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TYPE REGION P-w: DOBRZYŃ-OLSZTYN LAKE DISTRICTS

Location: longitude 18°10′—20°50′E, latitude 52°35′—54°25′N.
Altitude: 50—312 m a.s.l.
Climate: temperate lowland climate, transitional between marine (W) and boreo-continental (NE) influences. Mean January temperatures —2.4 — —4.0°C, mean July temperatures 16.0°—18.0°C, mean annual temperatures 6.0 (NE)—7.4°C (SW). Westerly winds prevailing, easterlies less frequent. Annual rainfall 512 (SW)—600 mm (NE); growing season 190—214 days.
Geology: Cretaceous marls and limestones and Mio/Pliocene silts, sands and clays, covered with Quaternary tills and sands 60—200 m thick.
Topography: young morainic landscape formed mostly by Poznań and Pomeranian stages of Vistulian glaciation. Parallel W—E ranges of morainic ridges and hills and morainic plateaus dissected by perpendicular or oblique systems of subglacial channel lakes, frequent eskers, kames, and glacial kettles.
Soils: originating from clays and fluvio-glacial sands: brown soils, or degraded leached brown soils, podsols, and the poorest rusty soils on tops of sandy hills. Gley and marsh soils in depressions.
Vegetation: many plants distribution limits run through the area of Olsztyn Lake District, including such western plants as *Fagus sylvatica*, *Acer pseudoplatanus*, and such boreal species as *Picea abies*, *Salix lapponum*, *Chamaedaphne calyculata*.

The most common forest communities are *Tilio-Carpinetum* on more fertile soils, *Pino-Quercetum* on more sandy acidic soils, and pine forests on poorest sands. In the western part beech forests are widespread. Around the lakes and along the rivers various types of carrs (*Carici elongatae-Alnetum*, *Circaeo-Alnetum*, *Fraxino-Ulmetum*) occur. Small stands of *Potentillo albae-Quercetum* grow in Brodnica region. *Picea abies* occurs in NE part of the area as an admixture to different forest types, not forming any individual community. The undrained waterlogged depressions are occupied by variours bog and, fen communities.
Population: 115/km² (SW) — 54/km² (NE).
Land use: rye, barley, potatoes, are the most common crops, wheat and sugar-beet also in SW part. The natural vegetation is largely destroyed by man. The forests including plantations cover up to 30% of the area in NE part. The woodland management favours conifers (pine, spruce), and beech.

	Toruń voivodeship	Włocławek voivodeship
cultivated land	69.0%	73.0%
forests	17.7%	15.7%
other	13.3%	11.3%

