2006, 209). According to M. Ralska-Jasiewiczowa (1998a), its beginning correlates with a decline in elm (*Ulmus*), as is also the case in the diagram from Nasiłów in Kuyavia (Makohonienko 2008, 364-365). The proportion of birch (*Betula*) declines in the Gościąż diagram, while the percentages of *Corylus* and *Populus* (*tremula* type) increase, and the increase in oak (*Quercus*) is less evident. The proportion of spruce (*Picea*) drops, and juniper (*Juniperus*) appears. Permanent fluctuations can be observed in *Quercus* and *Corylus*. The proportions of NAP (*Gramineae*, *Artemisia*) and ruderal plants (*Urticadioica*, *Plantago major*, *Chenopodiaceae*) show a rise. In addition, pollens of *Frangula alnus*, *Humulus lupulus*, *Solanum dulcamara*, and *Thalictrum* were recorded, which suggests openings in alder forests. At the same time, changes in deciduous forests are reflected in the Gościąż diagram by *Melampyrum* and *Pteridium aquilinum*, and *Calluna vulgaris* and *Juniperus* appear in dry places. Species like *Plantago media* and Anthericum appear in forest openings. Single grains of wheat pollen were also identified, providing direct evidence of the presence of Neolithic communities. These

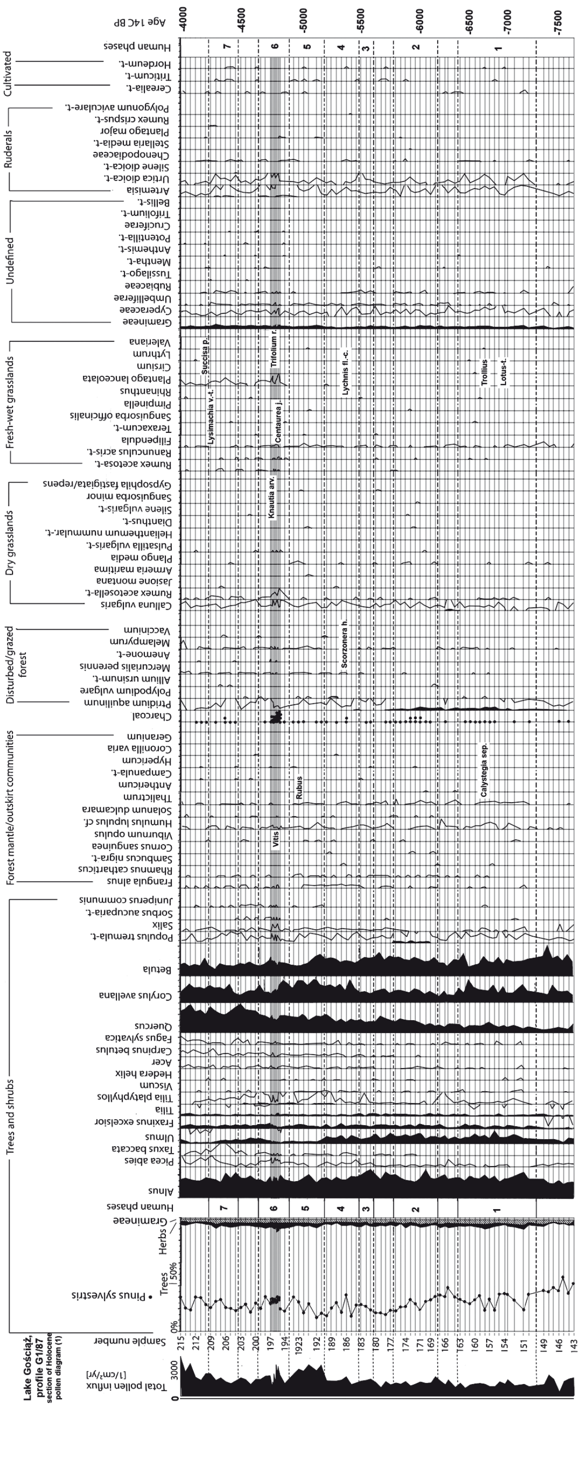


Fig. 2. Lake Gościąż. Kujawsko-Pomorskie voivodship. Pollen diagram referring to the period 7500-4000 BC (after Ralska-Jasiewiczowa and van Geel 1998 a)

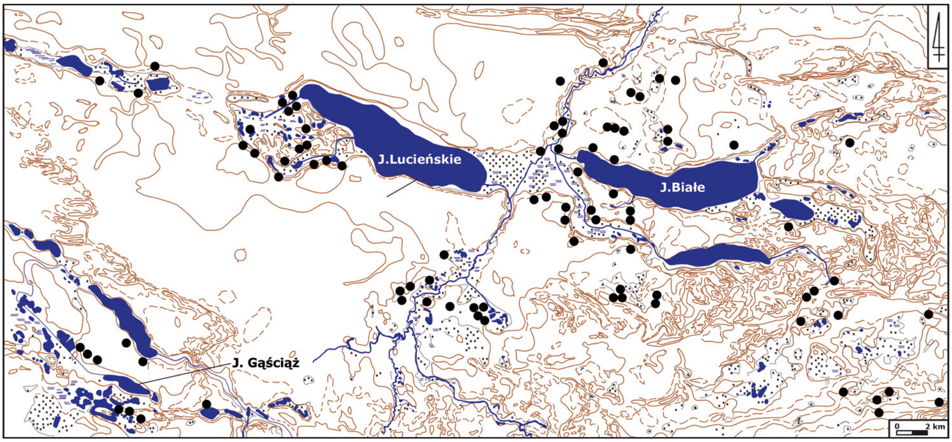
changes were interpreted, first of all as evidence of forest grazing and collecting forest fodder for animals (Ralska-Jasiewiczowa, van Geel 1998a, 272; Pelisiak *et al.* 2006, 22).

