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Climate records from a bivalved Methuselah (*Arctica islandica*, Mollusca; Iceland)

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Abstract

We measured annual shell growth rates of a 374-year-old (radiometrically confirmed) bivalve mollusk specimen of *Arctica islandica* (Linnaeus). This bivalve represents the oldest ever reported individual animal. In addition, we analyzed 1051 individual powder samples from ontogenetic years two to 40 (=80% of the entire shell height) for isotope analyses. Oxygen and carbon isotopes exhibit clear intra-annual cycles. The highest measured carbon isotope values (on average+2.73‰) occurred during summer, i.e., during maximum primary productivity. The $\delta^{18}O_{aragonite}$-derived temperature time-series cover the period of AD 1496–1533. Temperatures calculated from oxygen isotopes ranged from 4.5 to 9.3 °C and exhibit a mean value of 6.2 °C. The latter coincides well with the 1854–2003 mean value of 6.81 °C for sea-surface temperature between February and September (=growing season of *A. islandica*). Neither oxygen nor carbon isotopes exhibit age-related, unidirectional trends. However, $\delta^{13}C_{aragonite}$ and $\delta^{18}O_{aragonite}$ values fluctuated at decadal periods of four, six and eight to nine years (NAO-type periods) as well as 12–14 years which may represent teleconnections to cycles in the tropical Atlantic. Annual shell growth is positively correlated to intra-annual $\delta^{18}O_{aragonite}$ minima, i.e., warm summer temperatures (R^2=0.34), and to intra-annual $\delta^{13}C_{aragonite}$ minima (higher food supply; R^2=0.42). Using a linear multiregression model, 65% of the variation in annual shell growth can be explained by summer temperature and food supply. The formation of extremely narrow annual increments coincides with major volcanic eruptions (e.g., Tambora 1815). A period of extremely variable growth occurred during the culmination of the Little Ice Age in Iceland between ca. AD 1550 and 1620. Shell growth during AD 1765–1780, however, was characterized by very little year-to-year variability, probably as the result of extremely mild climate near the end of the Little Ice Age. This study demonstrates that shells of *A. islandica* provide

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