SCLEROCHRONOLOGY OF MIOCENE AND RECENT OYSTERS: USING LIGAMENTAL INCREMENTS OF CRASSOSTREA TO INTERPRET ONTOGENY AND ENVIRONMENT

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Most sclerochronologic studies of bivalve shell utilize growth increments preserved in the outer prismatic layer. A different method is considered here for crassostreine oysters. Oysters grow both their ligamental areas and attached ligaments incrementally in a ventral direction throughout their ontogeny. Ligamental areas may therefore record various ontogenetic and environmental events which may be recognized as structural growth increments within the ligostracum and foliaceous layers. These events may either be periodic, such as spawning or tides, or they may be stochastic, such as storms or predator disturbances. Though previous observations have demonstrated the temporal nature of the skeletal record preserved in oyster ligamental areas, very few studies have utilized this phenomenon. This study examines crassostreine ligamental areas in order to decipher this skeletal record and to better understand oyster ontogeny, demography, and associated paleoclimatology. Sclerochronologic examination of Recent ligamental areas demonstrates the potential of determining season of death, life spans, and calcification rates, as well as tidal and seasonal patterns, from the fossil record. The Cretaceous to Holocene range and cosmopolitan distribution of crassostreine oysters in shallow marine deposits permit oyster sclerochronology to be widely applicable to addressing paleobiologic and paleoclimatic problems on an ecologic time scale (<100 years).

Four periodic orders of ligamental increments are recognized in left valves of Recent Crassostrea gigas (Pacific oyster) from California and Recent Crassostrea virginica (American oyster) from Louisiana. First-order ligamental increments are defined as a couplet of one convex band and one concave band. Each couplet is interpreted to represent one year. A growth break is commonly centered near the apex of the convex band. This growth break may be due to cessation of calcification during annual summer spawning. Second, third, and fourth periodic orders may represent seasonal, spring/neap tidal, and daily tidal periods, respectively. In order to determine the applicability of oyster sclerochronology to the fossil record, sixty specimens of Crassostrea titan were collected from a "reefal" life assemblage in the upper Miocene Santa Margarita Formation in Ventura County, California. In situ specimens were found in living position with their commissures oriented vertically. Minimum ages determined from first-order periodic ligamental increments (convex/concave couplets) range from <1 to 23 years. Fossilization has enhanced these couplets such that convex bands are white and concave bands are dark. This pattern of white and dark bands is visible in the underlying foliaceous layer in cross-section. Calcification rates (height/year) range from 1.3 to 11.0 cm/yr, depending on age, with a mean rate of 4.1 cm/yr for the entire assemblage. Higher periodic orders are evident in well-preserved specimens. Many oysters from this locality died during the onset of a white band located at the ventral edge of the ligamental area, suggesting that they may have died at the same time from a stochastic event. Planation of their ventral (top) valve margins to the same stratigraphic level and the presence of oyster fragments in an overlying coarse-grained sandstone suggest that this event may have been a storm that abraded and buried the oyster bed. Correlation of other sclerochronologic patterns among individual oysters within a life assemblage may potentially offer a better understanding of their demography and local environment. These results show that oyster sclerochronology can resolve various ontogenetic and environmental events on an ecologic time scale in the fossil record.

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