Silke Lischka · Katrin Knickmeier · Wilhelm Hagen

Mesozooplankton assemblages in the shallow Arctic Laptev Sea in summer 1993 and autumn 1995

Accepted: 18 September 2000

Abstract Mesozooplankton distribution and composition in the very shallow part of the Siberian Laptev Sea shelf were studied during the German-Russian expeditions “Transdrift I” (August/September 1993) and “Transdrift III” (October 1995). Maximum abundances were found close to the outflow of the Lena River (7,965 ind. m⁻³) and in the Yana river mouth (38,163 ind. m⁻³). Lowest abundances occurred in the northeast and west of the Laptev Sea (64–95 ind. m⁻³). Highest biomass values (104–146 mg DM m⁻³) were determined in the northern and northeastern part of the shallow Laptev Sea, as well as close to the river outflows, with a record biomass maximum in the Yana river mouth (270 mg DM m⁻³). Biomass minima were situated north of the Lena Delta and in the western part of the shallow Laptev Sea (0.3–1.0 mg DM m⁻³). Copepods dominated in terms of abundance and biomass. Cluster analyses separated four mesozooplankton assemblages: the assemblage “Lena/Yana” in the southern part, “Eastern-central” in the centre, “Kotelnuy” in the eastern part and “Taimyr” in the western part of the shallow Laptev Sea. The small-sized neritic and brackish-water copepods Drepanopus bungei, Limnocalanus grimaldii and Pseudocalanus major occurred in enormous numbers and made up the bulk of zooplankton abundance and biomass in the very shallow part of the Laptev Sea close to the rivers Lena and Yana. In the more northern and northeastern areas, Calanus glacialis, P. minutus and P. major were dominant copepod species, whereas Oithona similis and Acartia sp. became important in the western Laptev Sea. Appendicularians, as well as hydromedusae and the chaetognath Sagitta sp., contributed significantly to abundance and biomass, respectively, but not over the entire area studied. One can identify taxon-specific distribution patterns (e.g. Sagitta predominated the biomass in a zone between the area heavily influenced by Lena/Yana and the offshore area to the north), which differ from the patterns revealed by cluster analysis. Hydrographic features, especially the enormous freshwater inflow, apparently determine the occurrence and formation of zooplankton aggregations. Extremely high numbers of small-sized neritic and brackish-water copepods occurred locally, which were probably also supported by excellent feeding conditions.

Introduction

The Laptev Sea is situated on the Siberian continental shelf and belongs to the widest and shallowest shelf seas in the world (Weber 1989) (Fig. 1). The shelf extends 500 km into the Arctic Ocean and reaches a maximum depth of 50–60 m (Holmes and Creager 1974). South of 76°N the water depth never exceeds 25 m (Barnett 1991). Another characteristic feature is the strong freshwater influence from the big Siberian rivers, Lena, Yana and Kathanga, which also carry large amounts of sediments and nutrients to the Laptev Sea. Due to their shallow depth and the nutrient freight, marginal seas are known for their enhanced biological production (Smetacek et al. 1987).

Political reasons have prevented western scientific activities on the Siberian shelves previously, and Russian studies in the Laptev Sea were restricted to areas close to the coast. First reports on the zooplankton of the Laptev Sea are known from the “Fram” expedition 1893–1896 (Sars 1900) and the Russian Polar expedition 1900–1903 (Linko 1913). Data were available on abundance and biomass of zooplankton of the shallow eastern part of the Laptev Sea and the area close to the New Siberian Islands (Jaschnov 1940; Pavshitsk 1990). However,
investigations are lacking on the entire shallow Laptev Sea zooplankton concerning distribution, abundance, biomass, possible assemblages and seasonal succession.