Phase 6. The activity of Neolithic farming populations is even more evident in the Gościąż diagram during phase 6 of anthropogenic disturbances dated to 3600-3200/3100 BC (Fig. 2; Pelisiak *et al.* 2006, 109-110). Its beginning is marked by increased frequency of ruderal plants: *Plantago major*, *Artemisia*, and *Chenopodiaceae*. The curves of hazel (*Corylus*), oak (*Quercus*), elm (*Ulmus*), and ash (*Fraxinus*) initially decline to later increase, and the same can be said about the pollens of pine (*Pinus*), birch (*Betula*), aspen (*Populus tremula*), willow (*Salix*), and rowan (*Sorbus aucuparia*). Sorrel (*Rumex acetosa*), brown knapweed (*Centaurea jacea*), white clover (*Trifolium repens*), and many others grew in open meadows. There was a marked presence (1.5%) of ribwort plantain (*Plantago lanceolata*). Deforestations of dry habitats is evidenced, among others, by sorrel (*Rumex acetosella*). The sediment corresponding to that phase also contained large amounts of charcoal dust, possibly indicative of intensive, intentional burning of forests (Pelisiak *et al.* 2006, 22, 109). The proportion of the pollen of elm (*Ulmus*) declines. Phase 6 closes with a depression of ruderal plants and *Plantago lanceolata*.

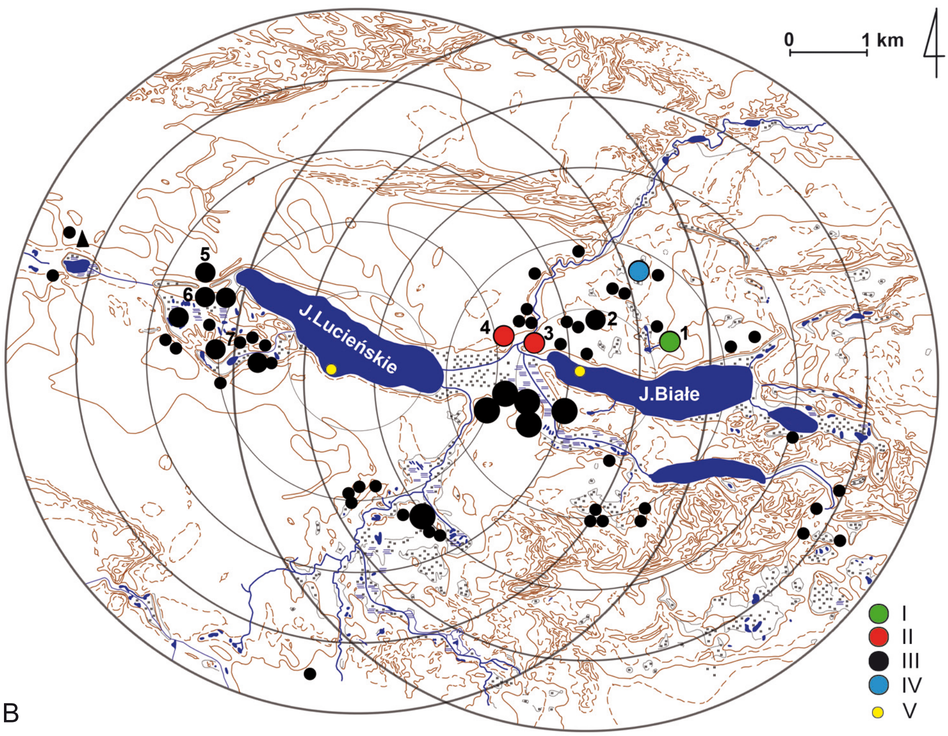
It should be also noted that M. Ralska-Jasiewiczowa and B. van Geel (1998a) identified three cycles of human activity within phase 6. In their opinion, the first one involved the appearance of human groups and settling of the area, evidenced by the spread of *Artemisia*, *Chenopodiaceae*, and *Plantago major*. The second cycle involved increased deforestation and creation of pastures, evidenced by a high proportion of NAP, a decline in deciduous trees, and a rise in pioneer tree species and pollens of nettle and plants typical of open areas. The last cycle was marked by decreased intensity of animal grazing and the return of vegetation to abandoned areas, as shown by the increase in pollens of *Artemisia*, *Pteridium aquilinum*, *Taxus*, *Juniperus*, *Corylus*, and trees (*Fraxinus*, *Ulmus*, *Quercus*).

Lakes Białe and Lucieńskie, and the Gąsak peat bog

To verify these findings, a research project entitled "The impact of Prehistoric and Medieval Societies on the Natural environment of the Gostynin Lake District, Central Poland" was carried out in successive years by M. Rybicka and A. Wacnik (Rybicka and Wacnik 2012). The research included collecting sample cores from laminated lake sediments in places varying in terms of the intensity of prehistoric occupation in their surroundings. Diagrams obtained for Lakes Białe and Luteńskie and the Gąsak peat bog (Wacnik and Rybicka 2012), sites situated approximately 10 km south of Lake Gościąż, were analysed. The intensity of Neolithic settlement around these three palynological sites was different from that around Lake Gościąż (Fig. 3: A, B; Rybicka 2012). It should be also noticed that unfortunately, the changes of the environment recorded in the pollen diagrams of Białe and Lucieńskie lakes and the Gąsak peat bog do not have as precise a chronology as those from the bottom sediment of Lake Gościąż (Wacnik and Rybicka 2012).



A



B

Fig. 3. Location of the FBC sites. A – in the vicinity of lakes: Gąsak, Białe and Lucieńskie. B – in the vicinity of lakes Białe, Lucieńskie. I – "Wiórek" settlement sites; II – Late Wiórek settlement sites; III – Funnel Beaker settlement points of undetermined chronology; IV – "Luboń" settlement sites; V – palynological sites; 1 – Białe, Site 14, Gostynin district; 2 – Klusek Biały, Site 28, Gostynin district; 3 – Klusek Blały, Site 7, Gostynin district; 4 – Lucień, Site 12, Gostynin district; 5 – Budy Lucieńskie, Site 1, Gostynin district; 6 – Budy Lucieńskie, Site 9, Gostynin district.

