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## Gelatinous zooplankton of the Arctic Ocean: in situ observations under the ice

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**Abstract** The gelatinous zooplankton of the Canada Basin were observed with a deep-diving remotely operated vehicle (ROV) during August–September, 2002. Taxa observed fell into four main groups: cnidarians, ctenophores, chaetognaths, and pelagic tunicates. We provide detailed data on the vertical distributions of many taxa from three sites which span the Canada Basin. The most common gelatinous organisms in the surface waters were the ctenophores *Mertensia ovum* and *Bolinopsis infundibulum*. These two species were found in very large numbers in the near-surface mixed layer. In the mesopelagic zone, below the transition from the Pacific water layer and the Atlantic water layer, the most common species was *Sminthea arctica*. Surprising numbers of the scyphomedusa *Atolla tenella* were found in the deep waters of the basin, along with an undescribed species of narcomedusae. The vertical distributions of the gelatinous zooplankton observed with the ROV show several trends related to the physical properties of the water and geographic location within the basin.

### Introduction

One notable gap in understanding the linkages between primary and secondary productivity in the oceans is the lack of knowledge about gelatinous zooplankton.

Predicting when, where and how these soft-bodied animals affect the flux of the materials and energy that flow through oceanic food webs is limited, especially so in Arctic seas. Gelatinous animals are ubiquitous in the oceans; however, when compared with crustaceans like copepods and euphausiids (Smith and Schnack-Schiel 1990; Schnack-Schiel and Mujica 1994; Mumm et al. 1998), relatively little is known about ctenophores, siphonophores, hydromedusae, scyphomedusae, and pelagic tunicates in polar seas (Pagès 1997). Basic descriptions of gelatinous zooplankton from the Arctic Ocean are widely scattered in the published literature over the past century (e.g. Bigelow 1920; Stepanjants 1989), but although an excellent compilation of species has been prepared recently (Sirenko 2001), it provides only crude information on distribution, and no information on abundance.

The most obvious explanation for the paucity of information on gelatinous zooplankton in the Arctic is their extreme fragility. Collection with nets destroys most soft-bodied species or reduces them to fragments. Not as apparent is that the small nets ( $\leq 1$  m diameter) commonly used to sample copepods filter inadequate volumes of water to provide reliable estimates of the widely dispersed, and often patchy gelatinous zooplankton. Furthermore, conventional preservatives often liquefy ctenophores. Therefore, it is not surprising that the basic biodiversity as well as the biomass and abundance of gelatinous animals are grossly underestimated.

A historical reason for ignoring gelatinous zooplankton, beyond those related to collection, has been the belief that they are unimportant to ecosystem function (Thibault et al. 1999); however, recent investigations have shown this to be untrue. For example, in the Arctic polynyas (Ashjian et al. 1997; Acuna et al. 1999), and the Bering Straits (Shiga et al. 1998), large populations have been shown to have considerable grazing impact. Ctenophores, siphonophores and medusae have been previously shown to be present and abundant in Arctic waters (e.g. Stepanjants 1989), feeding on a wide variety of prey, mostly mesozooplankton, but also

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including ichthyoplankton, microzooplankton, and other gelatinous species such as larvaceans, jellyfish, and ctenophores (reviews in Purcell 1991, 1997; Purcell and Arai 2001; also Raskoff 2002; Purcell 2003). Almost nothing is known about the diversity, occurrence, and density of these groups that would allow predictions to be made about their effects on prey populations, like the large stocks of copepods in the Arctic (Smith and Schnack-Schiel 1990; Conover and Huntley 1991; Mumm et al. 1998). Only recently was the trophic importance of large populations of carnivorous gelatinous species studied in Arctic surface waters. In the eastern Canadian high Arctic, the ctenophore, *Mertensia ovum*, is a predominant gelatinous species year-round (Swanberg and Båmstedt 1991; Siferd and Conover 1992). These ctenophores are estimated to consume up to 9% day<sup>-1</sup> of the populations of the larger copepods (*Calanus glacialis*) and 3–4% day<sup>-1</sup> of the smaller copepod species (Siferd and Conover 1992). Other gelatinous predators, when numerous, probably have similar ecological importance (e.g., Brodeur et al. 1999).

