Rusinowo. The Symbolic Culture of Foragers in the Late Palaeolithic
and the Early Mesolithic. T. Płonka, K. Kowalski (eds.) Wrocław 2017, p. 33–41
DOI: 10.23734/22.18.103

Małgorzata Malkiewicz

2.2. The vegetation in the light of palynological studies

Abstract: The chapter reports on the results of palynological analysis of sediments from the palaeolake at Rusinowo and the comparison of these findings with results previously obtained for two samples of lake chalk surviving on the ornamented antler artefact. Results from the pollen analysis were used to trace the history of vegetation during the Late Weichselian and the Holocene and to reconstruct the palaeoenvironment. The study identified eleven local pollen assemblage zones (L PAZ) within the pollen diagram and correlated four of them to the Late Weichselian and seven of them to the Holocene. The pollen analysis confirmed the palynological age proposed previously for the lake chalk residue extracted from the artefact as the Pine phase of the Allerød or, possibly, the transition from the Allerød to Younger Dryas. At the time of the deposition of the ornamented antler object, the area around today Rusinowo was covered by pine-birch forest with an admixture of juniper. Open landscapes were vegetated by communities of heliophytes with *Salix, Juniperus*, *Artemisia, Helianthemum, Rumex* and Chenopodiaceae.
Keywords: vegetation history, pollen analysis, Late Weichselian, Holocene

Introduction

The pollen analysis made within the interdisciplinary studies of the ornamented antler artefact focused on the pollen profile obtained from the palaeolake at Rusinowo, in the valley of the Mołstowa River. Nowadays this is an area of wet, periodically flooded meadows and a fragment of an ancient alder forest, protected site *Rusinowskie Łozowisko* (Miluniec, Wrzosek 2011). The profile was drilled in the neighbourhood of the presumed site of the discovery of the archaeological artefact. The location of the borehole and the lithology of the sediments are discussed in detail in chapter 2.1.

The main aim of the pollen analysis was to reconstruct the natural environment around the site at Rusinowo and to determine the age of the sediments; moreover, to correlate the profile with the results of an earlier analysis of two samples of lake chalk extracted from the ornamented antler artefact.

The sample and the methodology

The sediments submitted for the palynological analysis were obtained from an 11.00 m profile, drilled with a mechanical corer from the deepest part of the peat deposit, a location expected to yield the best results for the study. The central part of the palaeolake, presumably the least affected by water level fluctuation, was expected to produce the most representative pollen record (Amami *et al.* 2010).

Pollen analysis was made of 110 samples, with a total volume of ca. 10 cm^3, obtained at intervals of approximately 10 centimetres from cores with an undisturbed structure. All samples were prepared by a standard preparation procedure and the acetolysis was applied (Berglund, Ralska-Jasiewiczowa 1986). Pollen spectra were counted on two slides. On average, total of 600–1300 sporomorphs was found in each sample. Samples obtained from the base of the profile (depth of 10.60–11.00 m) were not analysed as they contained no spores or pollen. In all of the investigated samples, the preservation of the sporomorphs was good. No damaged and undeterminable grains were observed. The pollen taxa were

* University of Wrocław, Laboratory of Palaeobotany, Department of Stratigraphic Geology, Institute of Geological Sciences, ul. Cybulskiego 34, 50-205 Wrocław, Poland; e-mail: malgorzata.malkiewicz@uwr.edu.pl

determined with special keys and atlases (Moore *et al.* 1991; Reille 1992). The percentage calculations are based on the total sum (AP + NAP) which include trees, shrubs (AP) and herbaceous plants (NAP). Aquatic, swampy plants and spore plants were excluded from the total sum. The results of pollen analysis are shown on the percentage pollen diagram (Fig. 1). The pollen diagram was plotted using the POLPAL for Windows (Nalepka, Walanus 2003). In the diagram biostratigraphic units (L PAZ – local pollen assemblage zones) were distinguished with a characteristic content of sporomorphs in the individual profile section, thus illustrating the process of changes occurring in the vegetation cover (Berglund, Ralska-Jasiewiczowa 1986). The L PAZes contain sediments characterized by the occurrence of a distinct pollen and spore assemblage originating from the time of the deposition of a given layer (Cushing 1967). Eleven pollen assemblage zones were recognized, numbered from the bottom up, marked from R-1 to R-11. Their simplified description is presented in Table 1. The results obtained were correlated and compared with the results of the pollen analysis made in 2011 of two samples of lake chalk extracted from the elk antler artefact (Płonka *et al.* 2011).

