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- June 1999, May and July 2000

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by

Søren A. Pedersen,
Mads H. Ribergaard
&
Claus S. Simonsen

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Eqikkaaneq

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Resumé

Planktonprøver og målinger af temperatur og saltholdighed blev indsamlet langs stationer udlagt på tværs af de vestgrønlandske fiskebanker i juni 1999, maj og juli 2000.

Formålet med indsamlingerne var at undersøge udbredelsen af små dyreplanktonarter i havvandet, herunder deres udviklingsstadier, størrelser, antal og biomasser. Derudover var det formålet at sammenholde udbredelsen af dyreplanktonet med målinger af temperatur, saltholdighed og planteplankton.

Havstrømmens betydning for udbredelsen af planktonet er blevet undersøgt ved hjælp af en ny havstrømsmodel for Grønland. Betydningen af små dyreplankton for kulstofomsætningen og for produktion af fisk i de frie vandmasser er blevet analyseret og sammenholdt med hvad havforskere har fundet i andre områder af Nordatlanten.

Undersøgelsen konkluderer at havstrømsmodeller vil blive et nødvendigt redskab for fremtidig forskning, som ønsker øget forståelse af koblingerne mellem klima, havstrømme og økosystem forandringer, eksempelvis forandringer i produktionen af rejer og fisk.

Abstract

Plankton samples and oceanographic data were obtained during transect studies across fishing banks over the West Greenland shelf areas in June 1999, May, and July 2000. The study investigates the distributions of species, stage, size, abundance and biomass of micro- and mesozooplankton in relation to hydrography, phyto- and protozooplankton.

The role of current transport for life cycles of key plankton species is investigated using an ocean circulation model for Greenland. The role of micro- and mesozooplankton in carbon cycling and fish production in the pelagic food web over the southwest Greenland shelf are analyzed and related to findings from studies in other areas of the North Atlantic.

Simple (or complex) food web models will not be useful for assessments of the effects of climate change on fish populations. More promising ways towards predictions of changes in fish production at higher trophic levels under climate change seems to be development of coupled bio-physical models of larval recruitment, hybrid recruitment models, and studies of indicator species.

In the present study we identified the following research areas in particular relevant for understanding species distributions, current transport, and life cycles of the West Greenland micro-, meso- and meroplankton: 1) better understanding of calanoid larval dormancy, 2) species identification (e.g. nauplii of *C. finmarchicus vs. C. glacialis*) using genetic identification, 3) vertical migrations, and 4) trophic interactions.

The ocean circulation model developed for Greenland will be useful for future research in the coupling between climate, ocean circulation and ecosystem changes. It should be further developed to treat baroclinic effects prognostic in order to describe oceanographic features like the dynamics of fronts and upwelling/downwelling of different watermasses.

1. Introduction

The waters of West Greenland are dominated by the *West Greenland Current*, which represents a mixture of water from the *East Greenland Current*, the *Irminger Current*, and sub-Atlantic water (Buch 2000a, b). The watermass characteristics in the West Greenland Current are formed in the western Irminger Basin where the East Greenland Current and the Irminger Current meets and flowing southward side by side while mixing is taking place. As the currents round the tip of Greenland the Irminger water subduct under the Polar water and extensive missing is taking place. Hence, the marine shelf ecosystems around south Greenland are in the intermediate between cold Polar water masses of the Arctic region and temperate water masses of the Atlantic Ocean. The ocean currents that transport water from the polar and temperate regions affect the marine productivity in the shelf areas, and changes in the North Atlantic climate and ocean circulation have major impact on species distributions and fisheries yield (Pedersen & Kanneworff 1995, Jensen *et al.* 1999, Pedersen & Smidt 2000, Buch *et al.* 2003).

During the last decades northern shrimp has become a dominant species for the commercial fisheries in the Northwest Atlantic (West Greenland and East Canada). At present there is no complete explanation for the increase in abundance of northern shrimp, but changes in the ocean climate is unquestionably an important factor (Buch *et al.* 2003). Scenarios of impacts of climate change point to a modification of the hydrographic regime in the Northwest Atlantic. Although global warming, melting ice, and changes in the thermohaline circulation may create regional lower temperatures and increased ice cover in the future in West Greenland (e.g. Serreze *et al.*, 2000). Scenarios of changes in sea-climate imply an impact on the biological properties of the water masses including conditions that likely affect fish and shellfish recruitment. Understanding the dynamics of the lower trophic levels of the pelagic food web are one of the keys to understand changes in community structure and recruitment success for fish and shellfish (e.g. Pedersen *et al.* 2002).

In Greenland waters the marine ecosystems of West Greenland are in terms of commercial fisheries resources the most productive and best investigated. The plankton productivity of the area is evident from the ICNAF (International Commission for the Northwest Atlantic Fisheries) Norwestlant I-III surveys in 1963 and annual surveys carried out during four decades along a number of cross-shelf transects (ICNAF 1968, Pedersen & Smidt 2000, Pedersen & Rice 2002). The main object of historic sampling programs of hydrography and plankton in West Greenland was to study the effect of the environment on the planktonic stages of larval fish e.g. Atlantic cod (*Gadus morhua*) and the redfish (*Sebastes marinus and S. mentella*). Therefore these studies give an incomplete picture of the plankton community structure at the lower trophic levels. For example Pedersen & Smidt (2000) reports on distribution and abundances of zooplankton caught by 1 mm mesh size ring nets and a recently simplified mass balance model for the West Greenland large marine ecosystem ignores e.g. fluxes through the lower trophic levels, and the importance of the microbial loop (Pedersen & Zeller 2001). However, for many larval fish smaller organisms (< 1 mm) e.g. *copepod nauplii* and copepodites are main food sources and may be crucial for larval survival. The distributions and abundances of larval fish food and larval survival are determined by e.g. geographic origin, timing of production, oceanographic features and current transport (Petersen 1966, Sundby 2000, Pedersen & Smidt 2000, Pedersen & Rice 2002).

Research in pelagic food webs of the North Atlantic during the last century has stressed the key role of copepods, especially genus *Calanus*, as a direct link to the fish stocks, since copepods are dominating prey for fish larvae during their growth (e.g. Bainbridge & McKay 1968, Runge 1988, Sundby 2000). Fish and shellfish production depends on marine food web structure and functioning. However, only a small fraction of the pelagic primary production is eventually channeled up the food web to end as harvestable fish biomass (Fenchel 1988, Kiørboe 1998, 2001). Knowledge of the role of the microbial food web in the Arctic has been limited because the microbial loop in cold water ecosystems has been considered less important than at lower latitudes. Recent comprehensive investigations in Disko Bay, West Greenland, have documented that bacterioplankton and unicellular zooplankton also play a prominent role in the food web of Arctic ecosystems (Nielsen & Hansen 1995, 1999, Hansen *et al.* 2003). The Disko Bay marine food web is as complex as in temperate areas, and is dominated by the large calanoid copepods (Hansen *et al.* 1999, Madsen *et al.* 2001, Niehoff *et al.* 2002). These large grazers are key organisms in the determination of ecosystem structure and energy transfer to higher trophic levels such as fish stocks and marine mammals. In Disko Bay the three *Calanus* species co-occur and can contribute to more than 90% of the zooplankton biomass during spring and early summer. The behavioural adaptations of *Calanus* spp. to climate change may have strong effects on the food web structure, generating trophic cascades and eventually influence the fisheries (Hansen *et al.* 2003).

Historic descriptions of zooplankton from Southwest Greenland exists: Maclellan (1967) described the annual cycle of certain calanoid species in West Greenland based on an annual study in Godthaab fjord and studies in several other West Greenland fjords at various seasons during 1942-1944. Bainbridge &d Corlett (1968) described the zooplankton of the Norwestlant I-III surveys in 1963. Pavshtiks (1968, 1972) described the species composition and the biological seasons of zooplankton in the Davis Strait based on zooplankton collections during 1962-1964. Smidt (1979) described the annual cycles of primary production and zooplankton in coastal/fjord areas of Southwest Greenland based on studies during 1955-1967. Since these descriptions little information on the structure and functioning of the plankton community exists from Southwest Greenland.

In 1999 and 2000, four research cruises collected hydrographical data and plankton samples to describe species distributions and community structures of the plankton food webs in relationships with hydrographic processes (e.g. shelf break fronts) across commercially important West Greenland fishing banks (Poulsen & Reuss 2002, Pedersen *et al.* 2002, Munk 2002, Simonsen *et al.* in prep.).

The present paper reports on (1) distributions of species, stage, size, abundance and biomass of micro- and mesozooplankton in relation to hydrography, (2) the role of current transport for life cycles of key plankton species using an ocean circulation model, and (3) the role of micro- and mesozooplankton in carbon cycling and fish production. Based on new information on the structure and dynamics of the pelagic food web summarized in this paper, we seek a better understanding of the coupling between climate, ocean circulation, plankton and fish/shellfish production and suggestions for future research. The present contribution is relevant in view of the need for a long-term ecosystem-based management of natural marine resources in West Greenland and elsewhere (Jarre, 2002; Pauly *et al.*, 2002).

2. Materials and Methods

2.1. Study area and sampling

Sampling was carried out in June 1999, May, and July 2000 between 63°50'N and 66°50'N over the West Greenland shelf with the Greenlandic research vessels *Adolf Jensen* and *Paamiut* (Figure 1, Table 1). In May and June, sampling was performed at stations along transects crossing Fyllas- and Sukkertop Bank. In July, sampling was carried further north to include stations along transects crossing Lille- and Store Hellefisk Bank using the two research vessels at the same time. In May two stations in Davis Strait and 6 coast/fjord stations were sampled in the inshore Nuuk-area (Figure 1).

Depth integrated micro- and mesozooplankton samples of the upper 200 m (or 2 m above bottom at shallower stations) were obtained from each station shown in Figure 1. In June and in July with *Paamiut*, samples were collected from one vertical haul with a WP-2 net (0.58 m diameter and 50 mm mesh size) retrieved at 10 m min^{-1} assuming 100% filtration efficiency. In May and in July with *Adolf Jensen*, samples were collected using a submersible pump (900 l min^{-1}, HOMA-H500, DIFRES-design) equipped with a conical net of 50 mm mesh size. The pump or WP-2 net were lowered to max 100 m in May and July with *Paamiut* and max 200m in June and July with *Adolf Jensen* started and retrieved to the surface at 10 m min^{-1}. Samples were preserved in 4-8 % buffered formalin in seawater.

At each station, and at additional stations between these (not shown in Figure 1), vertical profiles of temperature, salinity, and density were obtained with a Sea-bird SBE 9-011 sealogger CTD. Fluorescence was measured with a HydroScat2 fluorometer from HOBI-Labs, except during the cruise with *Paamiut* in July. The fluorescence was calibrated against fluorometrically determined chlorophyll *a* content in water samples collected on selected stations in May and June (Poulsen & Reuss 2002). The chl *a* concentrations were used as indices of phytoplankton biomass.

2.2 Plankton distribution, abundance and community structure

Micro- and mesozooplankton were sorted and identified to the lowest possible taxon in the laboratory. Each species or taxonomic category was enumerated and length measured (Table 2). Within each copepodite stage up to 10 specimens were length measured. Abundance and length information was used to estimate the biomass as total carbon within taxonomic categories at each sampling station. Length-weight relationships (carbon content or ash-free dry weight) were obtained from the literature: *Calanus* (all three species) and *Metridia longa* from Hirche & Mumm (1992), *Acartia* spp. and all copepod nauplii from Berggreen *et al.* (1988), *Pseudocalanus* sp. from Klein Bretler *et al.* (1982), while for the smaller

Table 1. Sampling data from the four research cruises.

Period	Reseach vessel	Transect	Gear (net mesh size)
May 12-21 2000	RV Adolf Jensen	1, 3	Zooplankton pump (50µm)
June 21-30 1999	RV Adolf Jensen	2, 3	WP2 (50µm)
July 11-23 2000	RV Adolf Jensen	1, 4, 5	Zooplankton pump (50µm)
July 12-27 2000	RV Paamiut	2, 3, 6	WP2 (50µm)

taxons *Oithona* spp., *Microcalanus* spp., *Oncaea* spp. and *Microsetella* spp. the relationship for *Oithona* spp. in Sabatini & Kiørboe (1994) was used. The carbon content of eggs (copepods and euphausiids) and egg sacks of copepods were estimated from egg/sack volume by assuming 0.14 pg C µm^{-3} (Kiørboe *et al.* 1985). The carbon content of egg sacks are overestimated because they are not spherical. The carbon content of *Calanus* spp. stages CI to CIII and the smaller taxons were assumed to be 50% of dry weight, while a conversion factor of 60% was used for older stages of *Calanus* spp. (Hansen *et al*. 1999). For none copepods the reference in brackets was used to estimate carbon biomass: Appendicularia (Uye 1982), Bivalvia (Fotel *et al.* 1999), Cirripedia (Turner *et al*. 2001), Euphausidacea (Lindley *et al.* 1999), Polychaeta (Hansen 1999), Gas-

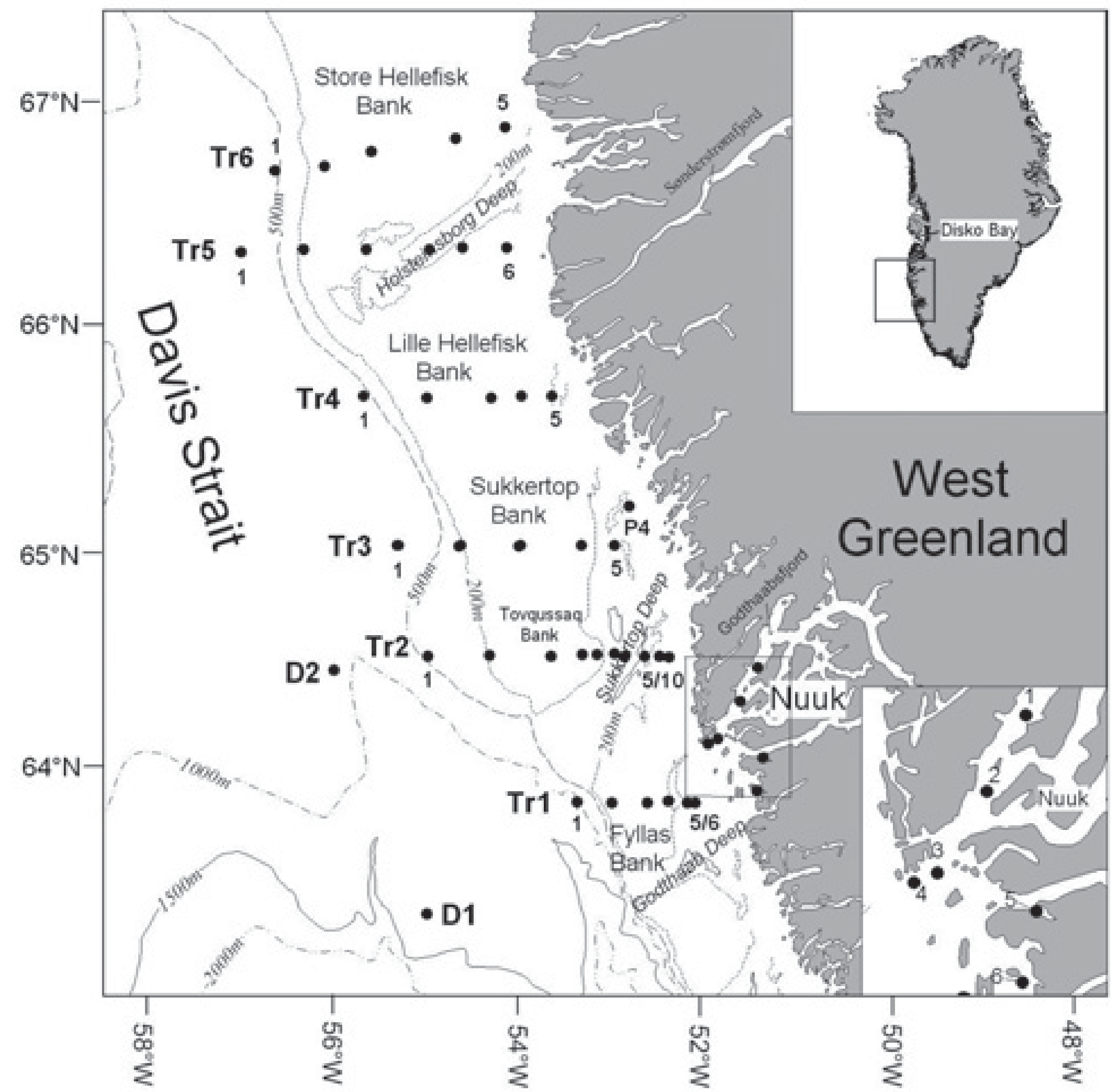

Figure 1
Bathymetric chart of the West Greenland Shelf study area, with indication of sampling stations along 6 cross-shelf transects (Tr1–Tr6). Transects were sampled as follows: Tr1 and Tr3 in May 2000, Tr2–Tr3 in June 1999, Tr1–Tr6 in July 2000. Six inshore sampling stations and two deep water Davis Strait stations, D1 and D2, were sampled in May 2000, only.

tropoda (Hansen & Ockelman 1991).

The structures of the plankton community in the upper ~100 m of the West Greenland pelagic food web were constructed from integrated values of carbon biomasses from this study and results by Poulsen & Reuss (2002).

2.3 Ocean currents and plankton transport

The current transport of key plankton species was investigated using a 3D-ocean current model using a finite element mesh to increase the resolution on the shelf. The model setup was split into a diagnostic baroclinic simulation and a prognostic barotropic simulation. The diagnostic simulations calculate the baroclinic currents from a temperature and salinity field constructed from observations centered at June-July. For the shelf area off West Greenland south of 70°N hydrographic measurements obtained at three different cruises in 2000 whereas for the rest of the area historical data was used. The prognostic simulation calculate the time varying currents resulting from wind forcing estimated from the operational atmospheric model for Greenland and tides. For a detailed description and discussion of the hydrodynamic model see Ribergaard *et al*. (2003). The calculated current fields were used as input in a particle-tracking model to simulate the possible transport of plankton. We compared the model calculated flow field with drift tracks of two drifters deployed in May 2000 drogued at 30 meters (Pedersen *et al.* 2002). We conducted a number of drifter experiments to investigate possible effect on the plankton transport distances. Drifters were released on May 12 along three transects across the southwest Greenland shelf, in four depths (10, 30, 50, and 80 m) in 1999 and 2000. Vertical migration behaviour was not included in the particle-tracking model, but particles were tracked in four different depths to evaluate possible effects on transport distances of vertical migration behaviour of plankton.

Table 2. Measurements by taxonomic category.

