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IWONA OKUNIEWSKA-NOWACZYK

LATE HOLOCENE HISTORY OF THE VEGETATION GROWING IN THE VICINITY OF LAKE SKRZYNKA, THE GREATER POLAND NATIONAL PARK, OBTAINED FROM POLLEN ANALYTICAL DATA

Młodoholoceńska historia roślinności w otoczeniu Jeziora Skrzynka (Wielkopolski Park Narodowy) w świetle analizy pyłkowej

ABSTRACT. Reconstruction of the history of vegetation in the vicinity of Lake Skrzynka begins with the Boreal Period. Human impact which has taken place for about 5000 years has been recorded in the pollen diagram. The first radiocarbon dates available for the Greater Poland National Park are given. The results of Testacea analysis have been discussed.

INTRODUCTION

The Greater Poland National Park frequently attracted the attention of botanists, including palynologists who were interested in the history of vegetation of this area. Palynological studies were initiated there over fifty years ago (Tobolski, in press). The first analyses were carried out by Szaniawska in 1929 (Wodziczko & Szaniawska 1934). Ołtuszewski (1957) who investigated eight profiles from a variety of sites in the Greater Poland National Park made an extremely valuable contribution to the knowledge of the history of vegetation inhabiting this area. One of the studied profiles taken from a peatbog lying close to Lake Budzyńskie was investigated again by Szafrański (1973). In 1964 Wasylikowa reinterpreted the basal zones of pollen diagrams analysed by Ołtuszewski.

The present author took up palynological studies in the Greater Poland National Park in 1982. Among others, the necessity to provide a reference profile lying south of Poznań, which would meet the requirements of the IGCP 158B project (cf. Berglund 1979), was one of the reasons why the studies were undertaken again in this area. Up to now there has not been such a reference site in Greater Poland. Hence, the study of peatbog deposits occurring in the vicinity of Lake Skrzynka, which were earlier described by Ołtuszewski (1957), has been attempted again. Such a choice has been affected by the presence of carbonate-free deposits which allow correct radiocarbon dating. The first stage of study covering the major part of the Holocene profile has now been finished.

PHYSIOGRAPHIC CONDITIONS OF THE STUDY AREA

The Greater Poland National Park lies south of Poznań in the Greater Poland-Kujavian Lowland (Fig. 1). Its major portion is located over a belt of end moraines which are younger than the Leszno phase and older than the

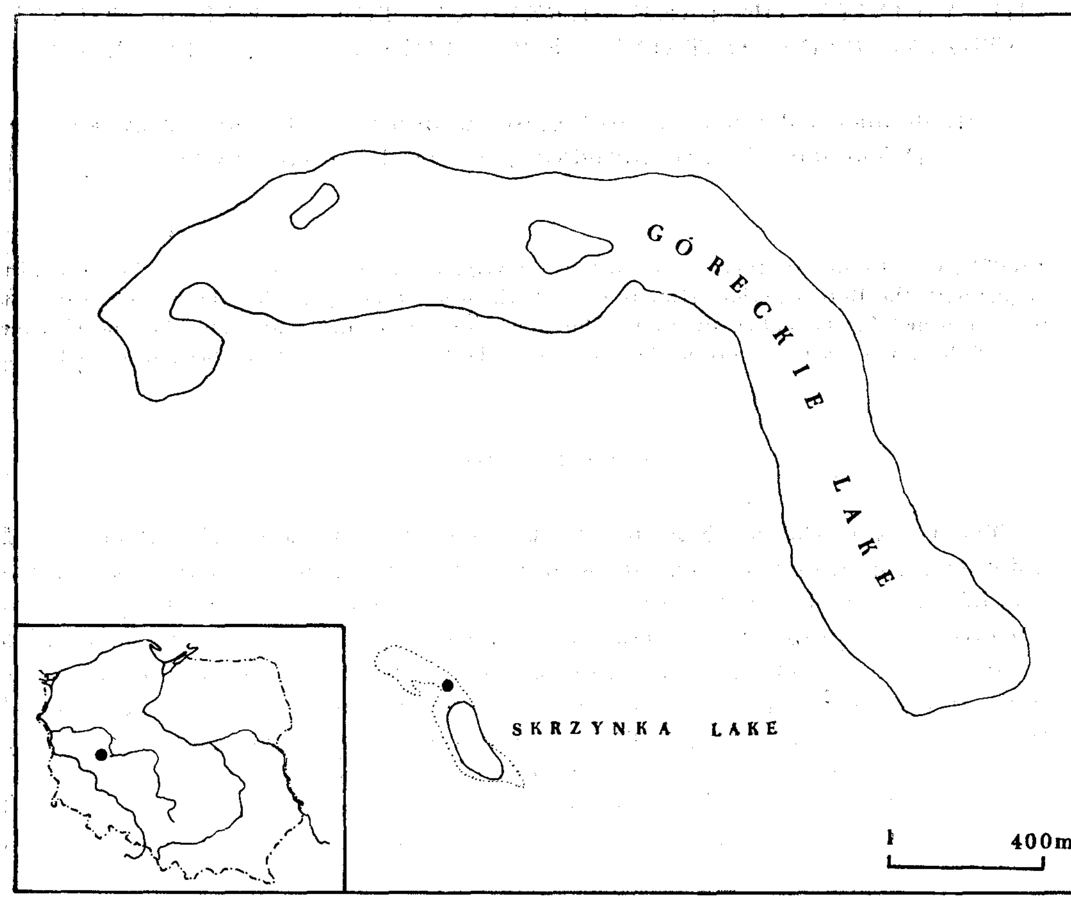

Fig. 1. Location of the study area (circle: sampling site supplying material for palynological study)

Poznań phase of the last glaciation. Their relief is extremely diversified and varies a lot in height. The end-morainic belt is dissected by deep glacial troughs which are generally perpendicular to the morphological axis of the moraines. Besides the glacial troughs, there are numerous melt-out hollows without outlets.