The distributions of gelatinous zooplankton are known to be related to physical structure in the water column, especially where water masses of different densities meet, and when water motion creates shear. Numerous examples exist of high densities of gelatinous species at convergences, fronts or halo- or thermoclines (e.g., Hamner and Schneider 1986; Pagès et al. 1996; Hood et al. 1999; Purcell et al. 2000; Graham et al. 2001), or aggregated in thin layers (Youngbluth et al. 1990; Brodeur 1998; Gorsky et al. 2000; Ashjian et al. 2001). The Arctic water column has strong discontinuities due to the gradients of temperature and salt, which result when sea water freezes and when ice melts, plus the existence of several distinct water masses of different

origin layered throughout the water column. The major layers are: reduced salinities and well-mixed waters immediately below the ice (0–20 m), the layer of minimum temperature originating from the Bering Strait and West-Wind Ridge (40–200 m), the Atlantic waters (AWs) entering the Arctic through the Fram Strait (350–600 m), and waters of uniquely Arctic character (below 600 m). Concentrations of plankton at such marked discontinuities are difficult to detect with sampling techniques using plankton nets, which may combine plankton from several layers.

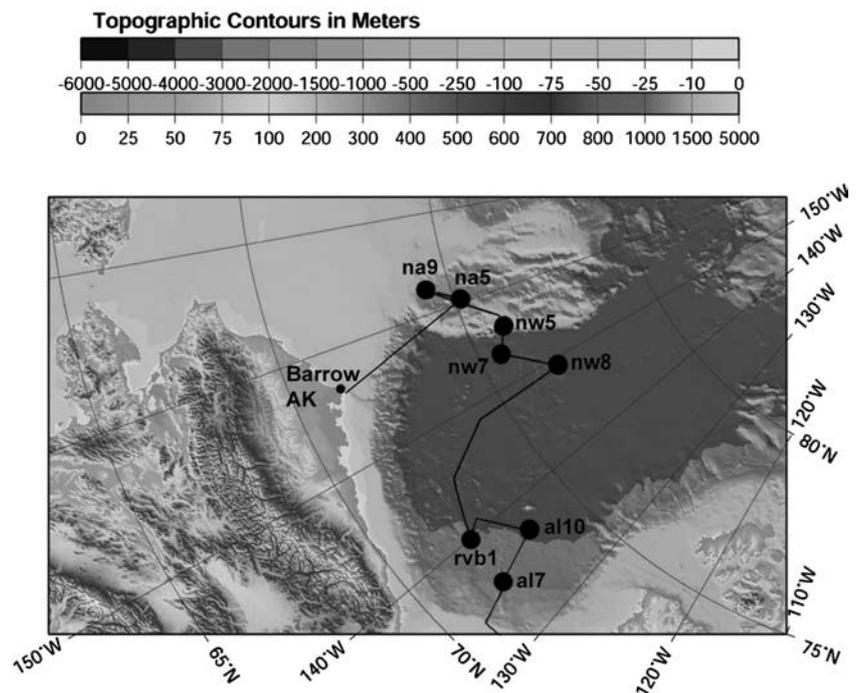
In contrast, the use of new technologies, like submersibles and remotely operated vehicles (ROVs), offer opportunities to examine the vertical distributions of gelatinous zooplankton at meter scales or finer, that are unattainable with towed net systems. Such undersea vehicles have substantially improved our understanding of biodiversity, as well as the interplay between vertical distribution and diel behavior (e.g. Pugh 1989; Larson et al. 1992; Mills 1995; Hopcroft and Robison 1999; Raskoff 2001a; Youngbluth and Båmstedt 2001). In the present study, we enumerate the gelatinous zooplankton observed on ROV dives, and supplement those observations with plankton net and diver collections made in the Canada Basin during August–September, 2002.

## Materials and methods

### Study site

The data were collected during August–September, 2002 aboard the *CCGS Louis S. St-Laurent*, a zone six ice breaker. Pelagic ROV surveys were performed at three stations in the Beaufort Sea and Canada Basin (Fig. 1).

