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PALYNOLOGICAL RECORD OF PALEOVEGETATION CHANGE DURING HOLOCENE AT NORTH TUMD PLAIN IN INNER MONGOLIA, CHINA[①]

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ABSTRACT: In this paper, the Holocene paleoenvironment change sequence in middle Inner Mongolia was primarily reconstructed on the basis of palynological analysis at the resolution of 70 years on a peat profile, which was located in the northern part of Tumd Plain with its oldest age of 9100 a. B. P. As the consequence indicated, the Holocene climate change in the middle Inner Mongolia had undergone cool→temperate→warm→temperate→cool series, and the history could be divided into 5 epochs: 9100 - 7400 a B. P., with slightly arid and cold climate; 7400 - 5000 a B. P., transitory climate with dynamic fluctuation, earlier period temperate and slightly arid, and later period temperate and slightly humid; 5000 - 4100 a B. P., with warm and humid climate; 4100 - 1350 a B. P., with transitory climate getting arid, as the result of human being's growing influence; 1350 a B. P. - present, with temperate and slightly arid climate, under strong influence of human being. The warm period of Holocene occurred in 7400 - 4000 a B. P., while the optimal period occurred in 5000 - 4100 a B. P.

KEY WORDS: Inner Mongolia, paleoenvironment change, Holocene

1 THE METHOD OF STUDY

The middle Inner Mongolia is situated in the rear part of the eastern Asian monsoon zone, it is sensitive to the climate change, therefore its environment change in the Holocene has been paid attention to by the scholars of paleoclimate and paleoenvironment.

We did high resolution pollen analysis on a peat profile in pluvial fan, which was located 3 km to the north of Qasq, the headquarter of the Tumd Banner, Inner Mongolia, with altitude of 1000 m above sea level. The average annual temperature was 5.6℃, annual precipitation 300 - 450 mm, the climate was continental and semi-arid, and the original zonal vegetation in this region was *Stipa bungeana* steppe and *Stipa breviflora* steppe.

The sediment belonged to stagnant limnetic phase, the upper part above 263 cm was mainly peat while the lower part below 263 cm was coarse sandstone. We analyzed 133 samples from the peat profile above 263 cm at the interval an 2 cm. Among the samples, pollen was absent in 25 samples, we made statistical record of the other 108 samples, the resolution of the analysis was 70 years or so. The total number of pollen grains of each sample was over 250, with the highest up to 1500. The diagrams were drawn with software Tilia.

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^{14}C dating of 4 peat samples were done in the Department of Archaeology, Peking University (see Table 1), the age for other strata were inferred by interpolation.

Table 1 Data of ^{14}C age

	Depth(cm)			
	33 – 37	55 – 60	211 – 216	258 – 263
^{14}C age(a B.P.)	1645 ± 80	2160 ± 75	8200 ± 80	9050 ± 150

2 RESULT OF THE POLLEN ANALYSIS

As the statistical result indicated, the spore and pollen types were rich in Qasq profile, with 50 types including 19 genera and species of trees, 22 genera and species of shrubs and herbs, 4 genera and species of ferns and 5 genera and species of aquatics plants. The highest influx of spore and pollen was up to 2764.4 grains /(cm^2·a), while the lowest was only 32 grains /(cm^2·a) in the profile.

The pollen of herbs and shrubs dominated in the pollen assemblage, among them *Artemisia* had the highest value, then Chenopodiaceae, *Ephedra*, also including Compositae, Graminae, Leguminosae, Polygonaceae, Ranunaceae, *Thalictrum*, Umbelliferae and Cyperaceae. Tree pollens also had higher value in some strata, among them *Pinus* had the highest value, with some *Betula*, *Quercus*, *Tilia*, *Corylus*, *Picea*. The aquatic pollen had little percentage and low frequency, for example *Typha* etc.. Fern spore had high value in part of the strata, among them *Polypodium* had the highest value, followed of *Selaginella sinensis* and *S. sanguinolenta* etc. Algae were absent from our observation.

According to the stratigraphically constrained cluster analysis of sample influx and individual pollen influx of tree, shrub, herb and their percentage range, the profile could be divided into 5 pollen assemblage zones (Fig. 1 and Fig. 2).