Taxonomic category	Measurment
Copepoda-Calanoida and Cyclopoida	Length of Prosome
Harpacticoida	Total length (without setae)
Copepoda nauplii	Body length (without setae)
Euphausiacea, Amphipoda and Mysidacea	Total length to the end of telson
Cirripedia nauplii	Body length (without spine)
Decapoda larvae	From posterior edge of orbit to the end of carapax
All eggs	Diameter
Egg sacks	Maximal length
Polychaeta, Bivalvia, Gastropoda larvae and Cirripedia cypris	Maximal length
Echinodermata larvae (pluteus)	Length of armspan
Echinodermata larvae (others)	Maximal body length
Hydromedusae and Siphonophora	Maximal body length
Scyphomedusae	Diameter
Appendicularia	Maximal body length (without tail)
Fish larvae	Maximal body length
Tintinnidae	Total length
Chaetognatha	Total length to the end of tail, Total length

3. Results

3.1 Hydrography, plankton distribution and community structure

From May to July, temperatures in the upper 50 m of the water column over the southwest Greenland shelf Banks (Tr1-3) increased from below zero to above 5°C (Figure 2a-d). During this period thermoclines developed in the upper 50 m and salinity dropped from 33.6 to below 33.2. The lowest salinities were found in the upper water column at the nearshore stations in May (Tr1 and 3), June (Tr3), and July (Tr1, 4, and 5). On Tr3 in June 1999, relative warm and low saline water was found east and on top of Sukkertop Bank, whereas the core of cold Polar water (< –0.5 °C) was seen west of the bank at depths between 25 and 125 m. In July 2000, cold Polar water (< 0°C) was distributed at intermediate depths between 50 and 150m over the shelf, and salinity showed an increasing trend from south to north (Tr1 to 6). Density lines (s_t) varied between 25.6 and 28.4 and followed the salinity lines (data not shown).

Chl *a* concentrations were highest during the spring bloom in May with peaks (4-6 µg l^{-1}) over the shallow parts of Fyllas- and Sukkertop Bank (Figure 2a-b), down to the thermocline depth, with similar high levels at most fjord stations, except at station 5 with much lower chl *a* values (> 0.7 µg l^{-1}) (Figure 2d). In June, a post-bloom situation prevailed resulting in low autotrophic biomass and low chl *a* values over Sukkertop Bank, but peak chl *a* values (1 µg l^{-1}) in the upper water column were seen at the westernmost stations of Tr3 (Figure 2b). In July, subsurface blooms with chl *a* peaks (1-2 µg l^{-1}) at water depths of about 30 m were seen along Tr1, 4, and 5 (Figure 2a and 2c).

Visual inspections of Figure 2a-d indicate generally higher abundance of *Calanus* copepodites at stations with higher concentrations of chl *a*. The small copepods and bivalvia larvae were more abundant over the banks in May, in the cold Polar water in June, and with less clear distribution patterns along transects in July.

More than 30 species and a larger number of taxonomic categories were identified in the zooplankton samples. Copepods dominated the zooplankton. The following species were identified: *Calanus finmarchicus, Calanus hyperboreus, Calanus glacialis, Metridia longa, Acartia longiremis, Microcalanus pusillus, Microsetella norvegica, Oithona similis, Oncaea borealis*, and *Pseudocalanus elongates*. The latter six species were grouped by genus, together with unidentified species of these taxa. A few specimens of *Euchaeta norvegica*, *Scolecithricella spp.*, *Temora longicornis*, *Centropages hamatus*, and *Pleuromamma robusta* were identified.

The larger *Calanus* copepodites (CI-CV) showed an increasing abundance from May to July (Figure 2a-d, Appendix Table 1a-l). *C. finmarchicus*, *C. glacialis* and *C. hyperboreus* occurred in about equal abundance in May, whereas *C. finmarchicus* dominated in June and July. In *C. finmarchicus* and *C. glacialis*, CI was dominating in May, CI-CIII in June, and CIII-CV in July. In *C. hyperboreus*, CII was dominating in May, CI and CIII in June, and CIV in July. Abundance was highest over deep water east and west of the banks in May, June, and July. *Calanus* spp. abundance was low at the fjord stations sampled in May, highest abundance (mainly CI) was found on the costal stations 4-6 and females of *C. finmarchicus* only in Godthaabsfjord station 1 (Figure 2d, Appendix Table 1a). In May there was relatively high abundance of *C. finmarchicus* females (few

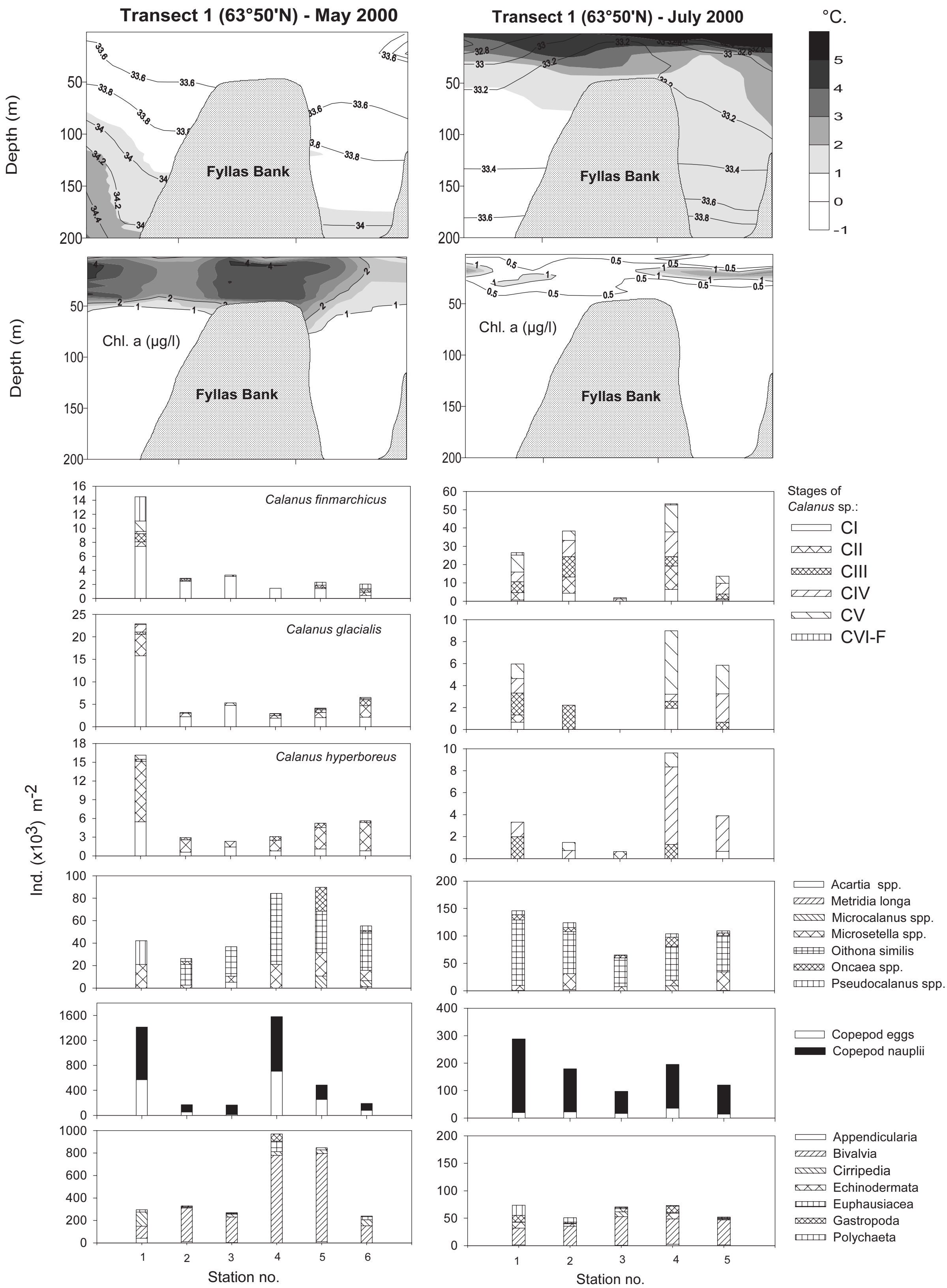

Figure 2a

Vertical sections of temperature (°C), salinity, chlorophyll a, abundance indices of stage composition of Calanus spp., other copepods (CI-CVI), copepod eggs, nauplii, and other invertebrate larvae along transect 1 in May 2000 (left panels), and July 2000 (right panels).

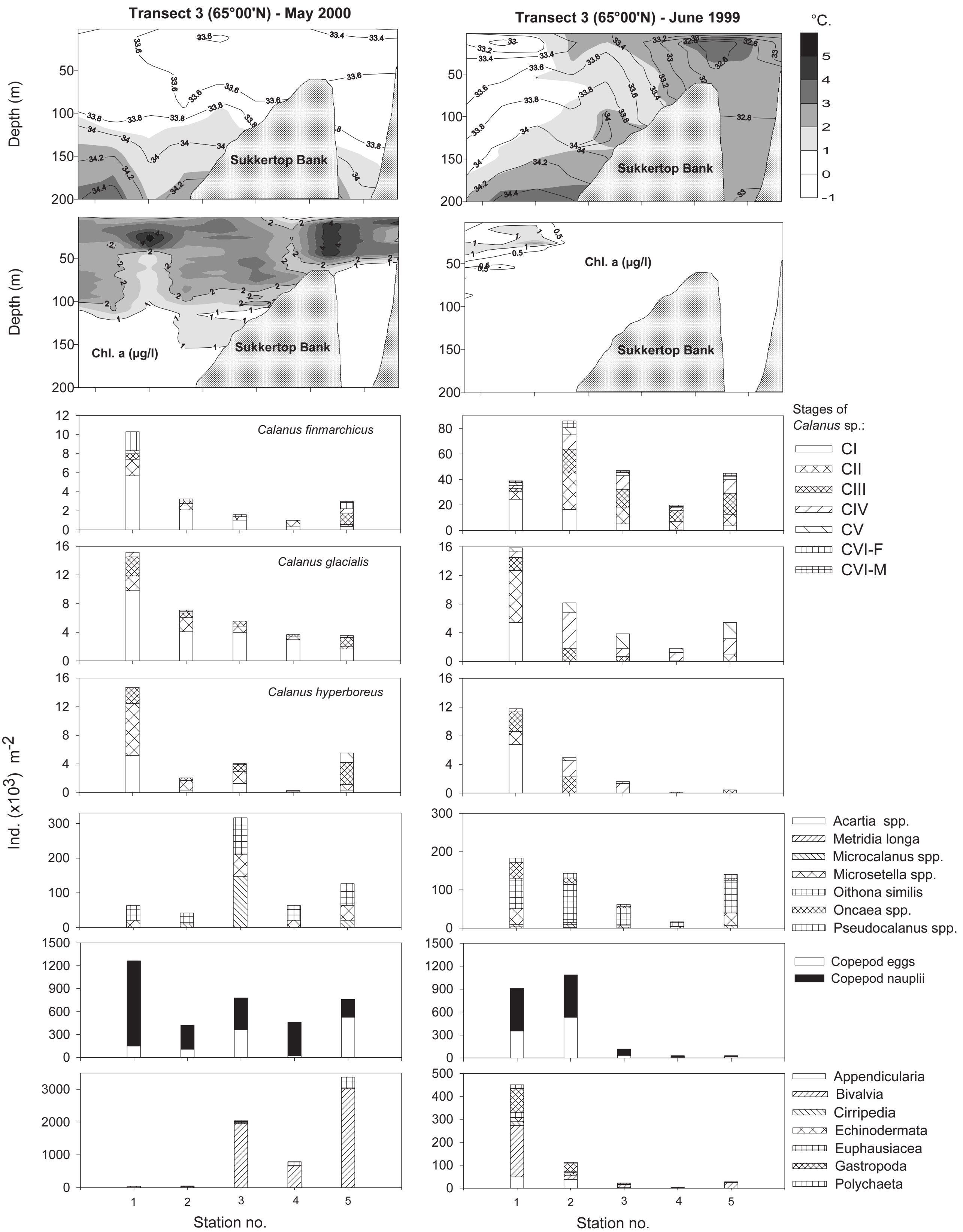

Figure 2b

Vertical sections of temperature (°C), salinity, chlorophyll a, abundance indices of stage composition of Calanus spp., other copepods (CI-CVI), copepod eggs, nauplii, and other invertebrate larvae along transect 3 in May 2000 (left panels), and June 1999 (right panels).

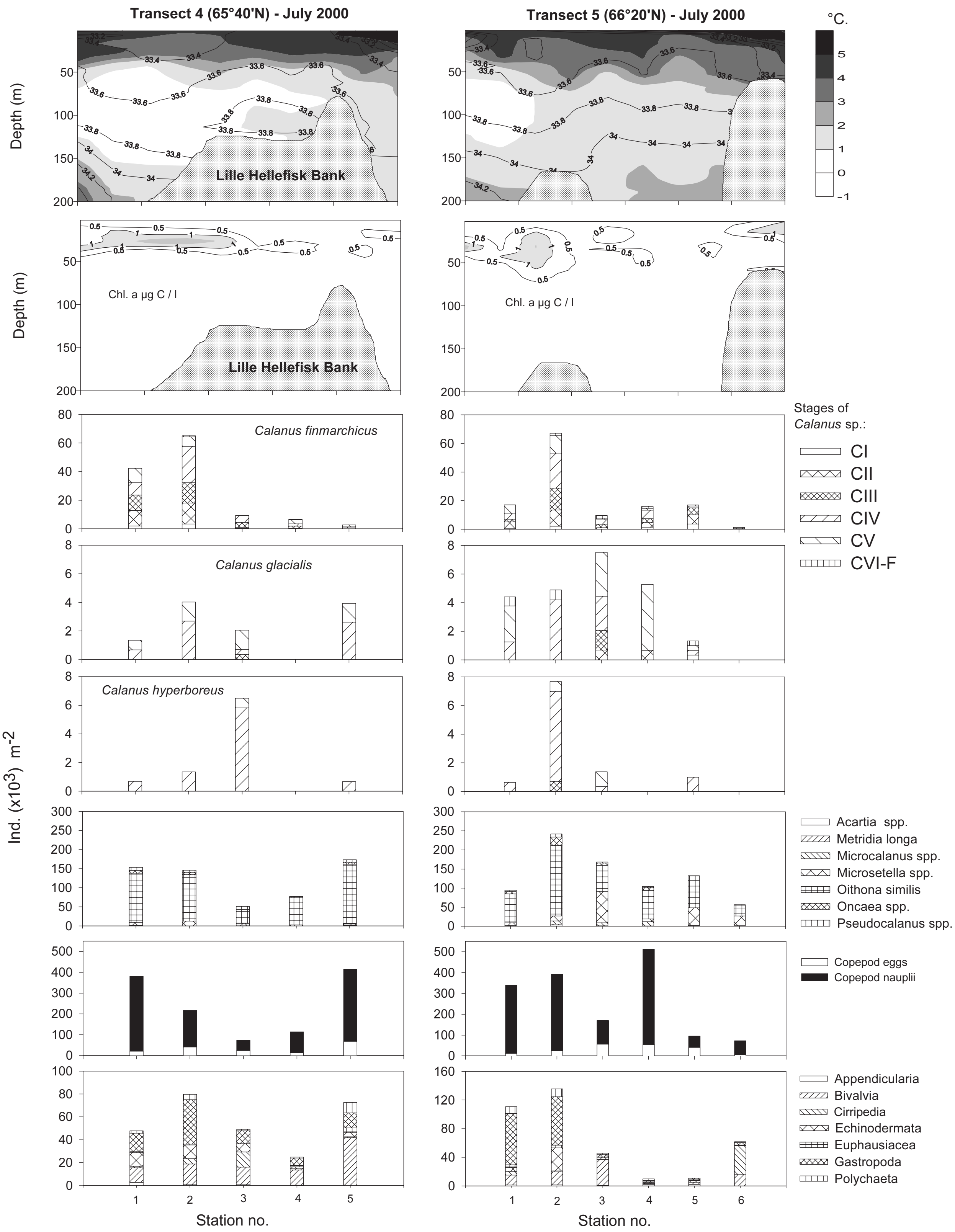

Figure 2c

Vertical sections of temperature (°C), salinity, chlorophyll a, abundance indices of stage composition of Calanus spp., other copepods (CI-CVI), copepod eggs, nauplii, and other invertebrate larvae along transect 4 (left panels), and transect 5 (right panels) in July 2000.

males) on especially the deeper stations west and east of the banks. In June and July the abundance of *C. finmarchicus* females were lower or nil. Generally no females or males of *C. glacialis* and *C. hyperboreus* were found. However, in July few *C. glacialis* females were identified at stations along Tr5.

The small copepod community (CI-CVI) consisted predominantly of *Oithona similes* and *Microsetella norvegica* during all sampling times. Total abundances were at similar levels in May and June, and highest in July. In May the fjordic stations were dominated by *Microsetella* spp., and *Pseudocalanus elongatus*. *Microcalanus* spp. was dominant at one station on Tr3 in May. *Pseudocalanus* spp. occurred in high abundance at the two shallow stations nearest to shore of Tr6 in July. The abundance of both large and small copepods was exceptionally high over deep water east and west of the bank on Tr2 and west of the bank on Tr3 in July (not shown). Copepod eggs showed highest abundance in May and June, whereas copepod egg sacks were dominating in July.

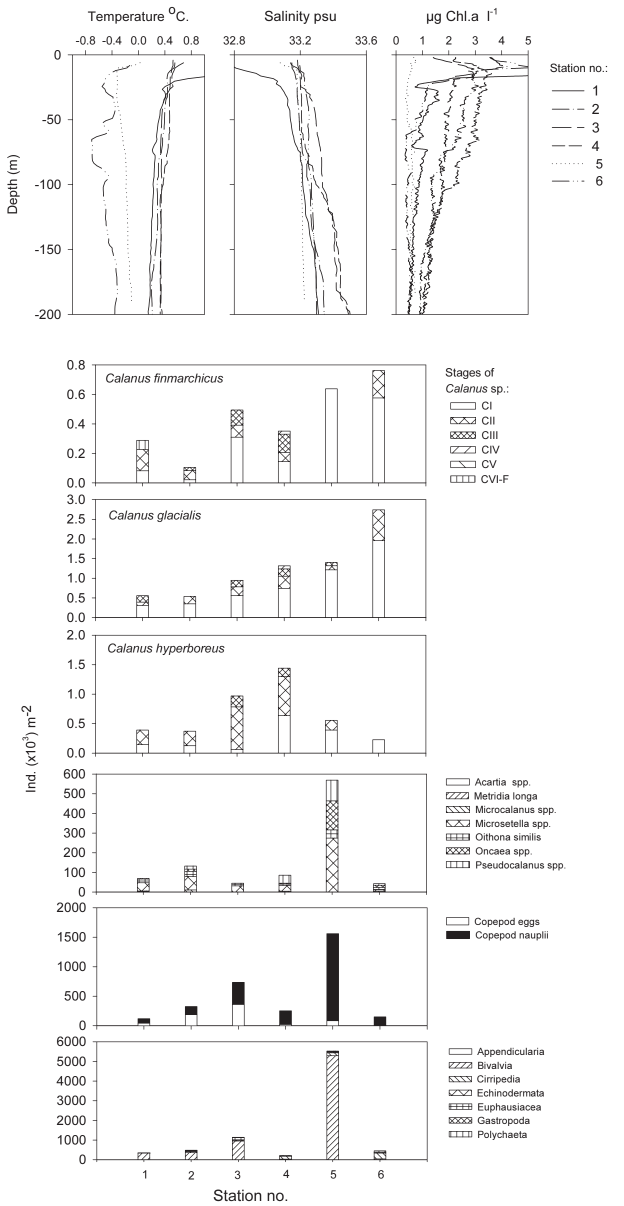

Figure 2d
Vertical profiles of temperature (°C), salinity, chlorophyll a, abundance indices of stage composition of Calanus spp., other copepods (CI-CVI), copepod eggs, nauplii, and other invertebrate larvae at coast/fjord station 1-6 in May 2000.