**Fig. 1** Map of ROV, net and diver stations in the Arctic Ocean (deep Canada Basin) in August–September 2002. See Table 1 for details



The first station, AL-10, was at the Eastern edge of the Canada Basin/Beaufort Sea (22 August 2002; 73.5000°N, -136.9833°W; depth 2741 m). The second station, NW-05, was at the Western edge of the Canada Basin (31 August 2002; 75.9333°N, -155.6333°W; depth 1,856 m). The third station, NA-05, was over the Northwind Ridge (5 September 2002; 74.3500°N, -162.1833°W; depth 1,400 m).

### Submersible

The study utilized the ROV Max Rover Mk III “Global Explorer” (Deep Sea Systems), a 2,895 m (9,500 ft) rated submersible. Its primary imaging system consisted of a three-chip wide-angle Sony DXC-390 camera (800 lines horizontal) and a single-chip zoom camera (480 lines horizontal). A 3.3 Mb digital still camera (modified Canon G1) with flash was used for still image capture. Four green lasers, 10 cm apart in a square pattern, enabled in situ sizing of larger objects. Lighting was accomplished with two 150 W halogen flood-lights and four 100 W high-intensity discharge gas arc lights. Lights were modified into spots-beams for better imaging in the midwater. A Seabird CTD was attached to the ROV for collection of oceanographic data during the dives. Images and data were carried to the surface by a fiber optic tether, which also powered the vehicle. A carousel suction sampler (Youngbluth 1984) was installed to capture specimens and bring them to the surface. On each dive, the entire water column was traversed vertically to ascertain the distribution of gelatinous animals.

The numbers of organisms observed were normalized to a proxy of abundance: number observed per hour. Normalization was accomplished by dividing the number of observations of a given taxa, in 50 m depth strata, by the amount of time the ROV spent in that strata (Fig. 2). This normalization allows for comparisons between depth strata that received different lengths of ROV observation time.

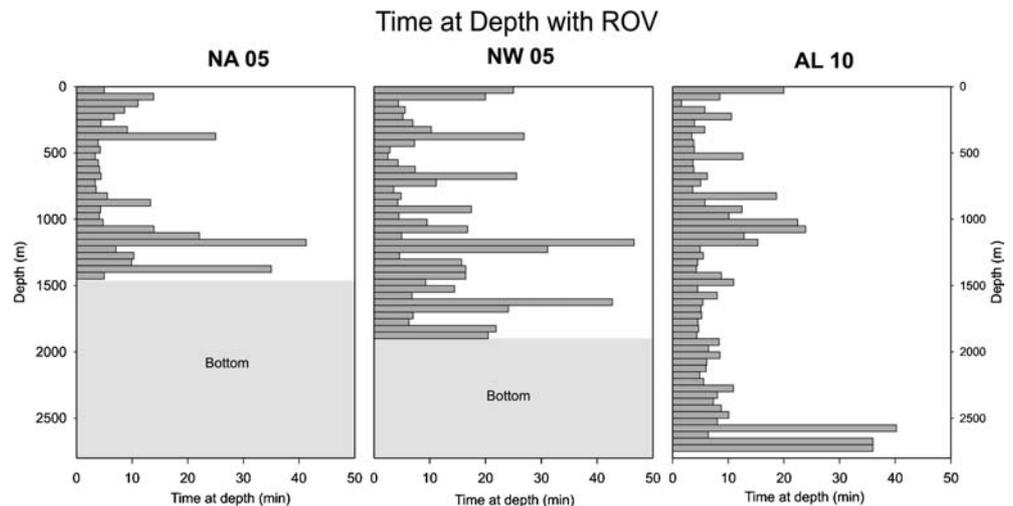
Supplementary qualitative collections were performed with a 0.6-m-diameter ring net fitted with a 64- $\mu\text{m}$  mesh and a large 25-l, non-filtering cod end. The net was hauled vertically from 500 m to the surface at 0.3 m  $\text{s}^{-1}$  and immediately sorted live for examination under the microscope. The lack of a flow meter, and potential clogging concerns, only permitted the net to be used for qualitative sampling for taxonomic and observational purposes. The net does, however, provide additional information on the small gelatinous species of the surface waters, which are very hard to image with the ROVs camera systems due to high levels of down-welling light. Additionally, scuba divers from other projects collected several animals, and reported qualitative numbers of gelatinous zooplankton in the surface 25 m of the water.