The large rivers flowing into the Laptev Sea create there an extremely variable environment for zooplankton organisms in terms of water temperature and salinity, turbidity and nutrients; hence, special species compositions can be expected. Jaschnov (1940) described three zooplankton regions for the Laptev Sea: the first one, situated nearest to the coast, is characterized by the presence of the brackish-water copepods Drepanopus bungei, Limnocalanus grimaldii, Pseudocalanus elongatus and P. major. Euryhaline species were typical for the second region and in deeper, more saline layers even marine species occurred (e.g. P. elongatus, P. major and Calanus finmarchicus). The third region is transitory between the second area and the sea proper, and marine species such as C. finmarchicus dominate. The Laptev Sea shelf is very shallow and dominant small-sized copepods usually do not contribute significant amounts to biomass. Highest zooplankton biomass for Arctic shelf seas is reported for the Barents Sea, the deepest among the Eurasian Arctic shelf seas (Jaschnov 1940; Slagstad and Tande 1990; Mumm 1993; Hansen et al. 1996). Kosobokova et al. (1998) investigated the zooplankton composition of the slope region and the outer Laptev Sea towards the Nansen Basin, and Abramova (1996) worked in the area near the New Siberian Shallows.

During the expeditions “Transdrift I” and “Transdrift III” of the joint project “German-Russian Investigations of the Ecology of Marginal Seas of the Eurasian Arctic”, zooplankton samples were collected within a wide area of the very shallow Laptev Sea. These investigations were part of the international and multidisciplinary “Russian-German Cooperation: Laptev Sea System”. The scientific goal of the biological work was to study interactions between the three biological habitats, sympagial, pelagial and benthal, in a high-Arctic shelf sea. The zooplankton samples collected offered the possibility of obtaining an extensive data set on mesozooplankton distribution, abundance and biomass in the very shallow part of the Laptev Sea. In addition to the evaluation of basic descriptive data analyses, multivariate analyses were applied to identify and describe different zooplankton assemblages and the governing environmental factors.

**Materials and methods**

Zooplankton was collected during the expeditions “Transdrift I” (ice-free conditions, RV Ivan Kireyev) and “Transdrift III” (new ice formation, IB Kapitan Dranitsyn) to the very shallow part of the Laptev Sea. During Transdrift I (August/September 1993), a Bongo net (0.28 m² mouth opening, 335 μm mesh size) was used, and sampling depths were between 10 and 42 m. Only the Z-stations (Fig. 2A) in the river mouths (Anabar, Olenek, Lena and Yana rivers) were sampled with a hand net (0.13 m² mouth opening, 20 μm mesh size) because of the very shallow depth (5–10 m). Due to the ice conditions, sampling during Transdrift III in October 1995 had to be conducted with a hand net (0.13 m² mouth opening, 200 μm mesh size) between 10 and 25 m water depth (Tables 1, 2).

Zooplankton was preserved in 4% borax-buffered formalin in seawater. Organisms were determined with a stereo microscope with bright field illumination, and abundances (ind. m⁻³) were calculated assuming 100% filtering efficiency of the nets. As a rule, the entire sample was enumerated for the larger plankton (≥1 mm). Routine identification was usually to species/genus level (copepods) or to major taxonomic groups, and calanoid copepods were further separated into copepodite stages. For the very abundant plankton, such as D. bungei and Pseudocalanus spp., an aliquot (1/2, 1/4, 1/8, 1/16, and exceptionally 1/32) of the sample was counted after fractionation with a Folsom splitter.

Biomass (mg DM m⁻³) was calculated via the individual abundances either using length-mass relationships or mean individual dry mass data derived from literature (Metz 1996; Kosobokova et al. 1998). Determination of individual length was performed under a stereo microscope (bright field illumination) connected to a video tape, and applying a custom-made image-analysing software (“BILD”). W. Hukriede, Institute for Marine Sciences (Kieler), on a NEXT workstation. If neither length-mass relationships nor mean individual dry mass data were available, length-mass relationships of similarly shaped species were used. For the genera Oithona and Oncaea, mean individual mass data of copepodite stages CI–CV from Metz (1996) were averaged to calculate dry mass. Meroplanktic larvae, gelatinous zooplankton and molluscs were not included in the biomass calculation, since they were very often damaged. Nauplii and harpacticoid copepods were also excluded from the calculation as they were not quantitatively sampled (except for the samples taken at the Z-stations with the very fine mesh size).

*C. finmarchicus* and *C. glacialis*, as well as *P. acuspes* and *P. major* stages CIV-CVI, were separated based on their cephalothorax length according to Hansen (1997): CIV > 1.9 mm, CV > 2.9 mm and females > 3.2 mm were determined as *C. glacialis*. CIV M > 0.9 mm, CIV F > 0.9 mm, CVM > 1.0 mm,