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Early Cretaceous marine isotope records from the Arctic

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Among the more compelling pieces of evidence for a Cretaceous greenhouse are isotopic signatures of unusually high sea surface temperatures preserved by planktonic foraminifera inhabiting the equatorial zone and evidence of temperate forests inside the Arctic and Antarctic circles. Little isotopic data and hence few palaeotemperature records, however, exist for the Arctic. This study presents the first detailed, biostratigraphically constrained (at the ammonite zonal level) record of oxygen and carbon isotopes from the early Cretaceous (Volgian -Valanginian) interval from the Yatria River, western Siberia, the Boyarka River (Taimyr Peninsula) central Siberia together with data from Svalbard. Oxygen and carbon isotopic compositions have been determined from well preserved specimens of the boreal belemnite genera Lagonibelus, Cylindroteuthis, and Acroteuthis. Data indicate a shift to cooler temperatures from the late Volgian through into the late Valanginian, with some warmer phases recognised within the earliest Berriasian and earliest Valanginian. These observations are consistent with subfreezing high latitude conditions and the formation of ice. A positive shift in carbon isotope values during the late Valanginian is observed both in the Yatria River and Boyarka River sections and appears to correlate with the positive carbon isotope excursion recorded from pelagic Tethyan successions. Surprisingly, these most positive carbon isotope values correspond with the most positive oxygen isotope values (and hence coldest palaeotemperatures). The positive carbon isotope excursion if attributable to increased burial of organic carbon, in the absence of widespread Valanginian organic-rich black shale deposition within Tethys, may point to increased storage of organic carbon in coastal areas and/or enhanced preservation within stratified waters in high latitude basins. Certainly the partial separation of Tethyan and Boreal realms during sea-level low stands in the Berriasian and Valanginian could have

restricted ocean circulation and potentially enhanced discrete episodes of ocean stratification. Cool polar temperatures and hence substantial temperature gradients may also in part explain the observed distinctive provincialism of belemnites. The observed correlation, between positive carbon isotopes and cool climates may expose the effectiveness of these high latitude carbon sinks and their ability to downdraw atmospheric CO2, the ‘inverse greenhouse’ effect.