WESTERN CARPATHIAN ISOPOLLEN MAP CONSTRUCTION METHOD

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In the years 2009–2010, the palynological database for the Holocene was established, and it served as a basis for the construction of isopollen maps of the Western Carpathians. Most of the data were provided by the authors of pollen diagrams. From which 21 of the profiles were newly published or yet to be published, since they were still in the course of interpretation. The other 18 profiles were the same as those used for the database used to construct Polish isopollen maps (Ralska-Jasiewiczowa et al., eds 2004). Only a few of the profiles (4) were derived from published diagrams by digitalization, as their archive data no longer existed. The list of sites, their unique isopollen number (No. Izo*), altitiude (a.s.l.), geographic coordinate, profile analysts and references are conteined in Table 4 (Appendix, this volume). The distribution of sites is shown in Figures 9 and 25.

The methods used in the creation of the Western Carpathians isopollen maps (collecting data, constructing the database and constructing maps) were largely consistent with the main procedure used in a previously published paper providing guidelines for the construction of isopollen maps for Poland (Nalepka & Walanus 2004). The idea was to continue the same basic methods as were used in those maps, for ease of comparison, while paying attention to the specific region (pp. 21–23 of chapter: Methods used for the construction of isopollen maps, Nalepka & Walanus 2004). Here, a short description has been included.

All numerical data (raw counts, sample depth, radiocarbon dating, etc.) are stored as text files (*.txt), and are manipulated by the POLPAL system (Nalepka & Walanus 2003a; Nalepka & Walanus 2004). All the authors have had to unify the nomenclature of the taxa in the submitted data. For all of the profiles, the Depth/Age (POLPAL) procedure was carried out, so as to date all spectra (Nalepka & Walanus 2003b).

Dating of the profiles

In order to be processed by the map creation software, each spectrum (sample, depth level) of each profile needs to be dated. Since the time axis is absolutely unique, this ensures the precise synchronization of the profiles. This

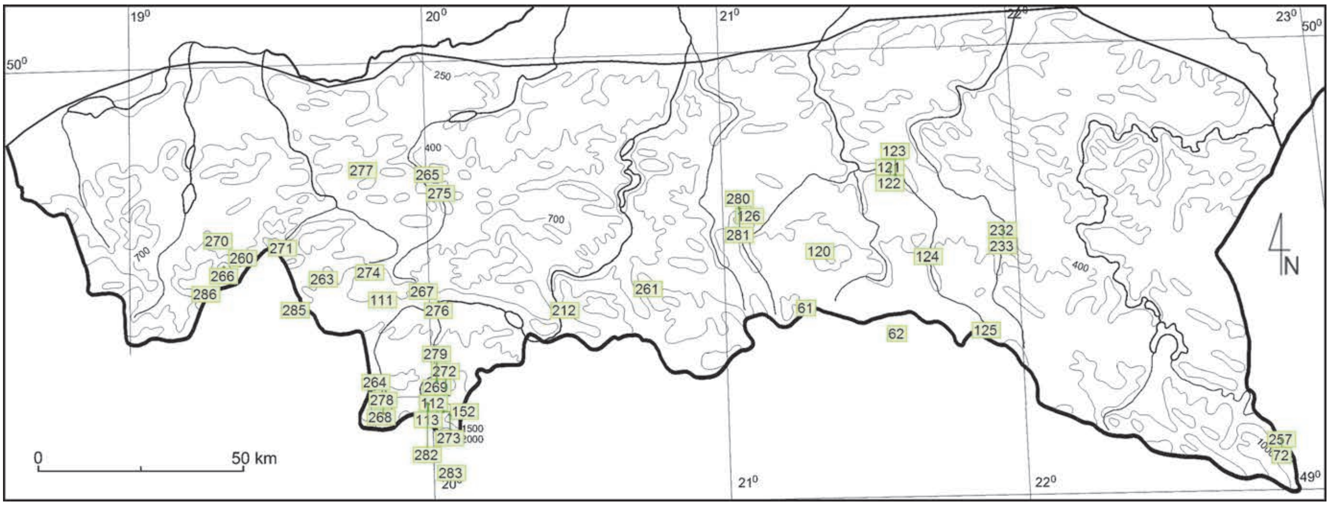

Fig. 9. Distribution of sites used for drawing the isopollen map of the Western Carpathians. 61–286 – identification numbers (Tab. 4, Appendix, this volume)

holds to some extent even if the time used is the so-called conventional ^{14}C age, which is the case in this study. The profiles are radiocarbon dated, frequently at times when the calibration of the radiocarbon dates was not obvious. Anyway, under the decision of the head of the project, the time axis used in the project is the BP conventional radiocarbon age, not calendar age. One reason for this is to ensure that it is comparable with the isopollen maps for Poland constructed in 2004 (Ralska-Jasiewiczowa et al., eds 2004).

