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Press release

Alfred-Wegener-Institut, Helmholtz-Zentrum für Polar- und Meeresforschung
Roland Koch

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Jellyfish may dominate the future Arctic Ocean

Climate change is putting countless marine organisms under pressure. However, jellyfish in the world's oceans could actually benefit from the rising water temperatures – also and especially in the Arctic Ocean. In computer models, they exposed eight widespread Arctic jellyfish species to rising temperatures. The result: by the second half of this century, all but one of the species in question could substantially expand their habitat poleward. The 'lion's mane jellyfish' could even triple the size of its habitat – with potentially dramatic consequences for the marine food web and Arctic fish populations. The study was just released in the journal Limnology and Oceanography.

In the future, jellyfish and other gelatinous zooplankton could be some of the few organism groups to benefit from climate change. As numerous studies have confirmed, the transparent cnidarians, ctenophores and pelagic tunicates thrive on rising water temperatures, but also on nutrient contamination and overfishing. When combined, these factors could produce a major shift in the ocean – from a productive, fish-dominated food web to a far less productive ocean full of jellyfish. As such, many researchers are already warning of an impending 'ocean jellification', i.e., a worldwide rise in jellyfish populations.

"Jellyfish play an important part in the marine food web," explains Dmitrii Pantiukhin, a postdoctoral researcher in ARJEL (Arctic Jellies), a junior research group specialising in Arctic jellyfish at the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI). "Now that climate change is putting more stress on marine organisms, it can often give the gelatinous zooplankton a leg up on their competitors for food, like fish. This in turn affects the entire food web and ultimately the fish themselves: many types of jellyfish feed on fish larvae and eggs, which can slow or prevent the recovery of fish populations already under pressure, which are often also heavily fished by humans. As such, anyone interested in how fish, an important food source for us, will develop in the future, needs to keep an eye on the jellyfish."

Despite their importance for all marine organisms, the transparent gelatinous organisms are often forgotten or neglected in ecological studies and model-based simulations. The study just released by Dmitrii Pantiukhin and his team closes an important gap in our knowledge, while also concentrating on a hotspot for climate change. "Of all the oceans, the Arctic Ocean is warming the fastest," says the study's first author. "In addition, roughly 10 percent of global fishing yields come from the Arctic. As such, the High North is the ideal site for our research."

A great deal is already known about the physiology of jellyfish, including the optimal temperature range for them to thrive. In the course of the study, the AWI team combined three-dimensional species distribution models with the oceanographic components of the Max Planck Institute Earth System Model (MPI-ESM1.2). "Simulations of species distribution in the ocean are often two-dimensional, a bit like a map," says Dr Charlotte Havermans, head of the ARJEL junior research group at the AWI. "But the distribution of jellyfish communities in particular is highly dependent on the specific water depth. Consequently, we made our species models three-dimensional. Once we coupled them with the MPI's Earth system model, we were able to calculate how the distribution of eight major jellyfish species could change from the reference period, 1950 to 2014, to the second half of this century, 2050 to 2099. For future years, we applied the

climate scenario 'ssp370', that is, a development path where greenhouse-gas emissions remain moderate to high."

The results speak for themselves: seven of the eight species – including comb jellies (Beroe sp. / + 110%) and pelagic tunicates (Oikopleura vanhoeffeni / + 102%) – could expand their habitat poleward, in some cases massively, by the period 2050 to 2099, and also stand to gain from the progressive loss of sea ice. The hair jelly Cyanea capillata, colloquially known as the 'lion's mane jellyfish', could especially expand northward, nearly tripling the size of its habitat (+ 180%). Only one of the species investigated (Sminthea arctica) would experience a minor decrease in habitat (- 15%), since it would have to retreat to greater depths to find its optimal temperature range.

"These results clearly show how dramatically climate change could affect the ecosystems of the Arctic Ocean," says AWI expert Dmitrii Pantiukhin. "The projected expansion of the jellyfish habitats could have tremendous, cascading impacts on the entire food web."

One question that remains open is how fish stocks in the Arctic would be affected by a jellyfish expansion. "There are many indications that key Arctic fish species like the polar cod, whose larvae and eggs are frequently eaten by jellyfish, will feel the pressure even more," says ARJEL Group Leader Charlotte Havermans. "Therefore, our study offers an important basis for further research in this field. And management plans in the fishing sector urgently need to bear in mind this dynamic development in order to avoid the collapse of commercially exploited stocks but manage them sustainably."

contact for scientific information:

- Dr Charlotte Havermans (phone: +49 471 4831-1530; e-mail: charlotte.havermans@awi.de)
- Dmitrii Pantiukhin (e-mail: dmitrii.pantiukhin@awi.de)

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Ctenophore Beroe sp.
Joan J. Soto-Angel
Alfred-Wegener-Institut / Joan J. Soto-Angel