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Paleobiology and skeletochronology of Jurassic dinosaurs: implications from the histology and oxygen isotope compositions of bones

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Abstract

Fossil biogenic phosphate of fast-growing primary bone tissue of dinosaurs can preserve a histologic and isotopic time-series of annual seasonality in temperature variations, similar to tooth enamel and other accretionary skeletal phases such as corals or wood. On two bone fragments from sympatric dinosaurs with different histologic patterns of bone growth, high-resolution oxygen isotope profiles were analyzed along the radial direction of bone growth. The investigated specimens are from the Jurassic Shishugou Formation in the Junggar Basin, NW China and have distinct patterns of compositional variation. A fibrolamellar dinosaur bone with multiple lines of arrested growth (LAGs) and periodic growth cycles of decreasing bone laminae thickness displays a cyclic intra-bone variation in $\delta^{18}O$ values of about 2‰ corresponding with the LAGs. These growth cycles in fast-growing fibrolamellar bone provide evidence for seasonal growth of dinosaurs in lower latitudes ($\sim 45°N$), possibly influenced by a monsoon-type paleoclimate. Seasonal changes in temperature and water supply are consistent with the oxygen isotope composition measured in dinosaur bone phosphate as well as with growth rings in contemporaneous fossil conifer wood from the same locality. In contrast, a plexiform sympatric sauropod bone displays continuous growth, free of LAGs and has a lower intra-bone variation of ≤ 0.8‰. Differences in bone histology are also reflected in the oxygen isotopic composition and its intra-bone variability, indicating different physiological responses to external climatic stress between sympatric dinosaur species. Seasonal intra-bone oxygen isotope variations combined with bone histology may thus yield new insights into species-specific response to climatic stress and its influence on dinosaur growth, formation of growth marks, growth rates, as well as dinosaur thermophysiology.

Keywords: Dinosaur bone; Oxygen isotopes; Histology; Climate; Growth; Diagenesis

1. Introduction

Knowledge of how dinosaurs grew (e.g., Reid, 1997a; Erickson et al., 2001; Padian et al., 2001) is fundamental to our understanding of their means of

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