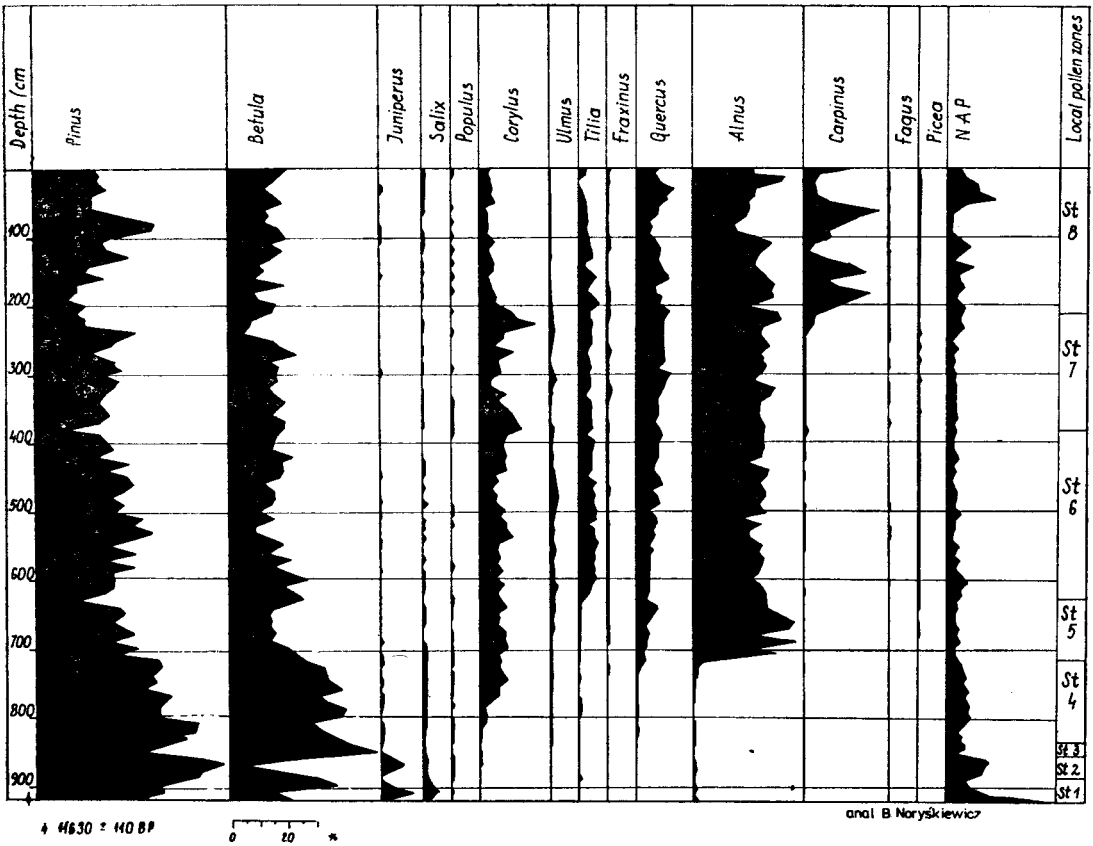

Fig. 1. The simplified pollen diagram from the Lake Steklin

2 reference sites from SW part (Dobrzyń and Brodnica Lake Districts), and 1 reference site from NE part (Olsztyn Lake District) are presented.
Reference site P-24: Steklin Lake (Noryśkiewicz 1982, Marciniak 1987).
Situation: 19°00′7″ longitude, 52°56′8″ latitude.
Altitude: 73.7 m a.s.l.
Age range: 11 600 — 0 B.P.; 1 ^{14}C date.
8 local pollen zones and 8 subzones (Fig. 1):
St 1a, St 1b — *Betula-Pinus-Juniperus*
St 2 — *Pinus-Juniperus*-NAP
St 3 — *Betula*
St 4 — *Pinus-Betula-Corylus*
St 5 — *Corylus-Alnus-Quercus*
St 6 — *Quercus-Tilia-Ulmus*
St 7 — *Pinus-Quercus-Corylus*
St 8a, St 8b, St 8c, St 8d, St 8e, St 8f — *Pinus-Carpinus*-NAP
Reference site P-25: Strażym Lake (Noryśkiewicz 1987; Niewiarowski 1987; Lankauf 1987; Różański 1987; Boińska 1987; Błędzki 1987).
Situtaion: 19°27′40″E longitude, 53°20′N latitude.

Altitude: 71 m a.s.l.
Age range: 12 000—0 B.P.; 10 local pollen zones and 4 subzones (Fig. 2)
Sm 1 — *Pinus-Betula*
Sm 2 — *Juniperus-Artemisia*
Sm 3 — *Pinus-Betula*
Sm 4 — *Pinus-Betula-Corylus*
Sm 5 — *Corylus-Alnus-Quercus*
Sm 5a — dominant *Corylus*
Sm 5b — dominant *Alnus*
Sm 6 — *Quercus-Corylus*
Sm 7 — *Pinus-Carpinus*
Sm 7a — *Corylus-Quercus-Tilia*
Sm 7b — *Alnus-Quercus*
Sm 8 — *Carpinus-Quercus-Alnus-Fagus*
Sm 9 — *Pinus-Fagus*
Sm 10 — *Pinus*
Reference site P-26: Woryty (Pawlikowski et al. 1982; Cieśla et al. 1978; Marciniak 1979; Szeroczyńska 1985).