By number, Bivalvia larvae and relatively large copepod nauplii (> 200 µm) dominated the zooplankton community in May, whereas smaller *copepod nauplii* (< 200 µm) were dominating in June and July (Figure 3a, b). In July high numbers of gastropod (pteropod) larvae were found especially along Tr2 and Tr3, and tintinnids on Tr1 (Appendix Table 1g-i).

By weight, the large copepodites of *Calanus* spp. dominated the copepod and invertebrate biomass in all sampling periods, with *Pseudocalanus* spp., *Metridia longa,* and *Oithona* spp. comprising most of the remaining copepod biomass (Table 3). *Calanus* spp., especially *C. finmarchicus*, became increasingly dominant from May to July with exceptionally high biomasses over the shelf slopes along Tr2 and Tr3 (Figure 4). In May, on the coast and fjord stations (St. 1-6) other copepod species *Metridia longa*, *Pseudocalanus* spp., *Microsetella* spp. were dominating.

In May, diatoms, *Thalassiosira* spp. and *Chaetoceros* spp., dominated the biomass structure of the plankton community of the upper 100 m followed by heterotrophic flagellates, ciliates and copepods (Table 3 and 4). Conversely in June (and July) where copepods dominated over heterotrophic flagellates, ciliates, autotrophic flagellates and other invertebrate zooplankton. We have no information on the species compo-

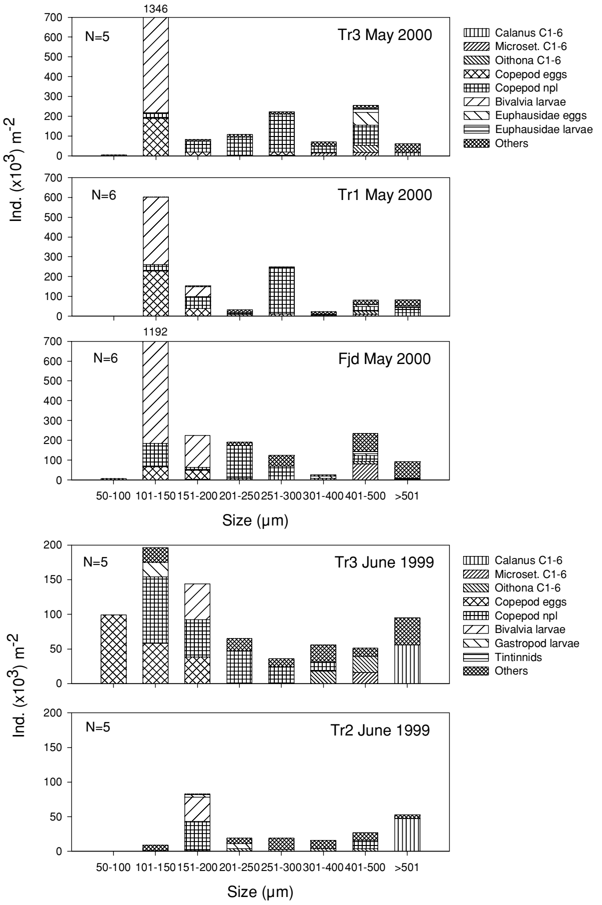

Figure 3a

Mean concentrations of micro- and mesozooplankton categories by size and sampling location in May 2000 (upper panels) and June 1999 (lower panels).

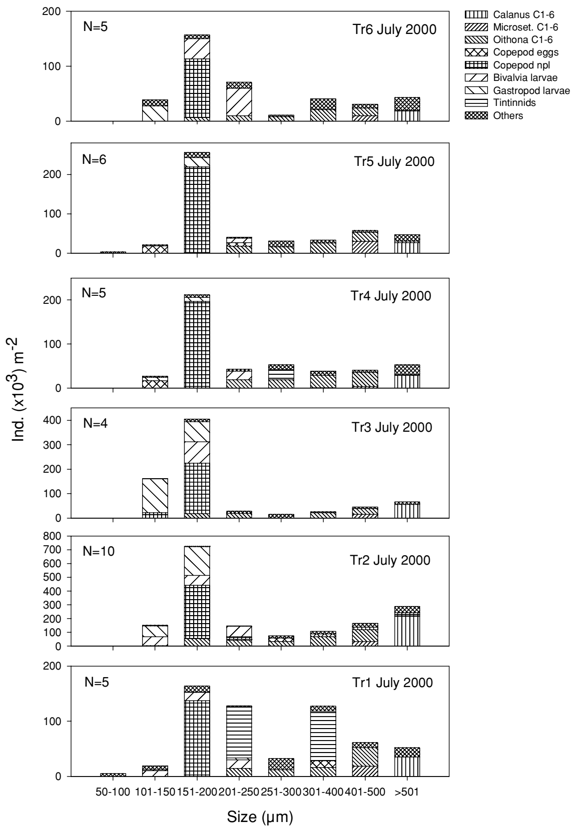

Figure 3b

Mean concentrations of micro- and mesozooplankton categories by size and sampling location in July 2000.

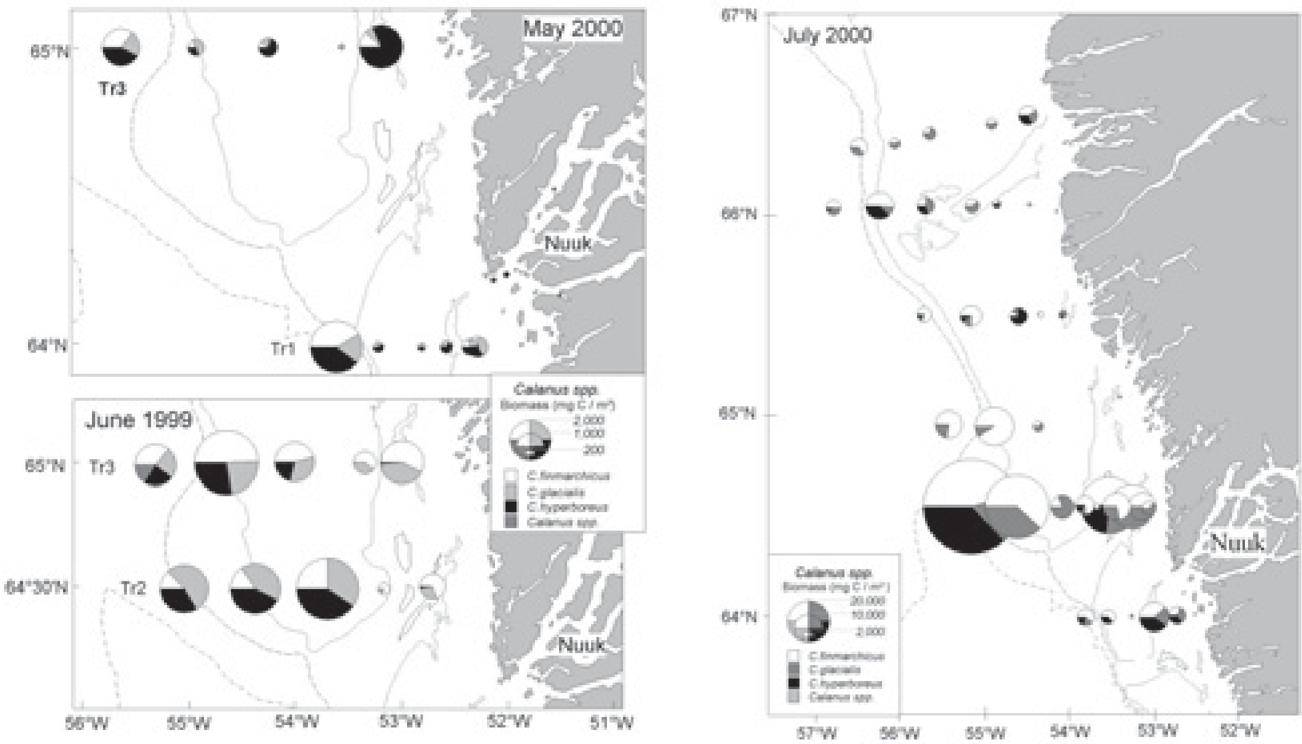

Figure 4

Distribution and biomass (mg C m $^{-2}$) of Calanus spp. in May 2000, June 1999 (left panels) and July 2000 (right panels). Dot sizes are graduated by square root. Note different scales between left and right panel.

sition and biomasses of phyto- and protozooplankton from July, however, tintinnids were very abundant on several stations.

Information about vertical distributions of micro- and mesozooplankton at some of the stations in May 2000 indicate that zooplankton was most abundant in the upper ~100m and at the Fjord stations between 100 and 30m (Appendix Table 2-4). However, copepod eggs and nauplii were most abundant in the upper 50 m along Tr1 and Tr3 over the shelf (Appendix Table 2b,c).

Table 3. Mean biomass (mg C m^{-2}) of each zooplankton category by sampling location and period.

Location	Transects 1, 3		Transects 2,3		Transects 1-6		Fjord (St. 1-6)	
Sampling period	May 2000		June 1999		July 2000		May 2000	
Number of stations	11		10		36		6	
Plankton category	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Copepods:								
C. finmarchicus	160	266	764	534	3120	5509	4	3
C. glacialis	123	114	724	480	1858	2847	14	7
C. hyperboreus	304	385	563	584	1291	3875	16	15
Acartia spp.	1	4	0	0	1	4	2	5
Metridia longa	16	52	51	114	37	109	94	230
Microcalanus spp.	17	31	3	4	2	4	4	5
Microsetella spp.	12	10	9	12	17	27	54	75
Oithona similis	27	21	21	21	65	74	13	7
Oncaea spp.	0	0	3	3	5	12	11	22
Pseudocalanus spp.	66	82	22	20	49	54	74	62
Copepod eggs	88	63	22	40	34	34	56	63
Copepod nauplii	413	349	27	33	34	42	226	242
Total Copepods	1229	1376	2210	1845	6513	12592	566	736
Other invertebrates:								
Appendicularia	16	22	24	29	7	11	4	4
Bivalvia	37	47	3	4	12	20	58	99
Cirripedia	103	190	63	115	45	85	301	315
Echinodermata	-		-		-		-	
Euphausiacea	209	450	15	24	14	42	109	119
Gastropoda	13	33	11	19	56	95	4	7
Polychaeta	8	6	4	2	4	3	21	8
Pandalus larvae*	15	29	7	5	8	8	23	19
Total other invertebrates	401	776	127	198	146	263	520	570

*From Pedersen et al. (2002).

3.2 Plankton transport by ocean currents and effects of hydrographic features

We found good agreement between the current simulations and drifter tracks of two drifters (drogue in 30 m) deployed along Tr1 in May 2000. The current model simulated hydrographic features seen in the drifter tracks – the semidurial tidal ellipses, circulation around shelf banks and a net northward flowing drift along the shelf which generally following the depth contour (Figure 5). The strength of the currents and the general cyclonic circulation in the Labrador Sea was also well modelled compared to other observations (Jacobsen *et al*. 2003).

Modelled trajectories of particles by release locations (Tr0, Tr1 and Tr3) for two years, 1999 and 2000, were almost identical in spite of differences in the wind fields between years. Tracking of particles released in different depths (10, 30, 50 and 80 m) showed minor differences in transport patterns indicating minor effects of adding vertical behaviour to the particles (plankton).

Simulations of drifters released in 30 m along Tr0, Tr1 and Tr3 across the shelf showed clear differences in the transport patterns (Figure 5). Drifters released in coastal areas and over the shelf drifted north ending in the cost or caught in eddies over the shelf banks. The westernmost drifters were either transported west to the Labrador shelf (Tr0) or north along the West Greenland shelf slope (Tr1 and Tr3).

Table 4. Mean biomass (mg C m^{-2}) of phytoplankton and protozooplankton by sampling location and period. Data from Poulsen and Reuss (2002).

Location	Transects 1, 3		Transects 2,3		Fjord (St. 4)	
Sampling period	May 2000		June 1999		May 2000	
Number of stations	8		5		1	
Plankton category	Mean	Std	Mean	Std	Mean	Std
Autotrophic organisms:						
Flagellates < 10 µm	90	39	185	86	107	-
Flagellates > 10 µm	16	23	44	64	0	-
Euglenophyceae	16	45	0	0	0	-
Phaeocystis pouchetii	436	341	-	-	4010	-
A.Dinoflagellates	44	42	37	50	83	-
Ceratium arcticum	0	0	94	209	0	-
Centric diatoms	339	339	18	22	8	-
Chaetoceros spp.	3567	2171	395	881	2327	-
Thalassiosira spp.	4985	1792	25	53	1716	-
Pennate diatoms	332	363	29	51	99	-
Mesodinium rubrum	7	6	5	3	0	-
Total autotrophic biomass (mg C m^{-2})	9831	3420	831	1224	8349	-
Heterotrophic organisms:						
Nanoflagellates < 10 µm	32	22	94	47	132	-
Nanoflagellates > 10 µm	1	3	6	7	0	-
Coanoflagellates	108	70	34	39	58	-
A.Dinoflagellates < 20 µm	95	65	149	101	294	-
A.Dinoflagellates > 20 µm	948	656	205	205	1683	-
T.Dinoflagellates	136	66	32	27	107	-
Ciliates < 50 µm	252	115	109	72	322	-
Ciliates > 50 µm	392	363	115	61	151	-
Laboea strobila	77	91	18	21	25	-
Tintinnids	12	27	2	3	3	-
Total heterotrophic biomass (mg C m^{-2})	2053	1108	763	376	2775	-

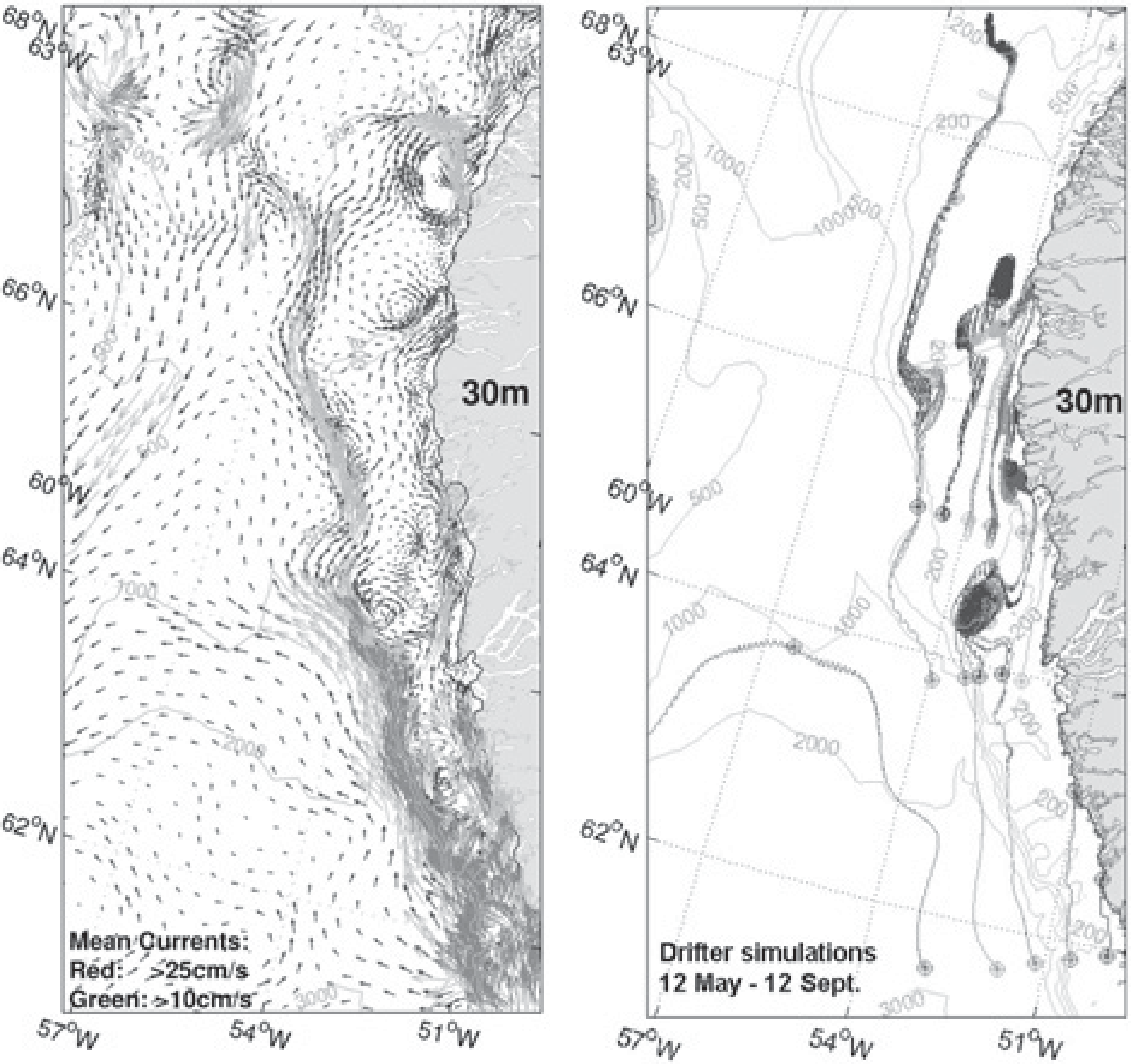

Figure 5
Model calculated mean current velocity, April-October 2000, in 30 m over the Southwest Greenland shelf (left panel), and model calculated tracks of particles released in 30 m on May 12 2000 along three transects across the shelf (Tr0, Tr1, and Tr3) (right panel). Additional marks on the calculated particle tracks in panel B indicated position on July 12 and the tracking was stopped on September 12.

4. Discussion

4.1 Plankton distributions, stage development and life cycles

The upper 200 m during May, June, and July were dominated by Polar water, which is characterized by temperatures below 0°C (increasing to 3–5°C in the surface layer during summer) and salinities below 34.4 (Buch 2000). A hydrographic frontal zone between cold Polar water and warmer mixed shelf water over the bank was most clearly seen in June on the western part of Tr3 (Figure 2b). In May and July, fronts were difficult to identify across transects. Vertical lines were clearly seen between warmer and less saline water in the surface layers and near the coast due to freshwater runoff. The coarse spatial and temporal resolution of hydrographical data measurements makes detection of the small scale frontal processes difficult. Fronts may only occur periodically within the sampled areas. We found no clear relationship between zooplankton abundance and water mass characteristics.

