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Regional-scale marine faunal change in Eastern Australia during Permian climate fluctuations and its relationship to local community restructuring

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ABSTRACT

Marine invertebrates are at risk of extinction if climate changes outpace their ability to adapt to thermal stress, and cold-adapted taxa may be especially vulnerable because of their specialized physiologies and because their high-latitude distributions permit only limited poleward migration. Here, we use a database of 1437 early and middle Permian eastern Australian fossil collections from the Paleobiology Database to test for latitudinal range shifts, extinctions, and faunal invasion among high-latitude marine invertebrates during climate changes in the late Paleozoic ice age. Latitudinal range shifts are not apparent, either because genera were unable to migrate or, more likely, because sampling noise or the scale of analyses prevent their recognition. Extinction rates were moderately elevated during the largest climate shifts, however, possibly suggesting that at least some taxa were unable to respond to the rate or magnitude of climate change. Although recognition of range shifts within Australia is difficult, warm-water brachiopods, bivalves, and ammonoids invaded the region during pronounced warming in the Artinskian, highlighting the importance of temperature on faunal distribution. That faunal invasion was coincident with substantial restructuring of local paleocommunities, but both likely resulted from the common cause of increasing temperature rather than having a causal relationship. Temperature warming would have stressed cold-adapted stenotherms, triggering changes in local dominance and allowing immigration of warm-water taxa. These local and regional shifts in dominance and distribution imply that physiological stresses from even gradual climate change can be sufficient to trigger biotic change.