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Seasonal variability recorded in bivalve shell as a proxy of paleo-depth

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The Japan Sea is a semi-enclosed marginal sea which is connected to open ocean through four shallow straits. Open ocean water flow into the Japan Sea only from the Tsushima Strait located in the south of the Sea. Inflow of the Tsushima Warm Current (TWC) from the Tsushima Strait is responsible for the sea surface temperature (SST) of the Japan Sea and climate of the Sea-side of the Japanese Islands. Because the sill depth is close to the sea level of the last glacial maximum, oceanographic environment of the Japan Sea has been highly sensitive to the sea level changes which could control the inflow of TWC. Therefore, an accurate estimation of the past sea level is crucial to constrain the past SST of the Japan Sea.

Well dated fossil bivalve shells have been widely used as proxy for water depth of the location where the fossils were collected. Basic assumption for this scheme is invariable habitats of the used fossil bivalve through time, which is not necessarily guaranteed. In order to test this assumption and estimate the past relative sea level (water depth) of the Japan Sea, we have looked for appropriate samples. Five fossils of Callista brevisiphonatawere discovered at the water depth of 131 or 133 m in the southern Japan Sea. Modern habitat of this species shallow (0-30 m) and cold (> 40 N). They are well-dated with AMS ^{14}C methods and the age are ranging from 1193 to 12552 cal yr BP. High resolution oxygen isotope analysis for these fossils was conducted along their growth direction and the SSTs and their seasonal variability was reconstructed. We assumed the sea water oxygen isotope ratio for these periods were same as modern value (0.5 per mil vs SMOW) and the SST-oxygen isotope relationship proposed by Carre et al. (2005) for aragonite shell of bivalve is applicable to this species.

Average SST estimated from fossil C. brevisiphonataof 1193 and 2365 cal yr BP are 6.4 and 12.2 degree C, respectively, which correspond to temperatures of 145 m and 112 m water depth, respectively. Considering the modern habitat of this species, they would have adapted to cold and deeper water and changed their habitat. Three samples dated around 12000 cal yr BP shows approx. 8 degree C of average SST and approx. 5 degrees of seasonal variation. Possible change in their habitat (living water depth) leads us to consider that the estimated SST value could not be one of the near surface (0 - 30 m water depth). Alternatively, we consider the seasonal variability of SST is relatively invariable through time and apply the modern relationship between water depth and seasonal SST variation to these reconstructed SST values. Annual SST variation of 5 degrees corresponds to the water depth approx. 100 m. The average SST 8 degree C at 100 m water depth estimated in this study is concordant to the alkenone-based SST reconstruction of approx. 14 degree C at near surface in 12000 cal yr BP. Here we propose that the reconstruction of SST seasonality using appropriate fossil samples could be a good estimator of their living water depth in the past, even though their habitat changes significantly.

Keywords: Japan Sea, oxygen isotope, paleo-SST, paleo-depth, bivalve, Callista brevisiphonata