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Communication

The mapping of Holocene pollen data in China

A project has been started at the National Climate Center, Beijing, China, in cooperation with the Institute of Palynology and Quaternary Sciences, Göttingen, Germany, to use Holocene pollen profiles for producing isopollen and isochrone maps for a better understanding of environmental and climatic changes. The area under study includes northern China north of the Yangtze River. A total of 150 radiocarbon dated pollen profiles with a time resolution better than 800 years have been selected from the existing literature. Most of the pollen profiles were obtained from lake sediments or peat profiles, but about 20% come from loess deposits, fluvial deposits, palaeosol layers or ice cores. The distribution of data sites used for the current project is shown in Fig. 1.

The density of data sites is low if compared with Europe, for instance. The data coverage is still poor, especially in the regions of Inner Mongolia, Xinjiang and most parts of the Qinghai-Tibet Plateau. The best data coverage is available in the eastern part, including eastern NE China, the middle and lower reaches of the Yellow River, the lower reach of the Yangtze River and the northeastern part of the Qinghai-Tibet Plateau. Even here pollen data are lacking for the northern Heilongjiang Province, the northern Liaoning Province, for Shanxi, Henan and Anhui Provinces. Nevertheless, an attempt is desirable to give a first survey and to stimulate further palynological work devoted to environmental history in China.

Basically, the method for data processing and map drawing is similar to that of Ren and Zhang (1998). Percentage values were digitized from the published pollen diagrams after smoothing for profiles with large short-term variability. The data was standardized to ensure its intercomparability, by recalculating the pollen percentages using a common sum which is defined as total terrestrial pollen grains excluding Cyperaceae. Time slices used for the digitization and mapping are 10,000 B.P., 8000 B.P., 6000 B.P., 4000 B.P., 2000 B.P. and 0 B.P., and pollen taxa or taxa groups include *Picea/Abies* (not separated by most of the authors), *Pinus, Quercus, Ulmus, Betula, Artemisia*, Chenopodiaceae, Gramineae (Poaceae) and the sum of trees and shrubs.

For drawing the isopollen and isochrone maps, SURFER 5.01 for WINDOWS was used. For isopollen maps, the program prescribes the contour interval as 5%.

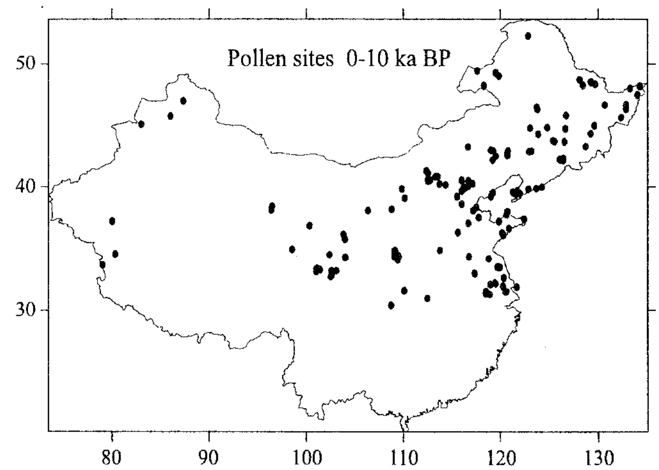

Fig. 1. Pollen sites used for the construction of isopollen maps of the last 10,000 14C years

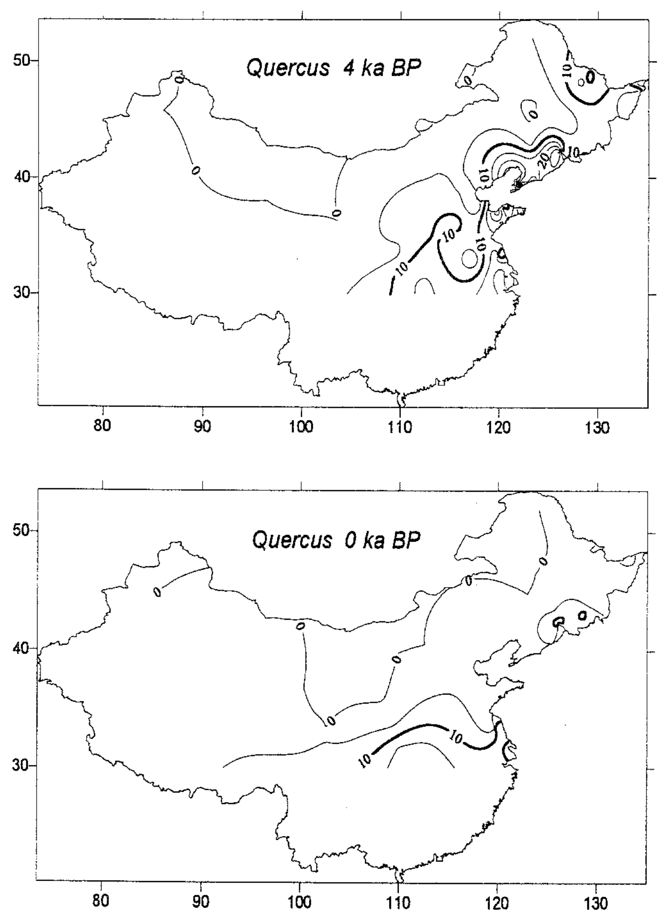

Fig 2. Isopollen maps for *Quercus*, 4 ka B.P. (above) and 0 ka B.P.(below). For 0 ka B.P., top samples of pollen diagrams have been used

