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TITLE: Global change drives modern plankton communities away from the pre-industrial state

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ABSTRACT:

The ocean-the Earth's largest ecosystem-is increasingly affected by anthropogenic climate change<sup>1,2</sup>. Large and globally consistent shifts have been detected in species phenology, range extension and community composition in marine ecosystems<sup>3-5</sup>. However, despite evidence for ongoing change, it remains unknown whether marine ecosystems have entered an Anthropocene<sup>6</sup> state beyond the natural decadal to centennial variability. This is because most observational time series lack a long-term baseline, and the few time series that extend back into the pre-industrial era have limited spatial coverage<sup>7,8</sup>. Here we use the unique potential of the sedimentary record of planktonic foraminifera-ubiquitous marine zooplankton-to provide a global pre-industrial baseline for the composition of modern species communities. We use a global compilation of 3,774 seafloor-derived planktonic foraminifera communities of pre-industrial age<sup>9</sup> and compare these with communities from sediment-trap time series that have sampled plankton flux since AD 1978 (33 sites, 87 observation years). We find that the Anthropocene assemblages differ from their pre-industrial counterparts in proportion to the historical change in temperature. We observe community changes towards warmer or cooler compositions that are consistent with historical changes in temperature in 85% of the cases. These observations not only confirm the existing evidence for changes in marine zooplankton communities in historical times, but also demonstrate that Anthropocene communities of a globally distributed zooplankton group systematically differ from their unperturbed pre-industrial state.

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