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Egg production rates of two common copepods in the Barents Sea in summer

Vladimir G. Dvoretsky*, Alexander G. Dvoretsky

Murmansk Marine Biological Institute, 17 Str., Vladimirskaya, Murmansk 183010, Russia

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Abstract

Small copepod species play important roles in the pelagic food webs of the Arctic Ocean, linking primary producers to higher trophic levels. The egg production rates (EPs) and weight-specific egg production rates (SEPs) of two common copepods, *Acartia longiremis* and *Temora longicornis*, were studied under experimental conditions in Dalnezelenetskaya Bay (southern Barents Sea) during summer. The average EP and SEP at 5–10 °C were 4.7 ± 0.4 eggs female^{-1} day^{-1} and 0.025 ± 0.002 day^{-1}, respectively, for *A. longiremis* and 13.1 ± 0.9 eggs female^{-1} day^{-1} and 0.075 ± 0.006 day^{-1}, respectively, for *T. longicornis*. EP and SEP were significantly higher at 10°C than at 5°C for both species. The mean egg diameter correlated positively and significantly with female prosome length (PL) in each species. SEP of *T. longicornis* correlated negatively and significantly with PL. Daily EP and SEP were similar to rates recorded for other *Acartia* and *Temora* species in temperate and warm regions. The influence of environmental factors (temperature, salinity, and phytoplankton concentration) on EP of both species is discussed. We conclude that temperature is the main factor determining the reproduction rate and timing in *A. longiremis* and *T. longicornis* in the Barents Sea.

Keywords: Egg production; *Temora longicornis*; *Acartia longiremis*; Coastal waters; Barents Sea

1. Introduction

Carbon fluxes and energy transformation in the pelagic webs of marine ecosystems strongly depend on the functioning of zooplankton communities, which connect primary producers with higher trophic levels, such as fish, marine mammals, and seabirds (Raymont, 1983). Calanoid copepods dominate the zooplankton assemblages of many Arctic and temperate marine environments (Mauchline, 1998), where they can be considered the main food source for the larvae of commercially important fishes (Thompson and Harrop, 1991; Fossum, 1996). Copepods are also consumed by other large zooplankters that are food for many demersal fishes (Pepin and Penney, 2000).

The Barents Sea is one the most productive shelf regions in the world oceans (Wassmann et al., 2006). Its coastal areas are the main nursery grounds for larval capelin and herring, linking secondary producers (zooplankton) to cod and haddock, which play a crucial role in the fishery potential of the region (Olsen et al., 2010). Large copepods of the genus *Calanus* and euphausiids of the genus *Thyssanoessa* prevail in the open sea, whereas the coastal waters are dominated by small copepod species (Timofeev, 2000). Among the

* Corresponding author.
E-mail address: v-dvoretsky@yandex.ru (V.G. Dvoretsky).

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latter, *Oithona similis*, *Pseudocalanus* spp., *Centropages* spp., *Acartia longiremis*, and *Temora longicornis* are the most numerous (Dvoretsky and Dvoretsky, 2009, 2010, 2012; Dvoretsky, 2012) in the coastal areas. The last two species can reach high densities in bays and fjords of the southern Barents Sea and adjacent areas (Timofeev, 2000). Despite the great importance of these copepod abundances to the coastal pelagic food webs, little is known about their life cycles or reproductive biology. Such information can be used to calculate zooplankton production and to estimate the value of food resources available to higher trophic levels.

The aim of this study was to measure the daily egg production rates of *A. longiremis* and *T. longicornis* in the coastal waters of the southern Barents Sea during the summer, i.e., when the species reach their maximum annual abundances, and to examine the influence of environmental factors on egg production in these copepods.

2. Material and methods

Zooplankton samples were collected at a fixed station at 10 m depth in Dalnezelenetskaya Bay (DZB; Fig. 1) in July 2011, using a Juday net (37 cm mouth diameter and 168 μm mesh) hauled vertically from near-bottom to the surface. The surface and bottom temperatures and salinities were measured with a digital thermometer and a GM-65 salinometer, respectively. Phytoplankton samples were collected from the surface (0 m depth) using a 1 L Niskin bottle. The samples were concentrated to volumes of 2–3 ml using the routine sedimentation method (Edler, 1972). Algae were identified, counted, and measured in 0.05 ml counting chambers (5 replicates), according to standard procedures (Karlson et al., 2010), under a Zeiss Amplival microscope (200 × and 400 × magnification). The linear dimensions of the cells were measured with an ocular micrometer with a precision of 3 μm, and cell volumes were calculated using the recommended approximations to simpler geometric bodies (Edler, 1972). For species with complex cell configurations, we used the standard biomass tables compiled by Makarevich et al. (1993). The phytoplankton carbon content was calculated using published conversion rates (organic carbon [C] = 5% wet mass) (Vinogradov and Shushkina, 1987). All biomass values are presented below as μgC l^{-1}.

Live and active copepods were gently moved into 1 L plastic jars with surface water. After 5–10 min, the adult female copepods were identified and sorted under a stereomicroscope and those with no eggs in their

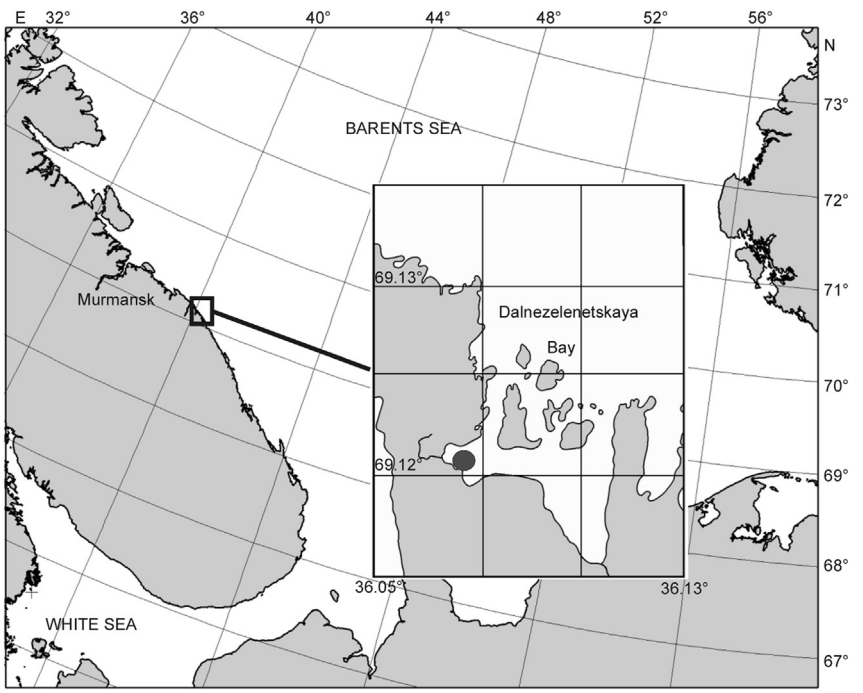

Fig. 1. Location of the sampling station in the Barents Sea (Dalnezelenetskaya Bay), July 2011.