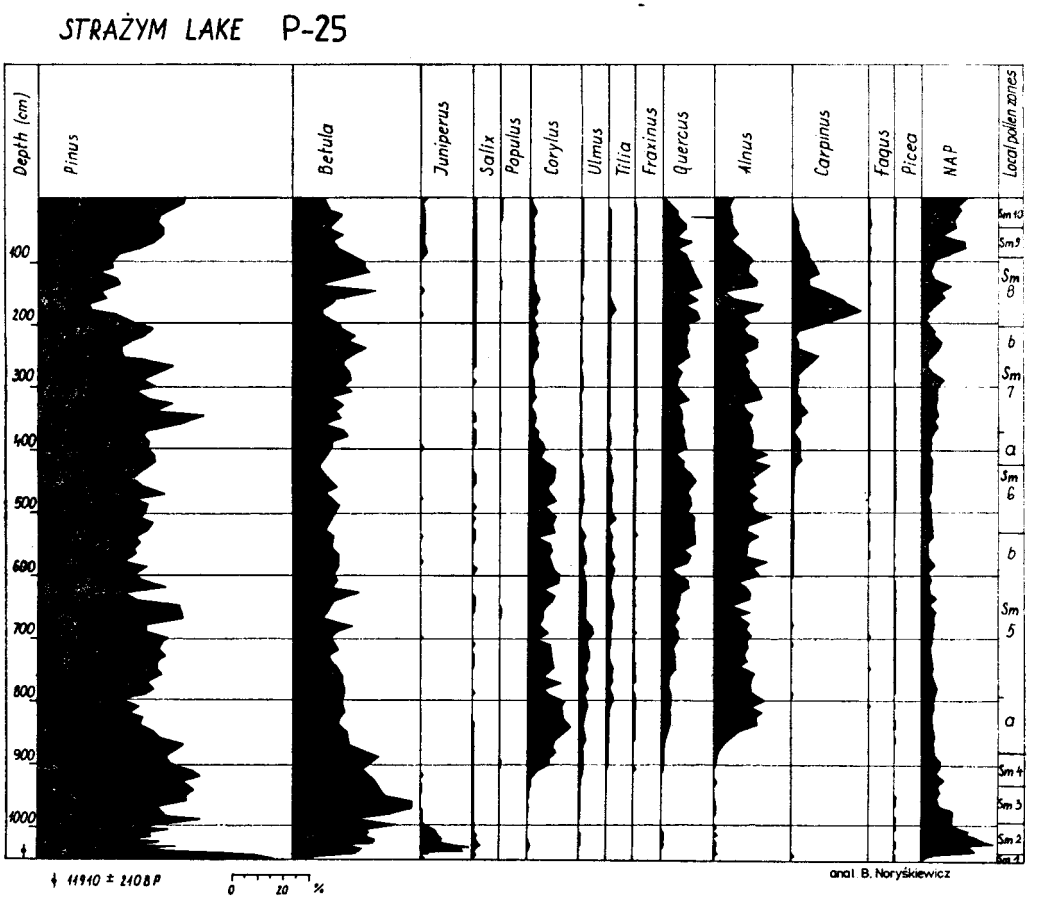

Fig. 2. The simplified pollen diagram from the Lake Strażym

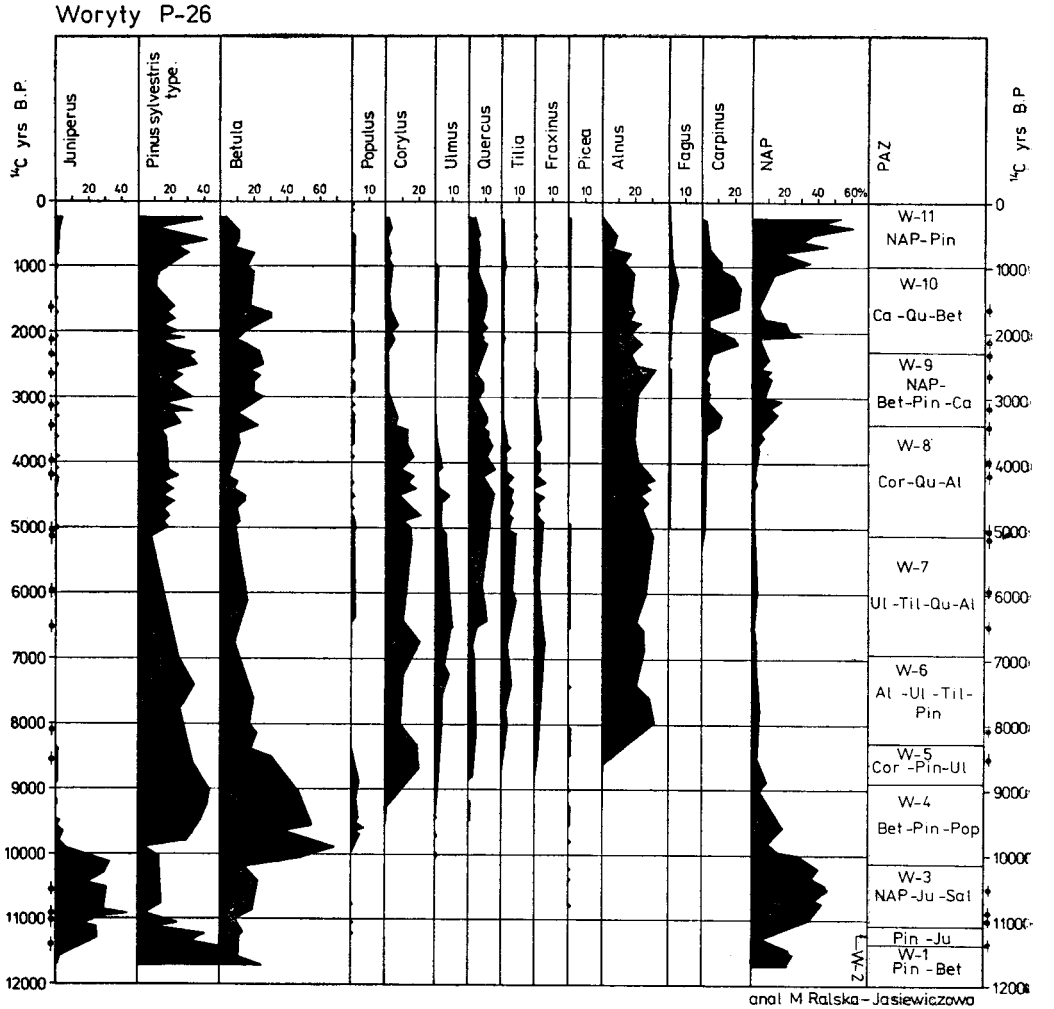

Fig. 3. The simplified pollen diagram from the extinct lake at Woryty

Situation: 20°12′ E longitude, 53°45′ N latitude.
Altitude: 105 m a.s.l.
Age range: ca. 11 800—0 B.P.; 20 ^{14}C dates.
An extinct overgrown lake composed of 2 parts 25 ha and 5.5 ha in area, max. sediment depth ca. 10.25 m, evidence of ancient in- and outflow. The site was the subject of complex palaeoecological studies, including chemical, mineralogical, *Cladocera*, *Rhizopoda*, *Diatomae*, plant macrofossil analyses.
11 regional pollen assemblage zones (Fig. 3):

W 1	11800—11300 B.P.	*Pinus-Betula*
W 2	11300—11050 B.P.	*Pinus-Juniperus*
W 3	11050—10100 B.P.	NAP-*Juniperus-Salix*
W 4	10100— 8900 B.P.	*Betula-Pinus-Populus*
W 5	8900— 8300 B.P.	*Corylus-Pinus-Ulmus*
W 6	8300— 6900 B.P.	*Alnus-Pinus-Ulmus-Tilia*

W 7	6900—	5050	B.P.	*Ulmus-Tilia-Quercus*
W 8	5050—	3400	B.P.	*Corylus-Quercus*
W 9	3400—	2300	B.P.	NAP-*Betula-Pinus-Carpinus*
W 10	2300—	1000	B.P.	*Carpinus-Quercus-Betula*
W 10a				
W 10b				
W 10c				
W 11	1000—	0	B.P.	NAP-*Pinus*

DISCUSSION

Regional vegetation (Figs. 4,5):

