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MAGDALENA RALSKA-JASIEWICZOWA

TYPE REGION P-x: MASURIAN GREAT LAKES DISTRICT

Location: 21°0′—22°25′E longitude; 53°25′—54°23′N latitude.
Altitude: 150—300 m a.s.l.
Climate: the coldest region in Poland, lowland climate with strong continental influences, exposed to the inflow of polar air — masses, and modified by high air humidity connected with the extensive surfaces of lakes; cold winter, cool, late springs; mean January temperatures —4.5 — —4.0°C, mean July temperatures 16.5—17.0°C, mean annual temperatures 6.0—7.0°C (in NE part below 6.0°C); strong and frequent south-western, western and south-eastern winds; mean annual rainfall 550—650 mm; growing season 180—190 days.
Geology: the area of tectonic depression of Cretaceous-Oligocene age; the infilling Miocene deposits eroded by glacial activities. The Quaternary deposits 100—200 m thick. During the Pomeranian stage of Vistulian nearly the whole area was glaciated.
Topography: young morainic landscape; the area of a transversal lowering in the morainic rempart, following the pre-Quaternary depression, so-called Masurian valley, filled with the lake systems which include 2 biggest lakes of Poland: Śniardwy and Mamry (the open water surfaces make ca. 20% of the area). The system of connected lakes has the water-table levelled at ca. 116 m a.s.l. The watershed between Vistula and Pregoła Rivers runs here.
Soils: mainly podsols originating from fluvio-glacial sands, only in the north-western part of the region brown soils and podsols formed of tills prevail.
Vegetation: according to the geobotanical subdivision of Poland, the region belongs to the Northern Division characterized by a high participation of northern and boreal species in its vegetation, many of them showing distribution limits running closely to the western boundary of the region, similarly as NE distribution limits of *Fagus sylvatica* and *Quercus sessilis*. *Carpinus betulus* is here in NE marginal zone of its range, and *Picea*, being at the margin of its boreal range, shows strong expansive tendencies.

The dominating forest communities are various type of pine and mixed pine forests, connected with the prevailing sandy soils, with the participation of *Picea* increasing towards NE. The areas of mixed deciduous forests (*Tilio-Carpinetum*) on morainic soils, with contribution of *Fagus* at western margins, increase in NW part of the area. Alderwoods (*Carici elongatae-Alnetum*, *Circeo-Alnetum*) are common around the lakes and in wet depressions. The forest communities characteristic for the area are those entering numerous peat-bogs: *Sphagno* (*Girgensohnii*) — *Piceetum*, *Betuletum pubescentis-Ledetosum palustris*, and *Vaccinio uliginosi-Pinetum*. The most typical feature of the regional vegetation are fens and bogs of all types. They are mostly the habitats of rare boreal and arctic species. On steep escarpments of lakes and rivers rich stands of xerothermic vegetation, including Pontic (s.l.) elements, occur.

