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Preliminary studies on vegetational changes since Late-Glacial times at the peat bog near Moszne Lake (Lublin Polesie, E. Poland)

Krystyna BALAGA, Agnieszka PIDEK and Jan RODZIK

1. INTRODUCTION

The study area is situated in the southern part of the Lublin Polesie within the Leczna-Wlodawa Lake District. This region lies within the zone of dispersed *Picea abies* occurrence and outside the area of *Abies alba* and *Fagus sylvatica* distribution (FIJALKOWSKI 1957b, SZAFER 1972). The low mean annual precipitation (c. 550 mm) explains why the Lublin Polesie is one of the areas in Poland which suffers most from water shortage. The mean annual temperature is c. 7.5°C (WISZNIEWSKI 1973).

The bedrock of this region consists of Cretaceous, marl and chalk. Erosive valleys occurring in sites where tectonic dislocations took place (MARUSZCZAK 1966) as well as karstic depressions give variety to the bedrock relief (BURACZYNSKI 1988, HENKIEL 1988). The depressions are filled with Pleistocene deposits, several dozen meters thick; clays, sands and fluvioglacial gravels of Mindel and Riss glaciations, as well as lake silts. The depressions of the Pleistocene deposits are filled with organogenic Holocene sediment (BURACZYNSKI and WOJTANOWICZ 1983).

The monotonous surface relief of the Leczna-Wlodawa Lake District is mainly due to the filling of the depressions with the younger deposits. This monotony can especially be observed in the central part of the region where the

study area is situated. The outflow of waters is impeded and in consequence vast areas are covered by swampy habitats with their own, often unique, flora and fauna.

The small lakes (up to 3 km^2) are the characteristic feature of the landscape. Their genesis is still being discussed although several hypotheses have been formulated concerning their origin. First a karstic origin of Leczna-Wlodawa Lake was assumed (WILGAT 1954), nowadays a thermokarstic genesis of the lake basins is preferred (BURACZYNSKI and WOJTANOWICZ 1983).

Due to its untouched flora the region is unquestionably very attractive for geobotanists. Several nature reserves and landscape park have been established there. Lately, the project of Poleski National Park has been prepared which covers an area of 48 km^2 (CHMIELEWSKI 1989). The decision of its formal creation was taken in May 1990. Due to the threat of drainage of vast areas and the vicinity of the Lublin Coal Basin the nature protection problems are of great importance in this region.