## Results

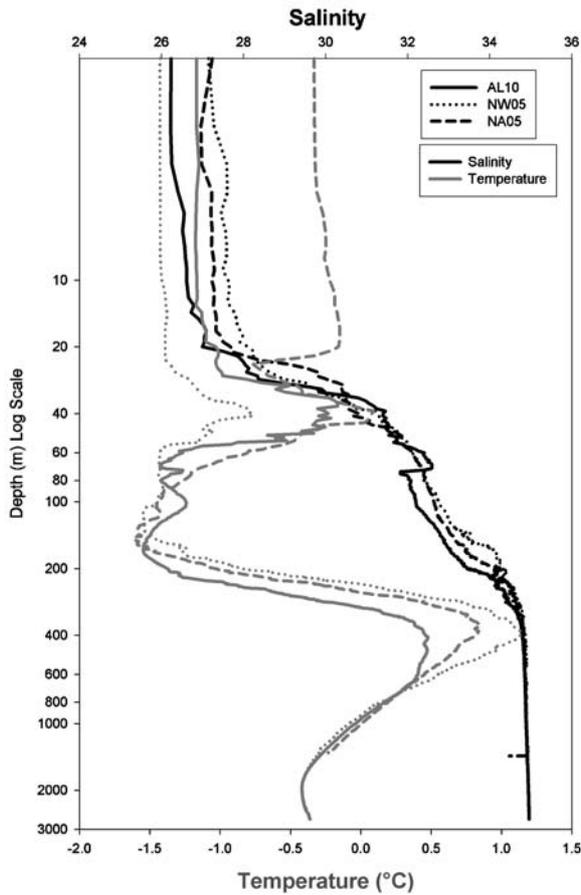
### Physical data

The complex nature of the three main water masses (and their transition zones) of the Canada Basin was apparent and similar on all dives (Fig. 3). From the surface down to ~25 m was the mixed zone (MZ), with a fairly uniform temperature profile. Below the MZ were the Pacific waters (PW), in which the temperature increased to a depth of about 40 m, then decreased to a minimum ( $T_{\text{min}}$ ) at 160–180 m. The  $T_{\text{min}}$  marked the transition to the third water mass, the AWs in which temperature increased to a maximum ( $T_{\text{max}}$ ) at ~400 m, indicating the location of the Fram Straight Branch waters (FSB). Below approximately 2,000 m were the deep basin bottom waters, which have very long ventilation times (> 500 years; F. McLaughlin, personal communication) and little mixing with the other water layers. A fuller account of the physical oceanographic conditions during the cruise is presented elsewhere (McLaughlin et al. 2004).

**Fig. 2** Durations of times spent at depth during three pelagic ROV dives in the Arctic Ocean (deep Canada Basin) in August–September 2002



### Temperature and Salinity Profiles from ROV Stations



**Fig. 3** Temperature and salinity profiles on the three pelagic ROV dives in the Arctic Ocean (deep Canada Basin) in August–September 2002. Depth is plotted on a log scale to elucidate the sharp transitions in the surface waters. Bottom depths for the three stations were: AL-10, 2,741 m; NW-05, 1,856 m; and NA-05, 1,400 m

#### Pelagic fauna

During the three pelagic ROV dives, we observed a total of 618 macrozooplankters. Many were easily identifiable to species level; however, because of the short time they were visible in the ROVs cameras, or because of the poor quality of some the images, often they could be identified only to a higher taxonomic level, such as “calycophoran siphonophore,” or “chaetognath.” The three ROV dives accounted for 22.15 h of observation time, yielding an average of 27.9 specimens observed hour<sup>-1</sup>. The gelatinous zooplankton that we observed fell into four main taxa: cnidarians, ctenophores, chaetognaths, and pelagic tunicates.