1. The Allerød forests were open, composed mainly of *Pinus sylvestris*, with the high contribution of *Betula* in SW part of the region only.
2. The expansion of *Juniperus* in the understorey of pine forests is recorded in NE part of the region since 11 300 B.P.
3. The vegetation of Younger Dryas was of parkland type with abundant shrub communities formed by *Juniperus* and *Ephedra* on drier places, and *Betula nana* and *Salix* on wetter grounds, and with scattered groups of birch and pine. Well drained fertile habitats supported rich steppe-like grasslands, and acidic soils — poor grass and sedge communities with dwarf shrubs (*Empetrum*, *Arctostaphylos*).
4. A rapid spread of birch woodland with *Populus* and gradually increasing contribution of pine started since ca. 10 100 B.P.
5. Since ca. 9200 B.P. *Corylus* began to expand in the understorey of open birch-pine forests and *Ulmus* appeared on fertile, more humid soils.
6. Between 8900 and 8300 B.P. both those species became essential forests components, and other deciduous trees, including *Alnus*, appeared during that time.
7. The time between 8300 and 6900 B.P. witnessed a slow expansion of mixed deciduous forests, and reduction of birch woodland, with pine forests still widespread. The lake shores were occupied by alderwoods.
8. The mixed deciduous forests reached their maximum development between 6900 and 5000 B.P., *Tilia* being their dominant component in SW part of the region. The pine forests were restricted to poorest sandy soils and were encroached by *Quercus*.
9. Since ca. 5000 B.P. the participation of *Ulmus* and less evidently of *Tilia* started to decline, *Corylus* spread in forest understorey and *Quercus* reached its holocene maximum development. The forests became more open, what might have been connected with Neolithic man activities. The disturbance of ecological equilibrium enabled *Carpinus* to invade the area.
10. Since 3400 B.P. a series of intensive human activities, including large scale clearances, resulted in a change of natural vegetation of the whole region. The role of virgin deciduous forests with hazel understorey was definitely reduced. The secondary birch woodlands spread in consequence of forests clearings, and the next successional stage of forest regeneration was the development of hornbeam-dominated woodlands with oak and small proportions of other deciduous trees on fertile soils, and of pine-oak forests on poorer soils.
11. The subsequent settlement phases were followed by similar cycles of forest regeneration, the participation of atlantic deciduous trees being more and more reduced, and birch, pine and anthropogenous herb communities more and more widespread as result of soil degradation.