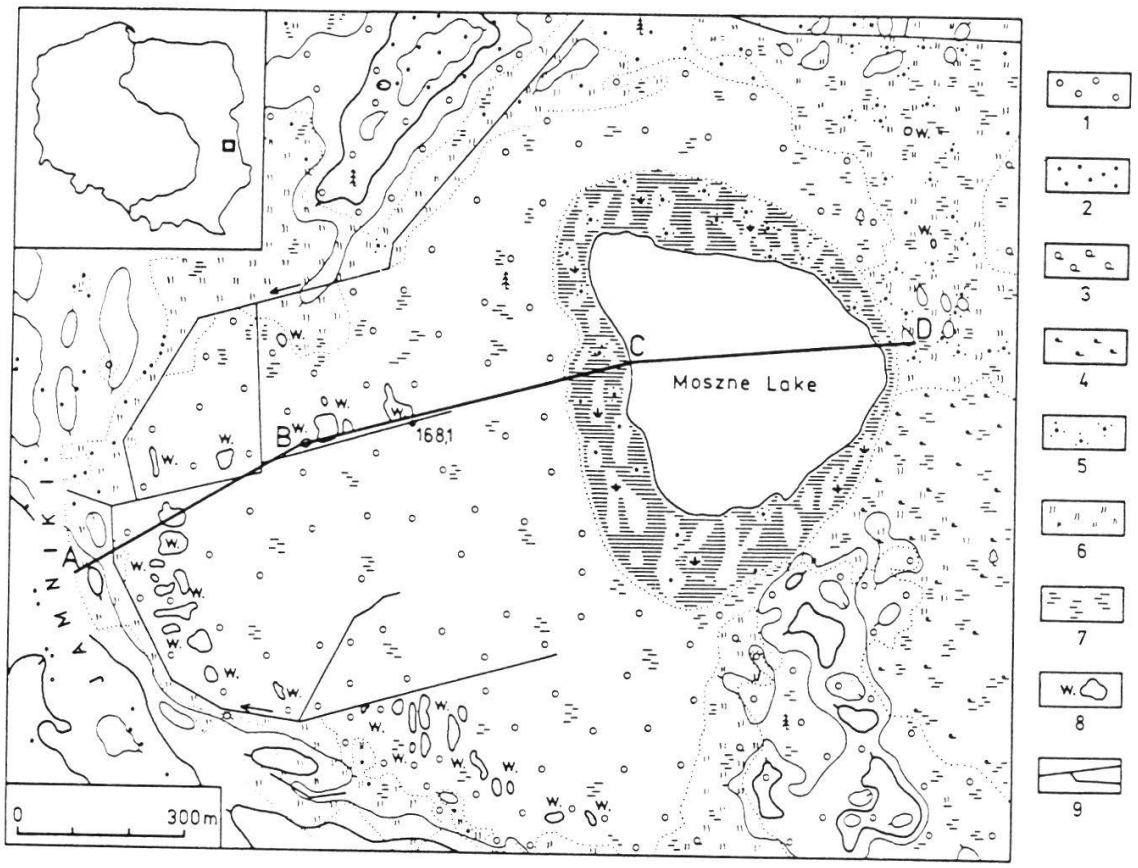

Fig. 1. The location of the Moszne Lake.
1. forest, 2 - younger forest, 3 - thin forest, 4 - dwarf forest, 5 - brushwood, 6 - meadow, 7 - bogs, 8 - water, 9 - ditch drain.

2. MATERIAL AND METHODS

The field research work at the peat bog on the margins of the Moszne Lake was carried out from February 1989 to May 1990. More than 30 borings were examined and described on the transect from Jamniki to the eastern bank of the lake (Fig. 1). The cross-sections were taken with the aid of a gimlet using a Russian sampler.
The bed relief of the organic sediments has been established on the basis of these investigations (Fig. 2).
One of the cores (P) served as material for palynological studies. The profile was obtained with a 5 cm diameter Russian sampler. Samples for pollen analysis were taken at 5 cm and 10 cm intervals. The material was prepared by various methods according to the character of the sediment (FAEGRI and IVERSEN 1964). The results of the pollen analysis are presented as a percentage pollen diagram (Fig. 3). The calculations are based on the sum AP+NAP including trees and shrubs, dwarf shrubs and herbs but excluding aquatic and swamp plants and spores.
The investigations have been supplemented by five radiocarbon dates, performed at the laboratory of the Silesian Technical University in Gliwice.

3. DESCRIPTION OF THE STUDY AREA

The Moszne Reserve is located east of Jamniki village (Fig. 1). It covers an area of 205 ha from which 17.5 ha are occupied by a shallow (1 m deep) dystrophic lake, which is surrounded by a floating bog, the so-called "spleja". The remaining part is occupied by terrestrial peat bogs.
The studies concerned the organogenic sediments filling the oval-shaped depression (1.5x1 km) in the Pleistocene deposits. The Pleistocene deposits are glacial clays, fluvioglacial sands and gravels as well as lake sands and silts. From the southeast the depression adjoins the hummock of the Cretaceous bedrock which has been subjected to karstic processes (BURACZYNSKI and WOJTANOWICZ 1981 a,b). The peat bogs form a flat surface at 168-169 m a.s.l. A series of borings (Fig. 2) have proved that the lake is located within the biggest and the deepest depression. The thickness of the organogenic sediments under the bottom of the lake is not known. Exploration of the bottom sediments with a Russian sampler was planned, but it could not be done because of very warm winters in 1988/89 and 1989/90 with a lack of ice on the lake surface. Several borings from the boat have been done with the aid of a gimlet which has a very