The Skrzynka site (Q 52°15′, λ 16°49′) is situated in one of the glacial troughs. The lake that occupies the trough is oval in outline and is the smallest one in this area (3.0 ha). Its greatest depth approaches 3.1 m, while the mean depth is 2.0 m. A transition peatbog characterized by rather varying hydrologic and trophic conditions lies close to the north-western shore of the lake. Information about the climatic conditions of the Greater Poland National Park may be obtained from data provided by a meteorological station at the Jeziory locality in the vicinity of Lake Góreckie (cf. Celiński 1969). The average annual precipitation is 520 mm with a maximum in July and August. The mean annual temperature is 9°C. Extreme temperatures fluctuate between —22.1° and +37.6°C. The average relative moisture content is about 80 percent. The highest moisture deficiency, i.e. 60 percent, is recorded in April and May. Light and consolidated clayey sands, overlying the till and sands poor in clay which overlie unconsolidated sand make up the parent rocks of the soils reported from the vicinities of Lake Skrzynka, i.e. leached brown and pseudopodsolic soils (Borowiec 1973). The diversity of forest types present in the park depends on soil type as well as on other factors, such as groundwater level or terrain morphology. The vast area is occupied by pine forests. The predominance of *Pinus* is not only due to substratum character but also to man's preference for this tree. Pine is accompanied by deciduous trees, especially oak, on more fertile soils. Deciduous forest fragments, for example the oak-hornbeam forest reserve on Lake Góreckie called Grabina, have survived here and there.

RESEARCH METHODS

The profile of deposits for pollen analysis was alternately sampled with a Russian sampler from two neighbouring holes located in the peatbog at a distance of about 60 m from the northern shore of Lake Skrzynka (Fig. 1), in the winter. The top part of the profile was not recovered because of technical limitations. This part was replaced by samples from peatmoss tussock, *Sphagnum magellanicum*. Samples 1 cm³ in volume were subjected to investigations in the laboratory. They were boiled in 10% KOH for an hour. Particles over 1 mm in diameter were next left on the sieve. The remaining material was subjected to acetolysis using Erdtman's technique. Two tablets containing *Lycopodium clavatum* (11850±200) were added to each sample to calculate the pollen concentration in 1 cm³ of deposit (Stockmarr 1971, 1973). The material was stained with alkaline fuchsine and stored in glycerine. Ninety four samples were analysed at 5 cm intervals. At least 1000 AP grains were counted in each spectrum. The results of the palynological studies are presented in two diagrams (Figs 2, 3), i.e. a percentage diagram (AP+NAP = 100%) and a simplified pollen concentration diagram of trees and shrubs, and some selected herbaceous and aquatic plants in 1 cm³ of the deposit. These histograms are supplemented by curves showing the concentration of three sporomorph groups, i.e. trees, shrubs, some herbaceous plants and selected plant species excluded from the NAP sum. The results of the analysis of two surface *Sphagnum* samples are presented as histograms at the top zone of the percentage diagram.

SEDIMENT DESCRIPTION

The profile consists of peats, gyttjas and the intervening water. The thickness of the whole profile (biogenic sediments and the water) is 637 cm. The sporomorph contents of peats and gyttjas were analysed down to a depth of 550 cm. The sediments are described using Troels-Smith's method (1955) by means of simplified symbols and notation systems (Aaby 1979). The stratigraphy of the profile zones analysed so far is as follows:

Depth (cm)	Description of sediments
50—55	light brown peat slightly decomposed, twig and leaf fragments $Tb^1 3$, Dh1
55—75	light brown peat slightly decomposed, a piece of wood lying cross-wise at the depth of 60 cm $Tb^1 4$
75—200	dark brown peat moderately decomposed $Tb^2 4$
200—250	brown peat slightly decomposed $Tb^1 4$
250—350	yellowish-brown peat slightly decomposed $Tb^1 4$
350—400	water
400—525	brown gyttja with an abundance of plant remains Ld3, Dh1
525—550	dark grey fine detritus gyttja Ld4

LOCAL POLLEN ASSEMBLAGE ZONES

The local pollen assemblage zones (LPAZ) recognized in the profile from the peatbog in the vicinity of Lake Skrzynka are as follows:

Betula-Pinus-Corylus PAZ: samples 520—550

The *Betula* pollen frequencies are 26.3 to 37.0%. Pine frequencies are about 30%; at the close of the zone there is a decline in the pine curve to 14.7%. The *Corylus* pollen reaches 25.2 % which is a maximum value in the whole profile. Among herbaceous plants, *Gramineae*, *Cyperaceae* and *Pteridium* occur in larger amounts, i.e. a maximum of 2.5—5.3, 1.3—3.3 and 1.5%, respectively. The amount of *Pediastrum*, especially that of *Pediastrum boryanum*, becomes significant (6.8%).

Ulmus-Tilia-Quercus-Fraxinus PAZ: samples 420—515

A characteristic of this zone is the dominance of Quercetum mixtum, including *Ulmus* (5.3% max.), *Quercus* (11.7% max.), *Tilia* (1.2% max.) and *Fraxinus* (5.7% max.). *Pteridium* forms a continuous curve (0.2—1.6%). *Calystegia* is present. The frequency of *Artemisia* is 1%. *Potamogeton* pollen is 4.3% and *Pediastrum boryanum* colonies are numerous (15.6%).

Pinus-Quercetum mixtum PAZ: samples 340—415

The *Pinus* frequencies increase to maximum values, i.e. 49.0—65.4%. *Quercetum mixtum* values range from 5.7 to 11.1%, including 4.3—8.6% of *Quercus*, 0.7—2.2% of *Ulmus*, 0.9—2.5% of *Fraxinus*. *Alnus* ollen oscillates between 8.8 and 12.5%. There are few herbaceous plants; the NAP sum is 3.8%.

Ulmus-Pinus-Fraxinus PAZ: samples 255—335

Ulmus (4.3%) *Fraxinus* (3.5%) and *Pinus* (33.3 to 61.2%) are dominant in this zone. The maximum frequencies of *Pteridium* spores reach 11%. *Sphagnum* spores occur for the first time in large amounts, i.e. 5.2%.

Quercus-Carpinus-Corylus PAZ: samples 145—250

New forest constituents, i.e. *Carpinus* (9.5% max.) and *Fagus* appear. The maximum proportions of *Quercus*, *Corylus* and *Fraxinus* are 15.8, 14.3 and 2.8%, respectively. Succisa is present. *Sphagnum* attains a maximum proportion of 262.2%. One of the *Testacea* genera, i.e. *Amphitrema*, reaches frequencies of 40.7%.

Carpinus-Alnus-Betula PAZ: samples 110—140

The amount of *Carpinus* pollen ranges from 4.0 to 8.3%. The *Alnus* frequencies reach maximum values, i.e. 24.3%. *Betula* forms a nearly continuous 20% curve. Among herbaceous plants, *Artemisia* occurs in substantial amount, i.e. 2.9%.