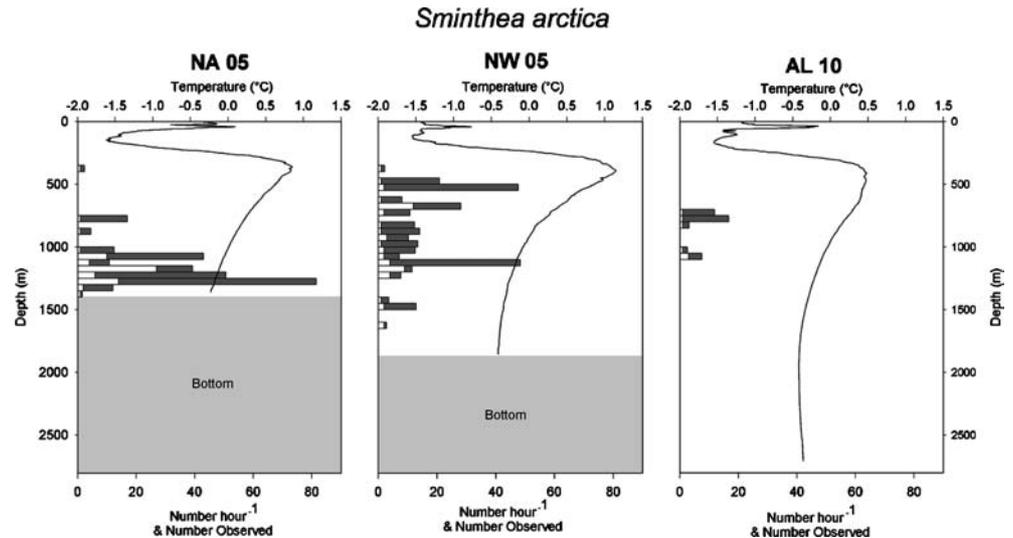
#### Cnidarians

Hydromedusae were the most common gelatinous taxa in the non-mixed layer waters (i.e., deeper than 25 m). Six species were observed: the trachymedusae, *Sminthea*

*arctica*, *Botrynema ellinorae*, *Aglantha digitale*, a benthopelagic species thought to be a *Crossota* sp., and the narcomedusae, *Aeginopsis laurentii* and a new undescribed species (probably an Aeginidae). *S. arctica* was the most common species, with 126 individuals observed by the ROV, reaching frequencies of over 80 ind. h<sup>-1</sup> (Fig. 4). The population was restricted to the AW layer, being bounded by the FSB at the top and the lower reaches of the AW or the ocean floor. There were interesting differences between the distributions of *S. arctica* at stations NW-05 and NA-05. The population at NA-05 peaked much deeper in the water column, close to the bottom, but not within 50 m of it (i.e., not benthopelagic). There were increasing numbers of *S. arctica* from East to West, with the highest number of observations and ind. h<sup>-1</sup> at the western-most station; NA-05. *S. arctica* was also the most numerous jellyfish in the net hauls (Table 1). The net tows showed this species to be more common in the middle and eastern basin, with a maximum of 24 medusae collected at station NW-08. *B. ellinorae* were observed by the ROV at all three stations in low numbers. Two were found at station AL-10 (670 and 1,080m), ten at NW-05 (397, 880, 1,200, and 1,678 m), and one at station NA-05 (1,352 m). Aside from an upper boundary of the FSB waters, the data suggest a wide vertical range for *B. ellinorae*. Small numbers were captured in the net hauls, spread across the basin in fairly uniform numbers (Table 1).