In May and June, chlorophyll *a* was concentrated in the relatively cold Polar water mass. During the spring bloom in May the phytoplankton biomass (92 ± 45 mg C m^{-3}) was dominated by diatoms of *Thalassiosira* spp. and *Chaetoceros* spp. (Poulsen & Reuss 2002). In June, a post-bloom situation prevailed on most of Tr3 resulting in a very low phytoplankton biomass (2 ± 1 mg C m^{-3}) (Poulsen & Reuss 2002). Peak phytoplankton biomasses (30 mg C m^{-3}) were found at the western part of Tr3 where diatoms of *Chaetoceros* spp. dominated (Figure 2b). In July pronounced subsurface concentrations of chlorophyll *a* were observed in the upper 50 m of the water column on Tr1, Tr4, and Tr5. The phytoplankton composition of these subsurface blooms was not investigated, but diatoms probably dominated (Nielsen & Hansen 1999). In all cases the blooms extent down to the depth of the upper thermocline.

The onset of the seasonal phytoplankton development (spring bloom) begin in Southwest Greenland in April and it is delayed from south to north due to e.g. later increase in day-length and withdraw of the West-Ice covering the Baffin Bay and Davis Strait during winter (Pavshtiks 1968, 1972, Jensen *et al*. 1999, Head *et al.* 2000). However, duration and extent of the ice cover are related to climatic conditions, and, consequently, onset and development of the spring bloom vary from year to year. After the spring bloom, only minor blooms develop, caused by intrusions of nutrients due to temporal mixing of the surface water (Nielsen & Hansen 1999).

We found weak relationships between chlorophyll *a* concentrations and zooplankton abundance. High copepod and invertebrate abundances coincided with high chl *a* concentrations, which may indicate increased growth and survival in high productive areas.

The three species of large copepods *Calanus finmarchicus*, *C. glacialis*, and *C. hyperboreus* were dominating in terms of biomass. There was a general increasing biomass of the three *Calanus* species and especially of *C. finmarchicus* from May to July as individuals and populations gain weight and developed. According to Pavshtiks (1968, 1972) *C. finmarchicus* stage CVI-females was the most abundant mesozooplankton over the West Greenland Shelf in April. From April to July the progeny of the spawning *C. finmarchicus* females in this region gradually develops to copepodid stages IV and V, which by July became dominant in terms of biomass. *C. finmarchicus*, brought to West Greenland following the Irminger Water, probably spawns first, and then the local *C. finmarchicu*s population, which has overwintered in the costal waters spawns. This aspect, however, requires further study (Pavshtiks 1972). According to Pavshtiks (1972) it is quite probable that in the deep central part of the Davis Strait the first spawning also refers to *C. finmarchicu*s from the Irminger Water and that the forms which have overwintered in the deep waters of the strait spawn later. Because it is known that this area is inhabited by several populations of *Calanus* which differ in body size and in spawning periods these questions can be resolved by a more detailed study of the morphology of *Calanus* in Davis Strait (Pavshtiks 1972). According to Pavshtiks (1972), the *C. finmarchicu*s population which spawns in May on the Greenland shelf in the southern part of Davis Strait consists of small females (average length of cephalothorax 2.6-2.8 mm) and the females that spawn somewhat later in the deep basin of the Labrador Sea are larger (2.9-3.0 mm). The spawning of the latter population starts in June and continues during July and part of August. In July, the spawning of *C. finmarchicus* continued very actively in the waters of the West Greenland current off southern Greenland, leading to an extremely large increase in the numbers of juveniles 5,182 ind. m^{-3} (Pavshtiks 1972). The females of *C. finmarchicu*s which spawned in August and September in the northern part of Davis Strait were larger (3.2-3.4 mm) and apparently belong to a separate population (Pavshtiks 1972).

In May, in this study, there was about equal abundance of the three *Calanus* species with stage CI being dominating in *C. finmarchicu*s and *C. glaciali*s, whereas CII dominated over CI in *C. hyperboreus*. Females of *C. finmarchicu*s were abundant, whereas no females of *C. glaciali*s or *C. hyperboreus* were observed.

In Disko Bay in 1996, the maximum abundance of females of *C. finmarchicus*, *C. glacialis*, and *C. hyperboreus* in June was 6,498, 1,446, and 1,131 ind. m^{-2}, respectively (Niehoff *et al*. 2002). In the present study the maximum female abundance of *C. finmarchicus* was 3,458 ind. m^{-2} in May, however, very high abundances of CIV and CV of all three *Calanus* species was observed in July. The abundance and demographic structure indicate that the three species of *Calanus* have developed from CI-CII to CIV-CV between the sampling in May and July. In Disko Bay, the life cycle of *C. finmarchicus* was deduced to be 1 year and at least 2 year for *C. glacialis* and *C. hyperboreus* (Madsen *et al*. 2001). *C. finmarchicu*s, *C. glaciali*s, and *C. hyperboreus*, reproduce successfully in Disko Bay (Niehoff *et al*. 2002). However, their reproductive cycles were considerably different with respect to the timing of final gonad maturation and spawning. The three *Calanus* species have evolved different reproductive strategies to adapt to the seasonal phytoplankton development (Niehoff *et al*. 2002). *C. finmarchicus* in Disko Bay outnumbers both *C. glacialis* and *C. hyperboreus* by up to a factor of three throughout the year, indicating that this species can reproduce and recruit successfully in ecosystems strongly influenced by polar conditions (Madsen *et al*. 2001, Niehoff *et al*. 2002). At Svalbard and in the marginal ice zone of the Barents Sea in northeast Atlantic, Scott *et al*. (2000) and Falk-Petersen *et al*. (1999) found *C. finmarchicus* to have a 1 year life cycle, *C. glacialis* 1-2 year life cycle, and *C. hyperboreus* a 3-5 year life cycle. These generation times seems to fit for *Calanus* in southwest Greenland waters. However, based on only three sampling periods in this study it is difficult to deduce the development and life cycles of the three *Calanus* species, because one has to take into account e.g. advection by currents and mixing of different populations over the southwest Greenland shelf (Pavshtiks 1972). The stage composition of the species in plankton samples reflects the reproductive cycles and e.g. time/duration/intensity of spawning, stage development times, migrations, advections and survival/mortality.

We found high numbers of *Calanus nauplii*, low numbers of *Calanus* copepodites in stage CI mainly, few females of *C. finmarchicus,* no females of *C. glacialis* or *C. hyperboreus* in the coast and fjord samples in May. We hypothesize that the young *Calanus* stages have drifted into the fjord from offshore areas. Smidt (1979) found some zooplankton species to occur mainly in the inner fjord regions, while others mainly occur closer to Davis Strait, and are uniformly distributed. Among the copepods, *Pseudocalanus* spp., *Metridia longa*, *Oncaea borealis* and *Microsetella norvegica* were most frequent in the inner fjord regions, while species of *Calanus* and *Microcalanus* were mainly or exclusively found in costal regions. Maclellan (1967) found few young stages of *Calanus* in the inner fjord and suggests the progeny from the fjord population may have been advected out of the fjord with the runoff melt water. It seems therefore likely that e.g. the *Calanus* spp. populations in the fjord are sustained by inflow from offshore and coastal populations.

4.2 Plankton current transport and retention

We found unusual high abundance and biomass of copepods and invertebrates at stations over deep water on Tr2 and Tr3 in July 2000, which was an order of magnitude higher than other transects. The area crossed by Tr2 is an important summer feeding area for baleen whales, mainly humpback whale *(Megaptera novaeangli*ae), which supports the findings of exceptional high plankton densities here (Finn Larsen, DIFRES, Charlottenlund, Denmark, pers. comm.). Special hydrographical features in this area may cause plankton aggregations. As the northward drifting *West Greenland Current* meets Sukkertop Deep and pass west of Tovqussaq- and Sukkertop Bank it produces complex gyres and circulation patterns in Sukkertop Deep and along the bank slopes which may aggregate zooplankton. Further north along Tr5, Munk (2002) found plankton aggregations and juvenile fish feeding in a hydrographic frontal zone indicating the importance of fronts for biological production and fish recruitment. The drifter tracks of two drifters deployed in May 2000 along Tr1 and our drifter simulations also indicated complex ocean circulation patterns over the shelf north of 64°N at the same locations.

Hydrographic features, fronts and eddies may act as barriers to plankton transport or contribute to plankton retention - processes which is important for species and plankton distributions (e.g. Sinclair 1988, Sournia 1994, Hannah *et al.* 2000, Munk *et al.* 2003). In West Greenland larval drift by surface currents is assumed to be essential for the fish and shellfish recruitment to downstream fishing areas and fjords, whereas larval retention may dominate in other areas (Pedersen & Rice 2002, Pedersen *et al.* 2002, Ribergaard *et al.* 2003). Ribergaard *et al.* (2003) simulated particle transport from four release areas along West Greenland and they showed that after 100 days about 80% of the particles were located over the West Greenland shelf between 64°N and 67°N and about 20% were located on the Canadian Labrador shelf and in the Davis Strait at depths > 1,000 m. Of the latter 20 % most were released south of 63°N. Hence particles from the southern release areas were transported the longest distances, while particles from release area between 64°N and 67°N were transported relatively short distances.

The northward floating *West Greenland Current* has a strong effect on species composition, community structure, food web dynamics and hence ecosystem productivity. Plankton animals of different geographic origin occur in the survey area. As the individual life cycle of plankton increases in time the importance of the advection term increases and for e.g. *C. finmarchicus* with a life cycle of several months, the advection term may become very important (Sundby 2000). Micro- and mesozooplankton in the survey area e.g. *Calanus* spp. seems to be drifted to the area from South or East Greenland. Head *et al*. (2000) found high concentrations and productivity of *C. finmarchicus* in southwest Greenland. It seems likely that *C. finmarchicus* populations over the West Greenland shelf to a large extent is su-

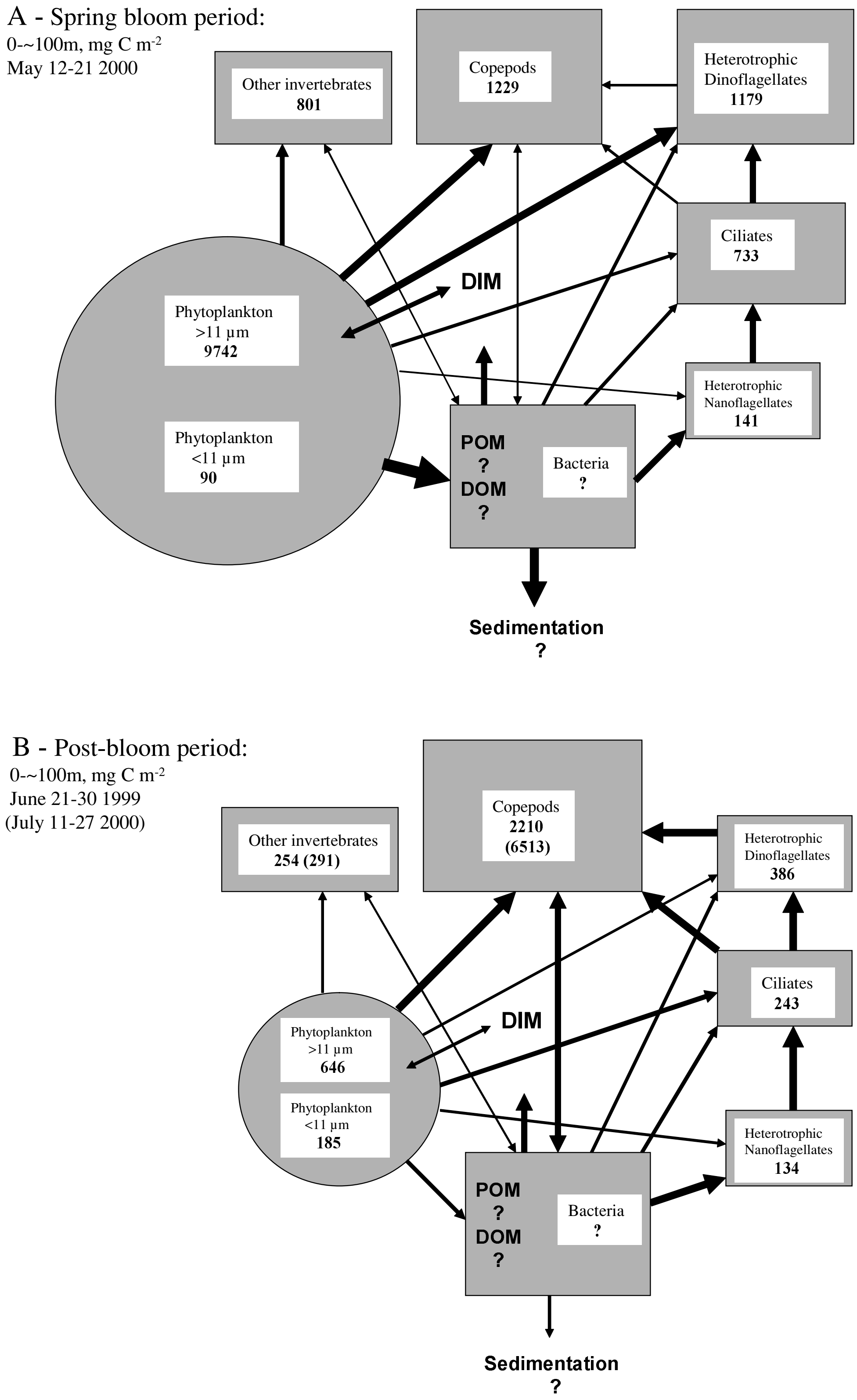

Figure 6

Simplified schematic representation of community structure (biomass in mg C m^{-2}), carbon and nutrient flow through the lower trophic food web during the spring-bloom period in May 2000 (A) and the post-bloom period in June 1999 (B). DIM=dissolved inorganic material (C, Ca, Si, N, P.....), POM=particulate organic material, and DOM=dissolved organic material.

stained from the main *C. finmarchicus* distribution area south of Greenland and that the variability in advectional transport to West Greenland have strong implications for e.g. Atlantic cod recruitment (Sundby 2000). Today the West Greenland cod population is at a very low level as several other Atlantic fish species. However, during the warmer period in 1950's and 1960's with higher biological production several fish populations was large and productive in Southwest Greenland, especially the commercially most important Atlantic cod (Pedersen & Smidt 2000, Pedersen & Rice 2002, Wieland & Hovgaard 2002). During the 1950s and 1960s large numbers of Atlantic cod larvae and other fish larvae were transported from southwest Greenland spawning grounds to the Labrador shelf to recruit to populations here.

4.3 Vertical flux, carbon cycling and fish production

During the May survey phytoplankton (diatoms) dominated the plankton community structure of the upper ~100 m whereas during June (and July) heterotrophic organisms were dominating (Figure 6). The shift in the phytoplankton community from a spring-bloom to a post-bloom community was most likely due to nutrition limitation of the phytoplankton (Paulsen & Reuss 2002). The dominance of small autotrophic flagellates in June suggested reliance upon recycled nutritions in the euphotic zone. The spring-bloom protozooplankton and the heterotrophic nanoflagellate (HNAN) biomass were comparable to biomass reported from Disko Bay (Nielsen & Hansen 1995), however the June post-bloom biomasses of protozooplankton and HNAN were lower than earlier reported. Poulsen & Reuss (2002) suggest that the low June protozooplankton and HNAN biomasses were due to the absence of phytoplankton subsurface blooms and the associated decrease in food availability. The microbial food web most likely played an important role in carbon cycling as indicated by the large standing stocks of primarily bacteriovorous HNAN especially during the post-bloom situation in June. We have no information on bacterial biomass from this study. However, Hansen *et al.* (2003) report the bacterial biomass to vary between 40 and 150 mg C m^{-3} during summer (during spring-bloom and post-bloom periods) in Disko Bay, which is at the same level as the autotrophic biomass during the spring-bloom in May. In Disko Bay, Nielsen & Hansen (1995) found an increase in bacterial production after the phytoplankton bloom but no increase in HNAN most probably due to grassing by planktonic ciliates. According to Paulsen and Reuss (2002) it seems unlikely that the low biomass of small autotrophic flagellates presented in June would be able to fuel a bacterioplankton community large enough to sustain the heterotrophic biomass present. However, DOM produced during the bloom may be the resource the bacterioplankton are utilizing during the post-bloom situation in June, which in turn is passed up the food web (Poulsen & Reuss 2002).

We found *Calanus* spp. to be dominating the copepod biomass in all sampling periods. In May and June the three *Calanus* species were of about equal biomass, but in July *C. finmarchicus* was dominating. These findings are similar to findings from the Disko Bay area (Nielsen & Hansen 1995, Hansen *et al.* 1999, 2003).

In May the phytoplankton biomass and production was able to sustain the heterotrophic plankton community but not in June (or July) during the post-bloom situation (Figure 6). In the latter situation copepod feeding must have been supplemented or dominated by heterotrophic food e.g. ciliates and heterotrophic dinoflagellates (Hansen *et al.* 1999). From a study of microzooplankton grazing of phytoplankton in the Barents Sea during early summer Verity *et al.* (2002) conclude that it may be that, except during the peak of the vernal bloom, microzooplankton are a major food source for mesozooplankton in the Barents Sea, and the importance of top-down influences on community structure and ecosystem function may be a general feature of these waters. According to Verity (2002) mesozooplankton depend on the utilization of rich protozooplankton growth and are thus more omnivorous in situ rather than herbivorous as previously assumed.

We found the smaller copepods, *Oithona similis*, *Microsetella* spp. and *Oncaea* spp. dominating in terms of number in July. Also in July we found high numbers of pteropods, pelagic snails, and tintinnids. Pavshtiks (1968, 1972) also describe *Oithona similes* and pteropods to be dominant taxa over the West Greenland shelf in July-September. The small sized copepods *Oithona* spp., *Microsetella* spp., *Oncaea* spp., pteropods and tintinnids have been described to be vertical flux feeders associated with marine snow particles, feeding on flagellates, fecal pellets, various detritus particles (e.g. Kiørboe 1998). Flux feeding and coprophagous mesozooplanktons may be important for keeping material and plankton biomass in the upper mixed layer, especially, during blooms of large-sized diatoms (Kiørboe 1998). According to Kiørboe (1998) the retardation of vertical material fluxes – and losses – may be the most important role of the mesozooplankton for pelagic communities and quantitative measurements are needed to allow assessments of the significance of the phenomenon.

A central theme in studies of marine plankton dynamics and higher trophic-level productivity is the efficiency and variability of linkages in the cycles of marine biological production (Runge, 1988). According to Runge (1988) we are most likely to detect a link in the food chain from phytoplankton variability to fisheries via copepod productivity in a *Calanus*-dominated system in fish populations that feed on *Calanus* eggs and juveniles during the early larval stages. In West Greenland the latter is the case for Atlantic cod (Bainbridge & McKay 1968). *Calanus* productivity (larval cod food) is determined by variability in the number of females, but for species like *C. finmarchicus*, the variability in specific egg production rate (eggs female^{-1} day^{-1}) determined by the variability in phytoplankton production is at least as important as the number of females (Runge 1988, Hansen *et al*. 2003).