Fagus-Quercus-NAP PAZ: samples 65—105

This zone records the history of vegetation growing over a period from 1000 to 1850 yr BP. The beech frequencies reach their maximum values of 2.5— in the whole profile. The *Fagus* frequencies show increase when *Carpinus* values are depressed. The *Quercus* frequencies range from 7.3 to 16.2%. The *Betula* curve oscillates between 10.8 and 41.0%. The frequencies of *Alnus* and *Carpinus* pollen reach 21.2 and 10.1%, respectively. The NAP sum becomes a proportion of importance in this zone, i.e. 37.1— at a maximum. Among them, *Cyperaceae* (6.2%), *Gramineae* (12.0%), as well as such indicators of human activity as *Artemisia* (8.2%), *Plantago lanceolata* (2.5%) and *Cerealia* (2.6%) are of major importance.

Pinus-NAP-*Salix* PAZ: samples 50—60

The curve for *Pinus* oscillates between 18.0 and 32.5%. *Salix* pollen reaches 1.9% (4.3%) *. The NAP sum frequencies, including 7.8% (28%) of *Gramineae*, 8.0% (17.1%) of *Cyperaceae* and 1.8% (7.5%) of *Cerealia*, approach 32.8% (53%). The maximum frequencies of *Polypodiaceae* are 11.3% (24.3%).

VEGETATION DEVELOPMENT IN THE VICINITY OF LAKE SKRZYNKA

The Boreal Period

The base of the profile under investigation can be identified with the middle and latest phases of the Boreal Period. *Pinus*, *Betula* and *Corylus* are dominant. The vast areas surrounding Lake Skrzynka during these phases were occupied by birch. *Betula* was represented in larger numbers than *Corylus*; oscillations in its curve are also smaller than those of the hazel pollen curve. Maybe this pollen picture provides only evidence of local conditions. It may be presumed that *Alnus* (17.1%) grew in the vicinity of Lake Skrzynka during the later phase of the Boreal Period. Indicator plants, e.g. *Viscum*, were present, and *Hedera helix* appeared in the closing phase of that period. Pine forests with *Pteridium* in the undergrowth prevailed. In the lake there existed suitable conditions for the growth of *Pediastrum boryanum*. During the Boreal Period widespread occurrence of this alga took place about 8.430 years BP.

The Atlantic Period

The opening of the Atlantic Period is characterized by an increase in the AP sum to 95.4%. *Quercus*, *Ulmus* and *Alnus* assume greater significance, and pine pollen declines to 11.3%. As a small number of new species arrive, this period is defined as a stable one which allowed the forest communities to mature. The development of mixed oak forests took place then. Hazel was an important

* Data given in brackets come from two samples taken from *Sphagnum magellanicum*.

constituent of those forests (11.5 % on the average). *Pteridium* grew in the undergrowth. The *Alnus* frequencies increase to 14.4%. *Alnus* together with ash occupied the lake shores. In the area around Lake Budzyńskie alder was of still greater significance (Szafrański 1973), with frequencies reaching 21.8%. In Lake Skrzynka there existed particularly favourable conditions for the growth of *Nymphaea* and *Potamogeton* in the middle phase of the Atlantic Period. The infilling of the basin initiated in the Boreal Period still proceeds. The flourishing of *Pediastrum boryanum* is also indicative of this. In the closing phase of the Atlantic Period there is a decl'ne in the constituents of *Quercetum mixtum* to 7.4% and a concurrent increase in the pine frequencies to 59.8%.

The Sub-Boreal Period

It is difficult to define palynologically the boundary between the Atlantic and Sub-Boreal periods. The earlier works suggest that the opening of the Sub-Boreal periods. The earlier works suggest that the opening of the Sub-Boreal Period in Poland is associated with the beginning of a continuous curve for hornbeam (Szczepanek 1961, Mamakowa 1962, Szafrański 1973, Jankowska 1980). Some research workers (Ralska-Jasiewiczowa 1964, 1966, Latałowa 1982) point out the anthropogenic character of the expansion of this tree. Recent radiocarbon analyses made it possible to date the arrival of hornbeam. Latałowa (1982) assigns the date of 4300—4000 yr BP to an increase in the significance of *Carpinus* in the vicinity of Lake Żarnowieckie and the Darżlubska primeval forest. Palynological studies of the profile from the peatbog in the vicinity of Lake Skrzynka support the presumption that the opening of the Sub-Boreal Period cannot be identified with a rising limb for *Carpinus* (Figs. 2, 6). A change in climatic conditions led merely to a reduction in the areas occupied by some tree species. The opening of the Sub-Boreal Period in the study area is associated with a decline in elm and pine, and with an increase in oak and hazel. There are still pine-oak forests present. Their undergrowth contains Pteridium, especially in the initial phases. In the middle phase of the Sub-Boreal Period there are alterations in the species composition of forests. Hornbeam and beech arrive. It was most likely man who contributed to the growth of *Carpinus*. People of Neolithic culture contributed to the destruction of elms and to concurrent expansion of hornbeam as a consequence of developed agriculture and stockraising (Ralska-Jasiewiczowa 1964, 1966, 1968, 1977, 1982). As can be inferred from the results of radiocarbon dating, this phenomenon occurred in the vicinity of Lake Skrzynka about 4000 years ago. The ^{14}C date of 3990 ± 80 yr BP has been obtained for a layer in which the *Carpinus* frequencies (AP = 100%) increase to over 1%. The *Fagus* frequencies (AP = 100%) reach 1.7% in a horizon for which the date of 3410 ± 60 yr BP has been obtained. The Sub-Boreal Period covers four settlement phases. It was only then that the action of man affected this area by changing radically the character of communities. The changes were produced by people of Lusatian culture. For the first time the herbaceous plant frequencies are higher than one third of the AP and NAP sum. It is thus at that time that larger-scale deforestation of the plateau is observed. *Calluna* is of more frequent occurrence. Its growth is due to clearance in formerly dense forest assemblages. *Succisa* and *Trifolium*, which are indicators of pastoral land utilization, are present. An area colonized by *Sphagnum* expands.