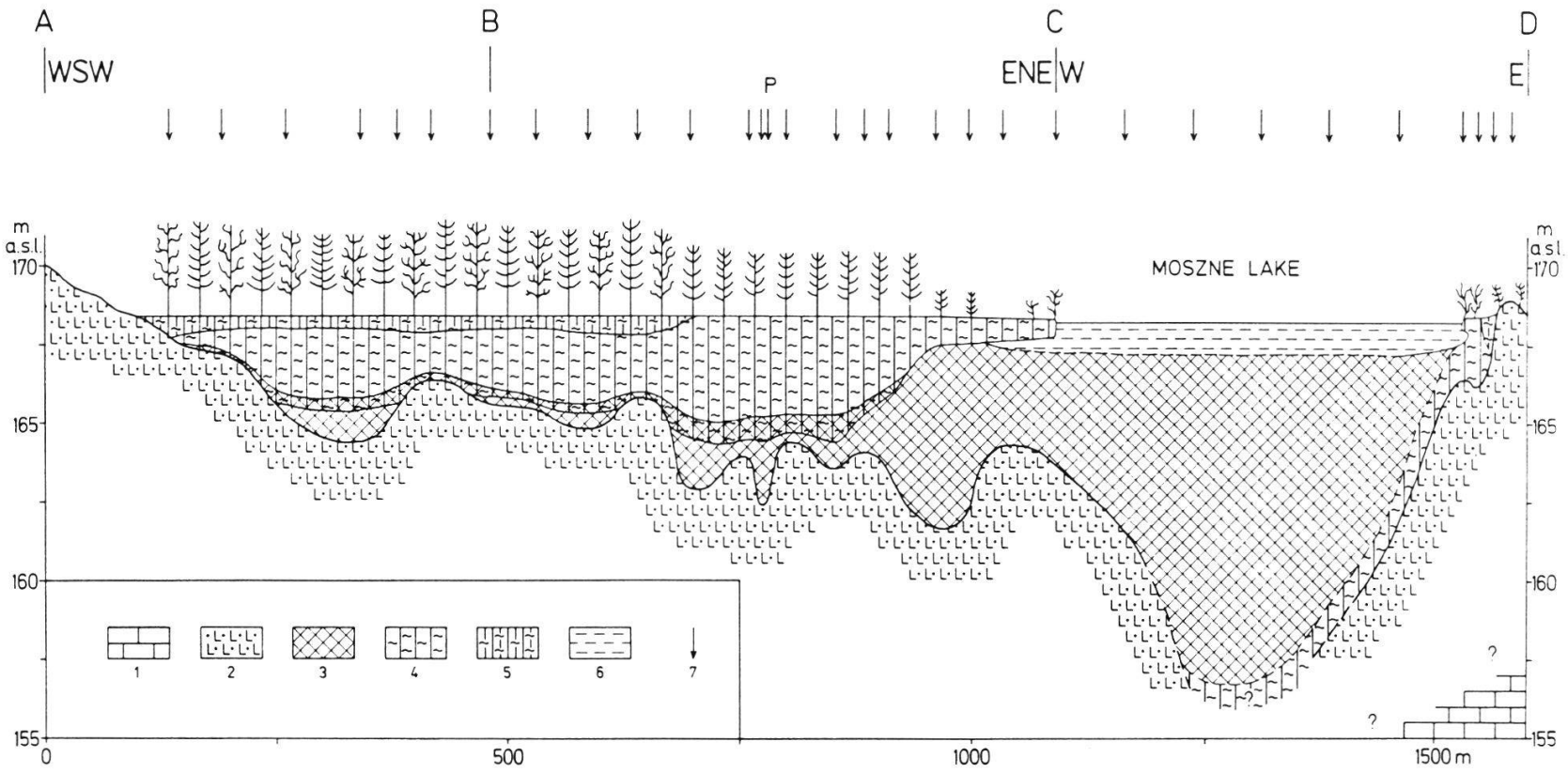

Fig. 2. Section across the organic sediments of the Moszne Lake.
1 - chalk, 2 - silt and sand, 3 - gyttja, 4 - sedge-moss peat, 5 - sedge-moss peat, very decomposed, 6 - water, 7 - borings.

limited possibility of taking sediment samples. It has been found that the lake basin is filled with gyttja of a thickness exceeding the length of the gimlet (11 m).

