Challenges using ultra-high-resolution isotopic records from fast-growing, short-lived molluscs

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Over the last two decades, innovations in micro-sampling techniques have advanced our capabilities to produce environmental reconstructions on seasonal to subdaily time scales, using ultra-high-resolution isotopic records from fast-growing, short-lived molluscs. Such advances have provided new insights into past climate changes that were otherwise not detected by more traditional proxy records that are often biased towards decadal to annual resolution and summer/growing season. Moreover, ultra-high-resolution shell records approach the seasonal range in temperature and reveal variations in seasonal growth rates. Therefore, bulk sampling shells would bias results toward the fast growing season. Using ultra-high-resolution time series from short-lived molluscs is not without challenges, however. Unlike long-lived bivalves, short-lived molluscs cannot be used to construct master chronologies. Rather, short-lived molluscs can produce "snapshots" of climate variability at seasonal to subseasonal scales. This approach works well for Holocene deposits where shells can be radiocarbon dated. In this case, multiple shells are used to generate ~30 years of snapshots, allowing characterization of a given century. This approach is more challenging, however, when using fossil shells from deposits where time averaging may span 1000s to 100s of 1000s of years or more. How many "snapshot" years are required to reconstruct seasonal variability in deep time? This paper discusses some of the advantages, challenges, and future directions in using ultra-high-resolution isotopic records from fast-growing, short-lived molluscs to reconstruct seasonally resolved coastal marine climate.