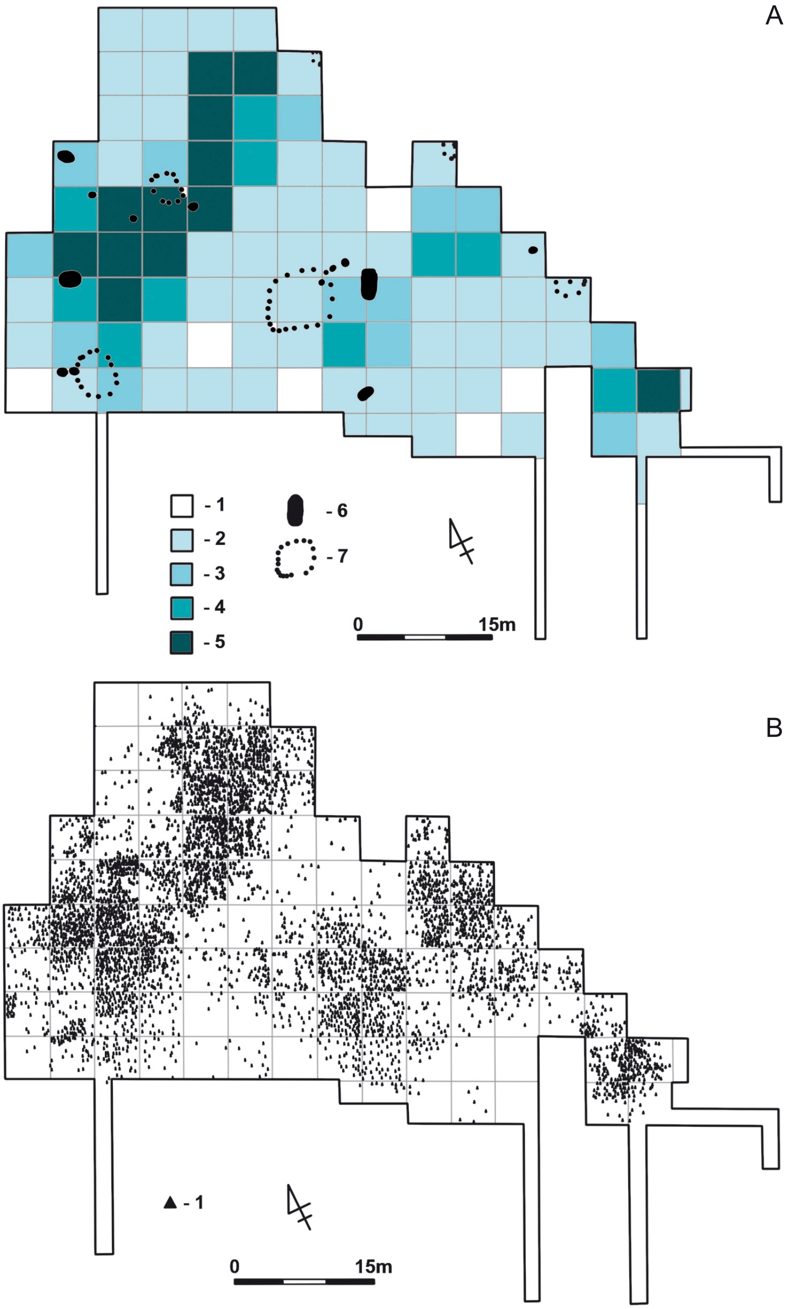


Fig. 4. Annopol, Gostynin District, Site 1. A – Frequencies of FBC pottery in the layers of the excavation unit. 1 – absence of pottery; 2 – 0,1-0,5 kg; 3 – 0,51-1,00 kg; 4 – 1,01-2,00 kg; 5 – 2,01-3,00 kg; 6 – more than 3 kg; 7 – concentration of daub; B – Scatter pattern of the FBC pottery

Summing up the results of the palynological analyses, it was concluded that distinct anthropogenic intervention in the woodland environment took place *c*. 3800-3700 BC around both Lake Białe and Lake Gąsak, detectable in a distinct reduction of *Ulmus*, a less significant reduction of *Fraxinus* and *Betula* (Wacnik and Rybicka 2012), and, around Lake Białe, of linden and pine as well. Changes observed in these diagrams correlate with phase 5 of the anthropogenic disturbances in the Gościąż diagram. Around 3810-3640 BC, a rise in concentrations of large charcoal fragments is observed. This is earlier than the dating of phase 6 of anthropogenic disturbances in Gościąż, marked by distinct traces of forest burning. The phenomenon recorded in the diagram from Lake Białe corresponds with phase 5 of anthropogenic disturbances in Gościąż, dated to around 3960-3600 BC (Pelisiak *et al*. 2006, 109). According to the authors of the analysis of environmental transformations in the vicinity of Lakes Białe and Lucieńskie and Gąsak peat bog, the decrease in the proportion of trees in plant assemblages around Lake Białe led to the increased frequency of light-loving shrubs (*Corylus*, *Juniperus*, and *Populus*). The appearance of a park structure was also recorded in that period in forest communities around Lake Gąsak (Wacnik and Rybicka 2012, 178), where *Sambucus nigra* shrubs started to grow, possibly accompanying human settlements. Around 3510 BC, declines in curves of *Fraxinus* and *Quercus*, and later *Ulmus* as well, were recorded in the diagram from Lake Lucieńskie, as well as an increase in the proportions of *Corylus*, *Betula*, and *Alnus*. The growing size of deforested areas resulted in increased proportions of herbaceous plants such as *Rumex acetossella*. *Cerealia* appeared as well. In the discussed period, the high percentage of *Corylus* in the diagram from Lake Białe possibly suggests the emergence of deforested areas nearby, with vegetation of the meadow type. An increase in *Alnus* and *Acer* was not particularly discernible in that diagram, possibly because herbaceous plants intensively grazed by animals did not produce much pollen (Wacnik and Rybicka 2012, 172). Around 3460-3140 BC, the percentage of herbaceous plants (like *Artemisia*, *Chenopodiaceae*, *Plantago lanceolata*, and *Rumex acetosella*) distinctly rises in the Lake Białe diagram, and *Centaurea jacea*, *Aster*, *Plantago media*, and *Rumex acetosa* appeared. However, no cultivated plants were recorded. *Plantago lanceolata*, associated with poorly grazed meadows (Makohonienko *et al*. 1998; Makohonienko 2004), appeared around the Gąsak peat bog about 3470 BC, and in the diagram from Lake Lucieńskie circa 3110 BC (Wacnik and Rybicka 2012, 178, 182). In the diagram from Lake Białe, fire indicators started to disappear around 3460-3330 BC, and a brief regeneration of forests with elm, oak, and linden took place *c*. 3240 BC, accompanied by increased proportions of pollens of *Poaceae* and *Artemisia* and a slight increase in *Rumex acetosa* and *Centaurea jacea*. This speaks for open areas with meadow-like vegetation, where animals could be grazed. Concentrations of charcoal increased again around 3240-3010 BC, possibly indicating continuation of local forest burning for the needs of intra-forest economy. Later, the percentage of herbaceous plants increases again.

