



Invited research papers

Late Turonian climate variability in the Bohemian Cretaceous Basin – A sclerochronological study of *Inoceramus hercules* shells from the Úpohlavy quarry (Czech Republic)

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ABSTRACT

The $\delta^{18}\text{O}$ record of well-preserved shells of the inoceramid *Inoceramus hercules* from the Úpohlavy working quarry (Czech Republic) provides an insight into the climate variability in the late Turonian benthic environment of the Bohemian Cretaceous Basin. Similar to modern bivalves, this inoceramid species built its shell near equilibrium with the oxygen isotope value of the ambient water. Due to the nearly year-round shell growth, sequentially sampled $\delta^{18}\text{O}$ values allowed to estimate the narrowest sub-annual temperatures fluctuations that prevailed during lifetime of the organisms. In accordance with previous studies, reconstructed temperatures suggest colder water conditions (19.0 ± 0.9 °C) during the earliest late Turonian (coinciding with the *Hyphantoceras* Event; also known as Hitch Wood Event) than during the later part of the substage (20.9 ± 1.1 °C). Climate warming, however, did not affect the sub-annual temperature fluctuations evenly, but predominantly affected the warmest part of the year (at least +4.0 °C). On the contrary, the coldest recorded temperatures remained more or less invariant, varying not (much) more than +1.0 °C across the studied time interval. The observed changes in the benthic temperature estimates likely reflect shifts in seasonal sea surface temperature amplitudes in response to climate forcing. Given the widespread distribution of *I. hercules* in the upper Turonian–lower Coniacian hemipelagic strata of Europe, the present study sets the basis for future continent-wide sub-annually-resolved climate reconstructions.

1. Introduction

The Late Cretaceous world was characterized by elevated atmospheric $p\text{CO}_2$ levels (up to 900 ppm) (Foster et al., 2017), a flat meridional temperature gradient (ca. 0.4 °C/latitude) (Amiot et al., 2004; Pucéat et al., 2007) as well as surface and marine temperatures generally warmer than today (ca. 5–10 °C) (Hay, 2008). As such, information on the paleoenvironmental conditions that prevailed during this interval of Earth history can be used to refine our understanding of climate feedbacks under sharply elevated radiative forcing. Of particular interest is the reconstruction of paleotemperatures on short time scales (e.g., seasonal to multi-annual) and their evolution during changing climate states. Such quantitative temperature data can be utilized to test and refine numerical climate models and ultimately, improve the prediction of climate development in the future. In this context, the late Turonian interval represents a valuable natural

laboratory to study the effects of climate warming on the temperature variability in the marine realm. During the late Turonian (ca. 90–91 Ma), marine environments of Western and Central Europe experienced a general climate cooling characterized by the alternation of short-lived (ca. 250 ka) warm and cold climate phases (e.g., Voigt and Wiese, 2000; Jarvis et al., 2015). Cooling episodes were characterized by the southward extension of high latitude water masses and shifts of the Boreal and Tethyan biogeographic provinces across the Central European marine basins (e.g., Wiese and Voigt, 2002). The repeated incidence of cooling episodes is also supported by synchronous shifts (up to 1.00‰) toward positive values of bulk-rock $\delta^{18}\text{O}$ profiles from various localities in the region (e.g., Jenkyns et al., 1994; Voigt and Hilbrecht, 1997; Stoll and Schrag, 2000; Wiese, 1999; Wiese et al., 2004; Dubicka and Peryt, 2012). These events reflect short-term changes in global climate conditions as a response to decreasing atmospheric $p\text{CO}_2$ (Jarvis et al., 2015) and possibly the existence of

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