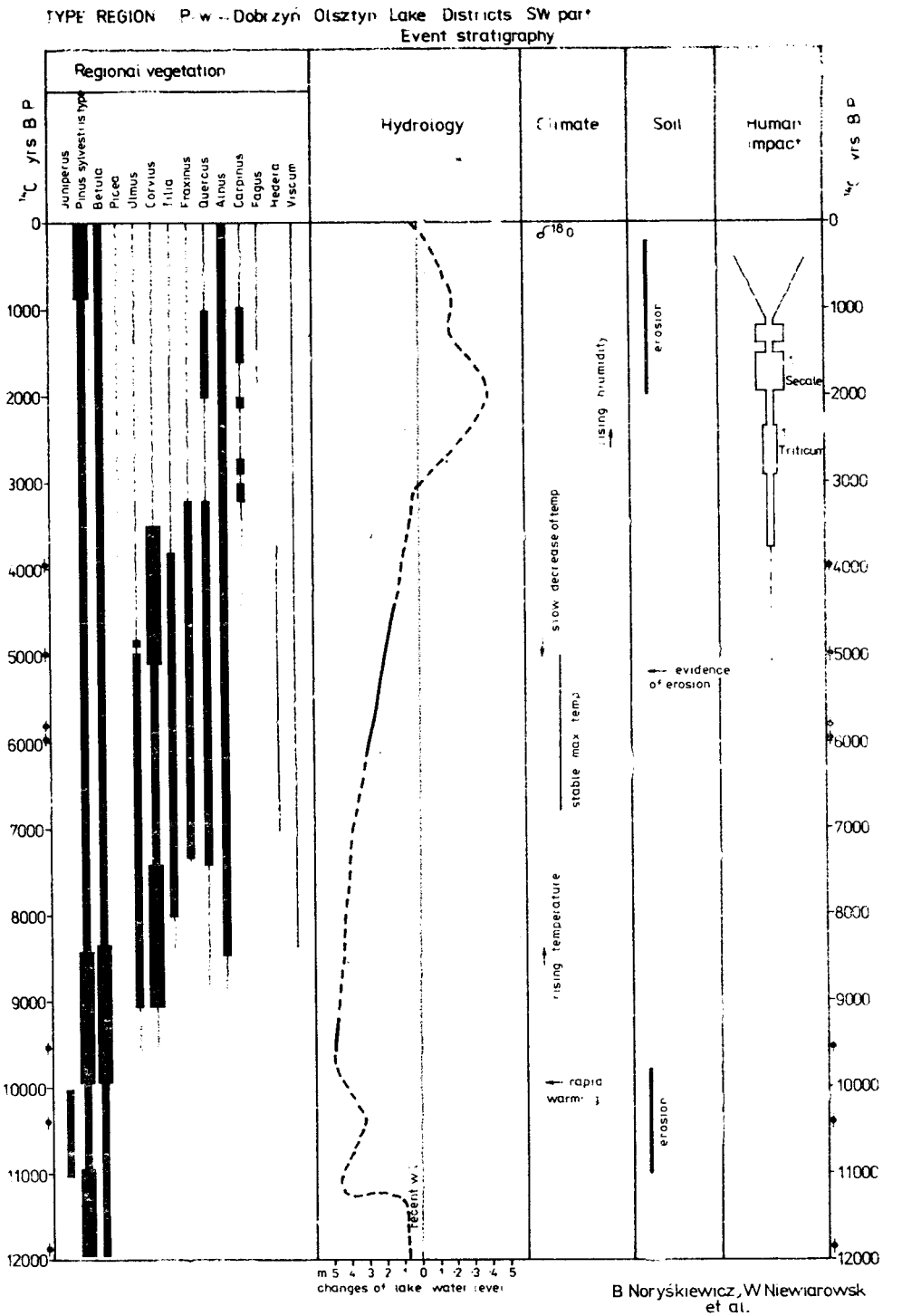

Fig. 4. The event stratigraphy table for the southwestern part of the Dobrzyń—Olsztyn Lake Districts type region