The Sub-Atlantic Period

At this time the action of man is one of the main factors affecting the development of plant communities. However, his influence varies with time. Frequent *Corylus* and *Betula* curve oscillations provide indications of changing human influence. Mixed pine-oak forests containing *Vaccinium* and *Pteridium* in the undergrowth, and *Corylus* and *Frangula* in the shrub layer are preserved here and there. Oak-hornbeam forests colonize extensive areas. Beech assumes greater significance. The frequencies of plants belonging to the NAP sum are highest, ie. 37.1%, whereas the *Pinus* frequencies are lowest, i.e. 13.6%. It is presumed that pine did not occupy vast areas in the closest vicinity of the lake. This period covers four settlement phases. Sorrel, which is of frequent occurrence, provides indications of a change in the substratum most likely due to the action of man. Particularly severe forest clearance took place in the Roman and pre-Piast times. In AD 900 nearly complete destruction of oak-hornbeam forests took place.

CHARACTERISTICS OF SETTLEMENT PHASES IN THE VICINITY OF LAKE SKRZYNKA

The palynological study permits not only the tracing of the history of vegetation but also provides an insight into the nature of the activity of man in the past. The palynological profile under investigation preserves a record of the effects of man's activities which have taken place for about 5000 years (Figs. 4, 5). The phases of settlement which have been recognized are given below.

Phase I: samples 315—410 (340—345: ^{14}C date of 4580±80 yr BP, Gd-975)

The presence of pollen from *Plantago lanceolata*, *Urtica* and *Artemisia* is indicative of pastoral land utilization. In the middle of, and at the close of, this phase *Cerealia* pollen appears. There is a decline in *Ulmus* and *Quercus*. The arrival of the heath assemblage provides an indication of progressing forest clearance. The *Calluna* frequencies reach 1.1%.

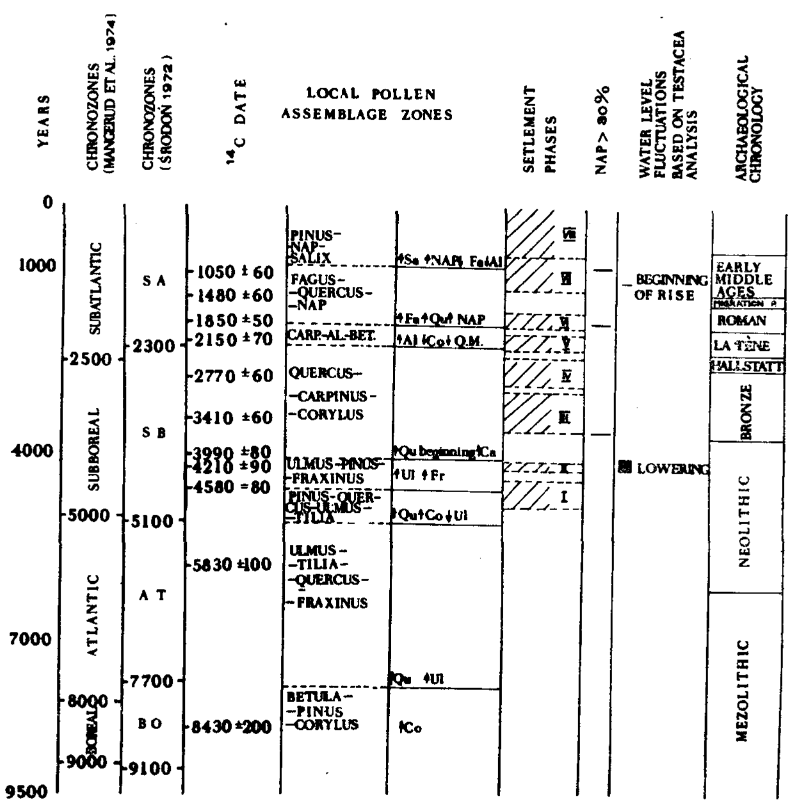

Fig. 5. Periods of human activity against changes in the natural environment

Phase II: samples 260—280 (270—275: ^{14}C date of 4210±90 yr BP, Gd-2110)

Artemisia and *Plantago lanceolata* assume certain significance. There is a decline in *Ulmus*. The *Pteridium* frequencies increase to maximum values, i.e. 11%. Increased quantities of coal dust have been found in the slides. From the above indicators, it can be inferred that forest burning and intensive pasturage took place in this area.

Phase III: samples 190—230 (215—220: ^{14}C date of 3410±60 yr BP, Gd-1631)

The diagram shows changing frequencies of trees, i.e. the constituents of *Quercetum mixtum*. *Betula* and *Corylus* grow again. It was probably man who caused these fluctuations. This can be inferred from a rise in the frequencies of such human activity indicator plants as *Plantago lanceolata*, *Artemisia*, *Urtica*, *Chenopodiaceae*, *Plantago maior-media* type and *Rumex acetosa-acetosella* type. Thus, there existed extensive areas of pastures.

Phase IV: samples 150—180 (170—175: ^{14}C date of 2770±60 yr BP, Gd-1630)

A vast area is still inhabited by *Carpinus* (9.5%) at the onset of the phase. The percentage of hornbeam is nearly equal to maximum values. However, it declines very rapidly under the influence of man's activity. This fact is shown on the diagram as continuous curves for *Cerealia*, *Plantago lanceolata*, *Artemisia*, *Urtica*, *Chenopodiaceae*, *Plantago maior-media* type and *Rumex acetosa-acetosella* type.

Phase V: samples 120—140 (125—130: ^{14}C date of 2150±70 yr BP, Gd-1806)

The *Carpinus* frequencies decline, while those of *Artemisia*, *Plantago lanceolata* and *Urtica* increase to high values. The curve for *Corylus*, the frequencies of which reach 4.3%, oscillates slightly. Hazel could grow again since cattle probably did not graze in this area.

Phase VI: samples 85—110 (100—105: ^{14}C date 1850±50 yr BP, Gd-1629)

There is a marked increase in economic activities of man. The area occupied by *Carpinus* becomes substantially reduced. The frequencies of a pioneer species, i.e. birch, increase simultaneously. The *Gramineae* frequencies of about 12% are indicative of the presence of open habitats. Thus, deforestation took place on a much larger scale. The human activity indicator plants reach their highest values, i.e. over 13%, in the whole profile. The *Cannabis* frequencies reach maximum values. Moldenhawer (1959) associates the cultivation of hemp with the Roman times.

The pollen diagram records an economic crisis linked to the migration of people (82—87: ^{14}C date of 1480±60 yr BP, Gd-1794) after this phase. The hornbeam frequencies increase to nearly maximum values. The area is colonized by forests and meadow areas become reduced, as can be inferred from a highly recessive limb of the *Gramineae* curve and a decline in numerous human activity indicator plants. Only the *Urtica* frequencies are low.