4. PRESENT-DAY VEGETATION

Nowadays the Moszne Lake with its surroundings is one of the nature reserves in the newly established Poleski National Park. The water of lake is dystrophic. The silty bottom sediment is covered with *Characeae* meadows. In the littoral zone, the most important community consists of *Myriophyllo-Nupharetum* with *Nuphar luteum*, *Potamogeton natans* and *Stratiotes aloides*. *Sphagnum* surrounds the lake and partly overgrows the open water (cover about 70 cm thick). From the south and southeast the "spleja" is overgrown by the *Caricetum diandrae* community with subordinate *Sphagnum* species. Other lake shores are overgrown by *Caricetum lasiocarpae* and *Caricetum limosae* communities. A great number of rare plant species occur on the "spleja": *Salix lapponum*, *S. myrtilloides*, *Carex limosa*, *C. chordorrhiza*, *C. heleonastes*, *Drosera rotundifolia*, *D. anglica*, *D. intermedia*, *Pedicularis sceptrum-carolinum*, *Epipactis palustris* and three species of *Utricularia* as well as *Aldrovanda vesiculosa* (FIJALKOWSKI 1957a,b, 1958a,b, 1960, IZDEBSKI and GRADZIEL 1981, KARCZMARZ 1989). The locality of *Salix lapponum* found here is the most abundant in Poland (c. 1000 individuals).
In the western part of the lake at 50-100 m from the shore there is a raised-bog with hummock structure. In its vicinity a c. 500 m wide belt of *Vaccinio uliginosi-Pinetum* occurs. From the north and east there occur *Salix cinerea* and *Betula humilis* thickets as well as a typical alder swamp.

5. REGIONAL HISTORY OF VEGETATION

The pollen diagram has been divided into biostratigraphic units (pollen assemblage zones) PAZ (Fig. 3). Blytt-Sernander chronostratigraphic units have been used (MANGERUD et al. 1974).
Zone M-1 PAZ. This zone probably corresponds to the end the Older Dryas. The high percentages of NAP and shrub pollen are typical for the open treeless vegetation of the study area at the time of Moszne Lake formation. Loose patches of steppe-like vegetation with *Artemisia*, *Chenopodiaceae*, *Ranunculus*, *Thalictrum*, *Helianthemum* and *Hippophaë* prevail. The abundance of different *Salix* species and high frequencies of *Betula* indicate that willow

and birch were dominant shrubs in moist habitats. The lake was shallow, with dominant *Myriophyllum spicatum/verticillatum* and *Pediastrum*. The presence of *Myriophyllum verticillatum* and *Filipendula* suggest that the mean July temperature was not lower than 10°C (CLEVERINGA et al. 1977).

Zone M-2 PAZ. This zone can be identified with the Allerød. During the older part of this period the vast areas the Moszne Lake were occupied by *Betula* forests, in the younger part, however, *Pinus* began to play much more important role. At this time, willow became less important. Xerothermic communities occurred with dominant *Gramineae*, *Cyperaceae*, *Artemisia*, *Juniperus* and *Hippophaë rhamnoides* (the latter occurring only in the lower part of this zone). This fact seems to indicate that the climate of this part of the country had continental features. The presence of *Typha latifolia* suggests that the mean temperatures of July were about 16°C and of January, not below -4°C (WASYLIKOWA 1964).

