

Arctic top predators like fat prey

Size Matters in the Fjords

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A recent examination of the biodiversity and food web in Svalbard suggests that climate warming will have a negative impact on the occurrence of large marine carnivores (seabirds and sea mammals) and will favor smaller carnivores (fish)

The most exciting experiences for tourists in the Arctic region are observing the vast numbers of seabirds which nest in coastal colonies and frequent sightings of sea mammals. Surprisingly, a recently published study of extensive data on seabird marine food from the North Atlantic indicates that the species-rich, productive Norwegian Sea (Boreal area) supports 1.8 million pairs of seabirds, while the equally productive but species-poor Barents Sea (Arctic area) provides food for 6 million pairs of seabirds.

An examination of the occurrence of sea mammals has indicated a similar pattern.

Our work involves the comparison of two similar marine ecosystems from the high latitude Arctic. The first is Kongsfjorden (79°N), which is supplied with Atlantic waters from the West Spitsbergen Current and has very diverse pelagic and benthic fauna of northern Atlantic origin. The second, Hornsund Fjord (77°N), is under the influence of mixed Atlantic and local waters, and is characterized by reduced diversity of a predominantly Arctic species pool. The aim of our study is to answer this question: *Why does the Arctic system, with its lower prey biomass and lower diversity, support more top predators than the more diversified and biomass-rich boreal system?*

Major populations of key Arctic seabirds and mammals live within Hornsund and Kongsfjorden. Their typical prey consists of both pelagic and benthic fish and crustaceans. The "Atlantic" Kongsfjorden hosts fewer seabirds (approximately 30 thousand pairs) than the more "Arctic" Hornsund (approximately 150 thousand pairs). The number of key prey species is similar in the two systems. For example, the Arctic copepod *Calanus glacialis* is replaced



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Plankton-eating little auks – the most numerous species of Arctic seabirds. The colony near the Polish Polar Station in Hornsund consists of about 150,000 pairs

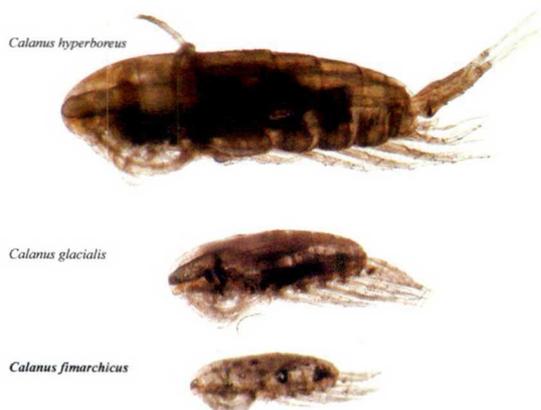


MAREK STROJAN

The glaciers of Spitsbergen are melting very fast, providing the most striking evidence of the ongoing warming of the Arctic

in Atlantic waters by *Calanus finmarchicus*. All Arctic prey species are generally larger and more nutrient-rich in comparison to their warm water relatives.

The collected data allows us to develop the following scenario: high biodiversity in Atlantic waters is associated with high overall biomass, while the individual size of the prey species tends to be smaller. Conversely, the lower diversity of the Arctic biota in Hornsund is associated with lower biomass, but the individual size of the species is larger. The low temperature at high latitudes supports the so-called "K strategy" in marine invertebrates, meaning slow growth, low fecundity, long life span, large individual size, higher survival rates and, consequently, larger population size. Higher temperatures permit faster growth of marine invertebrates, higher fecundity and, in consequence, smaller body size, which indicates a tendency towards the "r strategy," meaning higher mortality and smaller population size. These two contrasting strategies are related to biodiversity – the "r strategy" can be linked to the enhanced competition between species that promotes diversity, while the "K strategy" and slower growth rates permit increased survival rates at the expense of biodiversity.



S. Kwaśniewski

As the climate warms, fjords are filled with Atlantic waters, carrying numerous but small invertebrates. These waters replace cold Arctic waters, where invertebrates are less numerous but larger and thus more attractive to birds and mammals

Climate change in the Arctic causes an increase in sea temperature (as a consequence of increased inflow of Atlantic waters) and the associated advection of smaller species from the south, as was recently demonstrated by a study in the North Sea. Top Arctic predators, which have access to large, nutritious invertebrates, often rely on shortened food chains – e.g. a kittiwake feeding on a herbivorous Arctic sea snail *Limacina helicina* – but they are less inclined to do so in the Atlantic water mass, where the local sea snail *Limacina retroversa* is 20 times smaller.

While seabirds and sea mammals in the Arctic eat mainly fish, they have at their disposal a secondary, but very important and predictable food source: large invertebrates. The boreal ecosystem lacks them, hence if fish stocks subside, top predators may suffer from a scarcity of food. Other research has demonstrated that birds feeding in the Norwegian Sea take only 1-5% of the invertebrate prey, while seabirds in the Barents Sea take as much as 10-25% of this resource. High prey diversity, associated with smaller species size in the boreal domain, favors fish; while low diversity, linked to a larger body size and more energy stored, favors top predators.

Ongoing research is carried out mainly from two Polish research platforms: the Polar Station in Hornsund (the PAN Institute of Geophysics) and the research vessel "Oceania" (the PAN Institute of Oceanology), in cooperation with the Norwegian Polar Institute and MARBENA, an EU-funded program on marine biodiversity. ■

Further reading:

- Węśławski J. M., Kwaśniewski S. (2003), Biodiversity and ecosystem function. Case study of two arctic fjords. Abstract in: *Biodiversity of Coastal Marine Ecosystems Functional Aspects EUROCONFERENCE, Renesse, The Netherlands 11-15 May 2003*, eds. C. H. R. Heip, H. Hummel, P. H. van Avesaath, R. Warwick.
- Karnovsky N., Kwaśniewski S., Węśławski J. M., Walkusz W., Beszczyńska-Moller A. (2003), *Foraging behaviour of little auks in a heterogeneous environment*. Marine Ecology Progress Series 253; 289-303.