*Aglantha digitale*, classically one of the most common medusa in the Arctic, were found in the net hauls across the entire basin in even abundance (Table 1), but were not identified with certainty from the ROV. Their small size and great transparency made detection with the video system very difficult. An epibenthic trachymedusa, thought to be a species of *Crossota*, was found at stations NA-05, at 1,400 m, and the benthic ROV station RVB1, at 2,765 m (Bluhm et al. 2004). The similar-looking *Ptycogastria polaris* has been found off Greenland and the northern Barents Sea (Stüebing and Piepenburg 1998). The four-tentacled narcomedusae, *Aeginopsis laurentii*, often cited as one of the most common zooplankton in the area, were found in small numbers, both with the net (one collected at the eastern-most station; Table 1) and with the ROV. It appeared to have a greater abundance in the Eastern Canada Basin and Beaufort Seas, with seven observations at station AL-10 (1,130, 1,346, 1,350, 1,419, 1,520, 1,560, and 1,598 m), five seen at NW-05 (683, 1,200, 1,703, 1,790, and 1,808 m), while none were seen at NA-05. All were seen in the AW layer, well below the FSB peak. A single specimen of a previously unidentified narcomedusae was collected with the ROV at 1,346 m at station AL-10. This four-tentacled medusa resembles an *Aegina* species, but it has secondary tentacles and three stomach pouches per quadrant. Its description will be published elsewhere. Apart from these hydromedusae species, there were 33 other sightings of hydromedusae that were not identified, five at station AL-10, 24 at NW-05, and four at NA-05.

**Fig. 4** Vertical distribution of the trachymedusan, *Sminthea arctica*, observed on three pelagic ROV dives in the Arctic Ocean (deep Canada Basin) in August–September 2002. The temperature profile is also shown. Data show the numbers of specimens observed standardized to number hour<sup>-1</sup> (dark bars) with the numbers of observed specimens superimposed (light bars)



Three scyphomedusa species were found during the cruise, *Cyanea* sp., *Chrysaora melanaster*, and *Atolla tenella*. One *Cyanea* sp. was observed at station AL08, during an ROV test dive in the surface MW layer down to 40 m. *C. melanaster* was common in the surface MW layer and in the upper PW layer (Fig. 5). A single individual was seen at AL-10, ten at NW-05, and one at station NA-05. The medusae are relatively large, one individual being measured with a bell diameter of over 30 cm and a tentacle length greater than 3 m. *C. melanaster* was also observed by the divers at station NW08 (Table 1). The coronate scyphomedusae *A. tenella* was observed at all ROV stations (Fig. 6). It occurred in small numbers at the eastern and western stations, but in great numbers at station NW-05. The population was found below 1,000 m at all sites and, at station NW-05, occurred in numbers rivaling those of other mesopelagic cnidarians in well-studied, nutrient-rich coastal environments, such as Monterey Bay, CA (Robison et al. 1998; Raskoff 2001a, b), with 37 *A. tenella* observed at NW-05.

Siphonophores appeared in two groups, physonects at ~250–500 m depth in the top of the AW layer, and calycophorans at ~1,100–1,300 m depth in the bottom of the AW layer (Fig. 7). The physonects appeared *Nanomia*-like, but positive identification and collection was not possible. *Marras* sp. is the most common physonect described from Arctic waters. The calycophorans were diphyiids, but because of their small size, they could not be identified to species from ROV images. The diphyiid, *Dimophyes arctica*, was the only siphonophore collected in the net tows, and it occurred at several stations across the entire basin (Table 1).

#### Ctenophores

The large cydippid ctenophore, *M. ovum*, was abundant in the near-surface MZ waters (Fig. 8). *M. ovum* was found exclusively in the surface 50 m, with well over

99% found from 0 to 25 m. At station NW-05, 61 *M. ovum* were observed in just 20 min, giving a normalized frequency of ~150 ind. h<sup>-1</sup>. At station NA-05, they were even more common, with 41 seen in just over 5 min, for a normalized frequency of ~500 ind. h<sup>-1</sup>. Several unidentified deep-water cydippids were seen at stations AL-10 (310 and 770 m), NW-05 (857, 939, 1,340, and 1,502 m), and NA-05 (338 m). The lobate, *Bolinopsis infundibulum*, was also observed at very high frequencies in the surface waters (Fig. 9). Fifty-three *Bolinopsis vitrea* were seen at station NW-05, for a normalized frequency of more than 125 ind. h<sup>-1</sup>, and six were seen in 5 min at station NA-05. There were five sightings at 700–1,600 m depth of deep-water lobates that were not identified. Five *Beroe cucumis* were observed in the surface waters (one at AL-10 and four at NW-05) and one at 376 m at NA-05. The three species of near surface-dwelling ctenophores were also observed and collected by the divers at additional stations (Table 1). Thus, *B. vitrea*, *M. ovum*, and *Beroe ovata* occurred near the surface throughout the Canada Basin.

