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RESEARCH ARTICLE

Combined sclerochronologic and oxygen isotope analysis of gastropod shells (*Gibbula cineraria*, North Sea): life-history traits and utility as a high-resolution environmental archive for kelp forests

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Abstract The grey top-shell, *Gibbula cineraria* is a common member of temperate to cold water kelp forest communities, but its longevity and the age structure of its populations remains unresolved. Combined measurements of shell growth rates (sclerochronology) and oxygen isotope composition allow analysis of rate and timing of shell growth. Eight specimens were analyzed from the southern North Sea (near Helgoland, German Bight). Three age groups were identified but external measurements (width, height, ornamentation patterns and number of whorls) and shell weight are not adequate for ontogenetic age discrimination. Stable oxygen isotope data is consistent with shell growth during the interval from April to December in isotopic equilibrium with seawater, and growth increments exhibit strong tidal controls with fortnightly bundles well preserved. Reliable environmental proxy data (water temperature) can be extracted from the shell aragonite using conventional stable oxygen isotope analyses, with a temporal resolution of days attainable during intervals of maximum growth, but annual extremes are not always recorded in the shell. While demonstrating the utility of *G. cineraria* as a environmental and potential paleoenvironmental proxy for kelp forest habitats, its longevity has been significantly overestimated.

> ... the purpura lives about six years, and every year its growth is clearly observable from the intervals in the shell of the spiral.
> Aristotle, Historia animalium, Book V.XV; Peck AL (1970, Translator)

Introduction

High-latitude kelp forests, dominated by the brown seaweed, *Laminaria* sp. (Lüning 1990; Raven et al. 2002), form an important habitat for numerous species. These ecosystems are comparable to tropical rain forests or coral reef ecosystems in terms of productivity (e.g., Birkett et al. 1998). Extremely high biomass turnover rates ensure that huge amounts of detritus reach the coastal zone, supporting a diverse community of filter feeders and detritus feeders including barnacles, bryozoans, echinoderms, serpulids, sponges and ascidians as well as herbivorous organisms such as urchins, gastropods and chitons (Birkett et al. 1998; Wehrmann 1998). While productive and diverse, the long-term prospects of these ecosystems may be threatened by human activities and global climate

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