More than just whale food: Krill's influence on carbon dioxide and global climate

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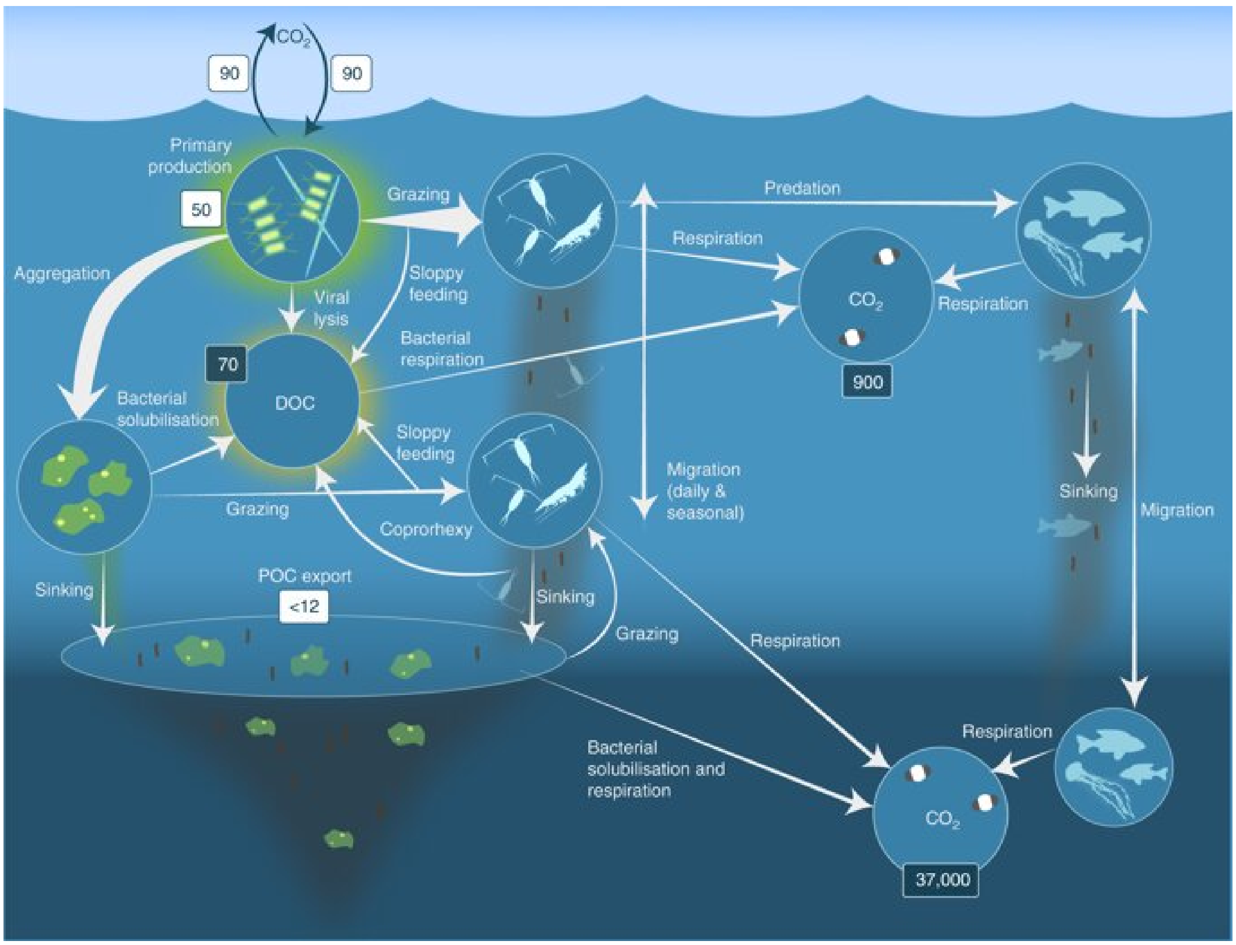