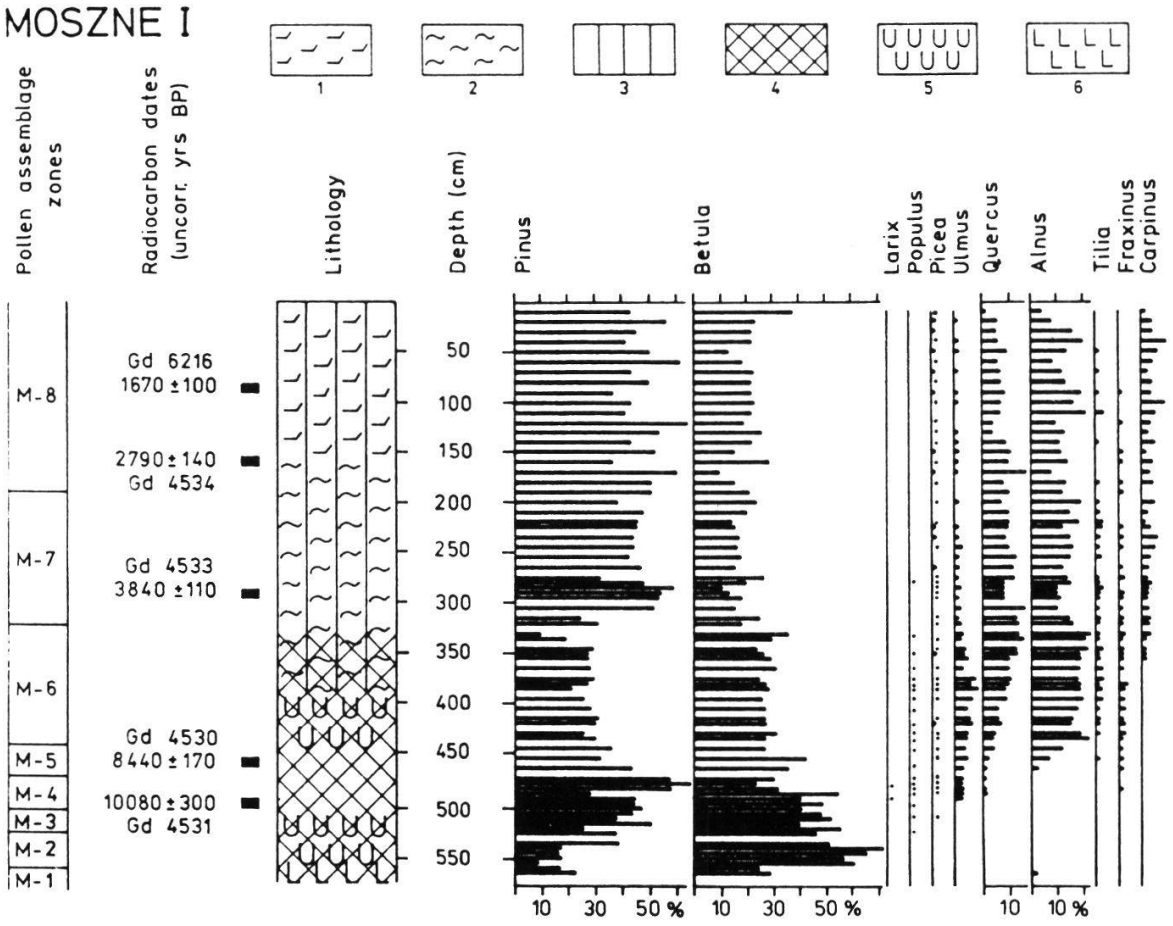

Fig. 3. Simplified percentage pollen diagram from the peat bog at Moszne Lake; values of the chosen taxa 0.5% marked by dots (analysed by K. Balaga).
1 - *Sphagnum* peat, 2 - moss peat, 3 - sedge peat, 4 - gyttja, 5 - calcium carbonate, 6 - silt.

Zone M-3 PAZ. The rise of *Artemisia* and *Thalictrum* pollen and the appearance of *Gypsophila fastigiata*, together with decreasing frequencies of *Betula* and *Pinus* suggest a minor oscillation towards a drier and more continental climate. This period was characterized by parkland landscape with dominant xerothermic, steppe-like communities with abundant *Artemisia* and *Chenopodiaceae*. According to palynological conventions, this zone should correspond to the Younger Dryas, however, it is represented by a very limited thickness of sediments (cf. BALAGA 1982, 1990, BALAGA et al. 1983).