#### Chaetognaths

Chaetognaths were seen at all stations in the upper 700 m of the water column (Fig. 10), but could not be identified from ROV images. They were observed in the near-surface waters at station NW-05 and in the upper AW layer (250–700 m). Chaetognaths were also collected in all net tows performed across the entire basin (Table 1, also see Hopcroft et al. 2004). Identification of images to species was not possible.

#### Pelagic tunicates

Pelagic tunicates observed by the ROV include larvae and an unidentified doliolid species. The larvae had a complex vertical distribution (Fig. 11), with

**Table 1** Collections of gelatinous predators made by plankton nets and scuba divers in the Arctic Ocean, Canada Basin

Station	Date	Depth (m)	Latitude	Longitude	<i>Sminthea</i>	<i>Botrynema</i>	<i>Aglantha</i>	<i>Aeginopsis</i>	<i>Chrysaora</i>	<i>Dimophyes</i>	<i>Beroe</i>	<i>Bolinopsis</i>	<i>Mertensia</i>	Chaetognaths
AG-05	16 August 2002	200	70°36'	122°56'			X (3)	X (1)			X	X	X	X
AL-07	18 August 2002	500	71°42'	134°41'		X	X		X			X	X	X
AL-10	20 August 2003	200	73° 9'	137°00'		X	X							X
RVB1	24 August 2004	< 25m	72°06'	139°50'							X (d)	X (d)	X (d)	
NW08	27 August 2005	500	76°46'	148°57'	X (18)	X (7)	X (5)		X (d)		X (d)	X (d)	X	X
NW08	28 August 2006	1,500	76°52'	148°10'	X (24)	X (6)	X (4)			X	X (d)	X (d)	X (d)	X
NW07	29 August 2007	500	75°33'	153°08'	X (4)	X (1)	X (1)							X
NW05	1 September 2002	500	75°56'	155°42'	X (7)	X (3)	X (3)			X(d)			X (2, d)	X
NA09	5 September 2002	500	75°09'	160°11'	X		X			X				X

X present, n number observed in net, if recorded, d diver observation or collection

individuals of *Oikopleura vanhoeffeni* observed from the surface to at least 1,200 m, spanning the near-surface MZ layer and transversing the entire AW layer. At station AL-10, a different species of very deep-water larvaceans were found at 2,200–2,600 m, that likely represents an undescribed species. Two doliolids were seen in the near-surface MZ layer at station NW-05 (18 and 45 m).