According to Rice (1995) simple (or complex) food web models will not be useful for assessments of the effects of climate change on fish populations. The models will be particularly unreliable if they do not represent accurately the life-history or size-selective patterns of predation, and intraguild predation. If they do represent those processes accurately, however, the models will prove intractable (Rice 1995). More promising ways towards predictions of changes in fish production at higher trophic levels under climate change seems to be development of coupled bio-physical models of larval recruitment (Werner *et al.* 2001), hybrid recruitment models (Bailey *et al.* 2002), and studies of indicator species (Anderson 2000).

4.4 Future research

There are many gabs in the understanding of the zooplankton dynamics of the Northwest Atlantic Marine Ecosystems. For the *Calanus* species there is a need for information on: dormancy/diapause, mortality, vertical structure (distribution, stage, physiological state), physiological dependencies (temperature, food, history), spatial distribution, genetic/phenotypic variation across regions (e.g. Hirche 1998, Head *et al*. 2001). In the present study we identified the following research areas in particular relevant for understanding species distributions, current transport, and life cycles of the West Greenland micro-, meso- and meroplankton: 1) better understanding of calanoid larval dormancy, 2) species identification (e.g. nauplii of *C. finmarchicus vs. C. glacialis*) using genetic identification, 3) vertical migrations, and 4) trophic interactions.

In the survey area over the West Greenland shelf each individual animal caught in plankton samples has a history which is a complex function of many factors. Temperature, ocean current speed and turbulence are key factors for transport distances during development from spawned as eggs until e.g. caught in a plankton sampler, natural mortality, non pelagic diapause, or settling to the bottom. The depth-integrated plankton hauls presented in this study provided no information on vertical distributions/migrations of different stages of during development. However, information on species behaviour and time of stage development is important and needed for coupled bio-physical modeling of transport and production in West Greenland (e.g. Olson & Hood 1994, Miller *et al*. 1998, Anon. 2002, Storm & Pedersen 2003, Pedersen & Bergström 2003). Individual biological models must be based on approximations consistent with individual dynamics. As computer power and the biological data required for IBMs increases the portion of the ecosystem represented by IBMs can increase (Anon. 2002).

The ocean circulation model developed for West Greenland will be useful for future research in the coupling between climate, ocean circulation and ecosystem changes. It should be further developed to treat baroclinic effects prognostic in order to describe oceanographic features like the dynamics of fronts and upwelling/downwelling of different watermasses. Furthermore models of biological production and pelagic food web dynamics should be coupled to the ocean model.

The goal of a recently planned Greenland research program is "to establish a scientific basis for long-term ecosystem-based management in West Greenland waters" (Jarre 2002). This Science Plan for future research outlined a number of needs and key questions concerning climate impact on the pelagic ecosystem off West Greenland.

We hope the resultats and data from the plankton study presented in this report will be useful for the detailed planning of future more comprehensive studies of pelagic ecology and ecosystem dynamics in West Greenland waters.

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References

Anderson, P. J. 2000.
Pandalid Shrimp as Indicators of Ecosystem Regime Shift. J. North. Atl. Fish. Sci. 27: 1–10.

Anonymous 2002.
Report of the Study Group on Modelling Physical/Biological Interactions. International Council for the Exploration of the Sea, ICES CM 2002/ C:09 Oceanography Committee. 42 p.

Bailey, K.M., L. Ciannelli, & V.N. Agostini 2002.
Hybrid Models of Recruitment. Poster presentation, 26th Annual larval fish conference. K.M. Bailey, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA 98115. Pers. Comm.

Bainbridge, V. & J. Corlett 1968.
The zooplankton of the NORWESTLANT surveys. ICNAF (NAFO) Spec. Publ., 7(I): 101-122.

Bainbridge, V. & B.J. McKay 1968.
The feeding of cod and redfish larvae. ICNAF (NAFO) Spec. Publ., 7(I): 187-217.

Berggreen, U., B. Hansen & T. Kiørboe 1988.
Food size spectra, ingestion and growth of the copepod Acartia tonsa during development: implications for determination of copepod production. Mar. Biol. 99: 341-352.

Buch, E. 2000a.
A monograph on the physical oceanography of the Greenland waters. Danish Meteorological Institute, Scientific report, 00-12, 405 pp. (Re-issued version of a Greenland Fisheries Research Institute report from 1990 with the same title).

Buch, E. 2000b.
Air-Sea-Ice Conditions off Southwest Greenland, 1981-97. J. Northwest Atlantic Fishery Science, 26: 1-14.

Buch, E., S.A. Pedersen & M.H. Ribergaard 2003.
Ecosystem variability in West Greenland waters. Journal of Northwest Atlantic Fishery Science, in press.

Falk-Petersen, S., G. Pedersen, S. Kwasniewski, E.N. Hegseth & H. Hop 1999.
Spatial distribution and life-cycle timing of zooplankton in the marginal ice zone of the Barents Sea during the summer melt season in 1995. Journal of Plankton Research 21(7): 1249-1264.

Fenchel, T. 1988.
Marine plankton food chains. Ann. Rev. Ecol. Syst. 19: 19-38.

Fotel, F.L., N.J. Jensen, L. Wittrup & B. Hansen 1999.
In situ and laboratory growth by a population of blue mussel larvae (*Mytilus edulis L.*) from a Danish embayment, Knebel Vig. J. Exp. Mar. Biol. Ecol. 233: 213-230.

Hannah, C.G., J.A. Shore & J.W. Loder 2000.
The drift-retention dichotomy on Brown Bank: a model study of interannual variability. Can. J. Fish. Aquat. Sci. 57: 2506-2518.

Hansen, A.S., T.G. Nielsen, H. Levinsen, S.D. Madsen, T.F. Thingstad & B.W. Hansen 2003.
Impact of changing ice cover on pelagic productivity and food web structure in Disko Bay, West Greenland: a dynamic model approach. Deep-Sea Research I, 50: 171-187.

Hansen, B. 1999.
Cohort growth of planktotrophic polychaete larvae – are they food limited? Marine Ecology Progress Series, 178: 109-119.

Hansen, B. & K.W. Ockelmann 1991.
Feeding behaviour in the opisthobranch *Philine aperta*. I. Growth and functional response at different developmental stages. Mar. Biol., 111: 255-261.

Hansen, B.W., T.G. Nielsen & H. Levinsen 1999.
Plankton community structure and carbon cycling on the western coast of Greenland during the stratified summer situation. III. Mesozooplankton. Aquat. Microb. Ecol., 16: 233-249.

Head, E.J.H., L.R. Harris & R.W. Campbell 2000.
Investigations on the ecology of Calanus spp. in the Labrador Sea. I. Relationship between the phytoplankton bloom and reproduction and development of Calanus finmarchicus in spring. Marine Ecology Progress Series, 193: 53-73.

Head, E., P. Pepin & J. Runge 2001.
Proceedings of the workshop on „The Northwest Atlantic ecosystem – a basin scale approach”. Canadian Science Advisory Secretariat Proceedings Series 2001/23. 113 pp.

Hirche, H.J. 1998.
Dormancy in three Calanus species (*C. finmarchicus*, *C. glacialis* and *C. hyperboreus*) from the North Atlantic. Arch. Hydrobiol. Spec. Issues Advanc. Limnol. 52: 359-369.

Hirche, H.J. & N. Mumm 1992.
Distribution of dominant copepods in the Nansen Basin, Arctic Ocean, in summer. Deep-Sea Research, 39 [suppl 2]: 485-505.

ICNAF Special Publication No. 7 (1968).
Environmental surveys – NORWESTLANT 1-3, 1963. Part I – III. Issued from the headquaters of the Commision. Today North Atlantic Fisheries Organization (www.NAFO.ca).

Jakobsen, P.K., M.H. Ribergaard, D. Quadfasel & T. Schmith 2002.
The near surface circulation in the Northern North Atlantic as inferred from Lagrangian drifters: variability from the mesoscale to interannual. Journal of Geophysical Research, accepted.

Jarre, A. (ed.) 2002.
Workshop "Ecosystem West Greenland". A stepping stone towards an integrated marine research programme. INUSSUK, Arctic Research Journal 1: 1-99.

Jensen, H.M., L. Pedersen, A. Burmeister & B.W. Hansen 1999.
Pelagic primary production during summer along 65 to 72 N off West Greenland. Polar Biol., 21: 269-278.

Kiørboe, T. 1998.
Population regulation and role of mesozooplankton in shaping marine pelagic food webs. Hydrobiologia 363: 13-27.

Kiørboe, T. 2001.
Food webs and fish production in the North Sea. Hist. Fil. Medd. Dan. Vid. Selsk., 82: 191-210.

Kiørboe, T., F. Møhlenberg & K. Hamburger 1985.
Bioenergetics of the planktonic copepod *Acartia tonsa*: relation between feeding, egg production and respiration, and composition of specific dynamic action. Marine Ecology Progress Series, 26: 85-97.

Klein Bretler, W.C.M., H.G. Fransz & S.R. Gonzalez 1982.
Growth and development of four calanoid copepod species under experimental and natural conditions. Neth. J. Sea Res., 16: 195-207.

Lindley, J.A., D.B. Robins & R. Williams 1999.
Dry weight carbon and nitrogen content of some euphausiids from the north Atlantic Ocean and the Celtic Sea. J. Plankton Res. 21(11): 2053-2066.

MacLellan, D.C. 1967.
The annual cycle of certain calanoid species in west Greenland. Can. J. Zool., 45: 101-115.

Madsen, S.D, T.G. Nielsen & B.W. Hansen 2001.
Annual population development and production by *Calanus finmarchicus*, *C. glacialis* and *C. hyperboreus* in Disko Bay, western Greenland. Mar. Biol. 139: 75-93

Miller, C.B., D.R. Lynch, F. Carlotti, W. Gentleman & C.V.W. Lewis 1998.
Coupling of an individual based population dynamic model of *Calanus finmarchicus* to a circulation model for the Georges Bank region. Fish. Oceangr. 7: 3/4: 219-234.

Munk, P. 2002.
Larval sand lance (*Ammodytes sp.*) in the diet of small juvenile wolfish (*Anarhichas spp.*): predatory interactions in frontal water masses off western Greenland. Can. J. Fish. Aquat. Sci. 59: 1759-1767.

Munk, P., B.W. Hansen, T.G. Nielsen & H.A. Thomsen 2003.
Changes in plankton and fish larvae communities across hydrographic fronts off West Greenland. J. Plankton Res. Accepted.

Nielsen T.G. & B.W. Hansen 1995.
Plankton community structure and carbon cycling on the western coast of Greenland during and after the sedimentation of a diatom bloom. Mar. Ecol. Prog. Ser., 125: 239-257

Nielsen T.G. & B.W. Hansen 1999.
Plankton community structure and carbon cycling on the western coast of Greenland during the stratified summer situation. I. Hydrography, phytoplankton and bacterioplankton. Aquat. Microb. Ecol. 16: 205-216.

Niehoff, B., S.D. Madsen, B.W. Hansen & T.G. Nielsen 2002.
Reproductive cycles of three dominant Calanus species in Disko Bay, West Greenland. Marine Biology 140: 567-576.

Olson, D.B. & R.R. Hood 1994.
Modelling pelagic biogeography. Prog. Oceanog. 34: 161-205.

Paffenhöfer, G.-A. 1976.
On the biology of Appendicularia of the southeastern North Sea. In: Persoone, G. & E. Jarpers

(eds.). Proceedings of the 10th European symposium on marine biology, vol 2. Universa, Wetteren, Belgium. Pp 437-455.

Pavshtiks, E.A. 1968.
The influence of currents upon seasonal fluctations in the plankton of the Davis Strait. Sarsia 34: 383–392.

Pavshtiks, E.A. 1972.
Biological seasons in the zooplankton of Davis Strait. Akad. Nauk. SSSR, Zool. Inst., Explor. Mar. Fauna. 12(20): 200–247. Israel Prog. Sci. Transl., Jerusalem 1975.

Pauly, D., V. Christensen, S. Guénette, T.P. Pitcher, U.R. Sumaila, C.J. Walters, R. Watson & D. Zeller 2002.
Towards sustainability in world fisheries. Nature 418: 689-695.

Pedersen, S.A. & E.L.B. Smidt 2000.
Zooplankton distribution and abundance in West Greenland waters, 1950-1984. J. Northw. Atl. Fish. Sci., 26: 45-102.

Pedersen, S.A. & D. Zeller 2001.
A mass balance model for the West Greenland marine ecosystem. In: Guenette, S., V. Christensen & D. Pauly (eds). Fisheries impacts on North Atlantic Ecosystems: Models and Analyses. Fisheries Centre Research Reports, 9(4): 111-127.

Pedersen, S.A. & J. Rice 2002.
Dynamics of fish larvae, zooplankton, and hydrographical characteristics in the West Greenland Large Marine Ecosystem 1950-1984. In: Large Marine Ecosystems of the North Atlantic. Changing States and Sustainability. Shermann, K.S. & H.-R. Skjoldal (eds). Chapter 5. Elsevier Science. Pp. 151-193.

Pedersen, S.A. & B. Bergström (Ed.) 2003.
Proceedings of the Workshop on "Coupling biological models to ocean circulation models of the seas of Greenland, Iceland, and Norway with special emphasis on northern shrimp (*Pandalus borealis*) recruitment", Held 7-9 October 2002 at the Danish Meteorological Institute, Copenhagen, Denmark. 50 p. (To be published by Nordic Council of Ministers in 2003).

Pedersen, S.A., L. Storm & C.S. Simonsen 2002.
Northern shrimp (*Pandalus borealis*) recruitment in West Greenland waters. Part I. Distribution of Pandalus shrimp larvae in relation to hydrography and plankton. Journal of Northwest Atlantic Fishery Science, 30: 19-46.

Poulsen, L.K. & N. Reuss 2002.
The plankton community on Sukkertop and Fylla Banks off West Greenland in a spring bloom and post-bloom period. Hydrography, phytoplankton and protozooplankton. Ophelia 56(2): 69-85.

Ribergaard, M.H., B. Ådlandsvik, S.A. Pedersen & N. Kliem 2003.
Modelling the ocean circulation on the West Greenland shelf with special emphasis on northern shrimp recruitment. Submitted to Continental Shelf Research, 29. Aug. 2003.

Rice, J. 1995.
Food web theory, marine food webs, and what climate change may do to northern marine fish populations. In R.J. Beamish (ed.). Climate change and northern fish populations. Can. Spec. Publ. Fish. Aquat. Sci. 121: 561-568.

Runge, J.A. 1988.
Should we expect a relationship between primary production and fisheries? The role of copepod dynamics as a filter of trophic variability. Hydrobiologia 167/168: 61-71.

Sabatini, M. & T. Kiørboe 1995.
Egg production, growth and development of cyclopoid copepod *Oithona similis*. J. Plankton Res. 16: 1329-1351.

Scott, C.L., S. Kwasniewski, S. Falk-Petersen & J.R. Sargent 2000.
Lipids and life strategies of *Calanus finmarchicus*, *Calanus glacialis* and *Calanus hyperboreus* in late autumn, Kongsfjorden, Svalbard. Polar Biol. 23: 510-516.

Serreze, M.C., J.E. Walsh, F.S. Chapin III, T. Osterkamp, M. Dyurgerov, V. Romanovsky, W.C. Oechel, J. Morison, T. Zhang & R.G. Barry 2000.
Observational evidence of recent change in the northern high-latitude environment. Climate Change 46: 159-207.

Simonsen, C.S., S.A. Pedersen & P. Munk 2003.
The distribution, and growth response of Greenland halibut and sandeel larvae to the dynamic environment associated to the banks offshore West Greenland. In preparation.

Sinclair, M. 1988.
Marine Populations. An Essay on Population Regulation and Speciation. University of Washington Press, Seattle, WA. 252 pp.

Smidt, E.L.B. 1979.
Annual cycles of primary production and of zooplankton at South-west Greenland. Meddelelser om Grønland, Bioscience 1. 53 pp.

Sournia, A. 1994.
Pelagic biogeography and fronts. Prog. Oceanog. 34: 109-120.

Storm, L. & S.A. Pedersen 2003.
Development and drift of northern shrimp larvae (*Pandalus borealis*) at West Greenland. Marine Biology. Publiced on-line.

Sundby, S. 2000.
Recruitment of Atlantic cod stocks in relation to temperature and advection of copepod populations. Sarsia 85: 277-298.

Turner, J.T., H. Levinsen, T.G. Nielsen & B.W. Hansen 2001.
Zooplankton feeding ecology: Grazing on phytoplankton and predation on protozoans by copepod and *barnacle nauplii* in Disko Bay, West Greenland. Marine Ecology Progress Series 221: 209-219.

Uye, S. 1982.
Length-weight relationships of important zooplankton from the inland sea of Japan. Journal of the Oceanographical Society of Japan 38: 149-158.

Verity, P.G., P. Wassmann, M.E. Frischer, M.H. Howard-Jones & A. Allen 2002.
Grazing of phytoplankton by microzooplankton in the Barents Sea during early summer. Journal of Marine Systems, 38: 109-123.

Werner, F.E., B.R. Mackenzie, R.I. Perry, R.G. Lough, C.E. Naimie, B.O. Blanton & J.A. Quinlan 2001.
Larval trophodynamics, turbulence, and drift on Georges Bank: A sensitivity analysis of cod and haddock. Sci. Mar., 65: 99–115.

Wieland, K. & H. Hovgaard 2002.
Distribution and Drift of Atlantic Cod (*Gadus morhua*) Eggs and Larvae in Greenland Offshore Waters. J. Northw. Atl. Fish. Sci. 30: 61–76.

Appendix

Table 1a.

Abundance of zooplankton categories (ind. m^{-2}) at sampling stations, fjord and coast, May 2000 (Pump, 50µm net).