Phase VII: samples 55—80 (67—72: ^{14}C date of 1050±60 yr BP, Gd-1795)

Large-scale deforestation occurs due to cultivation and pasturage. *Cerealia* occupied an extensive area. Large proportions of *Centaurea cyanus*, i.e. the rye weed, are indicative of intensive cereal cultivation. Hazel as a pioneer species occupies larger and larger areas. The *Corylus* frequencies approach 45.8%. There is a considerable decline in deciduous trees. Only oak has survived, although its frequencies are also lower.

Phase VIII: samples 50—55

The frequencies of cereal reach maximum values. Nitrophilous species like *Urtica* and *Chenopodiaceae* occur in larger amounts.

The considerations of the development of settlement may be based exclusively on the pollen analytical data (Fig. 4). Archaeological studies have been carried out in the Greater Poland National Park, but so far they have not provided any evidence of the settlement in the vicinity of Lake Skrzynka. Traces of Mesolithic settlement have been detected in the immediate vicinity of the peatbog under investigation on Lake Budzyńskie (Szafrański 1973). During

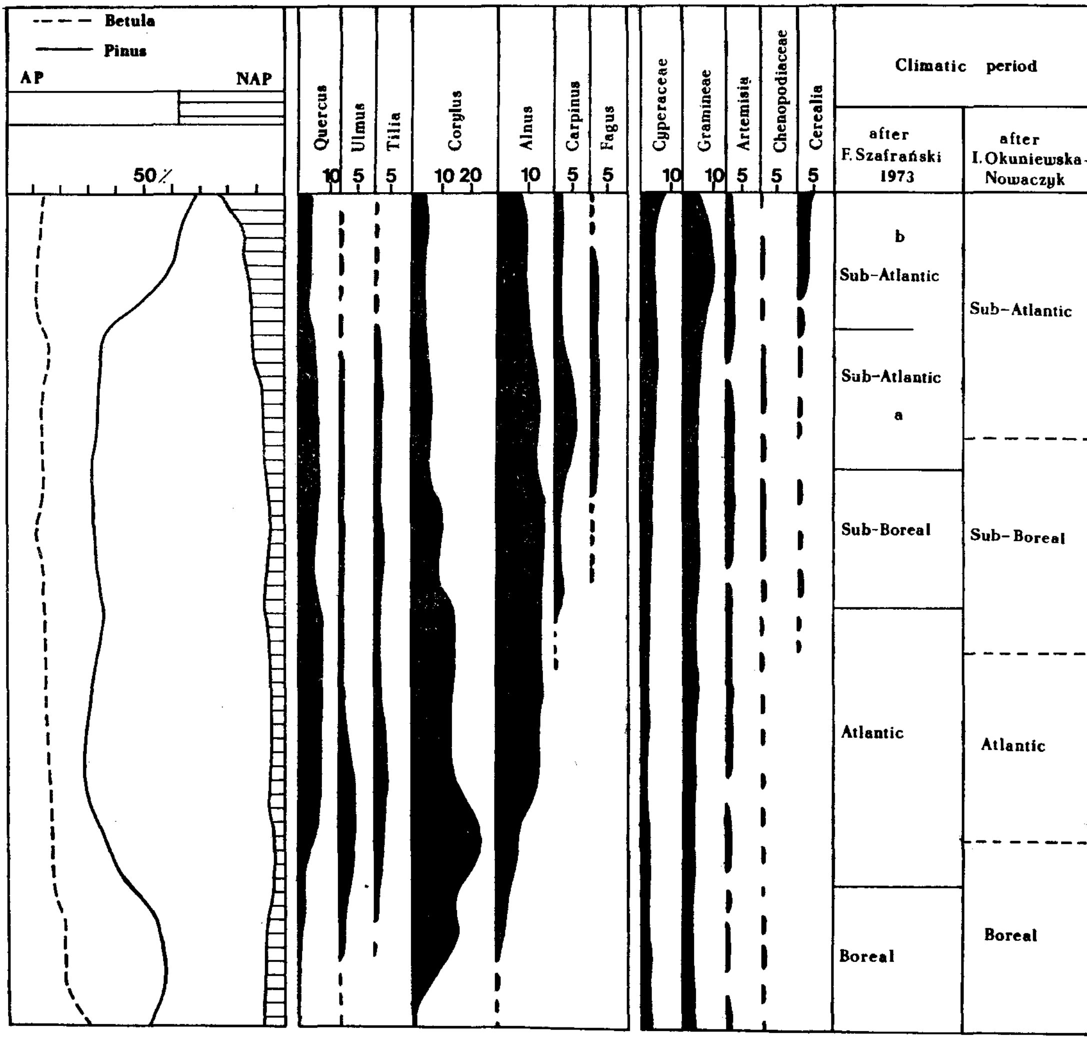

Fig. 6. Generalized diagram showing changes in vegetation in the Greater Poland National Park region (according to Szafrański 1968; simplified and modified)

the Bronze Age, man also lived in the vicinity of that lake. The prehistoric cemetery dates back to the period (Szamałek, personal communication). More evidence has been obtained from the eastern part of the park lying in the Warta river valley. Numerous finds are derived from the vicinity of Mosina. Paleolithic traces have been found on a dune lying close to this locality (Kobusiewicz 1970a, b). Mesolithic and Neolithic man also lived in that area. This region also attracted people of both the Lusatian and Pomeranian cultures during the Bronze Age and the Hallstatt Period (Szamałek, personal communication). People also settled an area in close vicinity to Mosina throughout the Early Middle Ages (Łosińska, personal communication). Detailed archaecological studies are now being carried out as part of Poland's Archaeological Image. They are also being conducted in the Greater Poland National Park area, and it is to be hoped that more information concerning settlement in this region may be acquired from archaeological sources.