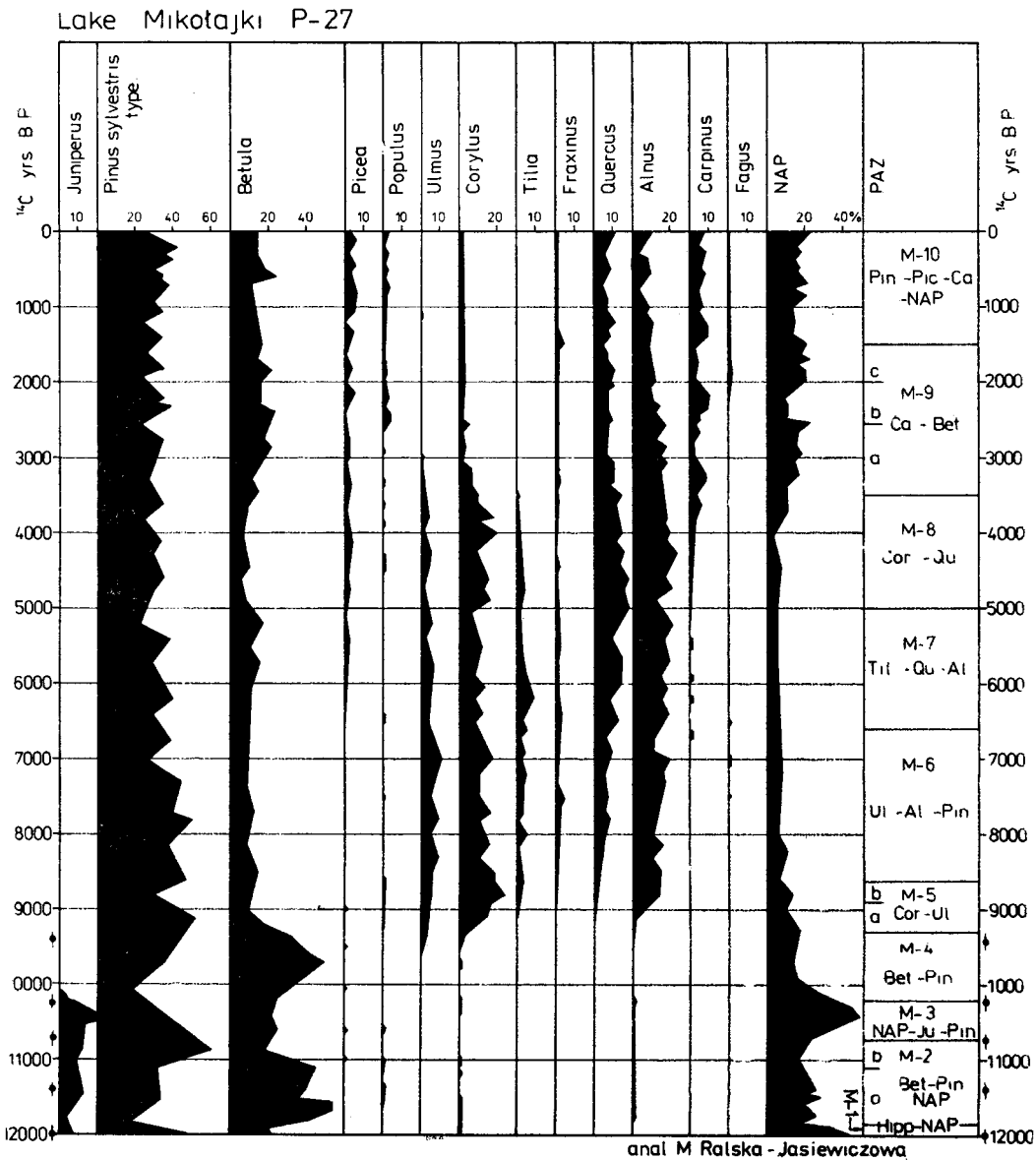

Fig. 1. The simplified pollen diagram from the Lake Mikołajki

Population: ca. 40 inhabitants/km².
Land use: cultivated land 64% (including 16% of meadows and pasturelands); forests 23%; main crops are rye and potatoes.
One reference site located in W-central part of the region have been studied, the main study made beyond IGCP-Project 158 (Ralska-Jasiewiczowa 1966), the complementary studies made in 1985, unpublished.
Reference site P-27: Lake Mikołajki (Mikołajskie).
Situation: 21°35'05"E longitude, 53°46'05"N latitude.

Altitude: 116 m a.s.l.
Age range: ca. 13 000—0 B.P., 7 ^{14}C dates
The lake is a part of a subglacial channel, 38 km long, running N—S, with a connection to Lake Śniardwy (the biggest lake in Poland, 113.8 km^2). The Lake Mikołajki, ca. 5 km long, mean width 907 m, max. depth 27.8 m, steep slopes and flat bottom.
Sediments: calcareous gyttjas.
The tentative time-scale for the time span 9400—0 B.P. calculated by local interpolations.
10 pollen assemblage zones (Fig. 1):

M-1	...—11800 B.P.	*Hippophaë*-NAP
M-2	11800—10700 B.P.	*Betula-Pinus*-NAP
a	11800—11150 B.P.	
b	11150—10700 B.P.	
M-3	10700—10250 B.P.	NAP-*Juniperus-Pinus*
M-4	10250— 9300 B.P.	*Betula-Pinus*
M-5	9300— 8600 B.P.	*Corylus-Ulmus*
a	9300— 8900 B.P.	
b	8900— 8600 B.P.	
M-6	8600— 6600 B.P.	*Ulmus-Alnus-Pinus*
M-7	6600— 5000 B.P.	*Tilia-Quercus-Alnus*
M-8	5000— 3500 B.P.	*Corylus-Quercus*
M-9	3500— 1500 B.P.	*Carpinus-Betula*
a	3500— 2600 B.P.	
b	2600— 2000 B.P.	
c	2000— 1500 B.P.	
M-10	1500— 0 B.P.	*Pinus-Picea-Carpinus*-NAP

Regional vegetation:

