The North Atlantic Ocean as habitat for Calanus finmarchicus: environmental factors and life history traits

Here we present a new, pan-Atlantic compilation and analysis of data on Calanus finmarchicus abundance, demography, dormancy, egg production and mortality in relation to basin-scale patterns of temperature, phytoplankton biomass, circulation and other environmental characteristics in the context of understanding factors determining the distribution and abundance of C. finmarchicus across its North Atlantic habitat. A number of themes emerge: (1) the south-to-north transport of plankton in the northeast Atlantic contrasts with north-to-south transport in the western North Atlantic, which has implications for understanding population responses of C. finmarchicus to climate forcing, (2) recruitment to the youngest copepodite stages occurs during or just after the phytoplankton bloom in the east whereas it occurs after the bloom at many western sites, with up to 3.5 months difference in recruitment timing, (3) the deep basin and gyre of the southern Norwegian Sea is the centre of production and overwintering of C. finmarchicus, upon which the surrounding waters depend, whereas, in the Labrador/Irminger Seas production mainly occurs along the margins, such that the deep basins serve as collection areas and refugia for the overwintering populations, rather than as centres of production, (4) the western North Atlantic marginal seas have an important role in sustaining high C. finmarchicus abundance on the nearby coastal shelves, (5) differences in mean temperature and chlorophyll concentration between the western and eastern North Atlantic are reflected in regional differences in female body size and egg production, (6) regional differences in functional responses of egg production rate may reflect genetic differences between western and eastern populations, (7) dormancy duration is generally shorter in the deep waters adjacent to the lower latitude western North Atlantic shelves than in the east, (8) there are differences in stage-specific daily mortality rates between eastern and western shelves and basins, but the survival trajectories for cohort development from CI to CV are similar, and (9) early life stage survival is much lower in regions where C. finmarchicus is found with its congeners, C. glacialis and/or C. hyperboreus. This compilation and analysis provides new knowledge for evaluation and parameterisation of population models of C. finmarchicus and their responses to climate change in the North Atlantic. The strengths and weaknesses of modeling approaches, including a statistical approach based on ecological niche theory and a dynamical approach based on knowledge of spatial population dynamics and life history, are discussed, as well as needs for further research.

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