Analysis of *Testacea (Rhizopoda)*

The collaboration between specialists in different fields of natural science is always of great value. Out of faunistic analyses, those on stenobionts, i.e. organisms which allow biotopes to be characterized, are particularly interesting. *Testacea* represent such a group. Their presence in the profile from the peatbog in the vicinity of Lake Skrzynka has been inferred from the pollen analytical data. Sometimes rhizopods were extremely numerous. For instance, the *Amphitrema flavum* frequencies reach 40.7 %. The genus *Euglypha* was also represented in great numbers. Representatives of the genera *Arcella* and *Nebela* were under--represented. Such a meagre diversity might be due to the chemical processing (acetolysis) of samples prior to their use for pollen analysis. Offierska (in press) identified 35 species of *Testacea* belonging to 15 genera on the basis of a detailed analysis of the core specially recovered for supplementary study in addition to the palynological studies. Certain differences between the results of pollen analysis and those of specially performed analysis of *Testacea* may be linked to the fact that two different profiles were studied although they were collected in close vicinity to each other. A few remarks given below, concerning changes in the *Testacea* fauna from the Skrzynka site, are based on the analysis carried out by Offierska (in press). She has not detected rhizopods in gyttja. The first specimens of *Testacea* have been found in peats as late as at the depth of 280 cm, i.e. about 4250 years ago. They began to occur continuously at the depth of 255 cm, i.e. about 4050 years ago. Rhizopod specimens occur at the depth range of 255—280 cm but as they are of quite sporadic occurrence, this material cannot be presented statistically. The pollen diagram records for this period higher oscillations of the *Sphagnum* curve (0.1—5.2 %). It may be presumed that the peatbog was drained at that time and hazel began to colonize it (13 %). There were suitable habitats for *Alnus* (18.8 %) expansion. The proportions of *Potamogeton* and *Nymphaea* increased in the basin **. *Amphitrema flavum* assumes absolute dominance in the whole profile from the peatbog in the vicinity of Lake Skrzynka. Its continuous curve occurs at the depth range of 75—255 cm. *Amphitrema flavum* and accompanying *Sphagnum* species such as *Hyalosphenia papilio*, *Arcella catinus*, *Heleopera petricola* and *Assulina*

** In the later phase of the Sub-Boreal Period similar changes in the composition of plant communities took place on Lake Gacno Wielkie (Hjelmroos-Ericsson 1981). The above author recognized the fourth period of water level lowering.

muscorum characterize raised bogs. Aquatic species such as *Centropyxis aerophila*, which is an indicator of oligotrophic lakes and *Difflugia globulus* appear at the depth of 75 cm. They are indicative of terrain flooding. *Salix* assumes greater significance at the same time. This may imply that the water level rose (Fig. 5). However, this argument is not convincing enough since a larger willow-covered area may be related to the economic activities of man. Salix which belongs to the group of pioneer plants grows again after intensive human activity. Presumably, those phenomena occurred about 1200 years ago, i.e. in the Early Middle Ages.

SUMMARY OF RESULTS

1) The reconstruction of vegetation changes which have occurred in the vicinity of Lake Skrzynka since the Boreal Period has been attempted.

2) Eight local pollen assemblage zones have been recognized.

3) The problem of detection of a boundary between the Atlantic and Sub-Boreal periods has been tackled.

4) The presence of man dating back to about 5000 years ago has been recorded in the pollen diagram.

5) Eight settlement phases have been described.

6) Evidence has been provided for the first time for largerscale deforestation during the Sub-Boreal Period.

7) A relationship between the history of hornbeam and human settlement has received confirmation.

8) The results of *Testacea* analysis have been discussed.

9) The first radiocarbon dates available for the Greater Poland National Park are given.

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Wielkopolska Archaeology Department, Institute of Material Culture History, Zwierzyniecka 20, 60-814 Pozrań
Zakład Archeologii Wielkopolski, IHKM PAN

REFERENCES

Aaby B. 1979. Characterization of peat and lake deposits. In: Berglund B. E. (ed.) Palaeohydrological changes in the temperate zone in the last 15000 years. Subp. B. Lake and mire environments, 1. Lund.

Berglund B. E. 1979. Definition of investigation areas. In: Berglund B. E. (ed.) Palaeohydrological changes in the temperate zone in the last 15000 years. Supb. B. Lake and mire environments, 1. Lund.

Borowiec S. 1973. Związki między glebami i zespołami roślinnymi w Wielkopolskim Parku Narodowym (Zusammenfassung: Beziehungen zwischen den böden und den Pflanzenassoziationen im Wielkopolski Nationalpark). Szczec. Tow. Nauk., Wydz. Nauk Przyr. Roln., 38 (1): 3—52.

Celiński F. 1969. Objaśnienia do mapy roślinności Wielkopolskiego Parku Narodowego w skali 1 : 10000. MS.

Hjelmroos-Ericsson M. 1981. Holocene development of Lake Wielkie Gacno area, northwestern Poland. University of Lund, Thesis 10: 1—101.

Jankowska B. 1980. Szata roślinna okolic Gopła w późnym glacjale i holocenie oraz wpływ osadnictwa na jej rozwój w świetle badań paleobotanicznych (summary: The vegetation in the Gopło region in the Late-glacial and the holocene and the influence of settlement on its development in the light of palaeobotanical researches). Przegl. Archeol., 27: 5—41.

Kobusiewicz M. 1970a. Paleolit schyłkowy w środkowozachodniej Wielkopolsce (summary: Late Paleolithic in Western Central Wielkopolska (Great Poland)). Światowit, 31: 19—100.

— 1970b. Mezolit w środkowozachodniej Wielkopolsce (summary: Mesolithic in Western Central Wielkopolska (Great Poland)). Światowit, 31: 101—188.

Latałowa M. 1982. Postglacial vegetational changes in the eastern Baltic coastal zone of Poland. Acta Palaeobot., 22 (2): 179—249.

Mamakowa K. 1962. Roślinność Kotliny Sandomierskiej w późnym glacjale i holocenie (summary: The vegetation of the basis of Sandomierz in the Late-glacial and holocene). Acta Palaeobot., 3 (2): 3—57.

Offierska J. 1986. Analiza *Testacea (Rhizopoda)* stropu profilu torfowiska otaczającego Jezioro Skrzynkę w Wielkopolskim Parku Narodowym. Sprawozdania PTPN.

Ołtuszewski W. 1957. Pierwotna szata leśna Wielkopolskiego Parku Narodowego w Osowej Górze pod Poznaniem w świetle analizy pyłkowej (summary: The development of the original vegetation of the Great Poland National Park). Prace Monogr. nad Przyr. Wielkopolskiego Parku Narod. pod Poznaniem. PTPN, 3 (1): 3—93.

Ralska-Jasiewiczowa M. 1964. Correlation between the holocene history of the *Carpinus betulus* and prehistoric settlement in North Poland. Acta Soc. Bot. Pol., 33 (2): 461—468.

