Estimation of paleotemperature from racemization of aspartic acid in combination with radiocarbon age

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We tried to estimate paleotemperatures from two chosen fossils by measuring D/L aspartic acid ratios and radiocarbon ages of the XAD-2-treated hydrolysate fractions in the fossils. Gelatin and XAD-treated hydrolysate fractions in a fossil were both investigated to assess fluctuation of the rate of aspartic acid racemization in the two fractions, which are generally used for measuring accurate radiocarbon ages of fossil bones. The same fraction was employed in fossil bones on measurements of ^{14}C ages and aspartic acid racemization rates. The D/L aspartic acid ratio was measured with a gas chromatograph, and radiocarbon dating was performed using a Tandetron AMS system at Nagoya University.

The radiocarbon age of a fossil mammoth molar collected from Bykovsky Peninsula, eastern Siberia, was found to be 35,170 ± 300 BP as an average value for the XAD-treated hydrolysate fractions. The aspartic acid in the mammoth molar showed a little evidence of racemization, which might be due to *in vivo* racemization during the lifetime, and then suggests negligible or no postmortem racemization during burial in permafrost. The D/L ratios of gelatin fractions were higher than those of XAD-treated fractions, because the amino acid racemization might proceed during gelatinization, which is performed on the conditions of high temperature of 90°C. Therefore, XAD-treated hydrolysate fractions in fossils are good for use on estimation of paleotemperature by measuring both the D/L aspartic acid ratios and ^{14}C ages.

From four animal bone fossils collected from a shell mound excavated at the Awazu submarine archeological site in Lake Biwa, Shiga, Japan, the racemization-based effective mean temperature was calculated to be 15-16°C using the D/L aspartic acid ratio of about 0.11 and the ^{14}C age of 4500 BP for the XAD-2-treated hydrolysate fractions in the fossils. The average annual temperature was estimated to be 11–12°C, which approximates to the temperature that the fossils have been experienced during burial in the site. Although it is surrounded with many difficulties in application of the racemization ratio in fossils as a paleotemperature indicator, the results obtained in this study suggest its feasibility.