Sediment age and correlation of the local pollen assemblage zones

Local pollen assemblage zones (L PAZ) identified at Rusinowo were correlated with the chronostratigraphic units of the Late Weichselian and the Holocene (Mangerud *et al.* 1974; Litt *et al.* 2001) (Table 2)

Sediments from the depth of 9.50–10.50 m correlate with the Late Weichselian. The two most ancient local pollen assemblage zones, R-1 *Hippophaë-Salix* and R-2 *Betula-Pinus,* correspond to the cooler period of the Preallerød and to the warming of the Allerød; the next two: R-3 *Betula nana-Juniperus--Artemisia* and R-4 *Salix-Juniperus*, to the youngest stage of the Late Weichselian (Younger Dryas). Zones R-5 through to R-11 have been correlated with the chronozones of the Holocene. The protocratic phase of the Holocene (Birks 1986) is represented by zones R-5 *Betula* and R-6 *Pinus*. The mesocratic phase is represented by sediments from the depth of 5.10–8.90 m. The two zones corresponding to this phase are R-7 *Corylus-Pinus-Ulmus* and R-8 *Corylus--Ulmus-Quercus*. The telocratic phase is represented by sediments from the depth of 0.30–5.10 m and corresponds to three zones: R-9 *Alnus-Corylus-Quercus,* R-10 *Alnus-Carpinus-Corylus* and R-11 *Pinus-NAP.*

Reconstructing the vegetation

The history of the Late Weichselian and early Holocene vegetation at the site and its immediate vicinity may be reconstructed using the data from the local pollen assemblage zones (L PAZ). The curves obtained for individual tree and shrub species obtained in the diagram mostly reflect the regional history of the forest communities in the Western Pomeranian Lake District. Non-arboreal, aquatic, marsh and cryptogram plants inform about local changes and help to trace the changes in hydrological conditions.

Late Weichselian

Preallerød

The oldest sediments in the palaeolake at Rusinowo go back to the time when the area around the study site was dominated by shrub communities with *Salix*, *Hippophaë rhamnoides*, *Juniperus* and herbaceous plants, mainly Cyperaceae and Poaceae. The regular occurrence of the heliophytes *Artemisia* and *Helianthemum* confirms the presence of open areas. It is unlikely that there were any trees in the immediate vicinity of the site. The percentage values of pine and birch indicate their presence at some distance from the study site.

In the postglacial stratigraphic record, the development of the community with *Salix* and *Hippophaë rhamnoides* is usually linked to the Preallerød (Tobolski *et al.* 1998). This unit has been recorded by many researchers and correlated variously – to Older Dryas, Bølling-Allerød interstadial complex, or Bølling (Wasylikowa 1964; Tobolski 1998; Malkiewicz 2002; Burdukiewicz *et al.* 2007; Noryśkiewicz 2012; Jurochnik, Nalepka 2013; Żurek *et al.* 2014). We can date the earliest sediments at Rusinowo with some confidence to the transition from the Bølling to the Older Dryas (Litt 1988). The radiocarbon date of 11 960 ± 70 BP (Poz-65935) available for this level concurs with the palynological dating. The warming of the climate during the Bølling could have contributed to the start of the melting of the blocks of dead ice. However, at Rusinowo the melting out of the buried ice did not immediately cause the creation of the palaeolake because at the bottom of the profile we found a 10 cm layer of mossy peat. Presumably, there was some sedentation of peat at the surface of the buried ice, which as ice continued to melt became sunk, and formed a layer of basal peat at the very bottom of the palaeolake. A similar process has

Table 1. Rusinowo. Local pollen assemblage zones (L PAZ) identified in the profile

No. L PAZ	**Name L PAZ**	**Depth [m]**	**Description L PAZ**
R-1	*Hippophaë-Salix*	10.44–10.50	high percentages of non–arboreal plants (NAP 35.0–31.1%) and *Salix* (6.7–6.2%); participation of *Betula* (40.8–36.6%) and *Pinus* (21.2–17.5); presence of heliophytes: *Hippophaë rhamnoides, Artemisia, Helianthemum*, *Juniperus communis, Selaginella selaginoides*
R-2	*Betula-Pinus*	10.00–10.44	increase of *Betula* to 51.5% and of *Pinus* to 38.3%; decrease of non–arboreal plants to less than 25.0%
R-3	*Betula nana-Juniperus-Artemisia*	9.70–10.00	decrease in the percentage of *Betula* on average to 34.2%, of *Pinus* on average to 23.0%; increase in NAP pollen to 40.0%; a maximum for *Juniperus communis* (6.4%), *Artemisia* (6.3%) and *Betula nana* (2.2%); participation of *Salix* of at most 1.5%; presence of heliophytes, eg: *Helianthemum, Ephedra, Hippophaë rhamnoides* and *Selaginella selaginoides*
R-4	*Salix-Juniperus*	9.50–9.70	increase in the participation of *Salix* to 3.1%; sustained high values for *Juniperus communis* (2.4–3.8%); slight increase in *Betula* and *Pinus*; NAP pollen in the range of 20.0%
R-5	*Betula*	9.20–9.50	domination of *Betula* (54.6–64.0%) over *Pinus* (26.8–38.8%); decrease in *Salix* (0.6%) and *Juniperus communis* (0.7%); the first appearance of *Ulmus* (0.2–0.5%); NAP pollen in the range of 10.0%
R-6	*Pinus*	9.00–9.20	domination of *Pinus* (59.0–65.0%) over *Betula* (25.7–37.2%); sustained low values of *Ulmus* (0.2–0.5%); the first appearance of *Corylus avellana* (0.4–1.8%)
R-7	*Corylus-Pinus-Ulmus*	8.10–9.00	high percentage of *Pinus* (41.1–79.0%); increase in *Corylus avellana* (6.9–25.8%), significant presence of *Ulmus* (0.5–2.2%); the first appearance of *Quercus* (0.1–0.9%) and *Alnus* (0.1–2.8%)
R-8	*Corylus-Ulmus-Quercus*	5.10–8.10	decrease in *Corylus avellana* (5.8–16.7%); maximum value of *Ulmus* (6.3%); increase in *Quercus* (2.4–7.8%) and *Alnus* (5.9–15.5%); the first appearance of *Tilia* (0.6–2.4%) and *Fraxinus excelsior* (0.2–1.4%)
R-9	*Alnus-Corylus-Quercus*	2.50–5.10	maximum value of *Alnus* (41.3%), *Corylus avellana* (26.0%) and *Quercus* (14.6%); decrease in *Ulmus* (0.3–3.7%), sustained significant presence of *Tilia* (1.0–4.1%) and *Fraxinus excelsior* (0.4–3.0%); the first appearance of *Carpinus betulus* and *Fagus sylvatica*
R-10	*Alnus-Carpinus-Corylus*	1.90–2.50	decrease in *Corylus avellana* on average to 12.6%, *Alnus* to 26.4%, and *Quercus* to 6.6%; increase in *Carpinus betulus* (2.7–8.3%) and *Fagus sylvatica* (1.0–2.5%); smaller significance of *Tilia, Fraxinus excelsior* and *Ulmus*
R-11	*Pinus-NAP*	0.30–1.90	domination of *Pinus* (max. 59.8%) and *Betula* (max. 16.0%); significant values achieved by non–arboreal plants (max. 55%)