Processes in the biological pump. Phytoplankton convert CO2, which has dissolved from the atmosphere into the surface oceans (90 Gt yr−1) into particulate organic carbon (POC) during primary production (~ 50 Gt C yr−1). Phytoplankton are then consumed by krill and small zooplankton grazers, which in turn are preyed upon by higher trophic levels. Any unconsumed phytoplankton form aggregates, and along with zooplankton faecal pellets, sink rapidly and are exported out of the mixed layer (1000 m). As krill and smaller zooplankton feed, they also physically fragment particles into small, slower- or non-sinking pieces (via sloppy feeding, coprorhexy if fragmenting faeces), retarding POC export. This releases dissolved organic carbon (DOC) either directly from cells or indirectly via bacterial solubilisation (yellow circle around DOC). Bacteria can then remineralise the DOC to DIC (CO2, microbial gardening). Diel vertically migrating krill, smaller zooplankton and fish can actively transport carbon to depth by consuming POC in the surface layer at night, and metabolising it at their daytime, mesopelagic residence depths. Depending on species life history, active transport may occur on a seasonal basis as well. Numbers given are carbon fluxes (Gt C yr−1) in white boxes and carbon masses (Gt C) in dark boxes . Credit: *Nature Communications*

Antarctic krill are well-known for their role at the base of the Southern Ocean food web, where they're food for marine predators such as seals, penguins and whales.

Less well-known is their importance to the ocean's carbon sink, where CO_2 is removed from the atmosphere during photosynthesis by phytoplankton and sequestered to the seafloor through a range of processes.

A new study published in the journal *Nature Communications* has highlighted the influence of krill in the carbon cycle and urged consideration of the impact of commercial krill fishing on ocean chemistry and the global climate.

Led by Dr. Emma Cavan, a former IMAS researcher now at Imperial College London, the study reviewed current scientific knowledge of the role of krill in processes that each year remove up to 12 billion tonnes of carbon from Earth's atmosphere.

"By eating phytoplankton and excreting carbon and nutrient-rich pellets that sink to the seafloor, Antarctic krill are an integral part of the carbon cycle and a key contributor of iron and other nutrients that fertilize the ocean," Dr. Cavan said.

"Krill fecal pellets constitute the majority of sinking carbon particles that scientists have identified in both shallow and deep waters in the Southern Ocean.

"Antarctic krill grow up to 6-centimeters long and weigh around one gram, but they swarm in such vast numbers that their combined contribution to the movement of ocean carbon and other nutrients can be huge.

"The Southern Ocean is one of the largest carbon sinks globally, so krill have an important influence on atmospheric carbon levels and therefore the global climate."

Dr. Cavan said management of the krill fishery currently centres on sustainability and krill's role in supporting megafauna such as whales, with little attention given to assessing the significance of krill to the carbon cycle and ocean chemistry.

"Today the fishery takes less than 0.5 percent of the available krill and only adults are targeted.

"But there is no consensus on the effect that harvesting Antarctic krill could have on atmospheric carbon and ocean chemistry nor, for that matter, how growing whale populations might also affect krill numbers.

"Southern Ocean ecosystems and chemical processes are highly complex and poorly understood, and our lack of knowledge about the extent of krill's ability to affect the carbon cycle is a concern, given that it is the region's largest fishery.

"We don't know, for example, whether a decline in krill might actually lead to an increase in the biomass of phytoplankton, which are also integral in transporting carbon to the seafloor.

"Conversely, a decline in krill would decrease the beneficial fertilization effect that their fecal matter has on phytoplankton biomass, at the same time also jeopardizing the important part krill play in circulating iron and other nutrients.

"Our study has shown there is a pressing need for further research to address these and other questions about the significance of krill, as well as for more accurate estimates of their biomass and distribution.

"This information would inform both our understanding of biogeochemical processes in the ocean and the management of the krill fishing industry.

"We also recommend that measures be put in place to ensure that as fishing technology advances, the fishery does not encroach on larval krill habitat near sea-ice, and steps should be taken to prevent potential larval by-catch when fishing for adults," Dr. Cavan said.

More information: E. L. Cavan, et al. The importance of Antarctic krill in biogeochemical cycles. *Nature Communications* volume 10, Article number: 4742 (2019). DOI: 10.1038/s41467-019-12668-7. www.nature.com/articles/s41467-019-12668-7#Abs1

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