PART N, REVISED, VOLUME 1, CHAPTER 14: BIVALVE SCLEROCHRONOLOGY AND GEOCHEMISTRY

Bernd R. Schöne and Donna M. Surge

[University of Mainz, Germany, schoeneb@uni-mainz.de; and University of North Carolina at Chapel Hill, donna64@unc.edu]

Bivalve shells act as unique skeletal diaries. They can provide precisely dated, unprecedented ultra high-resolution (daily, seasonal, annual) records of life history traits, as well as records of climate changes in environmental settings from which only limited data exist. Bivalve sclerochronology seeks to deduce these records from the growth patterns preserved in shells and is a term that was introduced for similar studies on corals (Buddemeier & Maragos, 1974). Sclerochronological techniques have been successfully applied to many different fields, including paleoclimatology, archeology, biology, evolution, and retrospective environmental biomonitoring. The full potential of bivalves for such studies becomes evident through the following considerations.

Many bivalve species are extremely long lived (Thompson, Jones, & Dreibelbis, 1980; Zolotarev, 1980; Strom & others, 2004), and thus, they are perfectly suited as long-term paleoclimate archives. For example, the ocean quahog, *Arctica islandica* (Linnaeus, 1767), lives for more than 500 years (Jones, 1983; Ropes & Murawski, 1983; Schöne, Fiebig, & others, 2005; Wanamaker, Scourse, & others 2008; Butler & others, 2011), *Neopycnodonte zibrowii* Wisshak & others, 2009, for more than 545 years (Wisshak & others, 2009), and the European freshwater pearl mussel, *Margaritifera margaritifera* (Linnaeus, 1758), exceeds a lifespan of 200 years (Mutvei & Westermark, 2001). Each specimen of such long-lived species opens a multi-century window into the climatic past. Moreover, such long-lived species allow the construction of master chronologies (much like tree rings) to extend the paleoclimate records beyond the lifetime of an individual animal (Jones, Arthur, & Allard, 1989; Marchitto & others, 2000; Schöne & others, 2003; Butler & others, 2010).

Throughout their lifetime, and assuming sufficient growth rates, bivalves sensitively and faithfully record changes—in chronological order—of the ambient physico-chemical environment, in particular temperature (Henderson, 1929; Kennish & Olsson, 1975), food availability (Ansell, 1968; Page & Hubbard, 1987; Sato, 1997), salinity (Davis & Calabrese, 1964; Marsden & Pilkington, 1995), and water quality (Frantsevich & others, 1996; Mutvei & others, 1996; Ravera & others, 2007). Environmental changes are encoded in the shells in the form of variable growth rates (Kennish & Olsson, 1975; Koike, 1980) and geochemical properties (Jones, Williams, & Romanek, 1986; Wefer & Berger, 1991; Gillikin, De Ridder, & others, 2005).

Among aquatic organisms, bivalves exhibit an unrivaled biogeographic distribution, extending from the poles to the equator, from the deep sea to shallow waters, and from marine to freshwater habitats. Therefore, they can provide environmental data from many different settings. In addition to their wide spatial distribution, they also have a long geologic history and cultural significance. Bivalves occur abundantly in the fossil record, documenting more than 500 million years of evolutionary history. On human time scales, they were important food resources for historic and prehistoric people. A vast number of shells of short-lived species (e.g., *Mercenaria* spp., *Spisula* spp., *Chione* spp., *Phacosoma* spp.; Jones, Williams, & Arthur, 1983; Tanabe & Oba, 1988; Goodwin & others, 2001;

Schöne, Bernd R., & Donna M. Surge. 2012. Part N, Revised, Volume 1, Chapter 14: Bivalve sclerochronology and geochemistry. Treatise Online 46:1–24, 8 fig.