A comparison of the evidence of human activity recorded in pollen diagrams from Gościąż and Białe lakes and the Gąsak peat bog led to the conclusion that similar tendencies of environmental changes occurred there: fluctuations of *Ulmus* values, evidence of forest clearings including presence of charcoal in the sediments, occurrence of formations of opened land, frequencies of ruderal taxa, and not considerable presence of *Cerealia* except phase 5 from Lake Gościąż and the period about 3500 BC in the diagram from Lake Lucieńskie.

FUNNEL BEAKER CULTURE IN THE GOSTYNIN LAKE DISTRICT. ARCHAEOLOGICAL EVIDENCE

In the fourth millennium BC, the Gostynin Lake District started to be settled by communities representing the FBC, marking the beginning of Neolithization of the region (previously first clearances had been locally opened in compact forest cover by Mesolithic groups: Pelisiak *et al.* 1994; 2006). This area did not offer sufficient environmental condition for early Neolithic people, and the presence of LBK settlements has not been recorded in the Lake District itself (Rybicka 2004; Pelisiak *et al.* 2006). LBK groups occupied Kuyavian areas with heavy, fertile soils, suitable for their mode of agriculture (Czerniak 1994), which were absent in the Gostynin Lake District.

FBC communities inhabited the entire area of the Gostynin Lake District, although the settlement network cannot be described as compact or well-developed (Rybicka 2004). In general, the chronological framework of FBC settlement in the Gostynin Lake District can be currently set as spanning from around 3800/3700 to 3200/3100 BC. A total of 240 settlement points (settlements and campsites) of this culture have been identified in the eastern part of the region. However, monumental tombs of the type known from Kuyavia have not been found there (Rybicka 2004; 2006).

The short-term FBC settlements in the Gostynin Lake District occupied an area of 0.5 ha each and were inhabited by groups of several dozen people. The settlements were often relocated, with good examples known from the vicinity of lakes Białe and Lucieńskie. Apart from settlements chronologically corresponding to phase 5 of the anthropogenic disturbances identified in Gościąż, settlement clusters in this area also included settlements correlating with phase 6, situated at a distance of a few kilometres from each other (*e.g.* Klusek Biały Site 7, Klusek Biały Site 28, and Białe Site 14). In the best-investigated parts of the Gostynin Lake District, settlements of similar chronology were established at least 4-5 km from each other (Rybicka 2004), and their inhabitants exploited an area within a radius of 4 km from the dwellings (Pelisiak *et al.* 2006, 34-44). However, the immediate vicinities of settlements seem to have played the major role in the economy (Rybicka 2004; Pelisiak *et al.* 2006, 44), as was demonstrated, for example, by research on LBK in Kuyavia (Nalepka 1999; Grygiel 2004), which confirmed hypotheses previously expressed in the literature (Kobyliński 1986; Kruk *et al.* 1996).

Period 3900-3600 BC

In the Gostynin Lake District, no remains linkable with the AB phase of the Sarnowo type have been identified (Rybicka 2004; 2012; Pelisiak *et al.* 2006). The chronology of that phase currently remains debatable (*e.g.* Nowak 2009; Rybicka 2011), and its beginnings can be placed in the early centuries of the 4th millennium BC (Papiernik and Brzejszczak 2018), which would correspond with phase 5 of the anthropogenic disturbances distinguished in Gościąż (Pelisiak *et al.* 2006). FBC settlements from the Gostynin Lake District included small, short-term settlements (up to 0.5 ha in size) linked with the younger stages of the Sarnowo phase/early Wiórek phase, such as Helenów Site 1 and Klusek Biały Site 28 (Rybicka 2004; 2005), or with the early stage of the Wiórek phase (*e.g.* Grzybów Site 23 and Witoldów Site 1; Rybicka 2004). They were found in different parts of the discussed region, including 10 km south of Lake Gościąż, near the palynological site of Białe and Lucieńskie at a distance of 1-3 km from them. It should be also emphasized that repeated surface surveys carried out in the forested surroundings up to 5 km around the Lake Gościąż have not revealed FBC sited dated to the period 3900-3600 BC.

FBC communities of that period established their settlements in environments resembling primeval forest, as evidenced by disturbances recorded in the diagram from Lake Białe around 3800-3600 BC, with an increase in the fraction of large charcoal fragments indicative of the burning out of forests. These changes may have been caused by the activity of inhabitants of the settlement at Klusek Biały Site 28, which was occupied in this period (Rybicka 2005). As for Lake Gosciąż, phase 5 is characterised there by the presence of wheat pollen and by evidence for forest clearances, although no human groups potentially responsible have been identified. Settlements of that date (Klusek Biały Site 28) situated in a cluster 10 km south of Gościąż produced no direct evidence of agriculture, such as plant macro-remains or osteological remains (Rybicka 2005), and they only yielded tools (sickles) made of imported chocolate flint (Dobrzyński 2014). No house remains have been found either (Rybicka 2005).

Period 3600-3300 BC

Of particular interest are FBC remains representing the period between 3600 and 3300 BC (Rybicka 2004), which means corresponding with phase 6 of the anthropogenic disturbances identified in the laminated sediments of Lake Gościąż (Pelisiak *et al.* 2006). No permanent FBC settlements from that period have been found close to Gościąż, but they were identified 10 km further south-east, around Lake Białe and the Gąsak peat bog (Fig. 3A; 3B; Rybicka 2012). These settlements form chronologically and functionally diversified clusters there, which are comprised of settlements from the early Wiórek phase (*e.g.* Klusek Biały Site 28) and the classic phase; examples of the latter are Białe Site 14, Klusek Biały Site 7, and Lucień Site 12 (Rybicka 2004; 2012). One can observe settlement

