

METHODS USED FOR THE CONSTRUCTION OF ISOPOLLEN MAPS

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In the years 2000–2003 the palynological database for the Late Glacial and Holocene was established, and it has served as a basis for constructing isopollen maps. Some of data were taken from the Polish Palynological Database (PPDB) available at the W. Szafer Institute of Botany, Polish Academy of Sciences in Kraków, but most of the data were provided by the authors of pollen diagrams. Some of them were unpublished or are still in the course of interpretation. The data for a few sites were derived from published diagrams by digitalisation.

Initially 257 pollen profiles were assembled, and after some were excluded because they appeared to be useless for map construction, 190 profiles remained (see Appendix, this volume). Each profile containing counts of all the sporomorphs is described by the following data: site name, geographic coordinates, and sample numbers, which correspond to their depth in the profile. These quantitative data as well as the radiocarbon dates are provided with textual description (site specification form).

Numerical data are stored in the POLPAL system (Walanus & Nalepka 1999, 2004, Nalepka & Walanus 2003a). Before supplying data to the PPDB all the authors had to unify nomenclature of the taxa occurring in the submitted tables. This was achieved with the help of special application POLPAL TabCom. The format of numerical data included in both the tables and the textual description was unified in the course of work on the chronology of the samples.

Descriptive data are registered as text files (*.txt). They contain lithological characteristics (depths of the layer boundaries and layer description) as well as conventional radiocarbon dates with laboratory error and the depth ranges from which the dated samples were taken. Apart from the radiocarbon dates the site specification forms are provided with the dates proposed by the palynologists studying the particular sites, designated here as estimated dates. The estimated dates are based both on palynological correlation with the nearest dated profiles and on the author's background knowledge of the general vegetation history and site lithology. Among the profiles

used in the construction of the isopollen maps, 17 are dated exclusively by radiocarbon measurements (^{14}C BP) and 79 profiles are also provided with the estimated dates in addition to the ^{14}C dates (Fig. 17). 92 profiles have only estimated dates (Fig. 18). Altogether 171 profiles contain estimated dates (Fig. 19). One profile, from Lake Gościąg (G1/87), has varve dates for all the counted

