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Common species link global ecosystems to climate change: dynamical evidence in the planktonic fossil record

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Common species shape the world around us, and changes in their commonness signify large-scale shifts in ecosystem structure and function. However, our understanding of long-term ecosystem response to environmental forcing in the deep past is centred on species richness, neglecting the disproportional impact of common species. Here, we use common and widespread species of planktonic foraminifera in deep-sea sediments to track changes in observed global occupancy (proportion of sampled sites at which a species is present and observed) through the turbulent climatic history of the last 65 Myr. Our approach is sensitive to relative changes in global abundance of the species set and robust to factors that bias richness estimators. Using three independent methods for detecting causality, we show that the observed global occupancy of planktonic foraminifera has been dynamically coupled to past oceanographic changes captured in deep-ocean temperature reconstructions. The causal inference does not imply a direct mechanism, but is consistent with an indirect, time-delayed causal linkage. Given the strong quantitative evidence that a dynamical coupling exists, we hypothesize that mixotrophy (symbiont hosting) may be an ecological factor linking the global abundance of planktonic foraminifera to long-term climate changes via the relative extent of oligotrophic oceans.