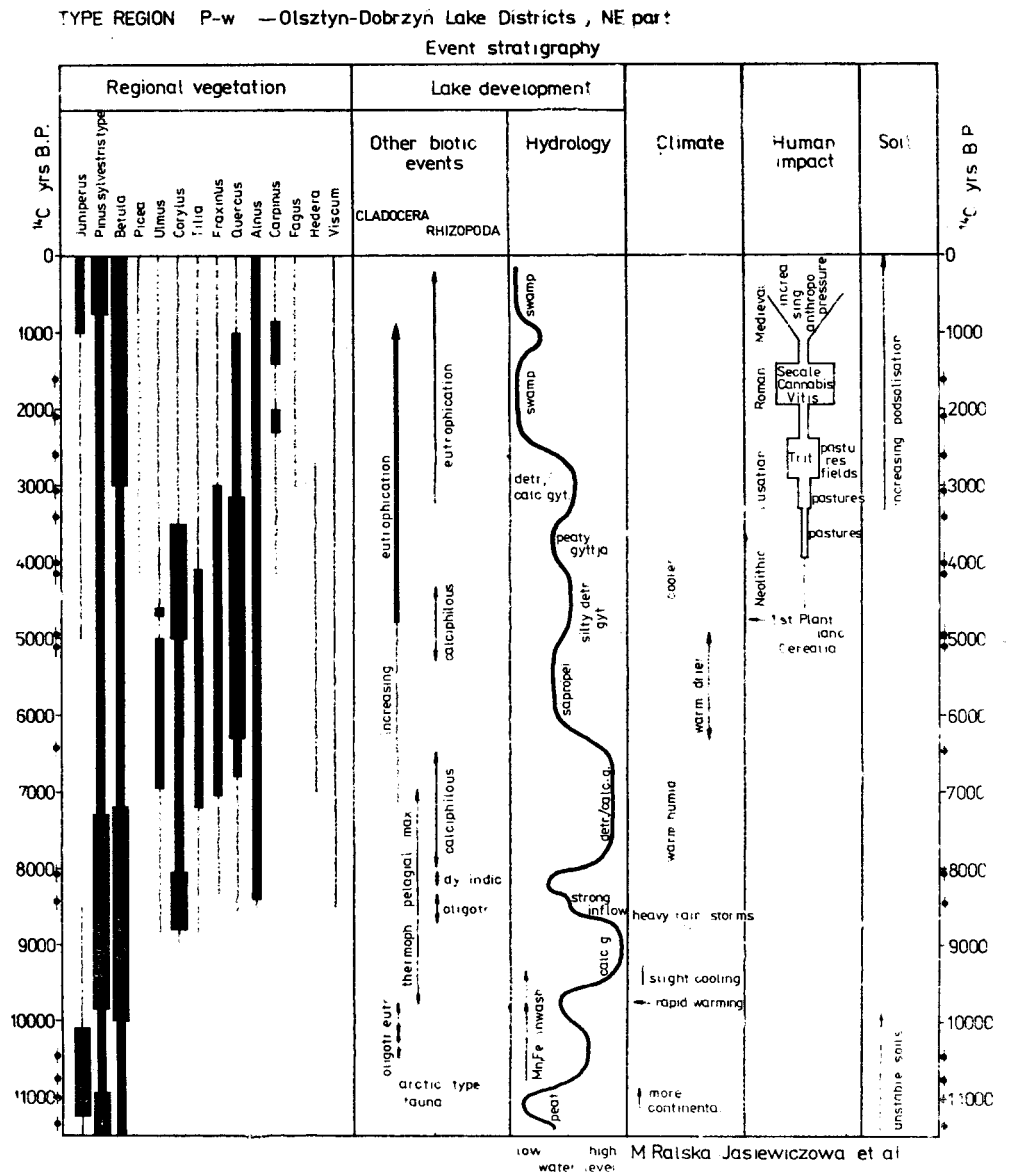

Fig. 5. The event stratigraphy table for the north-eastern part of the Dobrzyń—Olsztyn Lake Districts

Hydrological events:

1. The melting out of dead-ices infilling the lake basins progressed effectively since the end of Allerød; the Allerød sediments are commonly peats, or shallow-water, half-telmatic muds. The melting terminated usually between 10 000 and 9000 B.P.
2. The evidence of a strong inflow to the Woryty lake followed by the lake shallow-

ing is recorded between 8500 and 8000 B.P. (flooding of pra-Giłwa river flowing into the lake at that time?).
3. There are proofs of low water levels between 6500—6000 B.P. and 5000—4000 B.P. in both Strażym and Woryty lakes (change of sediment, formation of marginal peats).
4. After 5000 B.P. the natural hydrological processes at Woryty Lake were disturbed by man activities connected with the settlements in the immediate lake vicinity. The direct reaction to the forest clearances in the lake surrounding was the increase of water level, and the following stage was the rapid acceleration of eutrophication processes and the increase of lake productivity. These processes progressing after the Lusatian settlement phase brought about the gradual overgrowing of the lake leading finally to its extinction.
5. At lake Strażym, the maximum water level was reached at the beginning of Subatlantic (ca. 2000 B.P. ?).

Climate:

1. The trend of vegetational changes towards more open communities since ca. 11 300 B.P. (expansion of *Juniperus*) is suggestive of a cooling, and of increasing continentality.
2. A short temporary cooling of climate is recorded in Woryty sediments around the middle of Preboreal period.
3. The analysis of stable oxygen isotope (18—0) in calcareous sediments of Lake Strażym revealed the following relative temperature changes:
   a) a short period of a milder climate within Younger Dryas;
   b) a rapid warming since ca. 10 000 B.P., corresponding to the rise of temperature by 8°C;
   c) a following gradual warming by 2—3°C progressing till ca. 7000 B.P.;
   d) a stabilised maximum of temperatures between ca. 7000 and 5000 B.P.;
   e) a gradual slow cooling by 3—4°C till ca. 3000 B.P.
4. The pollen indicators of climatic optimum show warm summers since ca. 8500 B.P. (*Viscum*), and mild winters between 7000 and 3500 (3000) B.P. (*Hedera*) in both SW and NE parts of the region.