Table 2. Rusinowo. Correlation of local pollen assemblage zones with chronostratigraphic units of the late Weichselian and Holocene: (preAL – Preallerød, AL – Allerød, YD – Younger Dryas, PB – Preboreal, BO – Boreal, AT – Atlantic, SB – Subboreal, SA – Subatlantic)

Locall pollen assemblage zone (L PAZ)	**Chronostratigraphy**
R-1 *Hippophaë-Salix*	**preAL**
R-2 *Betula-Pinus*	**AL**
R-3 *Betula nana-Juniperus-Artemisia* R-4 *Salix-Juniperus*	**YD**
R-5 *Betula* R-6 *Pinus*	**PB**
R-7 *Corylus-Pinus-Ulmus*	**BO**
R-8 *Corylus-Ulmus-Quercus*	**AT**
R-9 *Alnus-Corylus-Quercus* R-10 *Alnus-Carpinus-Corylus*	**SB**
R-11 *Pinus-NAP*	**SA**

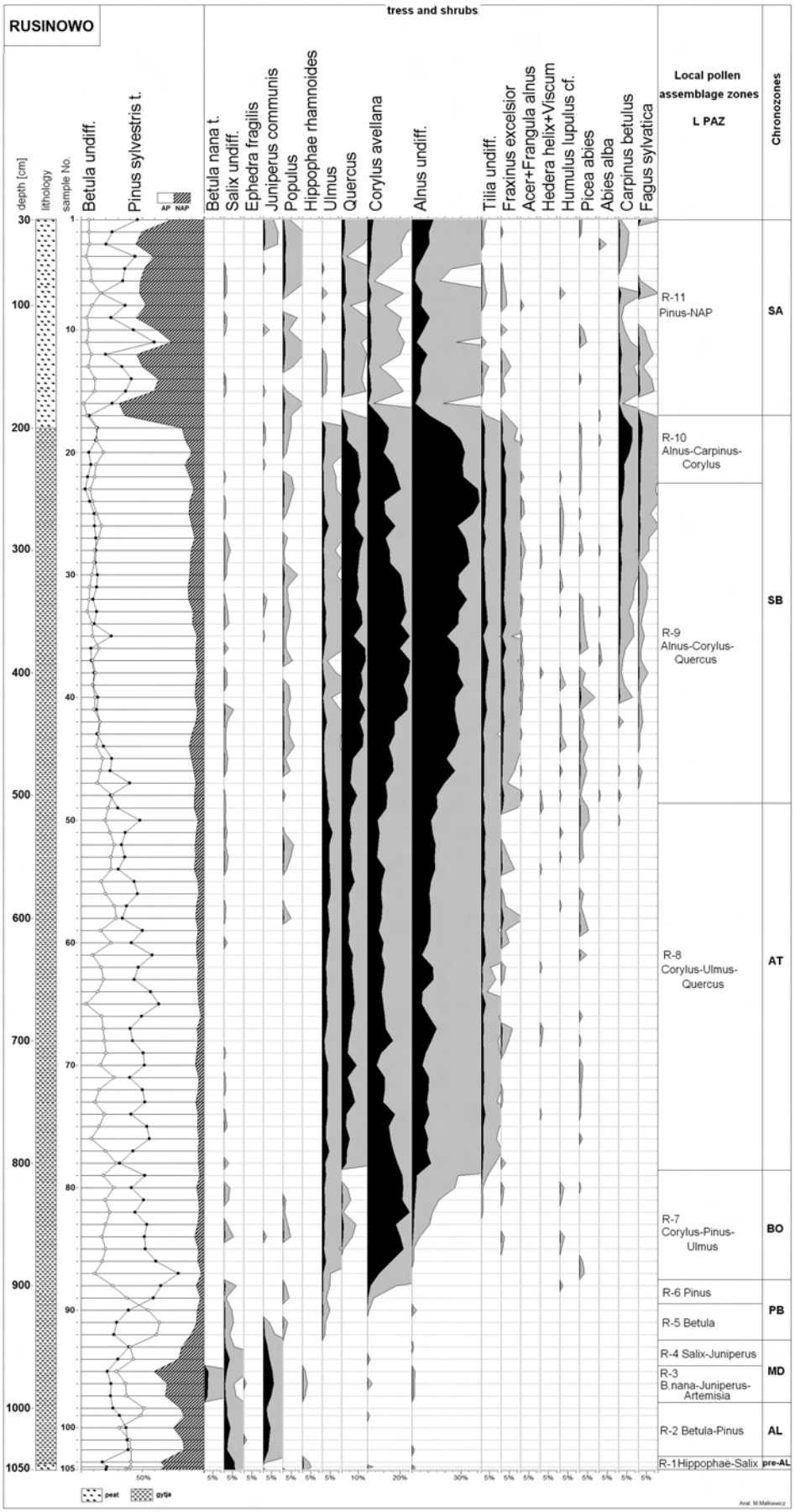
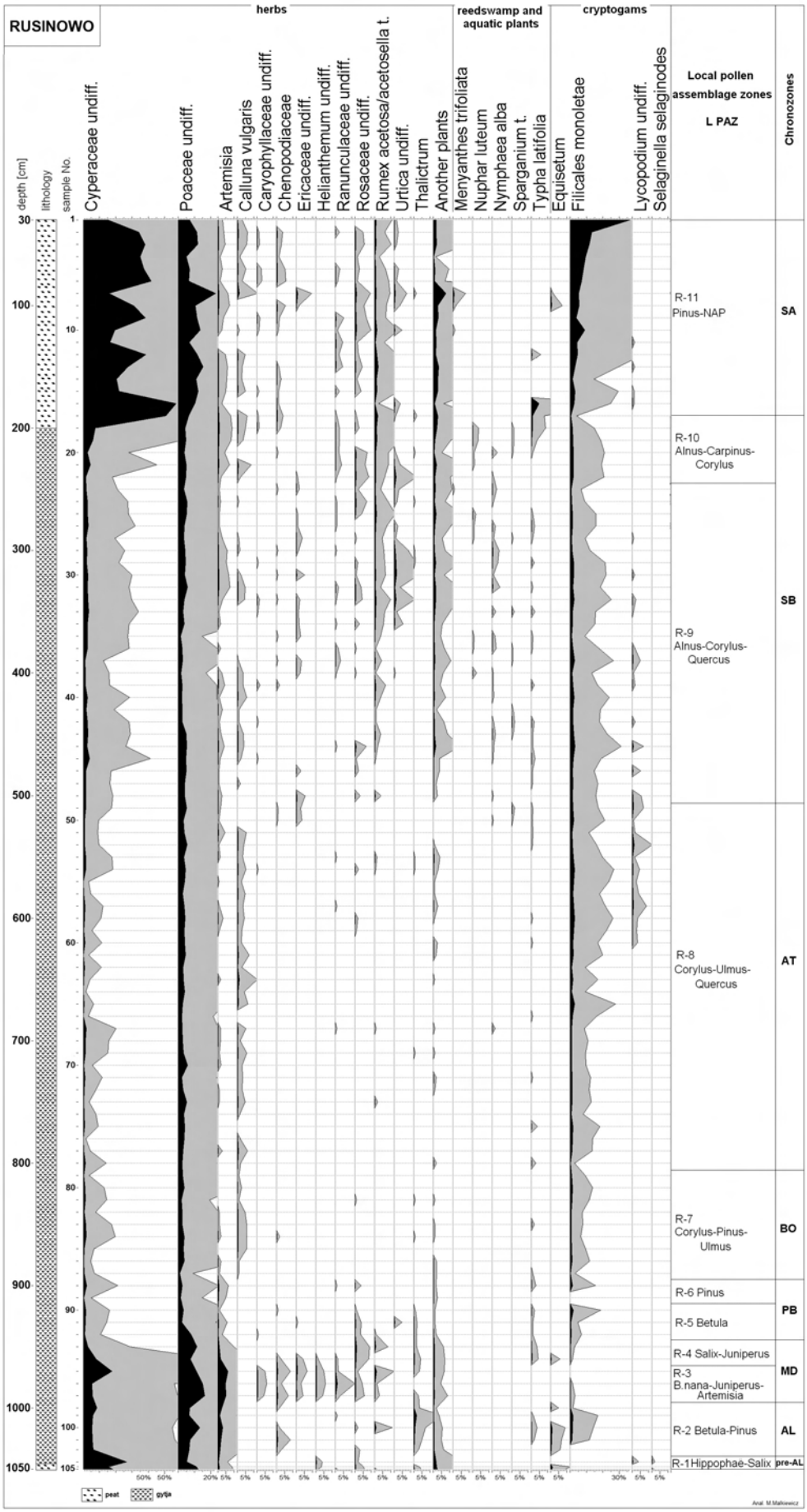