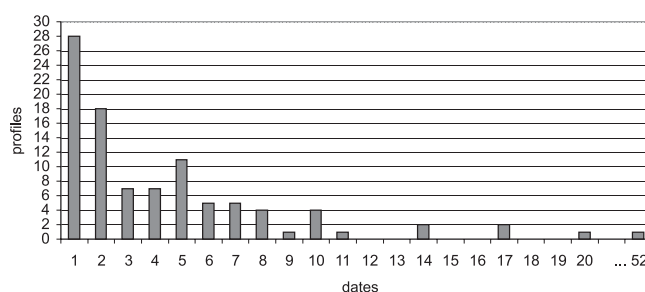


Fig. 17. Number of profiles with ^{14}C dates

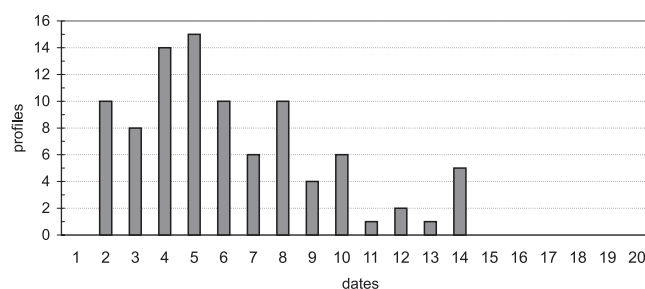


Fig. 18. Number of profiles with only estimated dates

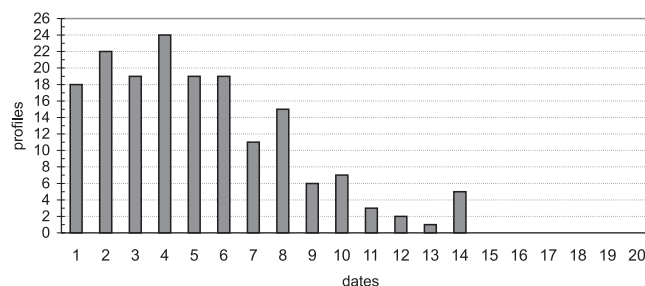
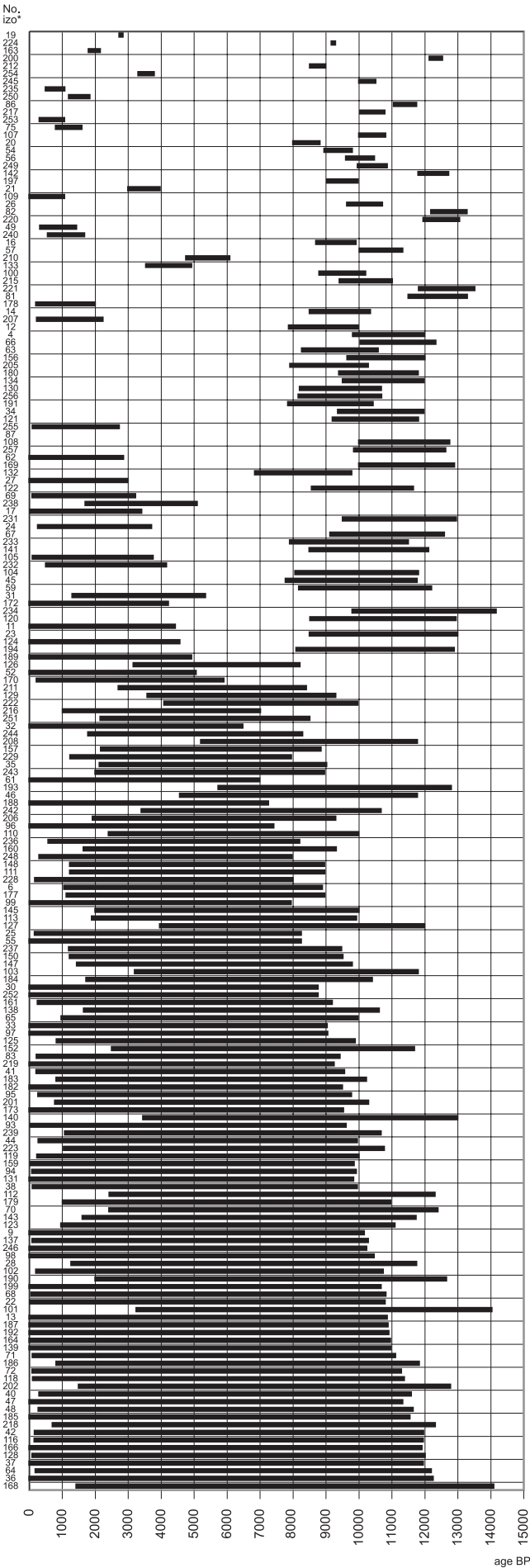


Fig. 19. Number of profiles with estimated dates in a profile



pollen samples, and these dates are correlated with several dozen ¹⁴C AMS dates based on terrestrial macrofossils (Ralska-Jasiewiczowa et al. 1998). Altogether 454 radiocarbon (¹⁴C BP) dates, 894 estimated and 310 varve dates (calendar dates of varve sediments converted to ¹⁴C BP age) were included in the project. The scope of dates for all the profiles used for maps construction is 14,149 ¹⁴C yr BP to -50 ¹⁴C yr BP. The time range of each profile is presented in Figure 20.

Three mathematical models of the depth-age relation were applied in all the profiles to date each pollen sample. This dating was made by computer with the Age application created in the POLPAL system (Nalepka & Walanus 2003b). Dating was based on approximation with use of interpolation algorithms: a broken line connecting dates with straight lines, cubic spline function connecting dates, polynomial (of any degree, cubic recommended) as well as approximation of depth-age relation through a hand-drawn broken line, considering lithology and other data. Each result of mathematical dating was verified by the author of the pollen diagram. The results of mathematical chronology were added to the pollen tables (as archival material), but only one of them (after verification) was used to draw isopollen maps.

In the next stage a summary table was prepared from the POLPAL BDI application. It contains percentage values of pollen/spores taxa selected for the maps construction, for each time horizons for all the sites whose positions on the map are specified by their geographic coordinates. The table is registered as *.csv file in MS Excel format. The maps are drawn for 29 time horizons. The missing spectra for the needed time horizons in the palynological continuous profiles were interpolated.

The maps are drawn for the following 24 tree and shrub taxa: *Abies alba*, *Acer*, *Alnus*, *Betula*, *Carpinus betulus*, *Corylus avellana*, *Ephedra* (= *Ephedra* undiff. + *E. distachya*-type + *E. fragilis*-type), *Fagus sylvatica*, *Fraxinus excelsior*, *Hedera helix*, *Hippophaë rhamnoides*, *Juniperus communis* (= *Juniperus* undiff. + *J. communis*), *Larix decidua*, *Picea abies*, *Pinus cembra*, *Pinus* subgen. *Pinus*, *Populus*, *Quercus*, *Salix* (= *Salix* undiff. + *S. glauca*-type + *S. pentandra*-type), *Taxus baccata*, *Tilia* (= *Tilia* undiff. + *T. cordata*-type + *T. platyphyllos*), *Ulmus*, *Viscum*, and *Vitis vinifera* subsp. *sylvestris*. Herbaceous plants include 14 taxa: *Artemisia*, *Cerealia* excl. *Secale* (= *Cerealia* undiff. + *Triticum*-type + *Hordeum*-type + *Avena*-type), *Chenopodiaceae* (= *Chenopodiaceae* + *Chenopodiaceae/Amaranthaceae*), *Cyperaceae*, *Dryas octopetala*, *Filipendula*, *Poaceae* (Gramineae) (= *Gramineae* + *Phleum*-type + *Phragmites*-type), *Helianthemum* (= *Helianthemum* + *H. alpestre*-type + *H. canum*-type + *H. cf. alpestre* +