		Station no.					
		1	2	3	4	5	6
Zooplankton category	Stage\Depth (m)	200-0	155-0	185-0	200-0	90-0	35-0
Copepoda	egg sacks	6588		36890		42160	2635
	eggs	34255	187086	321471	18445	42160	5270
Acartia longiremis	CVI-male				2635		
	nauplii	1318	28985	100130			15810
Calanus finmarchicus	CI	82	21	309	144	638	576
	CII	144	62	82	62		185
	CIII		21	103	124		
	CIV				21		
	CVI-female	62					
Calanus glacialis	CI	309	350	556	741	1215	1956
	CII	82	185	226	309	103	782
	CIII	165		165	185	82	
	CIV				82		
Calanus hyperboreus	CI	144	124	62	638	391	226
	CII	247	247	721	659	165	
	CIII			185	144		
Calanus sp.	nauplii	5270	5270	31620	36890	105400	10540
Metridia longa.	CVI-female	3953					
Microcalanus pusillus	CI			5270			
	CV						2635
	CVI-female			5270	2635		
	nauplii			42160		42160	
Microsetella norvegica	CI-VI	28985	31620	73780	42181	274041	7905
Oithona similis	CI			5270		21080	
	CII						5270
	CIII		2635				
	CV	2635					2635
	CVI-female	5270	5270	10540	10540	21080	5270
	CVI-male			10540	5270		
Oithona sp.	nauplii	18445	26350	36890	13175	548082	76415
Oithona spinirostris	CVI-female				2635		
Oncaea borealis	CI-5	2635				42160	10540
	CVI-female				2635	42160	
	CVI-male	1318		10540		63240	
Pseudocalanus elongatus	CVI-female		2635				
Pseudocalanus minutus	CI	11858				84320	5270
	CII	19763		10540		21080	
	CIII	9223					
	CIV						
	CVI-female		2635	5270			2635
Pseudocalanus sp.	nauplii	52700	76415	163371	181816	779963	39525
Bivalvia	larvae	334646	353091	943334	21080	5291101	39525
Chaetognatha (*Eukrohnia hamata*)					21		
Cirripedia cipris	nauplii	1318	55335	42160	150196	147561	289851
Decapoda	larvae	62	185	473	62	62	
Echinodermata	larvae	5270	28985	21080	10540	42160	5270
Euphausidae	eggs	6588	5270	68510	7905		36890
	nauplii	1318		42160	41	21080	5270
Fritillaria borealis			2635		5270		
Oikopleura sp.				5270			
Gastropoda	larvae					21080	5270
Hyperiidae					21		
Pisces	eggs				21		
Polychaeta	larvae		31620	15810	15810		63240

Table 1b.

Abundance of zooplankton categories (ind. m^{-2}) at sampling stations, Transect 1, May 2000 (Pump, 50µm net).

		Station no.					
		1	2	3	4	5	6
Zooplankton category	Stage\Depth (m)	100-0	60-0	30-0	60-0	100-0	100-0
Copepoda	egg sacks		10540	5270	10540	36890	17128
	eggs	569162	42160	7905	695643	216071	61923
Acartia longiremis	CI			2635			
	CVI-female			2635			
	nauplii			2635	115940		27668
Calanus finmarchicus	CI	7411	2429	3129	1441	1400	412
	CII	659	165	206		206	494
	CIII	1153	206			288	329
	CIV	329					
	CV	1482	82				165
	CVI-female	3458				412	659
Calanus glacialis	CI	15810	2223	4735	1894	2017	2141
	CII	4776	782	576	576	1153	2553
	CIII	494	165		412	618	1318
	CIV	1647				247	247
	CV	165			41	82	247
Calanus hyperboreus	CI	5435	576	1400	782	1112	823
	CII	9717	1976	906	1688	3417	4529
	CIII	329	371		618	700	247
	CV	659					
Calanus sp.	nauplii	126481	13175	76415	63240	15810	
Metridia longa.	CVI-male					41	1318
Microcalanus pusillus	CII						2635
	CVI-female					5270	1318
	CVI-male					5270	1318
	nauplii						2635
Microsetella norvegica	CI-VI	21080	2635	5270	21080	21080	9223
	nauplii			2635			
Oithona similis	CI		5270	7905	31620	10540	1318
	CII						3953
	CIII		2635				1318
	CV			5270			2635
	CVI-female		7905	10540	21080	21080	15810
	CVI-male		2635	2635	10540	5270	9223
	nauplii	168641	36890	5270	147561	42160	10540
Oncaea borealis	CI-5		2635			21080	1318
Pseudocalanus elongatus	CVI-female	21080					
Pseudocalanus minutus	CI		2635				
	CII						1318
	CIII						1318
	CVI-female						1318
Pseudocalanus sp.	nauplii	548082	65875	65875	548082	173911	71145
Bivalvia	larvae	105400	300391	226611	779963	785233	150196
Cirripedia cipris	nauplii	126481	7905	26350	31620	31620	54018
Decapoda	larvae				82		247
Echinodermata	larvae			2635		21080	
Euphausidae	eggs		2635		52700		21080
	nauplii	329	82		42160		6588
Fritillaria borealis		42160	10540	2635		10540	1318
Gastropoda	larvae		7905	5270	63240		
Hyperiidae		988			82	41	247
Ostracoda (*Concoecia elegans*)		329					
Polychaeta	larvae	21080		5270			5270

Table 1c.

Abundance of zooplankton categories (ind. m^{-2}) at sampling stations, Transect 3, May 2000 (Pump, 50µm net).

		Station no.				
		1	2	3	4	5
Zooplankton category	Stage\Depth (m)	100-0	100-0	100-0	45-0	100-0
Copepoda	egg sacks	21080	10540	42160	10540	42160
	eggs	126481	94860	316201	10540	484842
Acartia spp.	nauplii		10540			
Calanus finmarchicus	CI	5682	2100	1029	329	371
	CII	1729	659	329	679	206
	CIII	576	288	41	21	1112
	CIV					535
	CV	329				
	CVI-female	1976	206	206		659
	CVI-male					82
Calanus glacialis	CI	9799	4076	3953	2964	1647
	CII	2059	1976	906	391	329
	CIII	2635	618	700	309	1276
	CIV	659	247			288
	CV		165			
Calanus hyperboreus	CI	5188	329	1276	226	329
	CII	7246	1359	1647	62	782
	CIII	2223	371	988		3088
	CV	82		165		1318
Calanus sp.	nauplii	274041	63240	63240	52700	21080
Euchaeta norvegia	CIII			21080		
	CVI-female	21080				
Microcalanus pusillus	CI			42160		
	CII			21080		
	CIII			21080		
	CIV			21080		
	CV			21080		
	CVI-female		10540	21080		21080
	nauplii		21080			
Microsetella norvegica	CI-VI	21080		63240	21080	42160
Oithona similis	CI		10540			
	CII				10540	
	CV	21080				
	CVI-female	21080	10540	84320	10540	21080
	CVI-male				10540	21080
	nauplii	189721	42160	105400	84320	
Pseudocalanus spp.	CV		10540		10540	
	CVI-female			21080		21080
	nauplii	653483	179181	252961	305661	210801
Bivalvia	larvae		21080	1960448	642943	3014452
Cirripedia cipris	nauplii		10540	21080		21080
Echinodermata	larvae		10540		10540	
Euphausidae	eggs		10540	42160		316201
	nauplii				105400	21080
	larvae			329		
Fritillaria borealis		21080			21080	
Hyperiidae				329		
Polychaeta	larvae	21080		21080	10540	

Table 1d.

Abundance of zooplankton categories (ind. m-2) at sampling stations, Davis Strait, May 2000 (Pump, 50µm net).

		Station no.	
		D1	D2
Zooplankton category	Stage\Depth (m)	100-0	100-0
Copepoda	egg sacks	21080	21080
	eggs	189721	274041
Calanus finmarchicus	CI	6135	9717
	CII	988	6258
	CIII	288	823
	CIV		329
	CV		165
	CVI-female	1359	494
Calanus glacialis	CI	9017	22727
	CII	2347	5105
	CIII	329	1482
	CIV		988
Calanus hyperboreus	CI	1318	6423
	CII	1441	10211
	CIII	1688	2141
	CV	371	165
	CVI-female	41	
Calanus sp.	nauplii	147561	316201
Metridia longa.	CVI-female	21080	
Microcalanus pusillus	CIII	21080	21080
	CVI-female		21080
	nauplii		42160
Microsetella norvegica	CI-VI		21080
Oithona similis	CI	21080	42160
	CIII		21080
Oithona sp.	nauplii	84320	84320
Oithona spinirostris	CVI-female	21080	
Oncaea borealis	CI-5	21080	
Pseudocalanus spp.	nauplii	316201	1117244
Scolecithricella sp.	CVI-female		21080
Bivalvia	larvae	42160	63240
Cirripedia cipris			21080
Euphausidae	nauplii		21080
	larvae		63240
Fritillaria borealis		42160	21080
Hydromedusae		329	
Ostracoda			329

Table 1e.

Abundance of zooplankton categories (ind. m^{-2}) at sampling stations, Transect 2, June 1999 (WP2, 50µm net).

		Station no.				
		1	2	3	4	5
Zooplankton category	Stage\Depth (m)	200-0	100-0	100-0	40-0	200-0
Copepoda	egg sacks	4527	1358	2264	566	
	eggs	11771	2716	3169	1585	2264
Calanus finmarchicus	CI	3622	6338	4980	792	6791
	CII	4527	905	2716	1471	15393
	CIII	4527	4074	5433	1924	12223
	CIV	1811	3169	3169	1471	2716
	CV	905	905	4980	340	
	CVI-female			453		
Calanus glacialis	CI	2716	4527	2716	226	14940
	CII	3622	4074	5433	340	5433
	CIII	13582	7696	9960	113	
	CIV	6338	3622	4527		
	CV		1811	1358	226	453
	CVI-male			905		
Calanus hyperboreus	CI	1811	905	1811		2264
	CII	4527	2716	6791		
	CIII	8149	1811	2264		
	CIV	905	4527	5885		
	CV			453		
Calanus sp.	nauplii	21731	6791	6791	1358	30332
Eucalanus elongatus	CV	905				
Metridia longa.	CIII	905				
	CVI-female	905				
Microcalanus pusillus	CII			453		
	CIII			453		
Microsetella norvegica	CI-VI	9960	8149	12676	2716	8149
Oithona similis	CI	905		905	1471	2264
	CII	6338	905	3169	2264	6338
	CIII	3622	2264	1811	905	8602
	CIV	5433	1811	453	679	5885
	CV		453	905	1245	5433
	CVI-female	1811	1811	453	2037	4074
	CVI-male	905	905	1811	1019	6791
Oithona sp.	nauplii	176561	15393	10413	15506	5433
Oithona spinirostris	CVI-female					905
	CVI-male			453		
Oncaea borealis	CI-5	12676	6791	3169		13582
	CVI-female	1811		453		4074
	CVI-male	1811				
Oncaea borealis	CI-5				679	
Pleuromamma robusta	CIII		453			
Pseudocalanus elongatus	CI					4980
	CII					905
	CV			453	226	
	CVI-female				113	
Pseudocalanus minutus	CV	905	453			
	CVI-female	905	905	453		
Pseudocalanus sp.	nauplii				453	5885

Table 1e (continued).

Abundance of zooplankton categories (ind. m^{-2}) at sampling stations, Transect 2, June 1999 (WP2, 50µm net).

		Station no.				
		1	2	3	4	5
Zooplankton category	Stage\Depth (m)	200-0	100-0	100-0	40-0	200-0
Bivalvia	larvae	73341	40292	53421	1471	4074
Cirripedia cipris		5433	3622	1358		
Echinodermata	larvae	35312	9054	7244	679	4527
Euphausidae	eggs	905				
	larvae	905	453			
Fritillaria borealis		2716	1358			3622
Oikopleura sp.	tail	29879	15845	4527	792	3622
Gastropoda	larvae	32596	11318	6791	340	5433
Hydromedusae			57	453	57	28
Hyperiidae		1811		453		
Ostracoda (*Concoecia obtusata*)		905				
Polychaeta	larvae	6338	3169	2716		905

Table 1f.

Abundance of zooplankton categories (ind. m^{-2}) at sampling stations, Transect 3, June 1999 (WP2, 50µm net).

		Station no.				
		1	2	3	4	5
Zooplankton category	Stage\Depth (m)	200-0	200-0	100-0	45-0	200-0
Copepoda	eggs	398396	554130	35765	6055	12563
	nauplii	557752	554131	82395	24446	17656
Acartia longiremis	CIV				4	
	CV				14	14
	CVI-female				14	14
	CVI-male				11	14
Acartia sp.	CI	156	11	4	7	
	CII	99	4	11	4	
	CIII	42	18	28		11
	CIV	42	25	18		14
	CV	14	7	18		
	CVI-female	28	21	21		
	CVI-male	14	7	14	4	
Calanus finmarchicus	CI	24447	16298	5206	1188	3622
	CII	6338	28974	13129	5999	9054
	CIII	2264	18562	13808	8432	16298
	CIV	2264	11771	10865	2547	10865
	CV	2264	4980	2490	509	2716
	CVI-female	453	453	453	57	
	damaged		4527		170	
Calanus glacialis	CI	5433			57	
	CII	7244				905
	CIII	1811	1811	679		
	CIV	905	4980	1132	1188	2264
	CV	453	1358	2037	566	2264

Continued.....

Table 1f (continued).

Abundance of zooplankton categories (ind. m^{-2}) at sampling stations, Transect 3, June 1999 (WP2, 50µm net).

		Station no.				
		1	2	3	4	5
Zooplankton category	Stage\Depth (m)	200-0	200-0	100-0	45-0	200-0
Calanus hyperboreus	CI	6791				
	CII	1811				
	CIII	2716	2264		57	453
	CIV	453	2264	1358		
	CV		453	226		
	damaged	3169				
Euchaeta norvegia	CIV		905			
Metridia sp.	CI				57	453
	CV	1811	453			
	CVI-female	1358	453			
Microcalanus sp.	CI		1358	226		
	CII	453	905	226		
	CIII	1358	905	226		
	CIV	905		453		905
	CV		905			1358
	CVI-female	2716	3622	1132		4074
	damaged		905			
Microsetella sp.	CI		453			
	CIV	1811	1811	905		1358
	CV	23089	3169	2490	113	9960
	CVI-female	10413		905	3678	20372
	CVI-male	4980			226	905
	damaged	1358		679	113	
Oithona similis	CI	14487	15393	6791	2547	14034
	CII	9507	13129	6338	1471	14940
	CIII	6791	17203	7017	1075	9054
	CIV	4074	11318	8149	1245	8602
	CV	15393	15845	8375	2207	19467
	CVI-female	3622	13582	453	57	453
	CVI-male	23541		4301	1302	17656
	damaged	2264	16751	3622	679	1358
Oncaea sp.	CI	1358				
	CII	9507			57	
	CIII	5433	905			
	CIV	11318	1358	1811	57	
	CV	10413	905	1358		1811
	CVI-female	453	1811		57	905
	CVI-male	1358	6338	1132	57	1358
	damaged	905	1811	226	57	
Pseudocalanus spp.	CI	4980	3622	1585	170	1811
	CII	4074	2716	1358	113	1811
	CIII	1811	3622	1132	396	3169
	CIV		1811	453	113	1358
	CV	453	453	226	226	2716
	CVI-female	453			170	
	damaged	453		453	57	
Scolecithricella sp.	CVI-female	453				

Continued.....

Table 1f (continued).

Abundance of zooplankton categories (ind. m^{-2}) at sampling stations, Transect 3, June 1999 (WP2, 50µm net).

		Station no.				
		1	2	3	4	5
Zooplankton category	Stage\Depth (m)	200-0	200-0	100-0	45-0	200-0
Appendicularia		48894	37123	2264	255	226
Bivalvia	larvae	224549	16751	13016	1938	22862
Chaetognatha			453			113
Cirripedia cipris		16298	7696	679	141	792
Cnidaria			1811		85	
Echinodermata	larvae	18109	6791	2037	85	453
Euphausidae	larvae	21731	2717		283	113
Foraminifera		105031	453	679		226
Gastropoda	larvae	105031	34859	1245	141	566
Hyperiidae					14	113
Invertebrata	larvae		3622	113		453
Polychaeta	larvae	16298	6338	2830	71	2490
Rhynchoc. pilidium					14	
Siphonophora			905			
Gastropoda (Thecosomata)			453			3282
Unidentified invertebrates		1811			28	

Table 1g.

Abundance of zooplankton categories (ind. m^{-2}) at sampling stations, Transect 1, July 2000 (Pump, 50µm net).

		Station no.				
		1	2	3	4	5
Zooplankton category	Stage\Depth (m)	200-0	75-0	35-0	200-0	100-0
Copepoda	egg sacks	15905	22132	4497	21814	14295
	eggs	3976	20657	12206	14115	3899
Acartia longiremis	CI		1475			
	CII		738			
	CVI-female			321		
	nauplii				2566	
Calanus finmarchicus	CI	663	4426		6416	650
	CII	3976	8853	1285	12832	650
	CIII	5964	11066		5133	2599
	CIV	5302	8853		13474	5848
	CV	9278	5164	642	14757	3899
	CVI-female	1325			642	
Calanus glacialis	CI	663			1925	
	CII	663				
	CIII	1988	2213		642	650
	CIV	1325			642	2599
	CV	1325			5774	2599
Calanus hyperboreus	CI					650
	CII			642		
	CIII	1988			1283	
	CIV	1325	738		7058	3249
	CV		738		1283	
Calanus sp.	nauplii	12591	11066	1927	5774	650
Centropages hamatus	nauplii			642		
Metridia longa.	CIII					650
	CVI-female	663				
Microcalanus pusillus	CI				1283	
	CIII				1283	
	CVI-female				5133	
	CVI-male				1283	
	nauplii	1325				
Microsetella norvegica	CI-VI	9278	28772	7067	10266	33789
	nauplii		738	6424	10266	31190
Oithona similis	CI	13254	14755	16703	14115	10397
	CII	19881	14755	7709	7699	9097
	CIII	10603	8853	2570	6416	6498
	CIV	13254	5902	5782	6416	12996
	CV	38436	16230	10279	14115	11696
	CVI-female	21206	11804	8351	11549	12996
	CVI-male	2651	4426	1285	1283	2599
	nauplii	249171	156402	71309	137301	72777
Oncaea borealis	CVI-female	1325	2951	1285	3850	1949
	CVI-male	5964	3689	1927	6416	2599
	CI-5	1988	738	1285	6416	
Pseudocalanus elongatus	CI	663		642		
	CIII	1325				
	CIV	1325			1283	1300
	CV	663	1475		3208	1300
	CVI-female					650
	CVI-male				642	

Continued.....

Table 1g (continued).

Abundance of zooplankton categories (ind. m^{-2}) at sampling stations, Transect 1, July 2000 (Pump, 50µm net).

		Station no.				
		1	2	3	4	5
Zooplankton category	Stage\Depth (m)	200-0	75-0	35-0	200-0	100-0
Pseudocalanus minutus	CII				642	
	CIII	663				
	CIV	1988	3689			
	CV	663	3689		642	650
Pseudocalanus sp.	nauplii	5302			3208	1300

		Station no.				
		1	2	3	4	5
Zooplankton category	Stage\Depth (m)	200-0	75-0	35-0	200-0	100-0
Ascidia					1283	1300
Bivalvia	larvae	30484	35412	52036	46195	45485
Chaetognatha (*Sagitta* sp.)					642	
Cirripedia cipris				8994		1300
Echinodermata	larvae	10603	4426	5782	10266	650
Euphausidae	eggs				1283	650
	nauplii		738			
	larvae	663				650
Fritillaria sp.				642	1283	
Oikopleura sp.		1325		642		
Gastropoda	larvae	11928	2213	1927	11549	650
Hydromedusae		1325	3689			
Hydrozoa	actinula	1325	738			
Polychaeta	larvae	18555	8115	1285	1283	1300
Rotatoria			1475	8351	1283	1300
Protozoa (Tintinnidae)		6627	357069	465114	85974	46785

Table 1h.

Abundance of zooplankton categories (ind. m^{-2}) at sampling stations, Transect 2, July 2000 (WP2, 50µm net).