Fig. 1. Rusinowo. Percentage pollen diagram


RUSINOWO
herbs
reedswamp and aquatic plants
cryptogams
depth [cm]
lithology
sample No.
Cyperaceae undiff.
Poaceae undiff.
Artemisia
Calluna vulgaris
Caryophyllaceae undiff.
Chenopodiaceae
Ericaceae undiff.
Helianthemum undiff.
Ranunculaceae undiff.
Rosaceae undiff.
Rumex acetosa/acetosella t.
Urtica undiff.
Thalictrum
Another plants
Menyanthes trifoliata
Nuphar luteum
Nymphaea alba
Sparganium t.
Typha latifolia
Equisetum
Filicales monoletae
Lycopodium undiff.
Selaginella selaginodes
Local pollen assemblage zones
L PAZ
Chronozones
R-11 Pinus-NAP
SA
R-10 Alnus-Carpinus-Corylus
R-9 Alnus-Corylus-Quercus
SB
R-8 Corylus-Ulmus-Quercus
AT
R-7 Corylus-Pinus-Ulmus
BO
R-6 Pinus
R-5 Betula
PB
R-4 Salix-Juniperus
R-3 B.nana-Juniperus-Artemisia
MD
R-2 Betula-Pinus
AL
R-1 Hippophaë-Salix
pre-AL
peat
gyttja

been confirmed in Lake Strażym, in the Brodnica Lake District (Boińska 1987), made possible as this author suggests, by the draining of meltwater during the early stages of the melting of the ice. On the one hand, the same process delayed the accumulation of biogenic deposits, on the other, it made possible the sedentation of the peat during the initial phase of the palaeolake (Błaszkiewicz 2005).

Allerød

During the period coinciding with the Allerød warming forest communities were established with a minor proportion of herbaceous plants. At first, these were birch forests, and with time, birch-pine forests. Wetter sites developed willow and birch thickets with abundant Cyperaceae, *Equisetum* and *Filicales monolete*.

The presence of heliophytes like *Artemisia*, Chenopodiaceae, Poaceae or Cyperaceae suggests a significant role of open areas**.** Presumably, forest communities prevailing at the time were not too dense, as confirmed by the presence of pollen grains of *Juniperus communis* and the lack of *Helianthemum*.

The climatic conditions during the Allerød were favourable not only for the development of forests but also promoted the spread of species with higher thermal requirements, aquatic and marsh plants in particular. Seen for the first time during this period in the area around the palaeolake is *Typha latifolia* and on its waters *Nymphaea alba*. The presence of these taxa leads to the conclusion that the climate of the Allerød was of the cool-temperate variety. It is assumed that in western Poland during this period the mean July temperature ranged between 12 and 14°C (Jurochnik, Nalepka 2013), and at its highest point could not have been less than 15°C (Madeyska 1995).

Younger Dryas

A period of cooler climate during the Younger Dryas retarded the development of forest communities. Birch and birch-pine forests thinned out and there was an expansion of shrub communities. Next to the still present pine and birch, *Salix* and *Juniperus communis* increased in importance. *Betula nana* was noted for the first time, and there was a resurgence of *Hippophaë rhamnoides.* There was an increase in the proportion and taxonomic diversity of herbaceous plants. Among them, *Artemisia*, Poaceae and Cyperaceae were the most dominant. There was a dominance of Chenopodiaceae, Caryophyllaceae, *Rumex acetosa-acetosella*, Ranunculaceae, *Filipendula* and *Potentilla* and a recurrence of *Helianthemum*. The presence of so many herbaceous plants suggests a substantial opening up of plant communities. It may be assumed that at this time around Rusinowo tundra communities took form with a minor proportion of birch and individual pine trees. The low percentage curve of the Ericaceae at this zone could indicate the development of small patches of heath, possibly with *Empetrum nigrum* and *Arctostaphylos uva-ursi*. Plant communities of this type have been identified in sites on the island of Wolin not far to the north (Latałowa 1999).

The decline of *Nymphaea alba* and *Typha latifolia* confirms a deterioration of thermal conditions. There is some consensus that the climate during the Younger Dryas was not stable, marked by major oscillations (Lotter 1991). A strong dynamism of the environment has been recorded eg, at Retno (Brodnica Lake District), where the curve for *Juniperus communis* displays several fluctuations, with peaks of over 10.0% alternating with dips below 4.0% (Noryśkiewicz 2012). At Rusinowo, no similarly strong environmental dynamism is observed. At the same time, there is evidence for the dichotomy of the Younger Dryas which has been recorded in different parts of northern and central Europe (Berglund *et al.* 1994; Walker *et al.* 1994; Ralska-Jasiewiczowa *et al.* 1998). The older part of the Younger Dryas was decidedly cooler, with strong continental features. Mean July temperatures at this time could have dropped to 10°C (Jurochnik, Nalepka 2013). The younger part was decidedly warmer and more humid, with mean July temperatures not lower than 12°C (Tobolski 1998). The occurrence of *Typha latifolia* in the palaeolake confirms milder thermal conditions of the upper part of the Younger Dryas in the area around Rusinowo.