As the pollen diagrams showed, in this region the vegetation had undergone the development of typical steppe→forest steppe→broadleaf and coniferous mixed forest→forest→typical steppe since 9100 a B.P., while the climate had undergone the process of cool→temperate→warm→temperate→cool.

3 THE RECONSTRUCTION OF PALEOCLIMATE AND PALEOENVIRONMENT IN TUMD REGION, INNER MONGOLIA

1) Based on our high resolution sporo-pollen analysis on Qasq peat profile, combined with paleogeographical evidences from neighboring regions and ^{14}C dating, the environment change sequence of Tumd could be reconstructed as follows:

Zone 1: 9100 – 7400 a B.P., the vegetation was typical steppe, the climate was slightly arid and cold.

Zone 2: 7400 – 5000 a B.P. was warming and transitory epoch of the Holocene, with dynamic fluctuation. The climatic trend was getting more and more humid. This epoch could be divided into 2 stages: A. 7400 – 6000 a B.P., vegetation was forest steppe dominated by grass, climate was temperate and slightly arid. B. 6000 – 5000 a B.P., vegetation was forest steppe dominated by tree, climate was temperate and semi-humid.

Zone 3: 5000 – 4100 a B.P., climate was warm and humid, the coverage of vegetation was relatively higher, and it was the optimal period for this region in the Holocene. The vegetation was coniferous and broadleaf mixed forest dominated by *Pinus* and *Quercus*.

Zone 4: 4100 – 1350 a B.P. was the transitory period of climate for this region, the temperature and humidity were dropping, climate was getting more arid. This period could be divided into 3 stages: A. 4100 – 2400 a B.P., vegetation was slightly arid forest, climate was temperate-cool, semi-humid and turning arid. B. 2400 – 1850 a B.P., climate turned more arid continuously, vegetation was still mainly forest; a short temporary temperate and humid epoch