		Station no.									
		1	2	3	4	5	6	7	8	9	10
Zooplankton category	Stage\Depth (m)	100-0	100-0	100-0	80-0	40-0	100-0	100-0	80-0	75-0	65-0
Copepoda	egg sacks	217306	72435	2716	7244	4527	36218	54326	28974	39839	57948
	eggs				5433	905	21731			3622	9054
	nauplii			2716		1358		3622	7244		
Acartia spp.	nauplii	86922									
Calanus finmarchicus	CI	57948	21731	2716	3622	2264	86922	14487	18109	18109	1811
	CII	14487	28974	2716	5433	905	79679	18109	21731	21731	905
	CIII	86922	36218	8149	17203	453	115897	18109	28974	10865	4527
	CIV	130384	101409	5433	9960	905	57948	28974	25352	28974	2716
	CV	173845	94166	2716	10865	2264	28974	21731	65192	18109	3622
Calanus glacialis	CI		7244	2716			21731	3622	14487	14487	
	CII	86922	36218	16298	905		7244	7244	18109	7244	905
	CIII	57948			905		14487	10865	25352	3622	
	CIV	28974	7244	2716	1811		14487	3622	25352		905
	CV	14487	36218	13582	905	453	28974	3622	7244	10865	4527
Calanus hyperboreus	CV	28974			905		7244				
Calanus sp.	nauplii	159358	28974		6338	1811	94166	14487	43461	32596	1811
Centropages hamatus	CI						21731	3622		3622	
	CIV										905
Eucalanus elongatus	CV	14487									
Metridia longa.	CV							3622			
	CVI-male						7244				
Microcalanus pusillus	CV				905						
	nauplii						28974	14487			4527
Microsetella norvegica	CI-VI		21731	5433	5433	9054	101409	7244	7244	28974	167507
	nauplii										13582
Oithona similis	CI	144871	79679	24447	39839	11771	79679	65192	57948	43461	2716
	CII	101409	123140	46178	19014	3169	57948	36218	25352	18109	1811
	CIII	86922	65192	35312	8149	6791	65192	28974	3622	25352	4527
	CIV	72435	50705	29880	5433	4074	50705	50705	14487	28974	4527
	CV	173845	65192	43461	12676	5885	115897	25352	28974	47083	10865
	CVI-female	217306	94166	32596	21731	5433	79679	32596	90544	28974	9054
	CVI-male			2716	4527	2264	36218	3622	7244	32596	3622
	nauplii	1289349	644674	312377	134005	57043	644674	213684	293363	235415	35312
Oncaea borealis	CI-5	86922	7244	8149	4527	1358	43461	3622		10865	
	CVI-female	28974		10865	1811		21731		3622	7244	905
	CVI-male	28974	7244	5433		453	50705			14487	1811
Pseudocalanus elongatus	CI	28974			4527					3622	
	CII				905		7244			10865	
	CIII					453					1811
	CIV	14487					14487				
	CV	14487		8149	2716	453	14487			10865	
	CVI-female			2716	1811	453					
	CVI-male				905	453					
	nauplii				7244				25352		
Pseudocalanus sp.	nauplii		7244	5433		1811	72435			7244	
Scolecithricella minutus	CIV							7244			
	CV						21731	3622			
	CVI-female						14487	3622		3622	
	CVI-male						14487				
Appendicularia								7244			
Bivalvia	larvae	405638	239037	111369	110464	10865	123140	119518	575861	423747	13582
Cirripedia cipris	nauplii			2716	12676	905	7244		7244		905
Echinodermata	larvae		43461	35312	22636	2264		25352	43461	3622	
Euphausidae	eggs									3622	
	larvae				905					3622	
Fritillaria borealis				2716	905			7244			
Oikopleura sp.			7244	5433							
Gastropoda	larvae	1506655	543265	116802	15393	3622	94166	224549	325959	47083	7244
Limacina helicina		28974					7244	3622			
Hydromedusae		14487	7244	13582	9054	2264	7244	10865		10865	
Hyperiidae									3622		
Polychaeta	larvae		7244	5433	10865	905		3622		3622	
Scyphomedusae					1811						
Protozoa (Tintinnidae)											Many

Table 1i.

Abundance of zooplankton categories (ind. m^{-2}) at sampling stations, Transect 3, July 2000 (WP2, 50µm net).

		Station no.			
		1	2	3	4
Zooplankton category	Stage\Depth (m)	100-0	100-0	100-0	100-0
Copepoda	egg sacks	10865	18109		3169
	eggs		7244		2150
Acartia longiremis	CII			1811	
Acartia sp.	nauplii			3622	
Calanus finmarchicus	CI	3622			679
	CII	3622	3622		2264
	CIII	10865	3622	905	1358
	CIV	18109	43461	2716	905
	CV	28974	68814	1811	1019
Calanus glacialis	CI				226
	CII			905	
	CIII		10865		113
	CIV			905	113
	CV	7244	3622	2716	566
Calanus sp.	nauplii		7244	7244	113
Euchaeta norvegia	CIV			905	
Metridia longa.	CV	7244			
Microcalanus pusillus	nauplii				566
Microsetella norvegica	CI-VI	18109	39839		2830
Oithona similis	CI	21731	36218	10865	1358
	CII	25352	32596	17203	2603
	CIII	21731	7244	8149	2830
	CIV	10865	10865	4527	2943
	CV	10865	43461	1811	3735
	CVI-female	14487	57948	8149	3848
	CVI-male		10865	905	1245
	nauplii	271632	543265	86922	8828
Oncaea borealis	CI-5				453
	CVI-male		7244		113
Pseudocalanus elongatus	CI			2716	
	CIV		3622		
	CV		3622		113
	nauplii		14487	6338	113
Bivalvia	larvae	210062	90544	47988	4414
Chaetognatha (*Eukrohnia hamata*)					113
Echinodermata	larvae	3622	14487	1811	3622
Euphausidae	eggs				113
	larvae	3622			
Gastropoda	larvae	488938	329581	62475	566
Limacina helicina			3622		
Hydromedusae		3622		4527	
Oikopleura sp.		21731	10865	5433	113
Polychaeta	larvae	3622		4527	1132

Table 1j.

Abundance of zooplankton categories (ind. m^{-2}) at sampling stations, Transect 4, July 2000 (Pump, 50µm net).

		Station no.				
		1	2	3	4	5
Zooplankton category	Stage\Depth (m)	200-0	116-0	128-0	50-0	130-0
Copepoda	egg sacks	9412	21434	2732	5063	20923
	eggs	10757	19425	20832	7278	47076
Calanus finmarchicus	CI	2017	3349	342	316	654
	CII	10757	14736	683		
	CIII	10757	14066	3415	1582	
	CIV	8740	25453	4781	1582	654
	CV	10084	6698		2848	1308
	CVI-female		670		316	
Calanus glacialis	CIII			342		
	CIV	672	2679	342		2615
	CV	672	1340	1366		1308
Calanus hyperboreus	CIV	672	1340	5806		654
	CV			683		
Calanus sp.	nauplii	6051	3349	1708	2215	1961
Centropages hamatus	CI		670			
	nauplii				949	2615
Euchaeta norvegia	CV			342		
Metridia longa.	CII					654
	CIV				316	
	CV	672				
Microcalanus pusillus	CI					654
	CIII					654
	CIV			683		
	CV			342		
	CVI-female			683		
	CVI-male	672				
	nauplii					1961
Microsetella norvegica	CI-VI	8067	12727	4440	1899	3923
	nauplii	672	2009	683	2215	6538
Oithona similis	CI	29580	21434	3757	20884	20923
	CII	25547	21434	5123	15188	26153
	CIII	14790	16746	7172	7594	17000
	CIV	17479	17415	9221	9493	24846
	CV	33614	27463	9562	18353	48383
	CVI-female	4034	15406	1708	633	17000
	CVI-male	2689	2009		633	1308
Oithona sp.	nauplii	353620	166117	45761	94928	324299
Oithona spinirostris	CV	672				
Oncaea borealis	CVI-female		2009			
	CVI-male	1345	670	342		3923
	CI-5	6051	2679	683	316	1308
Pseudocalanus elongatus	CI	1345			316	2615
	CII					1308
	CIII		1340			1308
	CIV		1340			
	CV	2017	1340	2049	316	
Pseudocalanus minutus	CI			342		
	CII				316	
	CIII	1345		342		
	CIV	2017	670	2049		
	CV	1345	1340	2391	633	1308
Pseudocalanus sp.	nauplii	672	4019	1366	1266	9154
Temora longicomis	nauplii			342		

Table 1j (continued).

Abundance of zooplankton categories (ind. m^{-2}) at sampling stations, Transect 4, July 2000 (Pump, 50µm net).

		Station no.				
		1	2	3	4	5
Zooplankton category	Stage\Depth (m)	200-0	116-0	128-0	50-0	130-0
Amphipoda			21			
Bivalvia	larvae	12773	18085	15368	13290	41845
Cirripedia cipris		1345	4689	13319	949	654
Echinodermata	larvae	12101	12057	7172	1899	3923
Euphausidae	eggs		670		1266	3923
	larvae	672				
Foraminifera			670			
Fritillaria sp.				342		
Oikopleura sp.		2689	670	342	316	
Gastropoda	larvae	15462	37510	11270	6329	13077
Pteropoda (*Limacina* sp.)		752	1340		20	20
Hydrozoa	actinula	1345			1266	
Polychaeta	larvae	2017	4689	1366	633	9154
Rotatoria						2615
Protozoa (Tintinnidae)		1345			7911	108536

Table 1k.

Abundance of zooplankton categories (ind. m^{-2}) at sampling stations, Transect 5, July 2000 (Pump, 50µm net).

		Station no.					
		1	2	3	4	5	6
Zooplankton category	Stage\Depth (m)	200-0	155-0	185-0	200-0	90-0	35-0
Copepoda	egg sacks	8803	13973	24601	4613	17874	4514
	eggs	2515	9781	30751	50085	21847	19861
Acartia longiremis	CII		1397				
	CIII						301
	CIV		1397				
	CVI-female						602
	CVI-male						602
	nauplii						602
Calanus finmarchicus	CI	629	2096		1318	3641	
	CII	4401	11178	1025	3295	6289	
	CIII	1886	15370	2392	2636	4965	301
	CIV	3773	24453	3075	5931	1324	903
	CV	6288	12576	683	1318	662	
	CVI-female		1397	2392	1318		
Calanus glacialis	CI					331	
	CII			683	659		
	CIII			1367			
	CIV	1258	4192	2392		331	
	CV	2515		3075	4613	331	
	CVI-female	629	699			331	
Calanus hyperboreus	CIII		699				
	CIV	629	6288	342		993	
	CV		699	1025			
Calanus sp.	nauplii	1886	6288	683	1318	2317	
Euchaeta norvegia	CIV			342			
	CV	629					
Metridia longa.	CII		1397	342			
	CIII				659		
	CIV			342			
	CV	629	1397	342			
Microcalanus pusillus	CI			2050	2636	662	
	CII			342	1977		
	CIII				659	331	
	CIV		1397	1025			
	CV		4192	1708	2636		
	CVI-female	629	2795	1708	3295	662	
	CVI-male			683			
	nauplii	629		1367	6590		301
Microsetella norvegica	CI-VI	7545	13973	82003	7249	46341	25578
	nauplii			1367			43934
Oithona similis	CI	13833	34932	12300	21088	20523	3310
	CII	10060	26549	19134	25701	12578	4213
	CIII	16348	29343	12300	9226	11254	4213
	CIV	10060	27946	9567	7249	11916	4514
	CV	20120	54495	6834	7908	20523	8727
	CVI-female	5030	9781	9567	3295	6620	2708
	CVI-male		1397		330	331	301
Oithona sp.	nauplii	320665	360503	110704	445491	52961	23171
Oithona spinirostris	CV	629			659		
Oncaea borealis	CI-5	5030	18165	1708	5931		
	CVI-female		1397	342			
	CVI-male	629	2795	2457	1318		602

Table 1k (continued).

Abundance of zooplankton categories (ind. m^{-2}) at sampling stations, Transect 5, July 2000 (Pump, 50µm net).

		Station no.					
		1	2	3	4	5	6
Zooplankton category	Stage\Depth (m)	200-0	155-0	185-0	200-0	90-0	35-0
Pseudocalanus elongatus	CVI-male			683			
	CI		1397			331	
	CII	629					
	CIV	629					
	CV						301
	CVI-female				659		
Pseudocalanus minutus	CI		1397	1025	659		
	CII			683	659		
	CIII			342			
	CIV	629	1397				
	CV	1886	4192	1025			301
Pseudocalanus sp.	nauplii	4401	1397	683	3954		301
Scolecithricella sp.	CVI-female				659		

		Station no.					
		1	2	3	4	5	6
Zooplankton category	Stage\Depth (m)	200-0	155-0	185-0	200-0	90-0	35-0
Aglantha digitale						21	
Amphipoda				21			
Bivalvia	larvae	13833	18165	36218	1318	2979	15648
Chaetognatha (*Sagitta* sp.)					330		
Cirripedia cipris		5030	1397	342	1318	2648	40473
Decapoda	larvae				21		
Echinodermata	larvae	5659	32138	2733	1977	993	301
Euphausidae	eggs	2515	1397		659		903
	larvae	1258	2795	342			
Gastropoda	larvae	71678	67070	2392		1324	3310
Pteropoda (*Limacina* sp.)			44	1367	659	703	
Hydromedusae		629	1397			662	
Hydrozoa	actinula		1397				903
Isopoda				342			
Oikopleura sp.		1258	1397	683	1977	1986	
Polychaeta	larvae	9431	11178	1708	1977		1204
Rotatoria							3912
Protozoa (Tintinnidae)		1886			659	662	903

Table 1l.

Abundance of zooplankton categories (ind. m^{-2}) at sampling stations, Transect 6, July 2000 (WP2, 50µm net).

		Station no.				
		1	2	3	4	5
Zooplankton category	Stage\Depth (m)	100-0	100-0	100-0	40-0	50-0
Copepoda	egg sacks	7244	6338	13129		14487
	eggs			3622	28974	3622
	nauplii				5433	
	spermato					23541
Acartia longiremis	CIII			453		
	CVI-female					3622
	nauplii			905		3622
Calanus finmarchicus	CI		453	2264		1811
	CII	905	1811	1358		1811
	CIII	4527		2716	1811	1811
	CIV	3622		4074		1811
	CV	13582	4074	1811	3622	10865
Calanus glacialis	CI		453	453		
	CII	905	905	453		
	CIII	2716	2716	453		
	CIV	1811	905	905	1811	1811
	CV	3622	2264	4980	1811	3622
Calanus hyperboreus	CV					1811
Calanus sp.	nauplii					7244
Microcalanus pusillus	CI			905		
	CV			453		
	nauplii			2264	3622	
Microsetella norvegica	CI-VI	9054	10413	6791	14487	9054
	nauplii			8602		
Oithona similis	CI	8149	4527	12223	3622	5433
	CII	16298	6338	10865	10865	5433
	CIII	13582	4074	11318	5433	7244
	CIV	17203	7244	15393	3622	3622
	CV	18109	11318	20825	9054	5433
	CVI-female	4527	9960	11771	18109	12676
	CVI-male	1811	1811	1358	1811	
Oithona sp.	nauplii	149398	78773	51157	170223	81490
Oithona spinirostris	CVI-female	2716				
Oncaea borealis	CI-5	4527	905			1811
	CVI-male	905				
Pleuromamma robusta	CI					1811
Pseudocalanus spp.	CI			453	3622	3622
	CII			905		5433
	CIII			1811		5433
	CIV				5433	7244
	CV	1811		905	7244	3622
	CVI-female			905	10865	
	CVI-male			453		
	nauplii			2716	16298	12676
Appendicularia			2264			5433
Bivalvia	larvae	6338	24900	15845	153925	251713
Chaetognatha (*Eukrohnia hamata*)				28		
				28		
Cirripedia cipris	larvae	4527	453			1811
	nauplii			1358	39839	9054

Continued.....

Table 1l (continued).

Abundance of zooplankton categories (ind. m^{-2}) at sampling stations, Transect 6, July 2000 (WP2, 50µm net).

		Station no.				
		1	2	3	4	5
Zooplankton category	Stage\Depth (m)	100-0	100-0	100-0	40-0	50-0
Decapoda	larvae				1811	
Echinodermata	larvae	8149	2264			1811
Euphausidae	larvae	2716				
Fritillaria borealis			905	2264	7244	10865
Oikopleura sp.		3622	8602	4980	12676	14487
Gastropoda	larvae	44367	21731	10865	43461	18109
Limacina helicina			113		1811	
Hydromedusae			905	905		
Mysidacea						1811
Polychaeta	larvae	1811	2264	453		
Scyphomedusae		905				

Table 2a.

Abundance of zooplankton categories (ind. m^{-3}) at sampling stations, fjord and coast, May 2000 (Pump, 50µm net).

		Station no.																
		1			2			3			4		5			6		
Zooplankton category	Stage\Depth (m)	30-0	60-30	100-60	30-0	60-30	100-60	30-0	60-30	100-60	60-30	100-60	30-0	60-30	100-60	30-0	60-30	100-60
Copepoda	egg sacks	218	492	901	14				109	41	14	102	41	92	82	55		410
	eggs	1584	519	2622	833	1625	2704	1147	2622	1147	533	594	150	133	1557	41		
Acartia longiremis	CI						82											
	CVI-female								55		14					27	55	
	CVI-male																	
	nauplii		164	82	109	205	737	218	1475	819	137		82			300	109	82
Calanus finmarchicus	CI	1	3			1	1	4	1	3		6		3	3	3	7	19
	CII	1		3			3	1	2	7		3						6
	CIII	1		1			3		2	1	1				1	1		3
	CIV																	
	CV		1	2														
	CVI-female										1							
	CVI-male			1														
Calanus glacialis	CI	7	5	5	1	1	10	7	9	5	8	4	6	6	12	5	11	45
	CII	1	9	9			4		1	6	3	3	3		2	3	3	12
	CIII	1	3	6						4		1		1	1		1	3
	CIV			1														
	CV			1														
	CVI-female												1					
Calanus hyperboreus	CI	3	7	5			2	3	3	9	5	2		4	3	1	2	19
	CII	1	3	22		2	3	1	4	12	7	12	3		12			9
	CIII	1	2	1						6	1	4	3	1	1			
Calanus sp.	nauplii	191	82	573	41	68	246	137	382	205	150	123	55	102	246		109	82
Metridia longa.	CV			2														
	CVI-female	1		3			164											
Microcalanus pusillus	CI																	
	CV																	
	CVI-female								55	41	14							
	nauplii		27		20	41		492	382	205	82			51	246			82
Microsetella norvegica	CI-VI	1338	737	3113	89	68	410	601	710	451	218	225	246	451	1147	27	328	328
	CI-VI																	
Oithona similis	CI				7								27					
	CII					14					14			20				
	CIII	55				27							14					
	CIV										27			20	82	27		
	CV	27		82		27		27			14		27	31	246			
	CVI-female	137	218	655		14	82	27	164	82	41	20	96	41	410		109	164
	CVI-male	55	218	737		27		27			14							

Table 2a (continued).