Zone M-4 PAZ. This zone reflects successive woodland development during the Preboreal period with increasing occurrence of *Pinus* and decreasing occurrence of *Betula*. The continuous *Ulmus* curve is characteristic of the in situ occurrence of this tree. Elm began to expand at c. 10080 ± 300 years B.P. (cf. RALSKA-JASIEWICZOWA 1983). On sunny places and on the outskirts of the

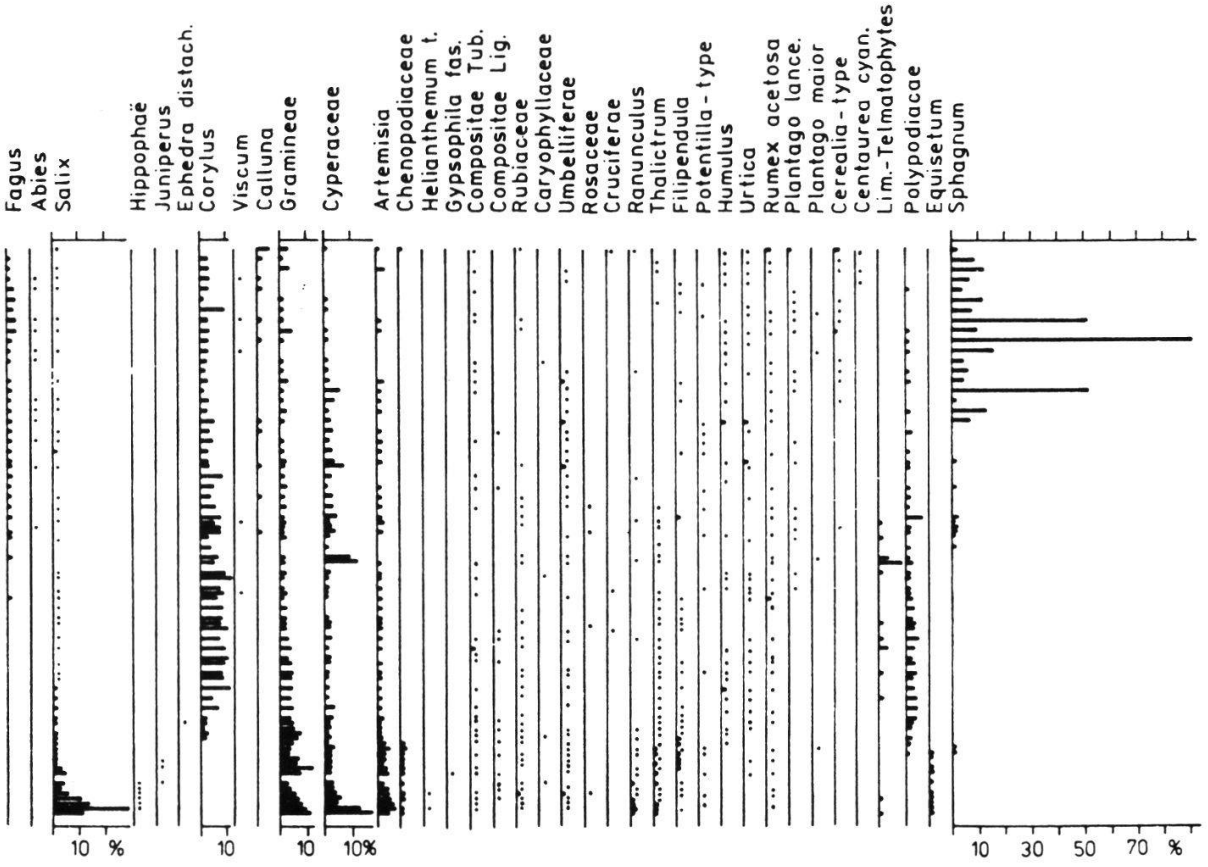

Fig. 3 (continued)

forests *Corylus* thickets appeared. *Quercus* and *Fraxinus* pollen, which occur in small quantities, show that oak and ash did not yet play an important role. The dominant forests were not dense, and there occurred some remnants of late glacial heliophilous communities as well as ferns in the herb layer. The occurrence of *Typha latifolia* and *Nymphaea alba* indicate the ameliorating climatic conditions and the temporary rise of the lake water level.