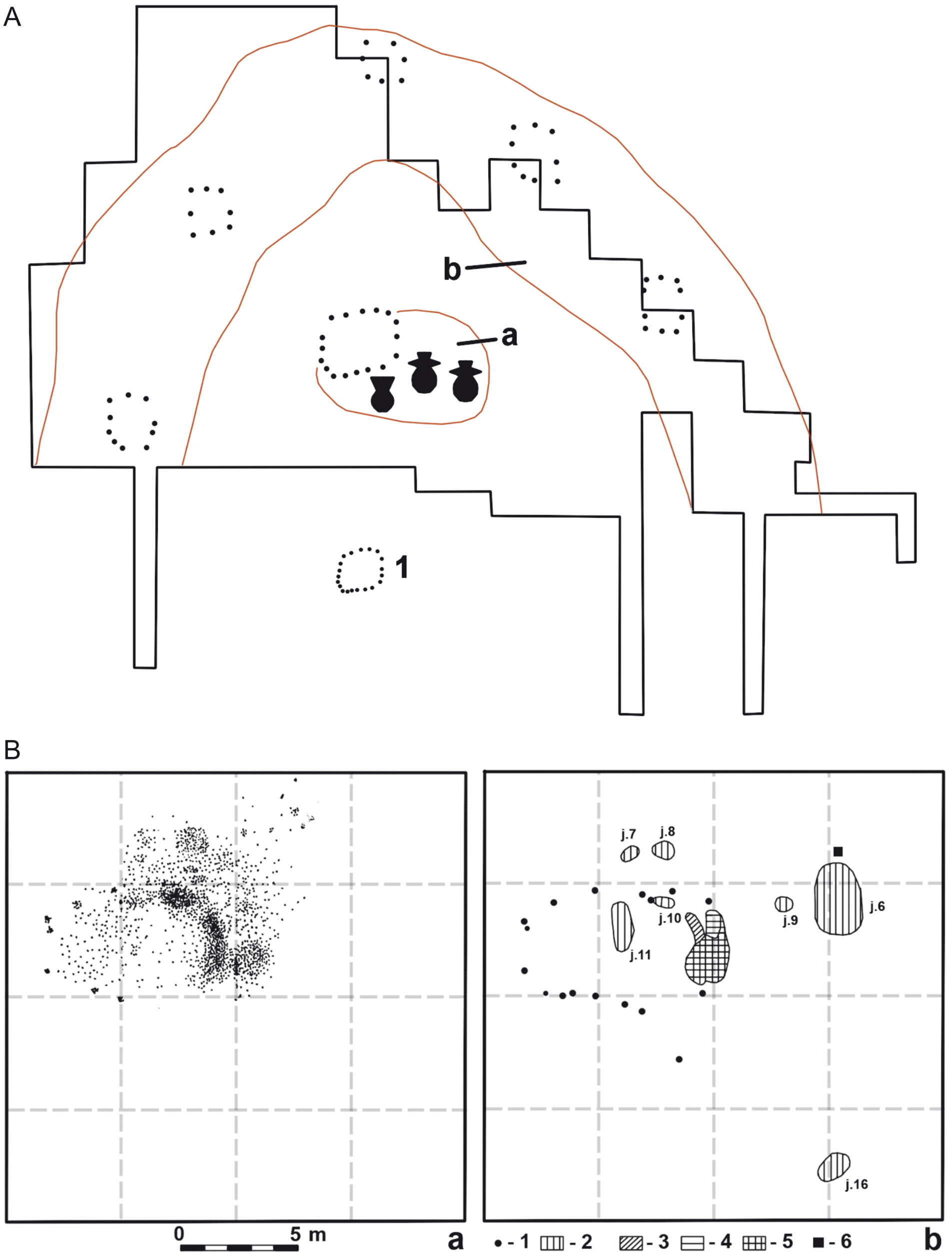


Fig. 5. Annopol, Gostynin District, Site 1. A – scheme of the settlement organization: a-utility-ritual area; b – utility area; 1 – houses (after Rybicka 2004). B – house no. 3 (after Papiernik and Rybicka 2002): a – distribution of daub within a concentration denoted as house no. 3: layer III (level 40-50 cm); b – distribution of settlement pits in the vicinity of house no. 3; 1 – post holes; 2 – pits; 3 – layer of daub; 4 – layer of clay; 5 – layer of clay with admixture of an undetermined substance of light grey colour; 6 – quernstone

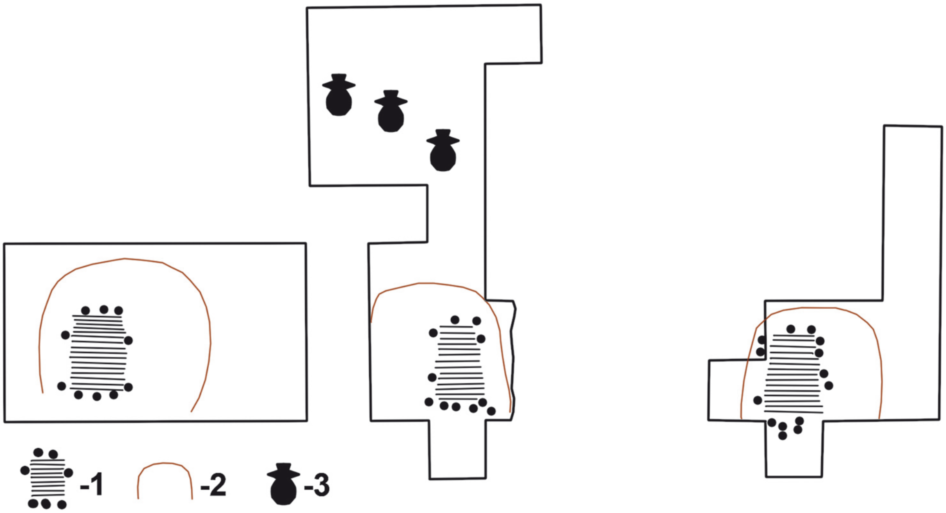


Fig. 6. Białka, Site 2, Gostynin district. Scheme of the settlement organization.
1 – houses; 2 – household area; 3 – ritual area

shifts within a small area (Klusek Biały Site 28 and then Białe Site 14, Klusek Biały Site 28, and Lucień Site 12). This may have translated into disturbances of plant cover becoming established in that area, evidenced in pollen diagrams by indicators characteristic of forest openings. Also, as was signalized above, *Cerealia* pollen grain are present in pollen diagram from Lucieńskie Lake; this group of plant remains is however, absent in FBC sites located around this lake (Rybicka 2004; 2012).

Remains of FBC datable to 3600-3300 BC were also recorded in more distant areas of the Gostynin Lake District. Examples include the relatively short-lived settlements in Annopol Site 1 (Fig. 4-5), Stefanów Site 3, and Białka Site 2 (Fig. 6), situated from 10 to 30 km from the above-mentioned palynological sites. These settlements differ in terms of their spatial arrangement (Fig. 4, 5; Papiernik and Rybicka 2002; Rybicka 2004), and they were inhabited by groups of several dozen people. Occupying an area of 0.5 ha, the settlement at Annopol Site 1, the best-excavated FBC Site in the Gostynin Lake District (and possibly representative for the region), yielded six dwellings manifesting themselves by concentrations of daub (Fig. 5: A, B; Papiernik and Rybicka 2002). They were arranged in an oval, with the largest dwelling in the centre (Fig. 5: A). The features arranged around the central area were also dwellings, and their surroundings were used for various economic activities (Rybicka 2004, 195-197). All the houses were surrounded by yards of differing sizes. The central house probably served some other social role as well, and the area around it possibly had some ritual meaning, as suggested by the prevalence of collared flasks among the pottery discovered there. In Białka Site 2 (Fig. 6), features manifesting themselves as daub concentrations were arranged in a row, while the centre of the site was a ritual area, where no other pottery than collared flasks was found (Rybicka 2004). In general, these settlements were built according to a plan.