Abundance of zooplankton categories (ind. m^{-3}) at sampling stations, fjord and coast, May 2000 (Pump, 50µm net).

		Station no.																
		1			2			3			4		5			6		
Zooplankton category	Stage\Depth (m)	30-0	60-30	100-60	30-0	60-30	100-60	30-0	60-30	100-60	60-30	100-60	30-0	60-30	100-60	30-0	60-30	100-60
Oithona sp.	nauplii		137		61	246	1311	82	655	369		266	451	461	2212	696	382	655
Oithona spiniros.	CVI-female																	
Oncaea borealis	CI-V		137	328				82	218	41	14	61		297	164			
	CVI-female													20	410			
	CVI-male			1				27				41	55	154	328	27	55	
Pseudocalanus elongatus	CVI-female																	
Pseudocalanus minutus	CI	246	628	492				27		82			205	82	328		55	
	CII	819	1038	2785			82			41			55	31	246			82
	CIII		82									20	27					
	CIV	55	355	246									27					
	CV	27	27				82				14							
	CVI-female		27				82			41			27		246			82
	CVI-male				1										82			
Pseudocalanus sp.	nauplii	1420	983	1720	533	1720	3113	1994	1912	1475	1147	1086	1283	1352	3605	806	546	328

		Station no.																
		1			2			3			4		5			6		
Zooplankton category	Stage\Depth (m)	30-0	60-30	100-60	30-0	60-30	100-60	30-0	60-30	100-60	60-30	100-60	30-0	60-30	100-60	30-0	60-30	100-60
Bivalvia	larvae	2048	10623	10241	676	983	11224	5134	9722	3932	2581	4875	2294	860	9995	2198	6882	5079
Chaetognatha (*Eukrohnia hamata*)														10		2		
Cirripedia cipris	nauplii	27			82	259	1393	683	109	1024	396	533	314	236	164	1898	7155	3236
Decapoda	larvae	4		2	1	1	5	2	5	2	3	2	1		2		5	3
Echinodermata	larvae	164	300	328	171	314	492	164	492	492	109	102	137	51	328	96		82
Euphausidae	eggs	218	137	82	48	96	164	191	164	82	150	82	109			41	273	164
	nauplii	191				55	164	164	218	164	164	102				27		
	larvae									1		1			1			
Fritillaria borealis						27	164											
Gastropoda	larvae		27														109	
Hydromedusae								1										
Hyperiidae			2										1	1				
Oikopleura sp.							82											
Ostracoda (*Concoecia spin.*)															1			
Pisces	eggs											1						
Polychaeta	larvae	27	27		7	27	573	164	109	205	96	61	68			396	492	82
Protozoa (Tintinnidae)								55	55			61			164			

Table 2b.

Abundance of zooplankton categories (ind. m^{-3}) at sampling stations,Transect 1, May 2000 (Pump, 50µm net).

		Station no.								
		1			2	3	4	5	6	
Zooplankton category	Stage\Depth (m)	50-0	100-50	200-10(	60-0	30-0	60-0	100-0	50-0	100-0
Copepoda	egg sacks			41	176	176	176	369	131	171
	eggs	29362	3146	328	703	264	11594	2161	1180	619
Acartia longiremis	CI					88				
	CVI-female					88				
	nauplii					88	1932		262	277
Bradyidi. similis	CVI-female			1						
Calanus finmarchicus	CI	60	70	1	40	104	24	14	16	4
	CII	3	15	1	3	7		2	18	5
	CIII	16	1	1	3			3	10	3
	CIV	5								
	CV				1					2
	CVI-female	46	7	1				4		7
Calanus glacialis	CI	110	228	3	37	158	32	20	47	21
	CII	12	9	8	13	19	10	12	45	26
	CIII	31	1	3	3		7	6	18	13
	CIV	29	4					2		2
	CV						1	1	2	2
	CVI-female	4								
Calanus hyperboreus	CI	52	25	4	10	47	13	11	6	8
	CII	56	34	1	33	30	28	34	63	45
	CIII	30	6	0	6		10	7	8	2
	CV	15	38							
Calanus sp.	nauplii	1049	1311		220	2547	1054	158	197	
Metridia longa.	CIII			1						
	CVI-male							0		13
Microcalanus pusillus	CII			41						26
	CV			74					33	
	CVI-female		262	49				53		13
	CVI-male			16				53		13
	nauplii		262	320					33	26
Microsetella norvegica	CI-VI			25					229	
	CI-VI				44	176	351	211		92
	nauplii					88				
Oithona similis	CI			90	88	264	527	105		13
	CII		262	8						40
	CIII				44				33	13
	CV		262			176			33	26
	CVI-female	1049	524	16	132	351	351	211	328	158
	CVI-male		262		44	88	176	53	98	92
Oithona sp.	nauplii	5243	2097	533	615	176	2459	422	66	105
Oithona spiniros.	CVI-female			16						
	CVI-male			16						
Oncaea borealis	CI-V			49	44			211		13
Pseudocalanus elongatus	CVI-female									
Pseudocalanus minutus	CI				44					
	CII									13
	CIII									13
	CVI-female		262							13
Pseudocalanus sp.	nauplii	22022	6816	295	1098	2196	9135	1739	950	711
Bivalvia	larvae	4195	1311	33	5007	7554	12999	7852	2556	1502
Chaetognatha (*Eukrohnia hamata*)				1						
Cirripedia cipris	nauplii		262		132	878	527	316	786	540
Decapoda	larvae			1			1			2

Table 2b (continued).

Abundance of zooplankton categories (ind. m^{-3}) at sampling stations,Transect 1, May 2000 (Pump, 50µm net).

		Station no.								
		1			2	3	4	5	6	
Zooplankton category	Stage\Depth (m)	50-0	100-50	200-10(	60-0	30-0	60-0	100-0	50-0	100-0
Echinodermata	larvae		262	8		88		211		
Euphausidae	eggs	1049			44		878		295	211
	nauplii						703		66	66
	larvae		4	1	1					
Fritillaria borealis					176	88		105	98	13
Gastropoda	larvae	1049		8	132	176	1054		66	
Hyperiidae			8				1	0		2
Oikopleura sp.									33	
Ostracoda (*Concoecia elegans*)										
Euchaeta norvegia	CIII			2						
	CIV			1						
Polychaeta	larvae			16		176			262	53
Protozoa (Tintinnidae)									33	

Table 2c.

Abundance of zooplankton categories (ind. m^{-3}) at sampling stations, Transect 3, May 2000 (Pump, 50µm net).

		Station no.								
		1		2		3		4	5	
Zooplankton category	Stage\Depth (m)	50-0	100-50	50-0	100-50	50-0	100-50	45-0	50-0	100-50
Copepoda	egg sacks		262		524		557	234	524	197
	eggs	9438	2359	2884	3670	9438	229	234	6292	786
Acartia longiremis	CVI-male			262						
	nauplii									
Calanus finmarchicus	CI	121	88	35	36	22	16	7	6	9
	CII	41	23	6	19	5	8	15	8	1
	CIII	6	31	4	16	8	1	0	15	2
	CIV									
	CV	18		9					5	
	CVI-female	96	49	12	7	1	6		17	15
	CVI-male									
Calanus glacialis	CI	188	186	57	90	34	25	66	14	6
	CII	45	51	28	35	12	9	9	39	1
	CIII	51	35	5	8	17	2	7	18	5
	CIV	8		2	24				3	
	CV									
	CVI-female	4								
Calanus hyperboreus	CI	115	25	16	11	4	1	5	6	1
	CII	158	96	20	25	15	5	1	15	4
	CIII	23	33	1	15	5	14		22	18
	CV					1			1	7
Calanus sp.	nauplii	4195	3146	6554	1049	3670	262	1171		
Euchaeta norvegia	CIII									
	CVI-female									
Microcalanus pusillus	CI									
	CII									
	CIII									
	CIV									
	CV						66			197
	CVI-female				262		98			147
	CVI-male									49
Microcalanus pygmaeus	CVI-female						33			
Microcalanus sp.	nauplii				524		262		524	262
Microsetella norvegica	CI-VI		1049	1049	786	524	197		786	82
	CI-VI							468		
Oithona similis	CI		262	262	262					33
	CII							234		
	CV			262		524				66
	CVI-female		786	262	786	524	164	234	524	
	CVI-male	1049		262			33	234		180
Oithona sp.	nauplii	2097	3932	786	524	1049	524	1874	1049	328
Oithona spiniros.	CVI-female						229			
Oncaea borealis	CI-V						262		262	131
Pseudocalanus elongatus	CVI-female									
Pseudocalanus minutus	CI			262						
	CV							234		
	CVI-female	1049	262				98		524	
Pseudocalanus sp.	nauplii	18876	12846	8651	3408	1573	1278	6792	3146	475
Bivalvia	larvae			1573	2359	34605	4981	14288	17565	737
Cirripedia cipris	nauplii			262		524			1311	
Echinodermata	larvae							234	262	
Euphausidae	eggs			262			1344		5505	610
	nauplii			786		524		2342	262	
	larvae			4						
Fritillaria borealis		1049	1049		524			468	524	
Gastropoda	larvae		262							
Hyperiidae										
Polychaeta	larvae							234		

Table 2d.

Abundance of zooplankton categories (ind. m^{-3}) at sampling stations, Davis Strait, May 2000 (Pump, 50µm net).

		Station no.			
		D1		D2	
Zooplankton category	Stage\Depth (m)	100-0	200-100	100-0	200-100
Copepoda	egg sacks	211	139	211	115
	eggs	1897	107	2740	786
Calanus finmarchicus	CI	61	3	97	5
	CII	10	1	63	0
	CIII	3	0	8	
	CIV			3	
	CV			2	2
	CVI-female	14	1	5	
Calanus glacialis	CI	90	4	227	6
	CII	23	2	51	1
	CIII	3	0	15	0
	CIV			10	1
	CV				0
Calanus hyperboreus	CI	13	2	64	5
	CII	14		102	1
	CIII	17	1	21	4
	CV	4		2	
	CVI-female	0			
Calanus sp.	nauplii	1476		3162	66
Metridia longa.	CIII		3		
	CIV		1		
	CV				66
	CVI-female	211			82
	CVI-male		1		
Microcalanus pusillus	CII		74		
	CIII	211		211	
	CIV		66		
	CV		57		49
	CVI-female		123	211	16
	nauplii		721	422	180
Microsetella norvegica	CI-VI			211	164
Oithona similis	CI	211		422	
	CII		82		
	CIII			211	
	CIV		57		
	CV		131		
	CVI-female		74		
	nauplii	843	582	843	705
Oithona spiniros.	CVI-female	211	41		82
Oncaea borealis	CI-V	211	66		
Pseudocalanus minutus	CVI-female		57		66
	CVI-male		41		
Pseudocalanus sp.	nauplii	3162	229	11172	475
Scolecithricella sp.	CV				49
	CVI-female		8	211	
Euchaeta norvegia	CII		5		
	CIII		3		37
	CIV				8
Bivalvia	larvae	422	188	632	66
Chaetognatha (*Eukrohnia hamata*)					4

Table 2d (continued).

Abundance of zooplankton categories (ind. m^{-3}) at sampling stations, Davis Strait, May 2000 (Pump, 50µm net).

		Station no.			
		D1		D2	
Zooplankton category	Stage\Depth (m)	100-0	200-100	100-0	200-100
Cirripedia cipris	nauplii			211	82
Cyclopoida	CVI-female		2		33
Echinode	larvae		41		49
Euphausidae	nauplii			632	66
	larvae			211	82
Fritillaria borealis		422		211	
Hydromedusae		3			
Hyperiidae					49
Ostracoda (*Concoecia elegans*)					4
Ostracoda			2	3	

Table 3.

Abundance of zooplankton categories (ind. m^{-3}) at day-night sampling at Fjord station 4, May 2000 (Pump, 50µm net).

		Station no.							
		Day			Night				
Zooplankton category	Stage\Depth	20-0	40-20	80-40	20-0	40-20	80-40	120-80	200-120
Copepoda	eggs	492	328		164	123	655	4588	1966
	eggs	1475	1147	2622	1311	307	1639	9831	4588
Acartia sp.	nauplii		164						
Calanus finmarchicus	CI	6	9	10	3	1	3	2	10
	CII	1	5	1	1		1	1	2
	CIII						1	11	3
	CIV				1				
	CV						1	3	
	CVI-female		3	1	3		2	6	2
	CVI-male			3					
Calanus glacialis	CI	10	22	20	4	5	1	18	15
	CII	3	3	10	3		3	8	5
	CIII	1		1	3		6	15	7
	CIV						3		4
	CV								3
	CVI-female						3		
Calanus hyperboreus	CI	1	1	6	3	6	12	7	1
	CII	4	13	12	5	3	10	23	26
	CIII	1		4	4	3	15	38	19
	CV				1				
Calanus sp.	nauplii	819	410			20	983		655
Metridia longa.	CVI-female								3
Microcalanus pusillus	CVI-female			655					655
	nauplii					20	655		
Microsetella norvegica	CI-VI	1147	1475	1311	1147	430	1311	5899	655
Oithona similis	CI						655		
	CVI-female		82						
	CVI-male		82			41	328	1311	
	nauplii	1311	901			61	328	1966	
Oncaea borealis	CI-V		82		328				
Pseudocalanus elongatus	CV				164				
	CVI-female			655	164	20		655	655
Pseudocalanus minutus	CI		82						
	CII		82				328		
	CV							655	
	CVI-female					20	328		655
	CVI-male							1311	
Pseudocalanus sp.	nauplii	5079	3277	11797	5735	963	9176	9831	1966
Bivalvia	larvae	63902	29165	110763	37194	3666	51449	104209	135668
Chaetognatha (*Eukrohnia hamata*)				655					5
Cirripedia cipris	nauplii	1311	901	3277	655	266	983	3932	655
Decapoda	larvae	1	3		1		2	2	
Echinodermata	larvae		328	1966	328	41			655
Euphausidae	eggs	164	246	655	328	143	655		1311
	nauplii	1639	246		983	20			
	larvae			1					
Gastropoda	larvae							1311	
Hydromedusae								3	
Hyperiidae		4	3						
Polychaeta	larvae	655	983	1311		164	655		1311

Table 4.

Abundance of zooplankton categories (ind. m^{-3}) at sampling stations, Davis Strait, May 2000 (WP2, 180µm net). + indicates < 1 individuals m^{-3}.

		Station no.											
		Transect 1: station no.1				D1				D2			
Zooplankton category	Stage\Depth (m)	100-0	200-100	400-200	800-400	100-0	200-100	400-200	800-400	100-0	200-100	400-200	800-400
Copepoda	egg sacks		50	2			27	1	+	54	7	6	
	eggs	688	10	1	2	29	11	+	2	398	29	11	3
Bradyidi. similis	CV			1									
Calanus finmarchicus	CI	86	6	1	+	25		+		163			
	CII	68		1		43		1		145			
	CIII	18		1		11		+		18			
	CV		+										
	CVI-female	23	+	1	1	7	1	+		181			
Calanus glacialis	CI	50		2	+	57		1		127			
	CII	41				18				36			
	CIII	36		+		2				18			
	CIV	5								72			
	CV		+										
	CVI-female									54			
Calanus hyperboreus	CI	32		1						199			
	CII	32								18			
	CIII	5				43				36			
	CIV			+									
	CV	9				29	2						
	CVI-female				1								
Calanus sp.	nauplii	933	22	3	2	217	3	2	3	2879	20	2	2
Cyclopoida	CI-V								3				
	CVI-female			1	3		2						+
	CVI-male						1		2				
Metridia longa.	CI			2				2	1				1
	CII			5			5						
	CIII			5	1		10	2			9	9	
	CIV			1									
	CVI-female		1		1	11							
Microcalanus pusillus	CIII		5				3			18	18		
	CIV			3	1		2	1		36	54	3	2
	CV		89	8	1		25	7	2		183	2	5
	CVI-female	81	111	34	8	57	29	17	7	54	389	27	10
	CVI-male		9	16	1		7	2	2		27	7	3
Microcalanus pygmaeus	CVI-female		5					2					
	CVI-male							+					
Monacill. typica	CIII						3						
Oithona similis	CI									36			
	CIV			1	1		12	1					
	CV		58	3	2		43		4	72	38	7	1
	CVI-female	27	41	1		36	47	1	2	127	118		1
	CVI-male		36	3	1	16	11	1	1	36	52	5	1
Oithona sp.	nauplii									109			
Oithona spiniros.	CV						2						
	CVI-female			1	+		8				25	9	
	CVI-male		1	1								1	
Oncaea borealis	CI-V			2	2		2	1	1	72			3
	CVI-female		7		3			1	4				2
	CVI-male			1				1	1				
Euchaeta norvegica	CI			2				1				7	
	CII			4			1				7	12	
	CIII			5			4					1	
	CIV			1									
	CVI-female			1	+								
	CVI-male											2	
	nauplii				1				3				1
Pseudocalanus elongatus	CI												1
	CIII												4
	CIV			2									
	CVI-female												2
	CVI-male			1			2						
Pseudocalanus minutus	CI	9						2					
	CII				3								
	CIV							1					
	CV							3					
	CVI-female	36		2	1			2		36	16	2	
	CVI-male			1									
Pseudocalanus sp.	nauplii	1105	14	+	1	369	12	3	2	1485	81	8	2

Table 4 (continued).

Abundance of zooplankton categories (ind. m^{-3}) at sampling stations, Davis Strait, May 2000 (WP2, 180µm net). + indicates < 1 individuals m^{-3}.

		Station no.											
		Transect 1: station no.1				D1				D2			
Zooplankton category	Stage\Depth (m)	100-0	200-100	400-200	800-400	100-0	200-100	400-200	800-400	100-0	200-100	400-200	800-400
Scolecithricella sp.	CII				+								
	CIII											3	
	CV							+				3	
	CVI-female				1			1	2				
	CVI-male				1								
Spinocalanus abyssali.	CII												+
	CIII												+
	CVI-female												+
Candacia armata	CII								+				
	CIV								+				
Chaetognatha (*Eukrohnia hamata*)		1		1	+		+		+		2	+	1
Cirripedia cipris	nauplii	27			1					145	54		
Echinodermata	larvae	118	14		1	38	2		1	109	9	1	
Euphausidae	eggs		3	1	1	18	5	4	1	36	11	2	
	nauplii	145	9	8	1	20		1	1	453	18	5	1
	larvae						4	+		36	81	2	
Fritillaria borealis		371	35	8	1	109	10	5		851	27	14	1
Oikopleura sp.		18		2				1	1	91	25		+
Gastropoda	larvae	36	6		+		5	2	3				
Pteropod											1		
Hydromedusae				1	+				1				1
Hyperiidae		5		+									
Ostracoda (*Concoecia elegans*)		27	5	7									
Polychaeta	larvae	9	+	1			2		1		9		
Siphonophora				1					1				

Technical reports from Greenland Institute of Natural Resources

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