1. The part of pollen diagram prior to 12 000 B.P. (not shown on simplified pollen diagram) illustrates strong oscillations of *Pinus*, *Betula* and NAP values and is contaminated with secondary pollen (up to 30%). It represents the period of open landscape with well developed grasslands containing *Helianthemum nummularium* type (up to 1.5%), *Dryas octopetala*, *Saxifraga*, *Polygonum viviparum*, *Plantago alpina* type, *Lycopodium alpinum* type, *Selaginella selaginoides*, *Pleurospermum*, *Gypsophila fastigiata*, with shrubs of *Salix* and *Hippophaë*. In its younger part *Filipendula* appears. This certainly is the time period preceding Allerød chronozone, but difficult to define in terms of biostratigraphy.
2. The Allerød began with the rapid spread of birch woodland (*B. pubescens* and *B. tortuosa* type in macrofossils, besides *B. nana* and *B. humilis*), followed by a gradual expansion of *Pinus sylvestris*. The forests with abundant participation of *Populus tremula* (macrofossils) were open and supported stands of heliophilous herb and shrub vegetation with *Helianthemum*, *Gypsophila fastigiata*, *Hippophaë*, *Ephedra distachya*.
3. During the Younger Dryas the vegetation was of parkland type, with rather xeric steppe-like grasslands being dominant herb communities, with shrubs of *Juniperus*, *Ephedra* and single *Hippophaë* and groups of *Betula pubescens* and *Pinus sylvestris*. No elements of so-called „Dryas" tundra were recorded.
4. Since ca. 10 250 B.P. open birch woodlands and then birch-pine forests with *Populus tremula* and single *Larix* spread in the area. Gradually pine became the dominant forest component.
5. *Ulmus* and *Corylus* expanded since ca. 9400 B.P. Till ca. 8600 B.P. the dominant forest communities were open pine forests with abundant hazel shrubs and some elm on wetter grounds. The contribution of other deciduous trees appearing since ca. 9000 B.P. was insignificant.

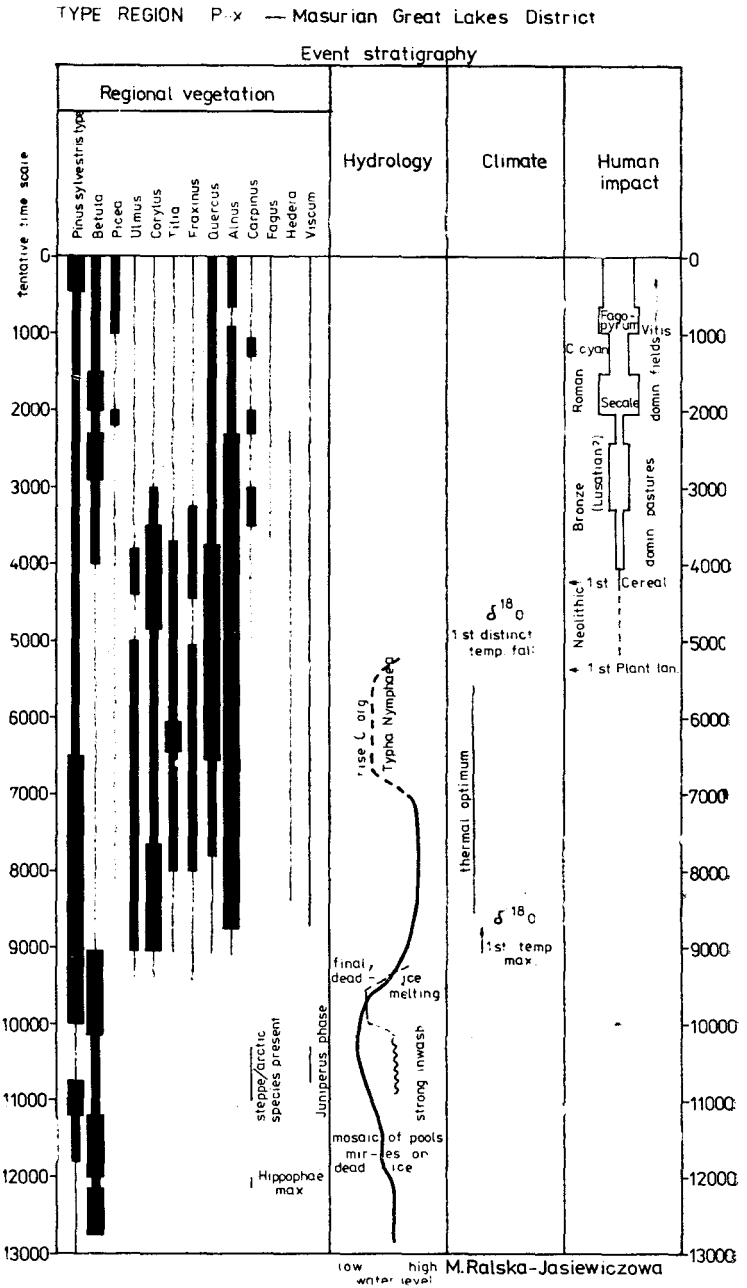

Fig. 2. The event stratigraphy table for the Masurian Great Lakes District type region