ARCHAEOLOGICAL AND ARCHAEOBOTANICAL DIRECT AND INDIRECT EVIDENCE OF PLANT CULTIVATION FROM FBC SITES IN THE GOSTYNIN LAKE DISTRICT

The location of FBC settlements on acid soils has affected the state of preservation of organic remains, with the discovered osteological remains being few and fragmented. Remains belonging to sheep/goat, pig, hare, deer, and birds were identified in the assemblage from Annopol Site 1, and a similar set of species was identified at Białka Site 2 (Rybicka 2004, 233). Cattle remains have not been found. The presence of hare – an animal typical of open habitats (Makarowicz 1998, 236) – is indicative of the presence of deforested areas around the settlements in question. No macroscopic plant remains have been recorded except those preserved in pieces of daub. The analyses of small samples from Białka Site 2 and Annopol Site 1, carried out by A. Bieniek, revealed two glume bases of hulled wheat (*Triticum* sp.), two impressions of einkorn (*Triticum monococcum*) wheat spikelets, and one impression of glume bases of einkorn wheat in Białka. The sample from Annopol contained two spikelet impressions of *Triticum monococcum* and one of einkorn wheat (Rybicka 2004, 231). These are direct indicators of cereal cultivation. Among indirect evidence, one can mention numerous quern stones (Fig. 7; five from Annopol Site 1, one from Huta Nowa Site 1, and six from Grzybów Site 43), sickles (Papiernik and Rybicka 2002; Dobrzyński 2014), and axes (Rybicka 2004, 228-232). In the Annopol settlement, 2 or 3 macrolithic artefacts made of Volhynian flint, 1 or 2 axes of Świeciechów and banded flint, and 1 to 3 tools of chocolate flint were found close to each house, demonstrating that all the inhabitants had access to imported raw materials from which the tools necessary in the agricultural works were made (Papiernik and Rybicka 2002). Finished lithic artefacts made from types of stone originating from south-eastern deposits were also used by people from other settlements, both from the area of Lakes Białe, Lucieńskie, and Gąsak (Białe Site 14, Huta Nowa Site 1; Rybicka 2004, 211; Dobrzyński 2014) and those situated more than10 km from Lake Gościąż (Białka Site 2, Stefanow Site 3; Rybicka 2004).

In summary, agricultural activity of FBC communities from the Gostynin Lake District in the period of 3600-3200 BC is known primarily from indirect evidence originating from archaeological excavations (sickles, quern stones), while direct evidence (wheat macro-remains, bones of domesticated animals; Fig. 8) is less abundant. Nevertheless, the indirect evidence provided by archaeological research, in the form of quern stones, sickles made of imported raw materials, and scarce cereal macro-remains

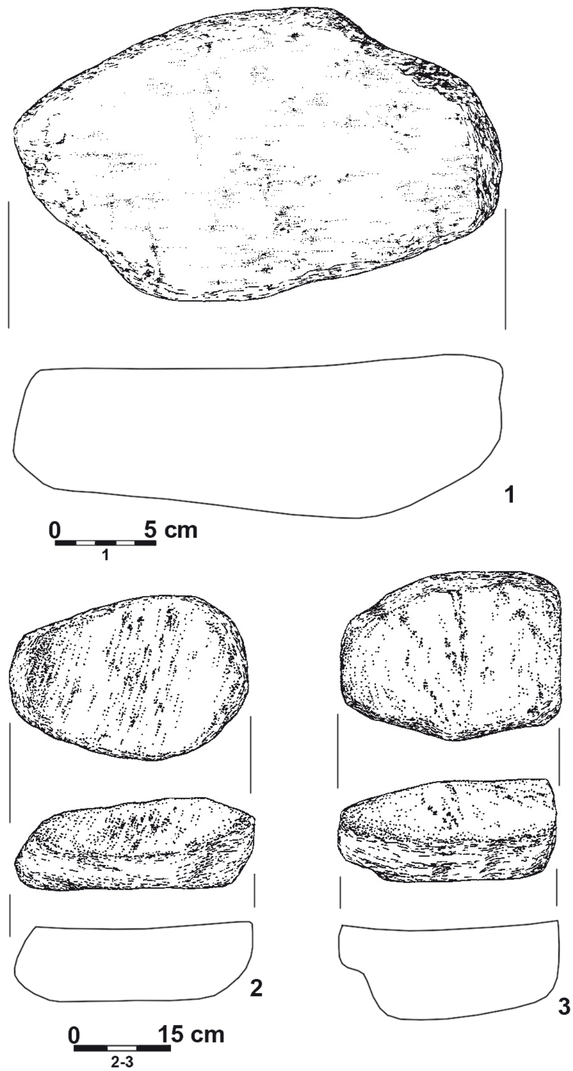


Fig. 7. Quernstones.
1 – Huta Nowa, Gostynin District, Site 1; 2, 3 – Annopol, Gostynin district, Site 1

from, Annopol Site 1 and Białka, Site 2 and other sites (Rybicka 2004), does not provide sufficient grounds for assessing the role of cereal cultivation in agriculture either. All they do is confirm the cereals were cultivated and confirm the results of the palynological analyses.