Zone M-5 PAZ. This zone corresponds to the Boreal period. Pine-birch forests were still dominant but the most characteristic feature of this period was the distribution of hazel with its maximum frequencies dated to 8840 ± 170 years B.P. In the younger part of this zone *Corylus* thickets were being replaced by the deciduous tree species gradually increasing in number. *Quercus* and *Tilia* occupied the more fertile and less permeable soils. Alder began to play an important role in swampy habitats. The alder woods had probably an admixture of ash. *Humulus* and *Urtica* cf. *dioica* were also present in the herb layer.

Zone M-6 PAZ. The pollen spectrum indicates that this zone corresponds to the Atlantic period. The development of deciduous forests with *Quercus*, *Corylus*, *Ulmus*, *Tilia* reached its maximum. The distribution of deciduous forests was determined by soil conditions. Pine forests survived on the sandy, less fertile, drier soils. The humid soils were still occupied by forests consisting of alder, elm and ash. The expansion of alder woods depended on the development of moist habitats, which was stimulated by progressive lowering of the ground water level resulting in the overgrowing of small water-bodies or of part of larger lakes. At this time the peat bog began to form. This phenomenon is signalled in the pollen diagram by the more frequently encountered *Cyperaceae* and *Typha latifolia* pollen.

Two new tree species, hornbeam and beech, appeared in the upper part of the zone. Their early occurrence in the Lake Lukcze was dated to 6420 ± 70 years B.P. (BALAGA 1982, 1990). In that period, however, *Carpinus* and *Fagus* did not play an important role in the forests. The first pollen grains of *Plantago lanceolata* signalled the beginning of human interference in the so far natural succession.

Zone M-7 PAZ. Except for the short period of an increasing importance, *Pinus* played no significant role in the forests. *Quercus* and *Alnus* were gradually increasing in number. This level was dated to 3840 ± 100 years B.P. It is at this time that some indicators of human activities appeared. They are probably associated with the activities of a population representing the Late Neolithic Corded Ware culture. At the same time, the proportion of *Ulmus*, *Tilia*

and *Corylus* decreased in the widespread deciduous forests. On the other hand, *Carpinus* began to play more and more important role. The high values of *Alnus* evidence to presence of the vast swampy areas. This zone corresponds to the older and middle part of the Subboreal period.

Zone M-8 PAZ. This zone certainly represents the late Subboreal and the Subatlantic periods. At this time the composition of the forests did not change but the development of vegetation was under the great influence of man. The first phase of colonisation, dated to 2790 ± 140 years B.P., is referred to the Bronze age. The Polesie territory was then inhabited by a population of Lusation culture. The second phase, dated to 1670 ± 100 years B.P., is connected with the period of Roman influences. The role of *Carpinus* and *Fagus* increased in this zone. *Abies* occurred sporadically. Today beech does not participate in the forest communities of the studied lake district (FIJALKOWSKI 1957b), its nearest stands are in the southeast, in the Lublin Upland and the Roztocze (GOSTYNSKA-JAKUSZEWSKA and ZIELINSKI 1976). Fir is also absent from the forest communities, its nearest stands occur in the Lukow Plateau and near Parczew (GOSTYNSKA-JAKUSZEWSKA 1972). This problem has been discussed by BALAGA (1990).