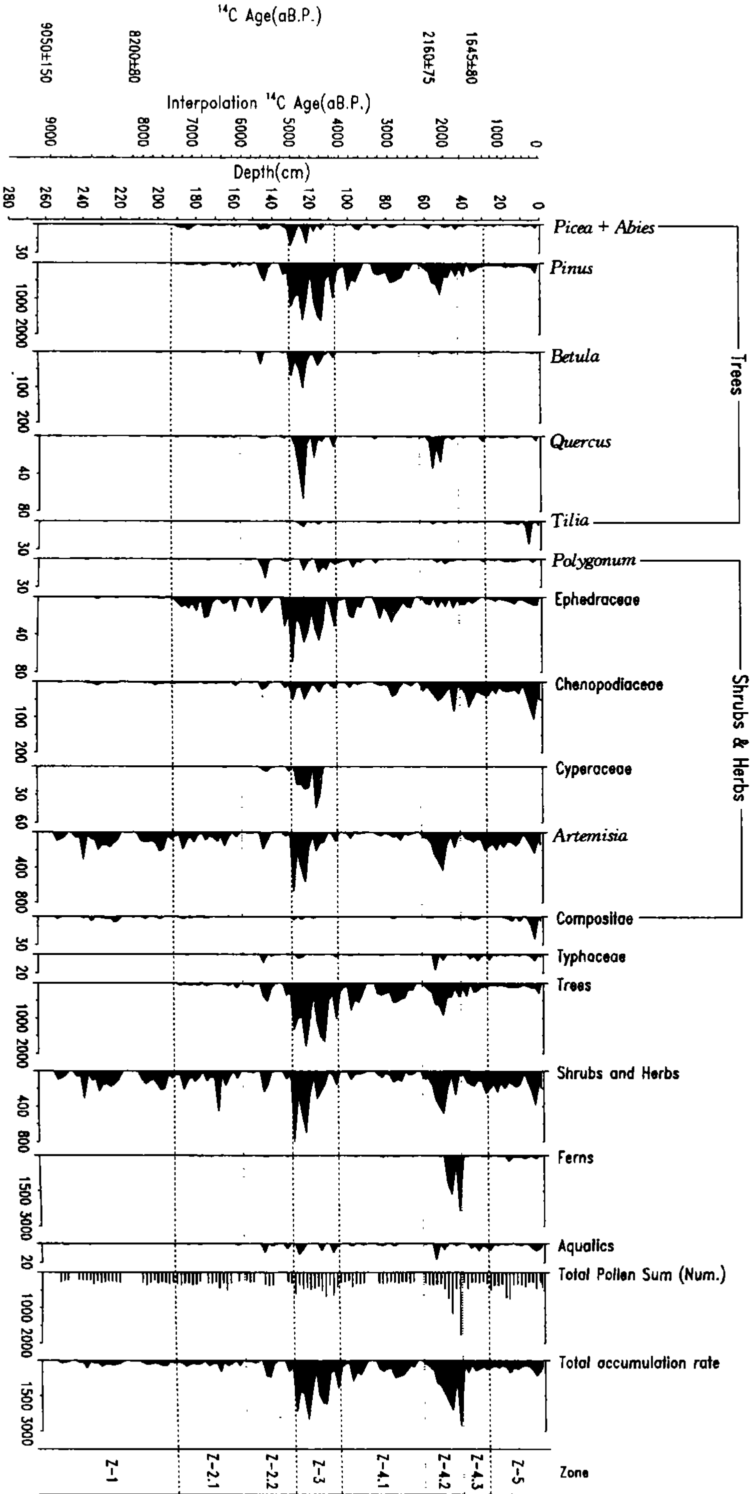

Fig. 1 Pollen diagram of accumulation rates (grains/cm^2 · a) from Qasq, Inner Mongolia (40°40′N, 111°08′E)

with forest vegetation and temperate semi-humid climate occurred during 2150 – 1850 a B. P.. C. 1850 – 1350 a B. P., climate was more arid than the preceding stage, vegetation was steppe and the climate was temperate-cool and arid.

Zone 5: 1350 a B. P. – present, vegetation was typical steppe, climate was temperate and semi-arid, recently getting more humid.

2) Pollen was absent in strata of 220 – 212 cm, 140 – 136 cm, 92 – 88 cm, 66 – 64 cm, without any evident sediment phase change and any evidence of fire catastrophe in the sample, therefore we thought that these strata stood for arid and slightly cold climate adverse for plant growing. The corresponding ages of these strata were about 8340 – 8100 a B. P., 5390 – 5160 a B. P., 3530 – 3300 a B. P. and 2530 – 2370 a B. P. respectively, they also could be correlated to the temperature dropping in north and northeast of China (Kong, 1982; Xia, 1988), and also to global low temperature period in the Holocene (Xu, 1990).

3) 7400 – 4100 a B. P. was the high temperature period for this region. Compared with Northeast and North China (An, 1990; Kong, 1982; Liu, 1989; Sun, 1990; Xia, 1988; Xu, 1990), this period was shorter, started later and ended earlier, which might be the reflection of the unique regional climate. The beginning limit this period was determined by vast occurrence of tree pollen, while the end was positioned at the boundary between Zone 3 and Zone 4 by the global climate deteriorating after optimal period.

4) 5000 – 4100 a B. P., this region underwent the relatively stable warm and humid period in the Holocene. This period could be regarded as the optimal period for the vast presence of broad leaf tree species. This conclusion was different from those in northeast and north of China (Li, 1992; Liu, 1989;

