J Oceanogr (2014) 70:35–44
DOI 10.1007/s10872-013-0210-8

ORIGINAL ARTICLE

# Shells of *Paphia undulata* (Bivalvia) from the South China Sea as potential proxy archives of the East Asian summer monsoon: a sclerochronological calibration study

**Lina Yan · Bernd R. Schöne · Shengrong Li · Yan Yan**

Received: 10 June 2013 / Revised: 25 November 2013 / Accepted: 26 November 2013 / Published online: 15 December 2013


**Abstract** The climate of the South China Sea is dominated by the East Asian monsoon (EAM) system. Existing paleoclimate reconstructions offered an excellent insight into longer-term EAM variations. However, due to a lack of appropriate high-resolution paleoclimate data, relatively little is known about the frequency and strength of EAM extremes during the Holocene. To evaluate and establish a potential proxy archive for past variations of the EAM on shorter time-scales, we have carried out a calibration study on shells of the bivalve mollusk, *Paphia undulata* (Born 1778) from Daya Bay, China. This species has a short lifespan (3 years). Shells grow uninterruptedly between February/March and mid-November and are formed near oxygen isotopic ($\delta^{18}O$) equilibrium with the ambient environment. Shell growth patterns, $\delta^{18}O_{shell}$ and $\delta^{13}C_{shell}$ values, can be used to estimate the relative amount of precipitation and terrestrial runoff. Therefore, shells of this species can provide reliable, sub-seasonally resolved data on past East Asian summer monsoon strengths. The feasibility of this method has been tested with two Holocene shells from sediment cores taken from the nearby Beibu Gulf. A rather peculiar finding is that shell growth of *P. undulata* seems to be largely uncoupled to measured local environmental variables. Growth rates are negatively correlated to seawater temperature and chlorophyll *a* levels and positively to salinity. It is hypothesized here that extraordinary fast shell growth in early spring (February/March; low temperature and primary productivity) are facilitated by preserved energy resources, ensuring that the bivalve quickly reaches the predation window and the required size for reproduction.

**Keywords** Bivalve mollusk shell · Sclerochronology · Light-stable isotopes · Environmental variables · Shell growth rate · Erratic monsoon event · Terrestrial freshwater runoff

L. Yan · B. R. Schöne (✉)
Department of Applied and Analytical Paleontology, Earth Science System Research Center, Institute of Geosciences, University of Mainz, Mainz, Germany
e-mail: schoeneb@uni-mainz.de

L. Yan · S. Li
State Key Laboratory of Geological Processes and Mineral Resources, China University of Geosciences, Beijing, China

Y. Yan
South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guangzhou, China

## 1 Introduction

To test and verify numerical models capable of predicting future climates in areas affected by the East Asian monsoon (EAM), it is crucial to understand the temporal and spatial environmental variability in the anthropogenically less disturbed past. Existing reconstructions based on proxy records from sediments (Wan et al. 2006; Wang et al. 1999), planktonic foraminifera (Chen et al. 2003; Steinke et al. 2011), and palynology (Li et al. 2010) offer an excellent insight into longer-term variations of the EAM since the Late Pleistocene. However, (sub)seasonally and inter-annually resolved EAM reconstructions are much rarer and largely come from corals (e.g., Sun et al. 2005; Yu et al. 2005) and bivalve mollusk shells (e.g., Marwick and Gagan 2011; Miyaji et al. 2010; Schöne et al. 2004; Stephens et al. 2008; Yan et al. 2013). Accordingly, relatively little is known about the frequency and strength of EAM extremes within individual years of the past. In fact, the number of erratic monsoons, i.e. individual years of