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Latitudinal Variations in the Lilliput Effect during the End-Permian Mass Extinction

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The Lilliput effect, a reduction in body size, was a distinctive feature in the evolutionary history of many marine invertebrate groups in the aftermath of the end-Permian mass extinction. Maximum body size in marine invertebrates is limited by the balance between oxygen availability and metabolic oxygen demand. As a result, more widespread ocean anoxia, reducing availability, and warmer temperatures, increasing metabolic oxygen demand in poikilothermic invertebrates, are plausible stresses that may have been responsible for the Lilliput effect in the Early Triassic. Temperature stresses should produce latitudinal variations in size reduction because metabolic rate and aerobic scope, the amount of energy available for growth and other activities above baseline metabolic requirements, tend to vary with latitude. This prediction can be tested using body size measurements of more than 13000 specimens representing more than 2500 Changhsingian-Anisian species stored in the Paleobiology Database (www.paleodb.org). Among bivalves, the mean

size of Early Triassic species is actually greater than latest Permian species in the tropics and at mid-latitudes, but the trend is reversed at high latitudes. This pattern is consistent with physiological predictions, because highlatitude invertebrates typically have small aerobic scopes as a consequence of their low metabolic rates, and therefore have less capability to maintain growth as temperatures and standard metabolic rates increase. Although anoxia would have been an important constraint on body size where it was present, anoxic conditions were more prevalent in the tropics, especially in Tethys, so cannot explain the observed latitudinal variations in the Lilliput effect. The details of the Lilliput effect highlight the importance of large-magnitude temperature warming in the end-Permian extinction and its aftermath.

Key words: body size, respiratory physiology, aerobic scope, mass extinction

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