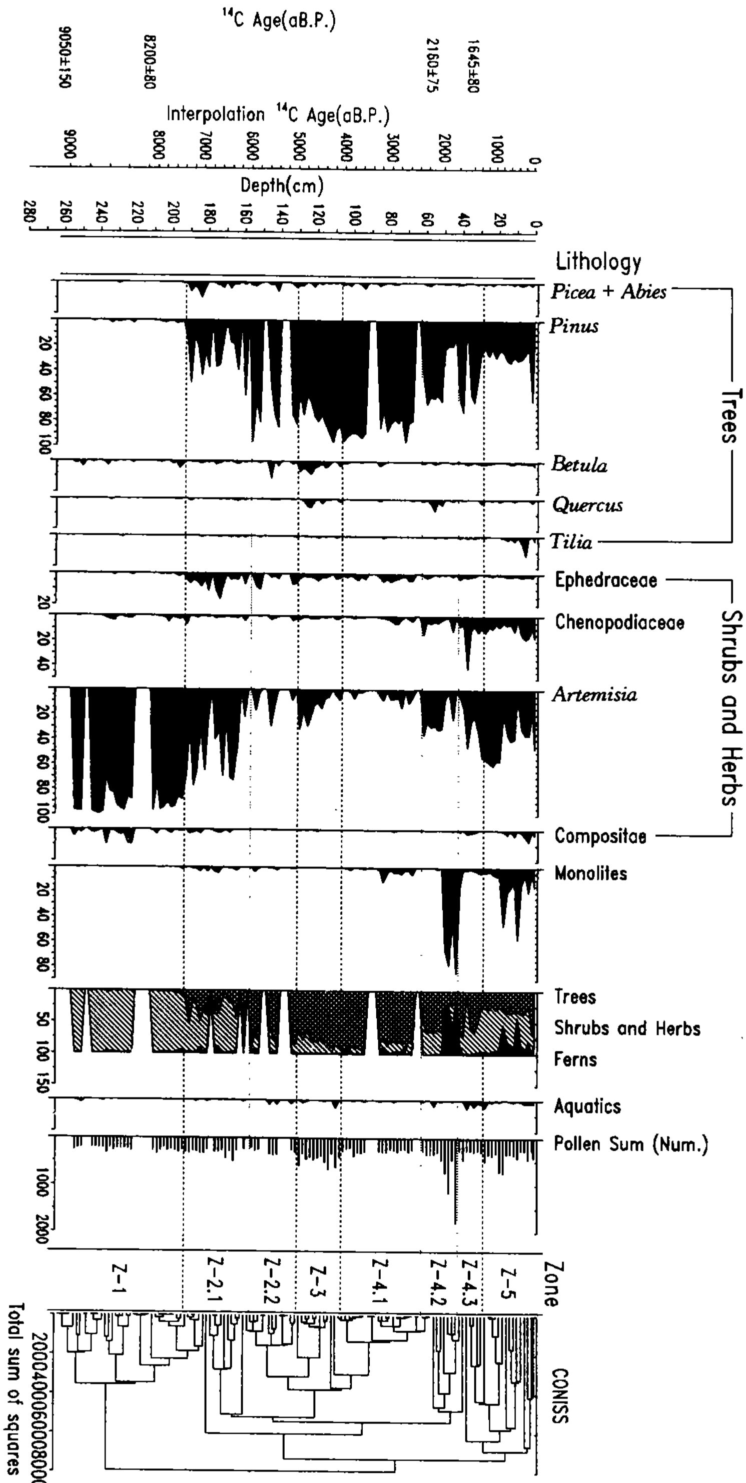

Fig. 2 Pollen percentage (%) from Qasq, Inner Mongolia (40°40′N, 111°08′E)

Sun, 1990), mainly in lagging in time. Rich evidence had proven that the occurrence of optimal period during 5000 – 4100 a B. P. was not coincidental, e. g. stable hot and high humidity period in the eastern Gansu(Li, 1992), paleosol forming period in Daqingshan Region(Cui, 1992) and the warm and humid period implied by high lake level in inland lakes (Daihai etc.) (Wang, 1990). All of these facts indicated that the climate in this region was warm and humid during 5000 – 4000 a B. P.. In addition, the result of ice-core δ^{18} analysis done in Dunde, Qilianshan indicated that there was a sub-stable warm and humid period in the western region during 5000 – 4000 a B. P. (Shi, 1992). The location of our profile was east of Dunde, Qilianshan and was not far from the position, so they should have more comparability. Research done in Beijing also indicated that climate was warm and humid during 5000 – 3500 a B. P. (Kong, 1982). In summary, the fact that the optimal period in the Holocene occurred 5000 – 4100 a B. P. is not only possible but also well-evidenced. One thing to keep in mind was that the optimal period for plant growth means to have suitable water and heat, not necessarily highest temperature, for water is rather more important than heat in natural environment in this region.

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