New Evidence of “Little Ice Age” Inferred from $^{14}$C and Pollen in the Kanas Wetland, Northern Xinjiang

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Objective

“Little Ice Age” (LIA) was first introduced by Matthes in 1939 with reference to the phenomenon of cirque glacier regrowth during the Holocene. China is located in the Asian monsoon region, and monsoon circulations on ecological environment have a variety of effects on ecological environment during the LIA. However, existing research has little documented on environmental changes based on pollen during the LIA. A 100-cm-deep section of drilling was collected at the Kanas wetland, northern Altay. By using the data of pollen and $^{14}$C, we obtained new evidence of “Little Ice Age” in the Altay area.

Methods

We collected 50 pollen samples in this section (48°43′0″N, 87°1′47.7″E), which is located in the Kanas Lake shore. Three $^{14}$C data were conducted at the Peking University AMS laboratory. $^{14}$C samples taken from the depths of 20–30 cm, 40–45 cm, and 60–66 cm calibrated to 289±20 cal. yr BP, 394±39 cal. yr BP, and 1440±26 cal. yr BP, respectively. All $^{14}$C dates were calibrated to calendar years before the present (1950 AD) using the program CALIB 7.1 (Fig. 1c). Pollen samples were treated with HF and HCl to extract pollen (Wang Zixi et al., 2017). All samples were identified under an Olympus CX51 light microscope. Digital graphs were made using the Tilia-Graph software (Grimm, 1990).

Results

We divide the pollen diagram into three pollen assemblage zones (Fig. 1d).

Zone I (3150–1440 cal. yr BP, 1200 BC–510 AD): Remarkably high percentages of arboreal (mean 68.14%) pollen were recorded, dominated by Pinus (mean 32.41%) and Picea (mean 30.72%). The hydrophytic pollen was 175 grains, including Zygnema (98 grains), Potamogetonaceae 429 grains, Sparganium (15 grains), and Typha (5 grains). The results indicated that the vegetation was dominated by coniferous forest and a deep-water area was present at that time.

Zone II (1440–350 cal. yr BP, 510–1600 AD) was marked by an increase in aquatic pollen (505 grains: Potamogetonaceae 429 grains, Zygnema 60 grains, and Typha 16 grains). Picea increased to 55.04%, whereas the Pinus decreased to 3.28%. The changes of Picea, Abies and hydrophyte pollen suggest a wet-cold environment.

The $^{14}$C and biological records from the Kanas wetland presented here reveal that the cold phenomenon was well known as the LIA and began on 1600 AD. Our research shows that the major vegetation changes recorded in the Kanas profile in the LIA primarily involve changes in the relative concentration of Picea, Abies and aquatic pollen. During the LIA, climate patterns in the study area were cold–wet, which are the same as the hydrothermal characteristics dominated the most time since the Holocene in northern Xinjiang.

Conclusion

$^{14}$C and pollen records from Kanas wetland presented here revealed that over the past 3000 years, especially in the “Little Ice Age”, the Kanas wetland in northern Xinjiang has experienced a vegetation transition from predominately pine forest to spruce forest. During the period of LIA, a variety of spruces trees were conducted in the Kanas wetland. Therefore, the results can help elucidate the vegetation types in the Kanas area during LIA.

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Fig. 1. (a) Location of study area in northern Xinjiang, China; (b) Representative samples of pollen (1, *Typha*; 2, *Potamogetonaceae*; 3, *Pinus*; 4, *Abies*; 5, *Zygnema*; 6, *Picea*); (c) Correction diagram of $^{14}$C for linear regression; (d) Pollen percentages of the Kanas wetland profile, Xinjiang.

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References