6. DISCUSSION ON STRATIGRAPHY AND WATER LEVEL CHANGES RECORDED IN THE PEAT BOG PROFILE

The pollen diagram from the peat bog at Moszne Lake illustrates the vegetational history and development of the water-body from the Older Dryas till recent times. The presence of the climatic fluctuation of Older Dryas at c. 12000 years B.P. and its stratigraphical significance is still controversial and widely discussed (VERBRUGGEN 1979, WATTS 1980). The changes illustrated by the Moszne Lake diagram, especially the high peak of *Salix* pollen percentages and the presence of *Hippophaë* pollen, are met frequently at the transition to interstadial forest phases. The maximum expansion of birch corresponding to the pollen zones L-1b was radiocarbon dated to 12330 ± 160 years B.P. in the diagrams of the Lukcze Lake (BALAGA 1982, 1990) and was assumed to represent the Bølling interstadial. This is the only date of this age from the Leczna-Wlodawa Lake District. However, it cannot be excluded that the date of 12330 years B.P. is too old owing to the hard water effect which may appear in karst areas with the Cretaceous bedrock. The high *Betula* pollen values may indicate the birch phase of the Allerød. In the Moszne Lake profile the birch maximum has been found in calcareous sediment which is

inadequate for radiocarbon dating. The sequence of the pollen curves in the Moszne diagram indicates that this phase corresponds to the birch phase of the Allerød. It has been found that the bottom deposits underlying gyttja sediment correspond to the Older Dryas. These are lake silts of a thickness of 10-20 cm with an admixture of sand and gravel. In other profiles along the transect the silt appears already at a depth of 2.5 m. This fact seems to indicate that the water level in the lake of that time was about 2 m lower than at present. It is also possible that there existed other water-bodies than the main one.

The examination of the described profile shows that in the shallow water-body calcareous gyttja was deposited. At the beginning of the Preboreal period the water level rose significantly which is marked in the profile by accumulation of gyttja without $CaCO_3$. The lake water level was almost as high as present. This interval has been radiocarbon dated at 10800 ± 300 - 8840 ± 170 years B.P.

From a depth of 4.6 m to 4.0 m detritus gyttja containing $CaCO_3$ accumulated again. This fact indicates that the lake was becoming shallower. Finally, during the Atlantic period peaty gyttja started to accumulate (at a depth of 4.0 m in the profile). All these changes led to the formation of a peat bog (c. 5000-4500 years B.P.) with dominant brown mosses. At this time similar overgrowing of the shallow lakes occurred in many parts of central Poland (Ralska-Jasiewiczowa and Starkel 1988). In the Subatlantic period (at a depth of 1.68 m in the profile) *Sphagnum* peat consisting mainly of *Sphagnum palustre* and *S. apiculatum* began to accumulate. Since then the water level has risen gradually and peat has steadily accumulated.

Many problems appearing during the investigations need further studies.

SUMMARY

On the basis of geological borings and pollen analysis supplemented by five radiocarbon dates, eight pollen assemblage zones have been distinguished and described illustrating vegetational changes of the lake surroundings from the Older Dryas to the modern times. 1. During the Older Dryas (M-1 PAZ) willow and birch thickets and heliophilous communities played the main role in the landscape. 2. During the Allerød (M-2 PAZ) birch-forests with *Pinus* were dominant. 3. The Younger Dryas (M-3 PAZ) was characterized by a parkland landscape with prevalent heliophilous communities. 4. In the Preboreal period (M-4 PAZ) a characteristic feature was the early *Ulmus* appearance dated to 10080 ± 300 years B.P. 5. During the Boreal period (M-5 PAZ) the spread of hazel dated to 8840 ± 70 years B.P. was most important. 6. The development of deciduous forests reached its maximum during the Atlantic period (M-6 PAZ). *Carpinus* and *Fagus* appeared. 7. The older

part of the Subboreal period (M-7 PAZ) was characterized by the decrease of the proportions of *Ulmus*, *Corylus* and *Tilia* and the increasing frequencies of *Carpinus*. 8. Zone M-8 PAZ represents the late Subboreal and Subatlantic periods. The increasing role of hornbeam and beech in the forests and the influence of human activities were the most characteristic features. 9. The most marked phases of human agricultural activities have been radiocarbon dated to 3840 ± 110, 2790 ± 140 and 1670 ± 100 years B.P. These phases refer to the activities of populations representing the Corded Ware culture and Lusation culture as well as the influence of the Roman period. 10. The beginning of sediment formation and changes of the water level have been discussed.

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