Human impact:

1. Since ca. 5000—4900 B.P. — evidence of Middle Neolithic penetrations in SW and NE parts of the area, at Woryty most probably of Funnel Beaker culture, with the record intermediate between classical landnam A and B.
2. Distinct traces of Late Neolithic, possibly Corded Ware Culture in the whole area since ca. 4100 B.P. — substantial clearings, grazing, single traces of agriculture.
3. The Late Bronze/Halstatt Lusatian Culture expanded in the area before 3000 B.P. Rather high population density, close network of settlements, extensive clearings resulted in the essential changes of natural vegetation. The animal breeding prevailed over agriculture, at least during the older phases of Lusatian settlements. A detailed ca. 400—500 years record of Lusatian colonization cycle was found at Woryty, where the studied site is situated in the centre of settlement area excavated by archaeologists in detail (Dąbrowski & Mogielnicka — — Urban 1976, Dąbrowski 1981).
4. Drastic devastation of forests during the time of Roman influences (since ca. 2000 B.P.). Agriculture prevailing — cultivation of *Secale*, *Cannabis* (single traces of *Vitis*!).

5. After the phase of forest regeneration during the Migration Period, the progressive processes of land management, deforestation, degradation of soils, continuously since Early Medieval (ca. 1000 B.P.) till recent times.

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REFERENCES

Błędzki L. A. 1987. Cladoceran remains analysis in sediments of Lake Strażym (Brodnica Lake District). Acta Palaeobot., 27 (1): 311—317.

Boińska U. 1987. Analysis of macrofossils in bottom deposits of Lake Strażym. Acta Palaeobot., 27 (1): 305—310.

Cieśla A., Ralska-Jasiewiczowa M. & Stupnicka E. 1978. Paleobotanical and geochemical investigations of the lacustrine deposits at Woryty near Olsztyn (NE Poland). Pol. Arch. Hydrobiol., 25 (1—2): 61—73.

Dąbrowski J. (ed.), 1981. Woryty — studium archeologiczno-przyrodnicze zespołu osadniczego kultury łużyckiej (summary: Woryty — an archaeological and naturalistic study of the settlement complex of Lusatian Culture). Pol. Bad. Archeol., 20. Ossolineum, Wrocław.

— & Mogielnicka-Urban M. 1976. Wyniki prac wykopaliskowych na stanowiskach zespołu osadniczego kultury łużyckiej we wsi Woryty, woj. Olsztyn (summary: Results of the excavations of the sites of the Lusatian settlement complex at Woryty, Province of Olsztyn). Spraw. Archeol., 22: 145—167.

Lankauf K. R. 1987. Results of physical and chemical studies on Lake Strażym deposits (Brodnica Lake District). Acta Palaeobot., 27 (1): 269—276.

Marciniak B. 1979. Dominant Diatoms from Late Glacial and Holocene lacustrine sediments in northern Poland. Nova Hedwigia, Bh., 64: 411—426.

— 1987. Diatoms from the Holocene sediments of Lake Steklin (Dobrzyń Lake District). Acta Palaeobot., 27 (1): 319—334.

Noryśkiewicz B. 1982. Lake Steklin — a reference site for the Dobrzyń-Chełmno Lake District, N. Poland — report on palaeoecological studies for the IGCP-Project No 158 B. Acta Palaeobot., 22 (1): 65—83.

— 1987. History of vegetation during the Late-Glacial and Holocene in the Brodnica Lake District in the light of pollen analysis of Lake Strażym deposits. Acta Palaeobot., 27 (1): 283—304.

Niewiarowski W. 1987. Development of Lake Strażym (Brodnica Lake District, Northern Poland) during the Late-Glacial and Holocene. Acta Palaeobot., 27 (1): 251—268.

Pawlikowski M., Ralska-Jasiewiczowa M., Schönborn W., Stupnicka E. & Szeroczyńska K. 1982. Woryty near Gietrzwałd, Olsztyn Lake District, NE Poland — vegetational history and lake development during the last 12 000 years. Acta Palaeobot., 22 (1): 85—116.

Różański K. 1987. The ^{18}O and ^{13}C isotope investigations of carbonate sediments from the Lake Strażym. Acta Palaeobot., 27 (1): 277—282.

Szeroczyńska K. 1985. *Cladocera* jako wskaźnik ekologiczny w późnoczwartorzędowych osadach jeziornych Polski Północnej (summary: *Cladocera* as ecological indicator in Late Quaternary lacustrine sediments, Northern Poland). Acta Palaeont. Pol., 30 (1—2): 3—69.