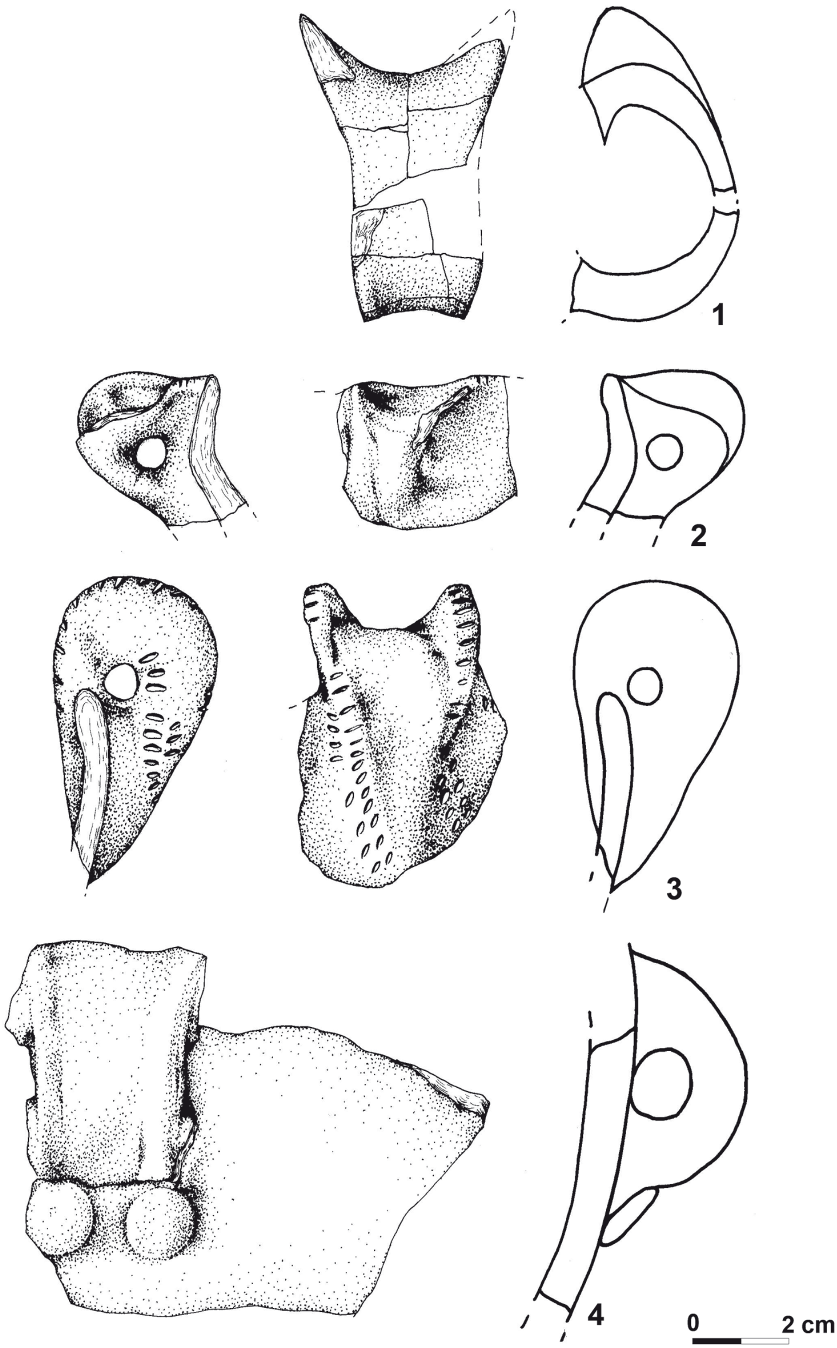


Fig. 8. Stefanów, Site 3, Gostynin District. Selection of pottery of the FBC

FINAL REMARKS. THE ECONOMY OF THE FBC COMMUNITIES IN THE GOSTYNIN LAKE DISTRICT IN THE CONTEXT OF THE KUYAVIAN CLUSTER OF FBC

As discussed above, palynological data from pollen diagrams are considered to be of key importance for studying prehistoric human activity (*e.g.* Kruk 1980; 1994; Pelisiak and Rybicka 1998; Pelisiak *et al.* 1994; 2006; Ralska-Jasiewiczowa, van Geel 1992; 1998a; 1998b; Makohonienko 2004). Such a conclusion, however, needs to be followed by a few reservations. Taking into account a number of factors influencing the pollen fallout, the explanation of changes in plant assemblages observed in palynological diagrams requires reliably placing these changes on the timescale and understanding the human presence in the area.

The presented diagrams from the Gostynin Lake District reveal distinct indicators of human activity, in the form of clear traces of fire, high percentages of pasture (*e.g.*, *Plantago lanceolata*) and ruderal plants, with an incidental presence of cereals (Ralska-Jasiewiczowa and van Geel 1998a; Pelisiak and Rybicka 1998; Pelisiak *et al.* 2006; Wacnik and Rybicka 2012). These are indirect indicators of agricultural activity, chronologically corresponding to the Funnel Beaker culture. However, they do not provide sufficient grounds for determining the character of the economic model. The insignificant presence of cereals in the diagrams (Pelisiak *et al.* 2006; Wacnik and Rybicka 2012) does not allow for the role of cereal cultivation in the FBC economy to be assessed. Distinct changes corresponding to phase 6 of the anthropogenic disturbances recorded in Gościąż (Pelisiak *et al.* 2006) can be linked with the classic stage of FBC development, in the Gostynin Lake District dated to around 3600-3200 BC (Rybicka 2004). Remains of permanent FBC settlement of such a date have not been recorded around Lake Gościąż itself. This discrepancy may stem from poor understanding of the settlement in the region, with the current picture not reflecting its actual importance for FBC communities in that period, or, more likely, the pollen preserved in the laminae representing this phase originated from more distant areas, 10 km from Lake Gościąż (*e.g.*, around Lake Białe) and even further, where settlement of that date is confirmed.

A fact documented beyond any doubt in the diagrams from Lakes Gościąż, Białe, and Lucieńskie is the practice of slash-and-burn agriculture, considerable changing the primary plants landscape. On the other hand, the short lifespans of the relatively small settlements inhabited by small groups of FBC people, and therefore their frequent relocations, would not have resulted in permanent deforestations in most parts of the Gostynin Lake District.

Interestingly, the intensification of agricultural activity of the FBC communities in the Gostynin Lake District from about 3600 BC correlates with the importation of Świeciechów flint, and Volhynian flint in particular (Papiernik and Rybicka 2002; Rybicka 2004; Diachenko and Rybicka 2018; 2019), which at that time is also present in Kuyavian settlements dated to around 3600-3300 BC, like Nowy Młyn Site 6 and Wilkostowo Site 23/24, (Domańska 2013; Rzepecki 2014; Grygiel 2016; Papiernik 2016; Diachenko and Rybicka 2019). Aleksander Kośko (1981, 139) believed that sickles from imported materials (especially those made of Volhynian flint) played an important role in harvesting cereals. Such tools have been found in large numbers in the Gostynin Lake District in the settlements of Annopol Site 1 and Białe Site 14 (Papiernik and Rybicka 2002; Dobrzyński 2014), as well as in the Kuyavian settlements of Nowy Młyn Site 6 and Wilkostowo Site 23/24 (Domańska 2013; Papiernik 2016).