— 1966. Osady denne Jeziora Mikołajskiego na Pojezierzu Mazurskim w świetle paleobotanicznych (summary: Bottom sediments of the Mikołajki Lake (Masurian Lake District) in the light of palaeobotanical investigations). Acta Palaeobot., 7 (2): 3—118.

— 1968. Ślady osadnictwa prehistorycznego w diagramach pyłkowych z obszaru Polski (summary: Traces of prehistoric settlement in pollen diagrams from the Polish territory). Folia Quatern., 29: 163—182.

— 1977. Impact of prehistoric man on natural vegetation recorded in pollen diagrams from different regions of Poland. Folia Quatern., 49: 75—91.

— 1982. Prehistoric man and natural vegetation: the usefulness of pollen evidence in interpretation of man-made changes. Memorabila Zool., 37: 31—45.

Stockmarr J. 1971. Tablets with spores used in absolute pollen analysis. Pollen et Spores, 13 (4): 615—621.

— 1973. Determination of spore concentration with an electronic particle counter. Danm. Geol. Unders. Årbog., 1972: 87—89.

Szafrański F. 1968. Zmiany roślinności Wielkopolskiego Parku Narodowego w świetle analizy pyłkowej (summary: Changes in the vegetation of the Wielkopolski National Park in the light of pollen analysis). Folia Quatern., 29: 41—47.

— 1973. Roślinność Wielkopolskiego Parku Narodowego w późnym glacjale i holocenie w świetle badań palinologicznych nad osadami Jeziora Budzyńskiego (summary: Vegetation of the Wielkopolski National Park in the Late Glacial and Holocene in the light of a palynological study on the deposits of Lake Budzyńskie). Folia Quatern., 42: 1—36.

Szczepanek K. 1961. Późnoglacjalna i holoceńska historia roślinności Gór Świętokrzyskich (summary: The history of the Late-glacial and holocene vegetation of the Holy Cross Mountains). Acta Palaeobot., 2 (2): 3—45.

Tobolski K. (in press). Pięćdziesiąt lat badań palinologicznych w Wielkopolskim Parku Narodowym (summary: Fifty years of palynological study in the Great Poland National Park). Bad. Fizjogr., nad Polską Zach.

Troels-Smith J. 1955. Karakterisering of løse jordarter. Danm. Geol. Unders. IV, 3 (10): 173—251.

Wasylikowa K. 1964. Roślinność i klimat późnego glacjału w środkowej Polsce na podstawie badań w Witowie koło Łęczycy (summary: Vegetation and climate of the Late-glacial in Central Poland based on investigations made at Witów near Łęczyca). Biul. Perygl., 13: 261—417.

Wodziczko A. & Szaniawska J. 1934. Przeszłość lasów Ludwikowskich w świetle analizy pyłkowej. Sprawozdania PTPN, 3: 114—116.

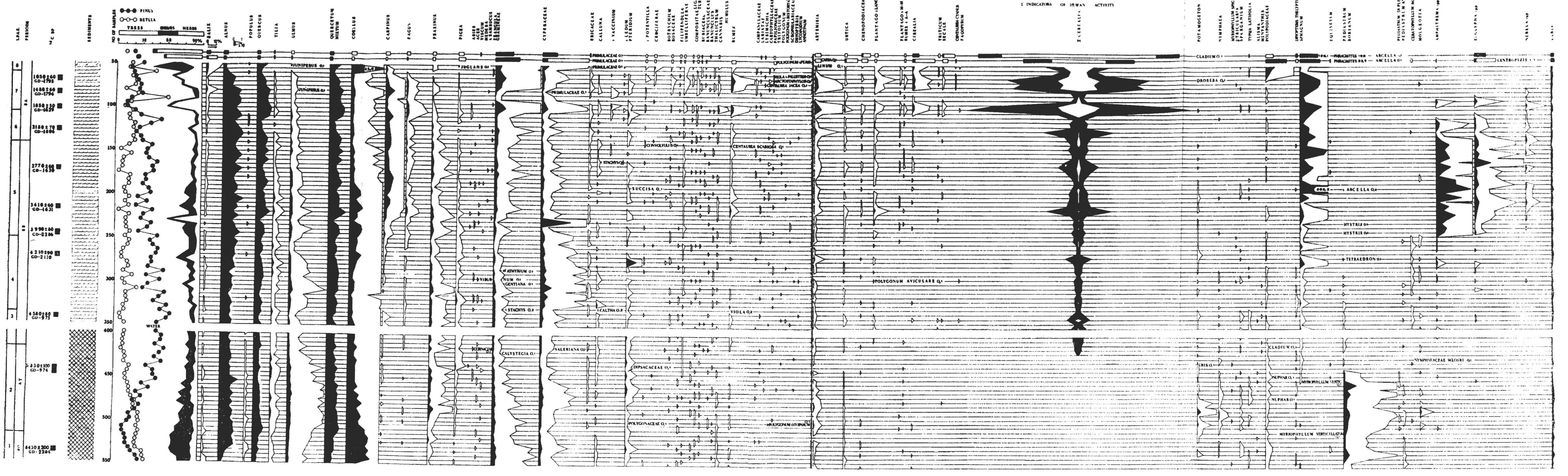

Fig. 2. Percentage pollen diagram, key to sediment identification symbols after Aaby (1979)