Specific taxa were chosen for drawing isochrones for the time slices mentioned above. They are respectively 40% for arboreal pollen, 25% for *Pinus*, 20% for *Artemisia* and Chenopodiaceae, 10% for *Quercus, Betula*, and Gramineae, and 5% for *Picea/Abies* and *Ulmus*.

For nine taxa or taxa groups and six time slices each a total of 54 isopollen maps in colour or black-and-white have been produced. Nine isochrone maps for all of the taxa or taxa groups have been completed as well. Fig. 2 gives the isopollen maps for *Quercus* at 4000 B.P. and 0 B.P. as an example.

The isopollen contour for 3% *Quercus* at 0 B.P. (not shown in Fig. 2) corresponds well with the modern distribution range of major species of *Quercus*, which mainly grow in the Changbai Mountains, the middle and lower reaches of the Yangtze River, and the Liaodong and Shandong Peninsulas of northern China (Wu 1980). An obvious difference between the two time slices is that *Quercus* was much more abundant at 4000 B.P. than at present in regions around the Bohai Sea, especially in the Liaodong and Shandong Peninsulas. It is also evident that the distribution range of *Quercus* forests at 4000 B.P. expanded northwestward generally, and it developed well in the middle and lower reaches of the Yellow River.

In fact, *Quercus* percentages for 8000 B.P. and 6000 B.P. are as high as, or higher than, those for 4000 B.P. in almost every region. In most areas, reduction of *Quercus* percentages occurred mainly after 4000 B.P. Other tree taxa or tree taxa groups also show a drop in pollen percentages after 6000 B.P. or 4000 B.P. Causes for the reduction in tree pollen percentages need to be further investigated, but it may have resulted from ancient human impact to the woods (Ren and Zhang 1998). An increase in *Pinus* in NE China since 4000 B.P. may also have been responsible for the drop in pollen percentages of the other types.

Most Holocene pollen data from China are still unsatisfactory in both quality and quantity, compared to those from Europe and North America. At present, there are few high resolution pollen profiles from continuous lake or bog sediments in the middle and lower reaches of the Yellow River. For some profiles in these regions, pollen samples were frequently taken from fluvial and loess sediment layers. Although the pollen percentages are more independent of sediment types than on pollen influx or concentration, the variable nature of the sediments throughout a profile still remains a big problem, considering the different sources and preservation of pollen grains in different sediment layers. An effort has been made to use only data from lake and bog sediments, but for the data-sparse regions, data from the other types of sediments have to be employed as well.

More attention has been given to the radiocarbon date control recently, but there are still some sites with limited dates for the profiles obtained. Many pollen profiles, in particular those analyzed before the 1980's, cannot be used due to the lack of radiocarbon dates. Besides, no calibration has been made for the possible carbon reservoir effect for the lake sediment profiles in arid and semi-arid areas. The carbon reservoir effect, however, may have been very important in northern and western China according to recent investigations (Ren 1998).

Relatively large sampling intervals offer another discouraging problem. In the last decade, some Holocene pollen profiles with quite a good time resolution have appeared. For most sites, however, the time resolution of the pollen series is more than 200-300 years. Many of the earlier pollen profiles have only ten or even fewer samples for the whole Holocene period. To increase time resolution is a major future task for Chinese palynologists.

As mentioned above, geographical coverage of data is not ideal in a few of regions. No pollen data have ever been obtained so far from the vast areas in the western deserts and mountains. Even in the east, large gaps remain in grasslands, loess regions and the fluvial plains flooded frequently in historical times. More attention should be given to these regions if we intend to understand the spatial and temporal patterns of the Holocene vegetation change in the country.

Therefore, the research work described here should be taken as the first step towards achieving a more complete synthesis in the coming years. The maps that have just been made should be regarded as preliminary ones. The data sets that support the mapped summary are open to future input. If more high quality data are available, improvement in detailed aspects of the map series is to be expected. However, certain major features or patterns on the maps produced so far will most probably remain unchanged. Reconstruction of vegetation changes and investigation of their causes on the basis of these maps can therefore be attempted. It is expected that this will be done in the near future.

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Prof. Dr. Guoyu Ren

National Climate Center
46 Baishiqiao Road
Beijing 100081, China

Prof. Dr. Hans-Jürgen Beug

Institut für Palynologie und Quartärwissenschaften
Wilhelm-Weber-Strasse 2
D-37073 Göttingen, Germany