Fig. 20. Diagram illustrating time range of particular profiles; * identification number of profile in the isopollen data base and on the maps (see Appendix, this volume)

H. nummularium-type + *H. oelandicum*-type), *Plantago lanceolata*, *Pteridium aquilinum*, *Rumex* (= *Rumex* + *Rumex acetosa/acetosella* + *Rumex acetosa*-type + *Rumex acetosella*-type + *Rumex/Oxyria*), *Secale cereale*, *Selaginella selaginoides*, and *Typha latifolia*.

A pollen sum of trees, shrubs, and terrestrial herbs (ΣP) is the basis of calculation of percentage pollen values. Cyperaceae pollen is excluded because of its mostly local character in the majority of sites. The isopollen maps for the pollen sum of the herbaceous plant taxa (NAP) were drawn in two ways including and excluding Cyperaceae pollen. For a few taxa selected isopollen maps with Cyperaceae pollen in a total sum were also included. These maps have different legend background colour. In the case of one site, Kunice (No. 180) the isopollen maps of herbaceous plants were constructed without this site, because herb pollen was available only as NAP sum. Percentage values of *Typha latifolia* pollen were calculated on the basis of the sum (ΣP) + pollen of all aquatic and telmatic plants. Percentages of *Pteridium aquilinum* and *Selaginella selaginoides* spores were calculated from the basic sum (ΣP) + the sum of all Pteridophytes (Berglund & Ralska-Jasiewiczowa 1986).

The following time horizons in conventional ^{14}C years were accepted for drawing the isopollen maps: from 14,000 BP to 500 BP every 500 years plus the top 100 BP. To all the horizons were assigned equal ranges of ± 100 years (for example, the horizon of 5000 has the range of 4900–5100, thus 4899 and 5101 are beyond this horizon). The possibility to express boundaries of time horizons in the calendar scale is presented in the chapter by Walanus & Nalepka (this volume).

Next the application of the POLPAL Map was applied to construct the isopollen maps from the data in the summary table discussed above. The maps are registered in bitmap (*.bmp) format. Their dimension is 2200×2200 pixels. In the Map application the contour map of Poland was used with marked parallels of latitude and longitude (every 2°) as well as the more important rivers and state boundaries. On this map the percentage pollen values were calculated on the square grid of 2 km intervals.

Drawing of the maps was preceded by testing of the mathematical algorithms used in their construction, i.e. a weighting function was chosen. Such a function describes the degree of dependence of the site on a distance. Percentage values in a particular point are influenced by pollen percentage values from all the sites, but the nearby

sites have the greatest influence, decreasing with distance. The weighting function determines how the influence of the site decreases with distance. From four proposed alternatives (inverse distance with dead field, square inverse distance with dead field, Gaussian function, and exponential function) the square function has been selected in which weight (influence) decreases with the square of the distance, i.e. a site situated at a two times greater distance will have four times smaller weight (influence).

Two parameters were used for drawing the maps: maximal radius and smoothing radius. A maximal radius describes the maximal distance to the nearest site at which the drawing of the isopollen line seems to be sensible. It is accepted that for the sites situated farther from the nearest site than a maximal radius, the percentage pollen values of a particular taxon will not be presented (white spot will be left). After many attempts the maximal radius of 200 km is established for drawing the maps. Because of this no white spots appear on most of the maps. However, it should be borne in mind that extrapolation of the data has been applied for a distance up to 200 km from the nearest site.

A smoothing radius describes a rate of decreasing influence of neighbouring sites with a distance on percentage values at a specified site. A smoothing radius of 30 km is used for the maps.

For trees and shrubs as well as for herbaceous plants various extensions of percentage ranges and various palettes of colours have been applied. For tree and shrub pollen the following percentage ranges have been accepted: 0.01, 0.1, 0.5, 1, 2, 3, 5, 7, 10, 15, 20, 25, 30, 40, 60%, and for sporomorphs of herbs: 0.01, 0.2, 0.5, 0.7, 1, 2, 3, 5, 7, 10, 20, 30, 40, and 60%. The maps of trees and shrubs have been drawn in colours from yellow to brown and of herbs in graded green colours. The lowest percentage values (0–0.01%) have been marked in light-grey colour in both scales, and the values >60% in black.

Most maps are presented in a form of isoline maps. Each map is provided with a fragment of legend containing a palette of those colours that are used in its construction.

Maps for taxa displaying low representation and occurring only sporadically have been presented in a form of dot maps provided with percentage values of a given taxon. Points without percentage values mark those profiles in which a specified taxon was absent in spite of the fact that the sediments of a particular age were present.