Analysing daub from several sites in Kuyavia representing the so-called Mątwy group horizon of FBC (Tarkowo Sites 23 A and 23B, Inowrocław-Mątwy Site 1), M. Klichowska identified barley as the predominant element in the crop structure (Kośko 1981, 137, 138). This allowed A. Kośko (1981, 138; *cf*. remarks in Mueller-Bieniek 2016, 762) to put forward a hypothesis positing the predominance of barley in the lowland FBC, as a crop more suitable for cultivation in medium-quality soils. In his opinion (Kośko 1981, 139), the cereal deposits from Radziejów Kujawski Site 1, Opatowice Site 12, and Zarębów Site 1 (Klichowska 1970; 1979; Rybicka 1995), suggesting *Triticum* as the main cereal cultivated in their environs cannot be treated as representative as they originate from cultural features. However, the analyses of impressions preserved in daub and pottery from Kuyavian settlements dated to 3600-3300 BC (*e.g*., Osłonki Site 2: Mueller-Bieniek 2016, 763; Wilkostowo Site 23-24: Abramów 2014; 706) indicate that it was actually wheat (*Triticum monoccocum*, *Triticum dicoccum*) that was the predominant crop cultivated by FBC groups of that period, while barley occurred only incidentally (Abramów 2014, 506). This is corroborated by the analysed daub samples, albeit not particularly large, from FBC settlements in the Gostynin Lake District, where, as in Kuyavia, wheat has been identified but barley has not (Rybicka 2004).

The changes in the frequency of *Plantago lanceolata* in the diagrams from the Gostynin Lake District cannot be given unambiguous interpretation in terms of the importance of animal husbandry (*cf*. Pelisiak *et al*. 2006; Wacnik and Rybicka 2012). Janusz Kruk (2004, 25) posed a very important question of whether there are "…environmental reasons for the appearance of deforested spaces (…) outside the climatically-determined steppe zone?". He also noted that "…the appearance of open landscapes might indirectly attest to keeping large herds of livestock…" (Kruk 2004, 25). In the classic palynological studies, the grazing of animals (not necessarily implying a pastoral economy) is reflected precisely by the increase in *Plantago lanceolata* (Kruk 2004, 26). There is no equivocal osteological evidence of cattle herding in the Gostynin Lake District. The bone remains discovered there were few and highly fragmented, and in Annopol Site 1 and Białka Site 2 they belonged to sheep/goat, hare, deer, and birds (Rybicka 2004, 233). The importance of sheep in the economy of the Funnel Beaker communities of the Gostynin Lake District is indirectly suggested by vessels with handles in the form of a ram's head (Rybicka 2004), numerous in the south-eastern group of FBC (Rybicka *et al*. 2014). In contrast, cattle prevailed in the economy of the Kuyavian groups of this culture in the Wiórek phase, *e.g*. in Inowrocław-

Mątwy Site 5, Inowrocław Site 55, and Dąbrowa Biskupia Site 21, with a lesser role of sheep/goat, and an insignificant role of pig (Kośko 1981, 139). A similar structure was recorded in Nowy Młyn Site 6 and Osłonki Site 2 (Makowiecki and Makowiecka 2016, 790, 795) dated to around 3600-3300 BC. Aleksander Kośko (1981, 140) suggested in this context that areas devoid of forest may have favoured some forms of mobile pastoralism, involving sheep. A different picture was recorded in the settlement of Wilkostowo Site 23/24, where cattle prevailed, with a significant percentage of pig and a smaller percentage of sheep/goat (Waszczuk 2014, 432). According to D. Makowiecki and M. Makowiecka (2016, 825, 826), cattle played the predominant role in the economy of FBC communities in Kuyavia, followed by sheep/goat. Pastoral husbandry of these animals was possible thanks to the presence of open grasslands (Makowiecki and Makowiecka 2016, 829, 833). In light of the osteological data, the deforestations and increases in wild herbaceous plants (including *Plantago lanceolata*) recorded in the diagrams from the Gostynin Lake District only allow animal grazing to be suggested, possibly including cattle and sheep (*cf.* Pelisiak *et al.* 2006; Wacnik and Rybicka 2012).

According to Kruk and Milisauskas (1999, 115), FBC communities in the lowlands adapted their economic model "…to conditions different than in loess areas, and transformed it into an agricultural model with great potential for development…". The slash-and-burn technique was crucial in agriculture, and the importance of axes and macrolithic blades used as sickles increased in the FBC (Kruk and Milisauskas 1999, 147). In addition, they noted that for cereal farming FBC communities could use "numerous small openings spread through woodlands, cultivated with the extensive use of fire. The source data clearly indicate that FBC communities used this method" …" (Kruk and Milisauskas 1999, 147). The analysis of both palynological diagrams and archaeological data from the Gostynin Lake District from a period spanning from around 3800 to 3200/3100 BC fit into these findings particularly well (Rybicka 2004; Pelisiak *et al.* 2006; Wacnik and Rybicka 2012). This was a period when the pattern of FBC settlement in the south-eastern group of this culture was marked by so-called mid-sized settlements, when the settlement network became more stable and the role of slash-and-burn agriculture was more established. The central-place stadium, whose beginnings have been dated to around 3640 BC (Kruk and Milisauskas 1999, 120), corresponds to phase 6 of the anthropological disturbances in Gościąż. The results of the palynological and archaeological analyses from the Gostynin Lake District fit well into the model of FBC settlement and economy presented by Kruk and Milisauskas (1999). Slash-and-burn agriculture, whose beginnings correspond to the stadium of mid-sized settlements, has been confirmed in the Gostynin Lake District. The settlements in that region were small and were frequently relocated (the case of Klusek Biały Site 7 and Białe Site 14), which translated into dynamic changes in charcoal frequency in pollen diagrams (Pelisiak *et al.* 2006; Wacnik and Rybicka 2012). At the same time, the import of Volhynian flint in Kuyavia and the Gostynin Lake District falls in a period corresponding with the central-site stadium in the loess areas of southern Poland. That period was marked by intensive contact with Trypillia groups, including direct contact at the peripheries of the latter, evidenced by imports of Trypillia pottery and artefacts of Volhynian flint (Kośko 1981; Rybicka 2008; 2017).

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