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The giant inoceramid *Platyceramus platinus* as a high-resolution paleoclimate archive for the Late Cretaceous of the Western Interior Seaway

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ABSTRACT

Platyceramus platinus was a giant inoceramid bivalve that inhabited the outer shelf environments of the Western Interior Seaway (WIS) in North America. With axial heights typically exceeding 1 m, the shells of this species potentially serve as a unique high-resolution geochemical proxy archive for Late Cretaceous paleoclimate. Here we present the first sclerochronological investigation of *P. platinus* shells to evaluate the usefulness of this species as an archive of short-term (e.g., seasonal to inter-annual) paleoenvironmental variability. We analyzed the growth patterns, the stable oxygen ($\delta^{18}O$) and carbon ($\delta^{13}C$) isotope values of well-preserved *P. platinus* shell fragments from the Santonian Niobrara Formation at Monument Rocks (Kansas, USA), a National Natural Landmark. A series of diagenetic tests, including cathodoluminescence (CL), scanning electron microscopy (SEM), and geochemical (LA-ICP-MS) analysis, confirmed the good state of preservation of the material. Shell microgrowth patterns suggested lunar daily (circalunidian) growth and that *P. platinus* grew nearly uninterruptedly throughout the year. Assuming a $\delta^{18}O_w$ value of −3.45 ± 0.26‰, reconstructions based on shell $\delta^{18}O$ data suggest average seasonal temperature variations between 12.5 ± 3.0 and 25.5 ± 1.1 °C and a mean annual temperature of 17.0 ± 4.1 °C for the outer shelf environment of the WIS. Repeated sudden negative $\delta^{13}C$ shifts of up to 2.00‰ and Mn-rich shell growth bands (Mn/Ca ratios up to 90.21 μmol/mol) suggest that *P. platinus* filter-fed on suspended organic detritus which sank from the upper water column during episodic events. The availability of large amounts of suspended food, however, slowed shell accretion rates of *P. platinus*. This shell growth behavior combined with the positive $\delta^{13}C$ values (0.03–3.96‰) possibly indicate a chemosymbiotic lifestyle that allowed *P. platinus* to survive under oxygen-depleted conditions at the seafloor.

1. Introduction

Inoceramids were marine benthic bivalves that occurred worldwide and were one of the most abundant bivalve taxon among Late Cretaceous macrofaunas (Saltzman and Barron, 1982; Dhondt, 1992; Voigt, 1995; MacLeod and Huber, 1996). During this time interval, some taxa evolved into very large forms with shells attaining sizes of several meters (Harries and Crampton, 1998). One of the largest known inoceramid species is *Platyceramus platinus* from the Late Cretaceous outer shelf deposits of the Western Interior Seaway (WIS). According to existing studies, *P. platinus* typically attained axial lengths of 1 m (Kauffman et al., 2007), and more rarely some individuals reached 2 (Stewart, 1990) or 3 m in size (Kauffman et al., 2007). Such gigantic bivalve shells potentially serve as unique high-resolution geochemical proxy archives for Late Cretaceous paleoclimate. Most of the existing studies on inoceramids have used $\delta^{18}O$ and $\delta^{13}C$ data of bulk shell material (e.g., Ludvigson et al., 1994; Elorza and García-Garmilla, 1996; Zakharov et al., 1999; Prokoph et al., 2013), shell chips (Tourtelot and Rye, 1969), arbitrarily chosen portions of the shell (Whittaker et al., 1987; He et al., 2005; Zakharov et al., 2011, 2012; Henderson and Price, 2012; Petersen et al., 2016) or individual prisms of the outer shell layer (MacLeod and Hoppe, 1992; Fisher and Arthur, 2002) to reconstruct paleoclimate. However, low-resolution sampling techniques applied in these studies did not allow climate reconstruction on short (seasonal to inter-annual)

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