Holocene

Preboreal period

An amelioration of thermal conditions at the beginning of the Holocene resulted in an increased proportion of trees, on average, by as much as 94.0%, and the revival of forest communities. At this time, after a brief episode of a dominance of birch forests, pine has occurred and then developed pine-birch forests. In these two types of forest, an important component was heliophilic *Populus tremula*. A similar composition of forest communities with a higher participation of birch has been recorded in the early part of the Preboreal period in locations lying southwest of Rusinowo (Malkiewicz 2002; Burdukiewicz *et al.* 2003, 2007; Masojć *et al.* 2006, 2014; Jurochnik, Nalepka 2013). The Preboreal forest communities in

the study area were rather open. Areas on their edge and in clearings still retain *Juniperus communis* and *Salix*. Other survivors were remnants of communities with *Artemisia,* Chenopodiaceae and *Rumex*. Only they no longer feature *Helianthemum*, a taxon which requires much sunlight.

There was a gradual spread to the study area of *Ulmus* – the first species representative of mixed deciduous forests. It established itself in fertile and wet sites, usually in river valleys and on the margin of watercourses. Together with *Salix* and *Populus,* it built the riparian forests developing in the area. The values for elm pollen at this time are below 1.0%. If we were to assume, after Hutley and Birks (1983), 1.5–2.0% as the threshold value, which confirms the local presence of elm, this would mean that elm was not present near our site. On the other hand, a species recorded next to elm was *Humulus lupulus* which is found in riparian forests. Consequently, it may be concluded that despite such a negligible representation of elm in the pollen spectra, the species did grow in the study area at this time. The younger part of the Preboreal period is also the time of expansion to the region of Rusinowo of *Corylus avellana* with *Juniperus communis* and *Salix*; it colonised clearings, gradually displacing birch from the forest communities, as is evidenced by the decline of the importance of *Betula*. The much greater importance of hazel at the younger part of the Preboreal period is known from other sites in western Poland, confirming the direction of the migration of hazel from Mecklenburg and Brandenburg (Ralska-Jasiewiczowa 1983). Herbaceous plant communities no longer had much importance. In the immediate vicinity of the palaeolake, wetter sites were vegetated by Poaceae, Cyperaceae and by Asteraceae, Apiaceae, Brassicacea, Rosaceae and Ranunculaceae. The climate during this age was temperate. The presence of pollen grains of *Typha latifolia* indicates mean July temperatures of 14–15°C (Wasylikowa 1964).

Boreal period

During the Boreal period, there was a change in the composition of the forests in the vicinity of Rusinowo. At first, these were pine forests with an admixture of birch and hazel in the understorey. Very soon, however, they were displaced by hazel. The value obtained for hazel, as much as 26.0%, suggests that single-species hazel shrub communities developed in insolated sites nearby. Hazel was able to enter forest communities with pine and birch thanks to its moderate requirements for sunlight and the lack of competition from other broadleaved species (Birks 1986). Hazel, as a shade-giving species, may have contributed to reducing the growth of heliophilic seedlings of birch and pine, leading to their gradual demise, especially in more fertile sites (Iversen 1960). The rapid increase in the percentage value of hazel during the Boreal period denotes the rapid expansion of this shrub (Huntley, Birks 1983). Also seen at this time is a steady expansion of *Ulmus*, building with *Fraxinus, Salix* and *Alnus* riparian forests occupying drier sites along river floodplains. Two new thermophilous species – oak and lime – appear in the forests of this time but have no major importance in the species composition of the forests. The participation of lime was minor, below 0.4%, which would agree with values found in other sites in Poland dating to the same period (Kupryjanowicz *et al.* 2004; Masojć *et al.* 2006). The situation of oak was similar. A decidedly lower participation of herbaceous plants noted during this period indicates the substantial density of the forest communities. In the immediate vicinity of the palaeolake Cyperaceae and *Equisetum* were present but at the meadows next to grasses also Asteraceae, *Epilobium*, *Hypericum*, Ranunculaceae, Rosaceae and *Thalictrum* occurred. In drier and more sandy sites *Artemisia* was to be found.

Atlantic period

During the Atlantic period the climate grew warmer and more humid (Starkel 1983) ushering in yet another change in the composition of forests and contributing to their substantial diversity. From the very beginning, there is an evident increase in the proportion of the mesotrophic taxa – *Ulmus, Quercus, Tilia, Fraxinus*, and a decline in the importance of hazel on the behalf of pine. On fertile soils around the site, stable, mixed broadleaved forests were established, less fertile sites developed pine-oak forests with some *Betula*, *Populus tremula* and *Corylus avellana*. Wet, periodically flooded sites were colonised by riparian forests with *Alnus, Ulmus, Fraxinus, Populus* and *Salix*. The sporadic presence of *Viscum*, an important climatic indicator (Iversen 1944; Granoszewski *et al.* 2004), suggests mean July temperatures of over 15°C, very warm summers, and mean January temperatures of over -7°C. At the same time, the presence of the flowering *Hedera helix* indicates that the climate became increasing oceanic (Mamakowa 1989), and confirms mild winters (Iversen 1944). The importance of herbaceous plants became lower from this at the beginning of the Holocene. There was a reduction of communities with Cyperaceae and of wet grassland communities too. One of

the components of the undergrowth of pine forests was *Calluna*, and the forest margin was vegetated by *Artemisia, Galium* and Rosaceae.

