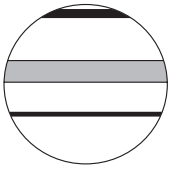

Research Paper

A 45-year sub-annual reconstruction of seawater temperature in the Bay of Brest, France, using the shell oxygen isotope composition of the bivalve *Glycymeris glycymeris*

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Abstract

A reconstruction of sea surface temperature (SST) spanning 45 years (1966–2011) was developed from $\delta^{18}O$ obtained from the aragonitic shells of *Glycymeris glycymeris*, collected from the Bay of Brest, France. Bivalve sampling was undertaken monthly between 2014 and 2015 using a dredge. In total, 401 live specimens and 243 articulated paired valves from dead specimens were collected, of which 24 individuals were used to reconstruct SST. Temperatures determined using the palaeotemperature equation of Royer et al. compared well with observed SST during the growing season between 1998 and 2010 (Pearson's correlation: $p = 0.002$, $r = 0.760$). Furthermore, a significant negative correlation was found between the reconstructed SST and the North Atlantic Subpolar Gyre (SPG) index ($p = 0.001$, $r = -0.50$), and a significant positive correlation was found with the East Atlantic Pattern (EAP) index when the reconstructed SST was lagged by 1 year ($p = 0.002$, $r = 0.46$). This led to the conclusion that EAP and SPG are major influences on SSTs in the Bay of Brest. As the SPG controls air temperature in Northern Europe and the EAP controls water temperature in Southern Europe, this suggests that the Bay of Brest is an interaction area between these two climate systems. As such, this locality is interesting as the $\delta^{18}O$ of the shells can be used as a proxy for both the SPG and EAP, and temperature reconstructions can provide a unique insight into how these climate systems interacted prior to the instrumental era.

Keywords

aragonite, climate signals, dog cockle, EAP, high-resolution proxy records, NAO, sclerochemistry, sclerochronology, SPG, stable isotopes, temperature reconstruction

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Introduction

The reconstruction of past climates is important because it provides a long-term context for modern climate warming. Numerous studies have focused on climate change of the past few centuries to millennia, using both modelling experiments based on estimated climate forcings (Hansen et al., 1998; Meehl et al., 2007; Murphy et al., 2004; Seager et al., 2007) and empirical reconstructions using proxy data (Braconnot et al., 2012; Jones et al., 2013; Mann et al., 1998, 2009; Moberg et al., 2005). In addition, since the late 19th century, meteorological stations have been providing records of temperature, precipitation and other climate indicators over both the northern and southern hemispheres (Jones et al., 1998). Until recent decades, these records have been predominantly land-based, supplemented by ship-based logs of sea surface temperatures (SSTs; García-Herrera et al., 2005).

In order to study marine climate before the development of the robust instrumental record, evidence derived from relatively scarce marine climate proxies must be used (Butler et al., 2009, 2010; Pollack and Huang, 2000) The requirement for such reconstructions is precisely dated, high-resolution proxy data that can be calibrated with instrumental measurements (Mann et al., 1999). It is especially important to take account of the seasonality of the proxy data (Mann et al., 1998).

This study uses stable oxygen isotope data from the shell of the marine bivalve *Glycymeris glycymeris* from the Bay of Brest to reconstruct seawater temperatures for periods before the availability of local instrumental data (1998–present). It has been shown using oxygen isotopes (Berthou et al., 1986) that *G. glycymeris* growth increments are formed annually, with the

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