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ORIGINAL PAPER

ENSO-coupled precipitation records (1959–2004) based on shells of freshwater bivalve mollusks (*Margaritifera falcata*) from British Columbia

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Abstract We present the results of sclerochronologically calibrated growth and stable isotope analyses of the freshwater bivalve *Margaritifera falcata* collected from an agricultural, suburban setting near Vancouver, BC. The oxygen isotope range of shell aragonite can be explained by the temperature range during the growing season, assuming the water δ^{18}O composition remained constant. However, shell growth is strongly influenced by local summer precipitation and potentially runoff of nutrient-rich stormwater. About 44% of the variability of annual shell growth can be explained by amounts of local summer (June–September) rainfall. Local winter precipitation and El Niño–Southern Oscillation (ENSO) strength during the preceding year exert a weak, but significant control on shell growth. In combination, summer and winter precipitation can explain up to 50% of the variability in annual shell growth. Spectral analyses substantiate the effect of precipitation on shell growth and demonstrate that shell growth and ENSO are coupled by precipitation. Common spectral density was found at periods of 6.5–9 years, particularly between 1985 and 2004. Higher frequency oscillation corresponding to periods of 3–5 years occurred during the early 1970s, early to mid 1980s, and later 1990s. These results suggest that skeletal records of bivalve mollusks provide suitable archives of ENSO-coupled precipitation in areas where other climate proxies such as tree-rings and speleothems may not be available.

Keywords Sclerochronology · Stable isotope geochemistry · Runoff · Climate records · El Niño–Southern Oscillation

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Introduction

Strong inter-annual and decadal-scale variations of precipitation can affect ecosystems and human societies. This is particularly true for rapidly growing populations in urban areas and agricultural landscapes such as the Lower Fraser Valley (LFV) region. Precipitation variability influences river discharge and the chemical composition of surface and groundwater. Increased precipitation can trigger unexpected floods that threaten housing, cause soil and stream channel erosion, and damage drainage infrastructure. Increased precipitation may also increase the transfer of contaminants from agricultural fields, urban areas, and industrial sites to sensitive aquatic ecosystems. In contrast, reduced precipitation may result in shortages of drinking water, reduce water available for irrigation, and affect fish populations through reduced stream flow.

It is well known that precipitation patterns across Canada and the contiguous United States are coupled to climate oscillations such as the Pacific Decadal Oscillation (PDO; 25–40-year cycles) and the El Niño–Southern Oscillation (ENSO; 2–7-year cycles) (Ropelewski and Halpert 1986, 1987, 1989; Groisman