Subboreal period
This period brings a further reconstruction of the forests in the area of Rusinowo. Most notably, since the beginning of the Subboreal period, there is clear evidence for the decline of *Ulmus*. The lesser importance of elm in the forest communities of the Subboreal period is a phenomenon widely discussed in the literature, attributed to many different factors (Huntley, Birks 1983; Latałowa 1992; Parker *et al.* 2002). At this time other trees eg, *Quercus, Fraxinus, Alnus, Corylus* and *Tilia*, reach an optimum of their Holocene development in the study area. Thus, there was change to the mesophilic broadleaved forests and to the pine-oak forests and the spread of open oak woodland. The change in the forest communities assisted colonisation by *Carpinus* and *Fagus*. Increase in the humidity of climate, coupled with its cooling, contributed to an increase in the importance of riparian forests near Rusinowo. The main component of these forests was *Alnus*, accompanied by *Populus*, *Fraxinus, Ulmus, Tilia* and *Picea*. Species which appeared at this time included *Acer, Frangula alnus* and *Humulus lupulus*.

During the youngest part of this period (R-10 *Alnus-Carpinus-Corylus* L PAZ) there is a decline in the importance of most broadleaved trees (*Corylus, Quercus, Alnus, Tilia* and *Fraxinus).* According to Ralska-Jasiewiczowa *et al.* (2004), the marked reduction of forest communities with oak and hazel could have been the result of the expansion of *Carpinus betulus*. This is observed in Rusinowo as well. The increase in the curve for *Carpinus* to 8.3% may be recognized as an indicator of its presence in the study area (Magyari 2002). The radiocarbon date of 3705 ± 35 BP (Poz-65935) obtained for the sample from the depth of 1.98–2.00 m suggests a slightly earlier appearance of the *Carpinus* in the study area. The percentage values of *Carpinus* in the range of 7.0% in northern Poland around 3500 ± 100 BP are confirmed by isopol maps (Ralska-Jasiewiczowa *et al.* 2004). This was also the time of the expansion of *Fagus*. Near Rusinowo its proportion was still minor, in the range of 2.5%, but consistent with isopol maps for this area (Latałowa *et al.* 2004). Unfortunately, the history of *Carpinus* and *Fagus* in forest communities around Rusinowo is unverifiable because, stratigraphically, the pollen zone R-10 corresponds only to a fragment of the Subboreal period. Correlation of this fragment with the Holocene succession in other sites of northern and western Poland suggests an absence of sediments from the time of the onset of the expansion of *Carpinus* and *Fagus* (Noryśkiewicz 1982; Krupiński 1991; Latałowa 1999; Balwierz 2010; Noryśkiewicz 2012; Jurochnik, Nalepka 2013). The palynological dating indicates that there is a gap in the sedimentation sequence, probably the result of a fire to the peatbog. The presence in the peat from the depth of 1.80-1.90 m of small charcoals, spores of *Pteridium aquilinum* and pollen grains of *Populus* confirms a local fire. It presumably destroyed the part of the peat deposit correlated with the late Subboreal, the early to the middle Subatlantic. This is confirmed by the radiocarbon date of 3705 ± 35 BP.

Subatlantic period
A sharp decline in the curves obtained for all the broadleaved trees at the beginning of pollen zone R-11 suggests the hiatus. The boundary with the pollen zone R-11, next to sudden changes in the composition of the forest vegetation, is emphasised by a strong increase in the importance of pine and herbaceous plants. The burning of a substantial depth of the peat deposit prevents us from a fuller reconstruction of forest communities around Rusinowo during the younger phase of the Subboreal period, as well as during the older and the middle phase of the Subatlantic period. This leaves unexplained also the history of man's presence in the study area and the extent of anthropogenic disturbance to the natural environment in the region. The top of the pollen diagram (pollen zone R-11) corresponding to the younger phase of the Subatlantic period. A precipitous decline in the AP curve corresponds to a major deforestation of the area. The tree species dominating the landscape around Rusinowo was now *Alnus*. It presumably grew around the peatbog and in the nearby lower lying grounds. Less fertile sites in the neighbourhood were mostly under pine forest with an admixture of birch, oak and hazel, whereas more fertile sites had developed grassland communities.

