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Environmental controls on daily shell growth of *Phacosoma japonicum* (Bivalvia: Veneridae) from Japan

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ABSTRACT: This study examined the environmental factors controlling the daily shell deposition of the intertidal bivalve *Phacosoma japonicum* from Seto Inland Sea, west Japan, and Tokyo Bay, central Japan. Sclerochronological analyses of microgrowth patterns in marked-and-recovered specimens indicate that a pair of 2 etch-sensitive increments and 2 etch-resistant lines is formed every lunar day (duration 24.8 h). The accretionary pattern of the lunar day growth increments (LDGIs) reflects tidal cycles. Prominent growth lines were formed during spring tides, when the bivalves were subaerially exposed, and weak ones were deposited during neap tides, when they were continuously submerged. The bivalves stop secreting shell carbonate during winter and early spring. The time interval encompassed by the winter break in the specimens from Tokyo Bay lengthened as the shells grew older. Although seawater temperature is the main controlling factor for shell growth, a number of mutually related environmental factors such as salinity and food availability also affect shell growth. In Tokyo Bay, the broadest LDGIs were deposited between temperatures of 21 and 24°C. Our findings provide a basis for the interpretation of the temporal changes in shell microgrowth patterns in terms of environmental conditions of extant and fossil *P. japonicum* specimens.

KEY WORDS: Sclerochronology · Bivalve mollusk · Shell growth · Tidal cycle · Seawater temperature

INTRODUCTION

Reconstruction of environmental conditions and life-history traits of modern and extinct organisms is an important subject in ecology and paleoecology. Mollusks are perfectly suited for such studies, because (1) they are distributed in a variety of geographic, bathymetric and environmental settings, ranging from tropical to polar realms, from intertidal to deep-sea environments and from freshwater to marine environments; (2) their shells have a high preservation potential as fossils; and (3) they can record environmental changes in chronological order and with extremely high temporal resolution (days).

Most existing paleoenvironmental reconstructions using bivalve shells have focused on geochemical data (e.g. Takesue & van Geen 2004, Gillikin et al. 2005) and used internal shell growth patterns as time gauges. Only a few studies have made use of variable shell growth rates (sclerochronology) as proxies for environmental conditions such as daily water temperature (e.g. Schöne et al. 2002, 2003, 2006). One of the main problems for the latter approach is that many different, complexly interacting environmental and physiological processes may exert control over shell growth rates. For example, temperature (Piditch & Grant 1999), food supply (e.g. Grant 1996, Carmichael et al. 2004), primary production and temperature (Witbaard et al. 1999) have been examined in terms of their impact on the growth of bivalves.

Disentangling the various environmental controls on shell growth is a tedious and time-consuming task that can be achieved, for example, through an analysis of shell growth patterns of many marked-and-recovered

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