6. *Alnus* (*A. glutinosa*, macrofossils) expanded between 9000 and 8500 B.P.
7. Between 8600 and 6600 B.P. pine forests were still dominant on sandy soils, and alder-elm carrs with ash on humid soils in connection with lakes and rivers.
8. Between 6600 and 5000 B.P. the mixed deciduous woodlands reached their

maximum development. The expansion of *Tilia* and *Quercus*, and decreasing importance of *Ulmus* and *Fraxinus* suggest drier climate.

9. After 5000 B.P. the forests became more open; pine-oak forests with abundant hazel understorey were dominant forests communities, and areas of mixed deciduous forests were gradually reduced, what might have result from climate and soil deterioration and human activities.
10. The expansion of *Betula* and *Carpinus* since ca. 3500—3000 B.P. was closely connected with the anthropogenic changes of vegetation. The role of mixed deciduous forests became insignificant.
11. Since ca. 1500 B.P. the progressive expansion of conifers — *Pinus* and *Picea* has been the sign of anthropogenic degradation of forests.

Hydrology (Fig. 2):

1. During the Late-Glacial the lake channel was still filled with the dead-ice, and shallow pools and mires were formed on its surface. The melting processes proceeded in an irregular way. In some places, corresponding with the central part of the subsequent lake, peat accumulated till ca. 9500 B.P. In other places, a strong erosion of mineral soils from unstable shores to a forming shallow lake occurring between 11 000 and 10 000 B.P. was followed by a period of more quiet gyttja sedimentation already during the Preboreal.
2. The time between 9000 and 7000 B.P. was the time of a high water level.
3. The rise of organic carbon content in the sediment (Więckowski 1966) and increasing values of telmatophyte pollen suggest a period of lake shallowing between ca. 6500 and 5000 B.P.
4. The deep and steep-sloped lake does not record minor water level changes in the late Holocene.

Climate:

1. The pollen indicators are suggestive of Allerød mean July temperatures not lower than 15°C (*Dryopteris thelypteris*, *Typha latifolia*, *Nymphaea alba*).
2. The climate of Younger Dryas was dry and continental, with July temperature possibly not higher than 12°C.
3. The content of ^{18}O isotope in calcareous lake sediments shows first Holocene temperature maximum around 9200—9000 B.P., the stable maximum temperatures between ca. 8500 and 5500 B.P. and a distinct temperature fall since ca. 5000 (5500?) B.P.
4. The pollen indicators of climatic optimum — *Viscum* and *Hedera* — appear between 9000 and 8500 B.P.; *Hedera* disappears around 2500 B.P.

Human impact:

1. The first single pollen indicators of human presence in the area are recorded around 5000 B.P., and the regular evidence of Neolithic penetrations since before 4000 B.P., what might represent Masurian group of Corded Ware Culture known by artifacts from the close lake vicinity.
2. A distinct and long-lasting settlement phase recording well developed cattle breeding economy and poor agriculture is indicated between ca. 3500 (3000?) B.P and ca. 2300 B.P. According to the archaeological knowledge the area of Masurian Lakes was a borderland of Lusatian culture, and the lake system itself might have been the tribal borderline. The East-Masurian tribes of that time kept Neolithic hunters and gatherers' traditions, practicing also grazing in the forest. The cultural attachement of phase 2 is unclear.
3. After a forests regeneration phase with dominant *Carpinus* a very distinct settlement phase since ca. 2000 B.P. records the well developed occupation of the area by people of Prussian culture during the period of Roman influences; cultivation of *Secale*, large scale occupation of sandy soils (*Rumex* maximum).

4. The image of youngest period of increasing anthropopressure since ca. 1000 B.P. till recent times includes the evidence of developing agriculture (max. of cereals, *Fagopyrum*, *Centaurea cyanus*, *Papaver* etc.) and progressing occupation of sandy grounds, but otherwise does not differs much from the preceding occupation phase. Possibly the uppermost part of sediments was disturbed by fishing?

Polish Academy of Sciences, Władysław Szafer Institute of Botany,
Department of Palaeobotany, ul. Lubicz 46, 31-512 Kraków
Instytut Botaniki im. Wł. Szafera, PAN

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