A ‘clam-ring’ master-chronology constructed from a short-lived bivalve mollusc from the northern Gulf of California, USA

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Abstract: Age-detrended and standardized annual growth increment width time series of 67 live-collected intertidal bivalve molluscs of the species *Chione cortezi*, *C. fluctifraga* and *C. californiensis* from the northern Gulf of California were strung together to form a master-chronology that covers the period from AD 1982 to 1999. A high positive correlation was found between standardized annual growth rates and summer sea-surface temperatures and river-flow volume in the period 1988–99; and 63–76% of the variation in mean relative annual growth rates of *Chione* spp. is explained by temperature and river flow. Seven dead-collected specimens were cross-dated with the master-chronology permitting the reconstruction of the year of hatching and death for these shells. The incorporation of dead-collected specimens in the master-chronology improved the correlation statistics slightly. Species-related growth differences were not significant, but geographic differences in growth rates occur: individuals at the Colorado River mouth grew more slowly when large amounts of fresh water reached the Gulf. This study demonstrates that even short-lived molluscs (average 6–10 years old) can be used to build a master-chronology of environmental and climatic history.

Key words: Master-chronology, sclerochronology, sea-surface temperature, river discharge, cross-dating, Gulf of California, bivalve molluscs.

Introduction

Most organisms with accretionary hard parts provide continuous records of environmental conditions during their growth. Favourable environmental conditions can increase growth rates, resulting in wider growth increments. Environmental conditions also control microstructures (Schöne, 1998; Schöne and Schweingruber, 1999) and geochemical properties of the growth increments (Epstein *et al.*, 1953; Wefer and Killingley, 1980; Wefer and Berger, 1991; Mutvei *et al.*, 1994). Hence biological growth records provide a valuable tool for the reconstruction of past environments and climates for which instrumental records or other sources of information may not be available.

Tree-ring width and density chronologies have been used extensively for the reconstruction of stand dynamics and year-to-year environmental and climatic variability (Fritts, 1976; Schweingruber, 1983). The underlying theory assumes that the growth rates of trees are controlled by certain environmental parameters (Hartig, 1891; Douglass, 1919). Increment-width time series of trees with overlapping lifespans are strung together to form composite dendrochronologies (tree-ring master-chronologies), which cover much longer periods than individual trees. In theory, tree-ring analyses can provide precise and continuous climatic reconstructions for the last 12000 years (e.g., Briffa *et al.*, 1990; 1998; Scuderi, 1993), i.e., the length of current tree-ring master-chronologies (e.g., Becker *et al.*, 1991).

Despite the fact that modern dendrochronology originated in the late nineteenth century (Hartig, 1891; Douglass, 1919; 1939), its marine counterpart, sclerochronology (Buddemeier, 1975; Hudson *et al.*, 1976), is still underutilized, in particular mollusc sclerochronology. Nevertheless, growth patterns in mollusc shells have stimulated speculations and scientific investigations about their formation since the time of Aristotle (384–324 BC). In *Historia animalium* (*De partibus animalium*, Book V, XV) Aristotle states: ‘The purpura [a gastropod in the Mediterranean Sea] lives about six years, and every year its growth is clearly observable from the intervals in the shell of the spiral’ (translation by Peck, 1968). Although the environmental controls on growth rates in

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