PALAIOS
Emphasizing the impact of life on Earth's history

PALAIOS, 2024, v. 39, 175–193
Research Article
DOI: http://dx.doi.org/10.2110/palo.2023.034

SCLEROCHRONOLOGICAL EVIDENCE OF LIFE HISTORY AND AMBIENT TEMPERATURE FROM MODERN AND EARLY PLEISTOCENE *GLYCYMERIS AMERICANA* (MOLLUSCA:BIVALVIA) OF THE U.S. EASTERN SEABOARD

ANDREW L.A. JOHNSON,[1] BERND R. SCHÖNE,[2] MELANIE J. LENG,[3] TRIPTI BHATTACHARYA,[4] DAVID K. MOSS,[5] LINDA C. IVANY,[4] AND RICHARD P. DUFF[1]

[1]*School of Science, University of Derby, Derby DE22 1GB, UK (ORCID: AJ; 0000-0001-5727-1889)*
[2]*Institute of Geosciences, University of Mainz, 55128 Mainz, Germany*
[3]*National Environmental Isotope Facility, British Geological Survey, Keyworth NG12 5GG, UK*
[4]*Department of Earth and Environmental Sciences, Syracuse University, Syracuse, New York 13244, USA*
[5]*Department of Environmental and Geosciences, Sam Houston State University, Huntsville, Texas 77341, USA*
email: a.l.a.johnson@derby.ac.uk

ABSTRACT: Growth-increment and isotopic studies of shells of the marine bivalve *Glycymeris americana* are a potential source of information bearing on its life history and preferred environment over the late Cenozoic on the U.S. eastern seaboard. We demonstrate that the ages of shells can be determined from growth bands and ontogenetic profiles of oxygen isotope (δ^{18}O) composition, and that shell aragonite is deposited in oxygen isotopic equilibrium with seawater, enabling calculation of ambient temperatures by means of a generic transfer function. Modern specimens from North Carolina rarely reach the large size commonly attained by modern forms from Florida and Early Pleistocene forms from both states, and modern populations from North Carolina probably include fewer old individuals, the most certain disparity being with Early Pleistocene populations from the state. The temporal change in age structure in North Carolina may be an effect of recent scallop trawling but earlier non-anthropogenic environmental change cannot be ruled out as the cause. Maximum and minimum temperatures calculated from the δ^{18}O profiles of Early Pleistocene shells indicate a larger seasonal range than now in both Florida and North Carolina, due to cooler winters. This may reflect greater southward penetration of cool northern waters, with transport along the shelf supplemented by upwelling of water brought south at depth.

INTRODUCTION

Glycymeris da Costa is a genus of non-siphonate, shallow-burrowing arcoid bivalves that evolved from cucullaeid arcoids in the Cretaceous (Cox et al. 1969; Thomas 1975) and, as recorded in the Ocean Biodiversity Information System (OBIS, undated), now occurs worldwide in tropical and temperate marine shelf settings. The genus is a common element in fossil assemblages representing these environments from the Neogene onwards. The aragonite shell (particularly the interior of the hinge plate, which serves as the attachment surface for the ligament and bears the taxodont teeth) generally shows a good record of annual increments. For this reason *Glycymeris* has attracted much attention from sclerochronologists, who have used the increment information to construct multi-decadal to multi-centennial (multi-individual) chronologies and to determine life and environmental histories (Peharda et al. 2012, 2016; Brocas et al. 2013; Reynolds et al. 2013, 2017a, 2017b; Royer et al. 2013; Bušelić et al. 2015; Moss et al. 2016; Yamaoka et al. 2016; Beaver et al. 2017; Featherstone et al. 2017; Nemeth and Kern 2018; Gimenez et al. 2020; Alexandroff et al. 2021; Johnson et al. 2021). In many of these studies, increment information has been supplemented by oxygen isotope (δ^{18}O) profiles to test the annual periodicity of bounding growth lines and supply temperature estimates. Some further studies of *Glycymeris* have been largely or entirely based on δ^{18}O data (Berthou et al. 1986; Walliser et al. 2015, 2016; Crippa et al. 2016; Peharda et al. 2019a, 2019b; Featherstone et al. 2020; Johnson et al. 2022).

Most δ^{18}O thermometry using *Glycymeris* has employed the generic aragonite equation of Grossman and Ku (1986). However, Royer et al. (2013) determined a species-specific equation applicable to modern *Glycymeris glycymeris* from Brittany (France). This equation, implying non-equilibrium isotopic incorporation, was subsequently used by Featherstone et al. (2020) for further work on modern *G. glycymeris* in Brittany and (in a comparison with results derived using the Grossman and Ku equation) by Reynolds et al. (2017a) for work in north-west Scotland; it has also been used for work on Oligocene *G. obovata* and *G. planicostalis* (Walliser et al. 2016). The equations of Grossman and Ku (1986) and Royer et al. (2013) yield significantly different estimates for seasonal temperatures and annual range from the same shell (and water) δ^{18}O values so it is important to know which equation is the better one to use in *Glycymeris*-based δ^{18}O thermometry (Reynolds et al. 2017a; Johnson et al. 2022).

A potentially useful *Glycymeris* species for δ^{18}O thermometry is *G. americana*, an apparently long-lived form (Johnson et al. 2021) that occurs in Neogene to present-day shelf assemblages on the eastern seaboard of the United States and farther south (Porter and Wolfe 1971; Campbell 1993; Abbott and Morris 1995). However, to date there has been no study of modern forms to determine whether isotopic incorporation in *G. americana* departs from equilibrium. We remedy this deficiency herein and go on to provide some initial temperature estimates from Early Pleistocene forms. We also use the δ^{18}O data to test whether the growth increments in the hinge plate of *G. americana* are annual and proceed to make some preliminary interpretations of life history at present and in the Early Pleistocene from counts and measurements of hinge increments and of cycles in δ^{18}O profiles. Life history information is of potential value for conservation of

Published Online: June 2024