Palynological samples from sediments extracted from the ornamented artefact

The palynological analysis made in 2011 of the residue of lake chalk, the original context of the elk antler artefact (Płonka *et al.* 2011) failed to determine the exact age of the investigated sediments. The floristic record then obtained showed that at the time of the accumulation of the sediment some areas

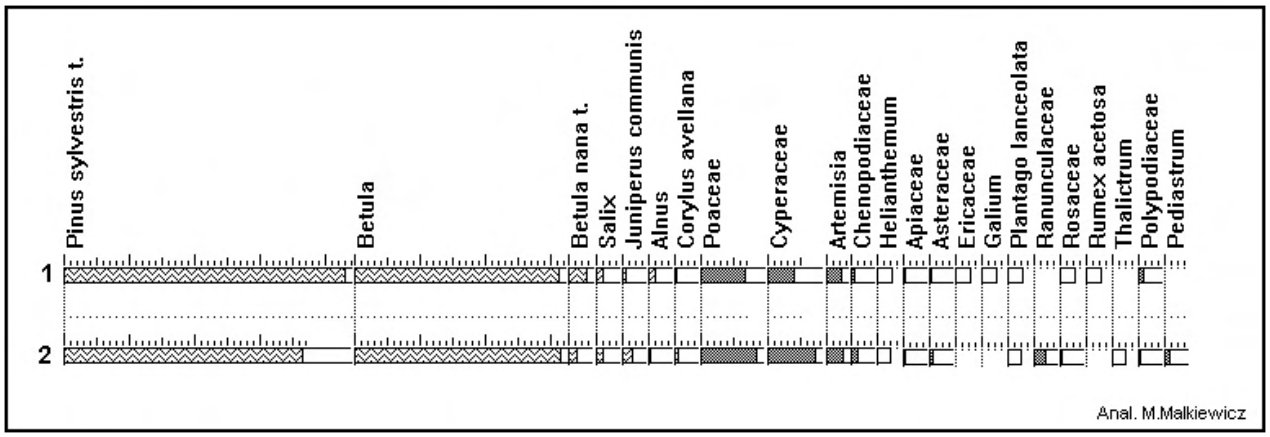


Fig. 2. Rusinowo. Percentage pollen histogram of the residue of lake chalk

near Rusinowo were wooded (Fig. 2). The dominance of *Pinus* and *Betula* and sporadic occurrence of other trees and shrubs identified this woodland as a pine-birch forest with an admixture of juniper. The relatively large proportion of herbaceous plants (on average, 22.0%) and the presence of many heliophytes suggested that the forest communities were not very dense. Exposed and sandy areas were under communities with willow and juniper and an admixture of heliophilic, herbaceous plants: *Artemisia, Helianthemum, Rumex,* Chenopodiaceae, etc. Wet sites were dominated by *Salix, Juniperus* and *Betula nana*, and by herbs from family Cyperaceae, Asteraceae, Apiaceae, Ranunculaceae, Rosaceae, as well as by *Galium* and *Thalictrum.* This plant cover is regarded as characteristic of a cool climate. The results of the pollen analysis made more recently of the profile from Rusinowo confirm the palynological age accepted at that time for the investigated lake chalk as the Pine phase of the Allerød, possibly the transition from the Allerød to the Younger Dryas. The proportion of pine in the range of 44.0%, and of birch reaching 32.0%, is similar to the percentage values recorded for these trees during the younger part of the Allerød in a few rare sites in western Pomerania (Latałowa 1999; Malkiewicz 2009) and shows a great similarity to the situation in other areas (De Klerk 2008). The radiocarbon date of the artefact (10 700 ± 60 BP) apparently confirms the adopted palynological date.

Conclusions

The palynological analysis of sediments from the palaeolake at Rusinowo based on a continuous lithological profile with a thickness of 11.00 m and on two samples of lake chalk extracted from the elk antler artefact has added to our understanding of the late glacial and postglacial evolution of the plant cover in the area around the village of Rusinowo. Based on the fluctuating proportion of individual taxa eleven pollen assemblage zones (L PAZ) were distinguished, four of them corresponding to the Late Weichselian, and seven to the Holocene. The accumulation of lacustrine sediments started in the Preallerød and lasted for the better part of the Holocene. Changes in the vegetation registered at Rusinowo display a great similarity to the Late Weichselian and Holocene plant succession of northern Poland, but do not diverge in the main from the landscapes reconstructed for other regions of Poland (Wasylikowa 1964; Ralska-Jasiewiczowa 1966; Noryśkiewicz 1982; Miotk-Szpiganowicz 1992; Tobolski 1998; Latałowa 1999; Ralska-Jasiewiczowa *et al.* 1998; Masojć *et al.* 2006; Balwierz 2010; Noryśkiewicz 2012; Jurochnik, Nalepka 2013; Żurek *et al.* 2014).

During the early stages of the palaeolake, the area around Rusinowo had only sparse vegetation which included shrub communities with *Salix, Hippophae rhamnoides* and *Juniperus communis*. During the Allerød there was development in the area of birch and birch-pine forests. It was interrupted by the climatic cooling during the Younger Dryas and the resurgence of shrub communities. Forest communities returned to the area of Rusinowo for good at the beginning of the Holocene.

At the time of the deposition of the ornamented antler object, the area around today Rusinowo was covered by pine-birch forest with an admixture of juniper. Open landscapes were vegetated by communities of heliophytes with *Salix, Juniperus*, *Artemisia, Helianthemum, Rumex* and Chenopodiaceae.