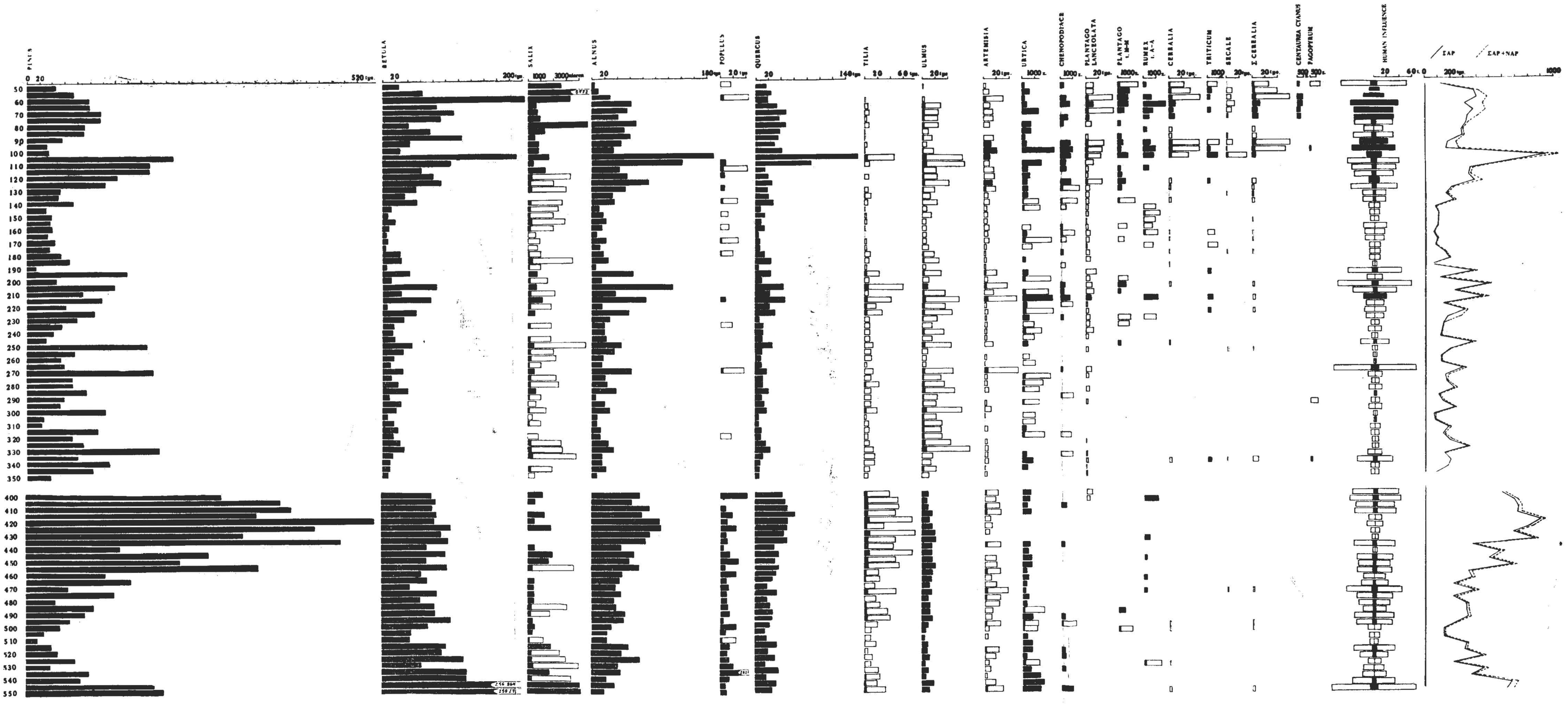

Fig. 3. Diagram showing the concentration of pollen grains from trees, shrubs, some herbaceous plants and the sum of AP and NAP in 1 cm³ of deposit

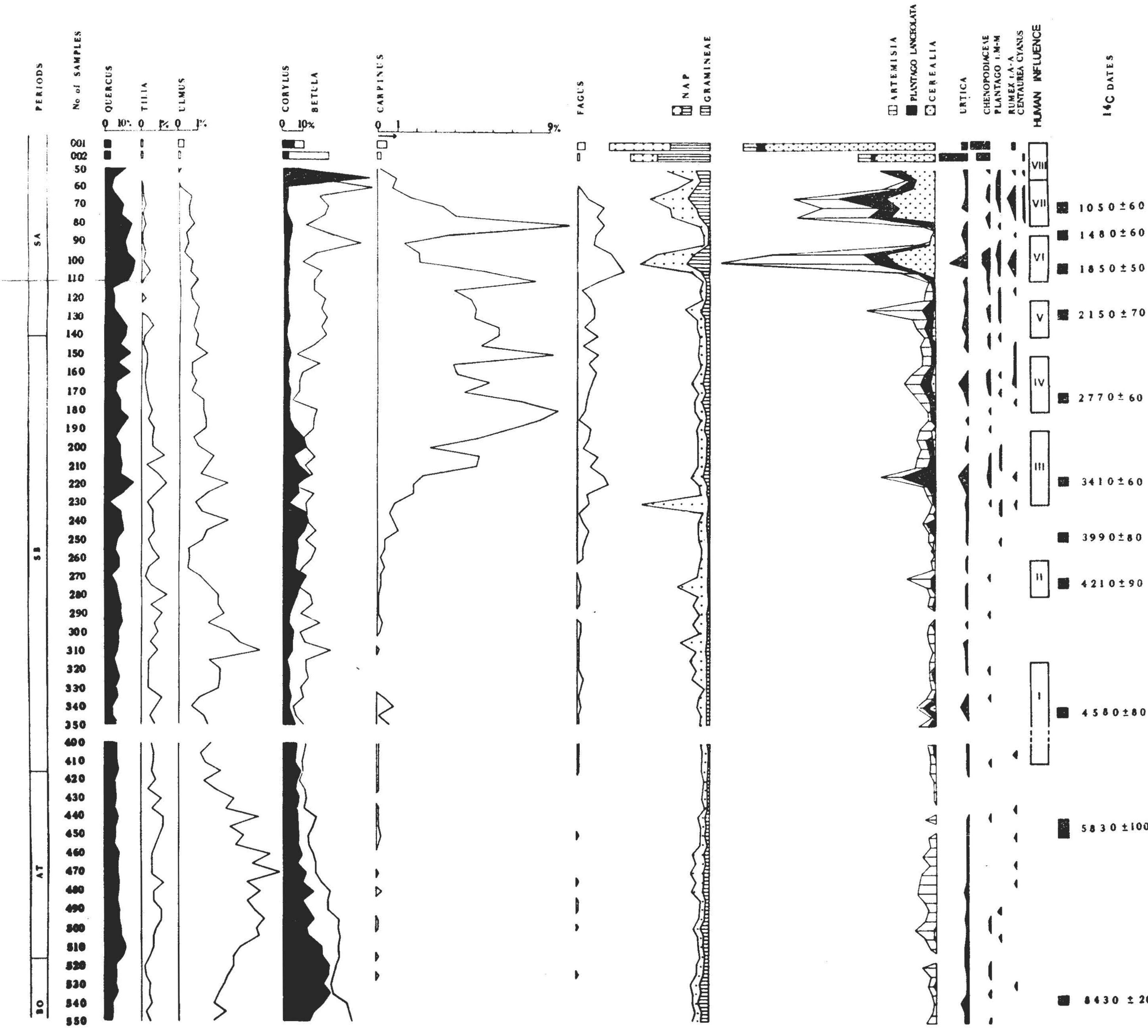

Fig. 4. Settlement phases