Based on the radiocarbon dates (in a number of one to a few) and some dates of another origin (like −50 BP at the 0 m level), each spectrum has been attributed with a date. The procedure used is based on linear interpolation and extrapolation, multinomial fitting and/or cubic splines fitting using an application created within the POLPAL system (Nalepka & Walanus 2003b). However, the final depth-age relation has been established with the assistance of the personal, subjective knowledge of the author responsible for a given profile (Walanus & Wasylikowa 2008). As a result, each spectrum has a unique age, with no estimated error. It has been decided to take a radical approach to the question of dating error (precision) for two reasons. The first of these is that it is extremely difficult to honestly estimate errors in the case of long distance interpolation or even extrapolation and in cases when the assumption of the constant sedimentation rate is deeply tentative at best. The second reason for omitting the error estimate is that it is difficult to include such an estimate in the map creation procedure, since the maps are produced not for a precise time horizon, but for a certain time span (with diffused boundaries).

Calculation of pollen percentage for a given time and profile

Pollen spectra in tables are attributed with dates (conventional ^{14}C age BP), which would appear to be of one year precision, however, this precision has nothing in common with real dating precision. The latter is difficult to quantify and is generally low. That is the most important reason for the application of weighted averaging of pollen percentages over time. Anyway, diffused time boundaries would also be recommended in the case of precise dating, since natural processes are by no means absolutely precise.

The weighted, smooth averaging being applied utilizes the Gaussian curve as a source of weights. The ‘heaviest’ are, of course, pollen spectra of a date close to the given time. Less weight is attributed to spectra that are not so close, and spectra whose dates are at a distance of more than 3σ are of almost no influence. The σ (standard deviation) of the Gaussian curve is generally assumed to be equal to 1/3 of the time span between consecutive time points. As a result, the spectra placed exactly in between the two time points used for the maps are attributed with 32% of the weight of the spectra positioned closely to the given time.

The σ is chosen so as not to be too small on the assumption that it is better to produce less information (more fuzzy maps), than to confront the map reader with artifacts with no background in the real past of the region. All the more so, since the region under consideration is of a mountainous type.

The profiles located on the map give, for a given taxon and given time horizon, a percentage value for the pollen, calculated according to the procedures described above. No estimate of the precision is available. Anyway, it is assumed that the precision is not high, mainly due to the dating problems as well as the question of local influences on the pollen. Even if the dating were assumed to be precise, the representativeness of the pollen percentage for the regional scale cannot generally be assumed to be good in the mountains. The Poissonian error which describes the pollen counting process is negligible in comparison to the two aforementioned sources of error.

Consequently, even the point occupied by the profile cannot be attributed to that profile percentage with absolute precision. The uncertainty (not estimated) of the percentage of the given profile is mixed on the map with the type of uncertainty that arises from the distance to the nearest profile, as well as to all the other profiles. The pollen percentage, for any point on the map close to or far away from the sites, is calculated on the basis of all the profiles, but with the application of a statistical weight which is dependent on the distance to the given profile. The weight decreases with distance, in a non-linear fashion. The essential factor, however is that the weight is finite (maximal but not infinitely high) even for the distance 0 km, i.e. at the site position. This means that surrounding profiles can dominate any exceptional instances.

The mathematical function driving the statistical weights, including the numerical parameter function, is essential to the final map layout. They were chosen on the basis of trial inspections of many maps (Walanus & Nalepka 2004a, 2006).

From the four proposed alternatives for weighting functions (inverse distance with dead field, square inverse distance with dead field, Gaussian function, and exponential function), it was decided to select the square function, in which weight (influence) decreases with the square of the distance i.e., a site situated at a distance two times greater will have a weight (influence) four times smaller. Two parameters were used while drawing the maps: maximal radius and smoothing radius.

A smoothing radius describes the rate of decreasing influence of neighbouring sites with a distance on percentage values at a specified site. Eventually, a smoothing radius of 10 km was used for drawing the maps.

Drawing maps

Subsequently, using another dedicated POLPAL application, maps were drawn within the given time horizons for all the considered sites whose positions on the map are specified by their geographical co-ordinates. The maps were drawn in 21 time horizons, from 10 000 BP to 0 BP, every 500 years, in conventional ^{14}C years.

It was agreed that the maps would be drawn for 13 taxa. These taxa denote the following trees and shrubs: *Abies alba*, *Alnus*, *Betula*, *Carpinus betulus*, *Corylus avellana*, *Fagus sylvatica*, *Fraxinus excelsior*, *Larix decidua*, *Picea abies*, *Pinus cembra*, *Pinus* subgen. *Pinus*, *Tilia*, and *Ulmus*.

In the Map application, a contoured map of the Western Carpathians was used with parallels of latitude and meridians (every 1°) marked, as well as the more important rivers, main geographical units and state boundaries.

For trees and shrubs, various extensions of percentage ranges and various palettes of colours were applied. The following percentage ranges have been adopted: 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, and 100%. The maps of trees and shrubs have been drawn in colours ranging from yellow to brown. The lowest percentage values (0–0.01%) have been marked in a light-grey colour, and the values >50% in dark brown.

The majority of the maps have been presented in the form of isoline maps. Each map is provided with a fragment of a legend containing a palette of those colours that were used in its construction.

Maps for taxa displaying low representation (occurring only sporadically) and present-day analysed spectra have been presented in the form of point maps provided with percentage values for 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.