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Earth & Space

The migration of marine plankton during the industrial era

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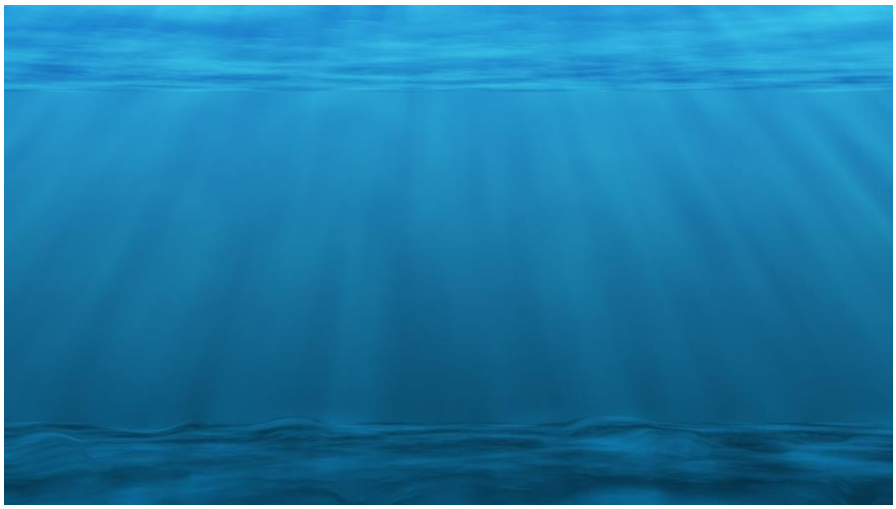
ABSTRACT

Due to climate change, the Earth is now in a state fundamentally different from before the pre-industrial era. Marine plankton, the basis of the food chain, has been responding to ongoing change. However, up to now, it was not known if plankton species had been pushed away from their undisturbed state.



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Marine plankton forms the basis of life in the ocean, and any changes in marine ecosystems have a profound impact. From observations since the 1950s, we knew that plankton species have been changing their distribution in a way that is consistent with anthropogenic climate change. Still, we lacked a baseline of what the species communities looked like before marked human influence, before the industrial era. This made it difficult to determine if the changes we see in plankton communities are part of natural variations on decadal time scales, or if they are due to climate change. Researchers thus needed a pre-industrial baseline of marine species communities.

This is where planktonic foraminifera come in. Planktonic foraminifera are tiny planktonic animals living everywhere in the surface ocean. The special thing about them is that they build a skeleton made of calcite, and this skeleton is preserved in the sediments on the ocean floor after the organisms die and sink. The process of burial in the sediment is slow, so the uppermost centimeter of the ocean floor contains information on planktonic foraminifera species communities of 100s to 1,000s of years ago. In our study, we used data from almost 4,000 samples collected from the seafloor over decades by many scientists to look at the pre-industrial distribution of planktonic foraminifera communities.

We compared these with observations on species communities since 1978. For this, we used information obtained using sediment traps, big funnels moored at great water depth that catch all particles that sink from the ocean surface, including

planktonic foraminifera. In this way, we could directly compare planktonic foraminifera communities from before and after the onset of the industrial era.

What we found is that modern species communities are no longer the same as the pre-industrial species communities in the sediment directly underneath the sediment trap. And this difference was larger in areas where the temperature had changed more. This was the first suggestion that modern communities have responded to climate change and are systematically different from the before human influence. Since the species communities in the sediment and in the sediment trap were not the same, we looked at where in the world we could find species assemblages similar to the modern ones in the sediment traps. We found that in virtually all cases, the most similar species community of pre-industrial age was in an area warmer than where the sediment trap was. This means that modern species communities have moved to areas that were previously too cold for them to survive. We thus found not only that modern planktonic foraminifera communities differ from their pre-industrial counterparts, but also that their distribution has changed in a direction consistent with temperature change. Our study confirmed earlier studies on marine ecosystems on the course of the shift in marine plankton. Furthermore, thanks to the unique sedimentary archive of species composition, we were able to put this change in a long-term perspective. We showed that global change had driven plankton species communities away from their unperturbed pre-industrial state.

We believe that the species community change we observe in planktonic foraminifera is indicative of a broader phenomenon of species community shifts in the marine biosphere. Species community shifts in response to rapid Anthropogenic climate change necessitates the need to establish new interaction networks among species. The question is whether they can do so quick enough, or whether climate change is progressing at a pace too fast for communities to adapt.