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Testing the accuracy of quantitative climate reconstruction using fossil pollen data of annually laminated sediment

Junko Kitagawa[1*], kazuyoshi yamada[2], Yasuharu Hoshino[3], OHYAMA, Motonari[4], YOSHITSUGU SHINOZUKA[5], Hitoshi Yonenobu[6]

[1]IRCJS, [2]Waseda University, [3]NRICP Nara, [4]Tohoku University, [5]Hokkaido Univeristy, [6]Naruto University of Education

Quantitative climate reconstructions play an important role in understanding the global climate changes as well as regional climate changes. Pollen data allows us to reconstruct the terrestrial climate change quantitatively. Recently the research on the climate change at Lake Suigetsu and Lake Mikata in Fukui prefecture in Central Japan has been conducted by modern analogue method using the surface pollen data set in Japan and meteorological data. It is said that the reconstruction accuracy is quite high. However, there is no study to test the actual accuracy of it comparing reconstructed with meteorological data. The sediment from Fukami-ike lake in Nagano prefecture is annually laminated and the laminae are thick enough to separate annually. 11 cores were recovered from the lake and 2 cores, 10-6-1 and 10-3-1 cores were used to test the accuracy of reconstructed climate data from 1918 to 1980 from the 10-6-1 core and from 1920 to 1969 from 10-3-1 core comparing to the meteorological data close to the lake. Marker grains were added during the pretreatment of pollen and pollen analysis was conducted annually. Pollen flux of 5 years, 11 years, 21 years and 31 years was calculated based on the marker grains. Polygon 2.2.4 (http://dendro.naruto-u.ac.jp/~nakagawa/) were used to reconstruct the annual mean temperature, spring (March, April, May) mean temperature, summer (June, July, August) mean temperature, autumn (September, October, November) mean temperature, winter (December, January, February) mean temperature, warm index, cold index, annual, spring, summer, autumn and winter precipitations. Then, those were compared with the meteorological data from the Iida meteorological station which is the closest to the lake.

The averages of the reconstructed precipitations were closed to the observed meteorological data. However, the correlation coefficients were low and the reconstructed data did not reflect the change of precipitation. The reconstructed annual, autumn and winter temperatures, cold index were relatively reliable. The averages of these reconstructed values were close to those of observed temperatures. The correlation coefficients between the reconstructed values and observed values were highest at 11 years and 21 years of pollen flux. The difference between the averages of reconstructed spring and summer mean temperatures and those of observed ones were great. The correlation was not observed between reconstructed summer mean temperatures and observed ones. The correlation existed between reconstructed spring mean temperatures and observed ones, but the reliability was doubtful since great difference existed between the average of reconstructed spring mean temperature and that of observed one. Warm index was also doubtful in reliability. There were great difference between the averages of reconstructed one and observed one although the correlation was good.

Recently, high-resolution analyses have been conducted, but the analyses of very high resolution, like 1 year and 5 years are not suitable to pollen analyses based on this study. The analyses of 10 years or 20 years improve the correlation coefficient. However, the analyses of over 30 years loose reliability. The reconstruction of precipitation may be difficult in high precipitated region like Japan. In high precipitated region, the change of precipitation may not affect much in pollen production. It is also difficult to reconstruct spring and summer mean temperature, but the reconstruction of autumn and winter mean temperatures is possibly reliable. It may be caused by phonology of plants. It is hard to say that these can be applied to all regions in Japan. It is expected that we will observe different results at the region with great difference in flora, precipitation and temperature.

Keywords: Fukami-ike lake, pollen analysis, climate reconstruction