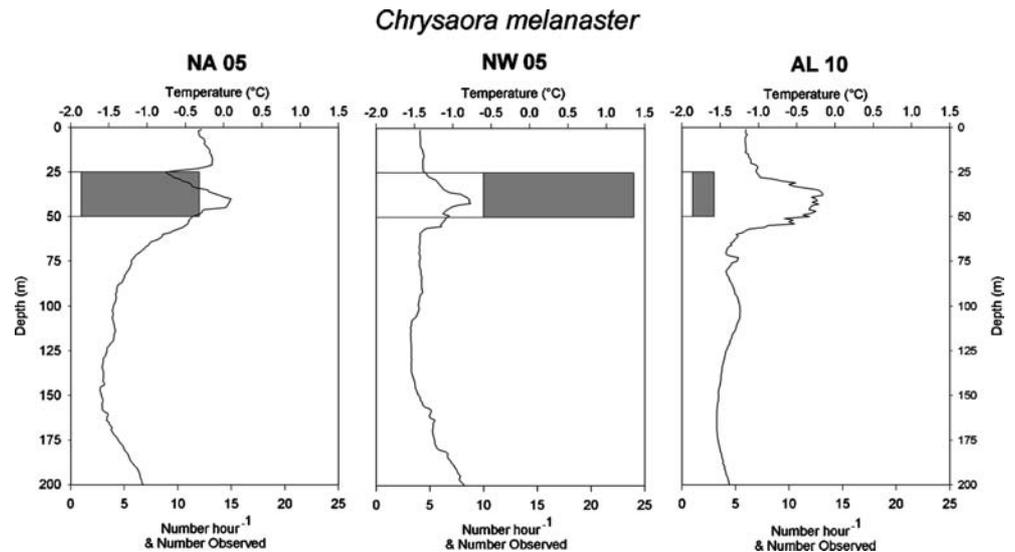
## Discussion

The vertical distributions of the gelatinous zooplankton observed with the ROV show several trends related to the physical properties of the water. The MZ waters in the near-surface were of constant temperature and salinity, and high oxygen concentrations (Fig. 3). Within this zone there were surprisingly large numbers of the cydippid ctenophore, *M. ovum*, and lobate *B. infundibulum* (Figs. 8, 9). Additionally, there were abundant scyphomedusae, *C. melanaster*, larvaceans, and chaetognaths (Figs. 5, 10, 11). All of these species feed either on near-surface phytoplankton (larvaceans), or on the primary consumers in the system, the copepods (ctenophores and chaetognaths). *C. melanaster* probably feeds on the copepods and all of the other gelatinous taxa. All of these gelatinous organisms are well suited to take advantage of episodic and unpredictable phytoplankton blooms under the ice and in polynyas. The extraordinary number of *M. ovum* observed points to what an important predator this species is in the Arctic waters. If the number of *M. ovum* observed hour<sup>-1</sup> at station NA05 held steady over a 24-h period, the number of individuals observed day<sup>-1</sup> is calculated at 11,808. Using ash-free dry weight values and copepod predation rates predicted by Swanberg and Båmstedt (1991b), the daily concentration of *M. ovum* would be in excess of 760 kg AFDW and the consumption over 470,000 copepods day<sup>-1</sup>. Admittedly, these numbers are hypothetical and rough at best, but they do well to illustrate the potential predatory impact these large populations may have on the ecosystem.

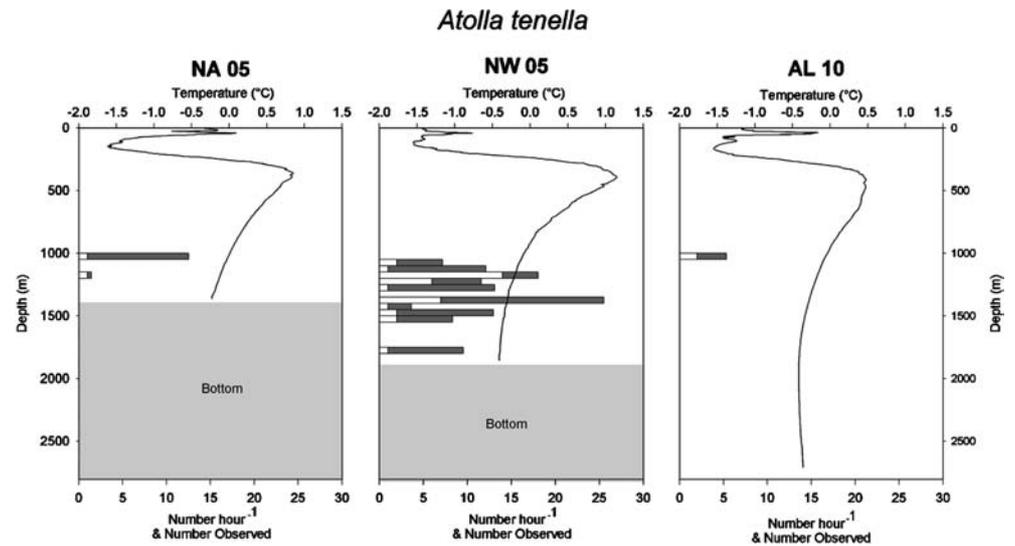
Below the MZ are the PW, in which the temperature quickly increases to a depth of 40 m and then decreases to a minimum ~170 m (Fig. 3). Coinciding with this low temperature water are very low concentrations of dissolved oxygen (F. McLaughlin personal communication), and very few organisms. The only taxa observed in the PW layer were the chaetognaths (Fig. 11), all other species were found below this low temperature, low oxygen concentration region. Many gelatinous taxa are very tolerant of low oxygen concentrations in coastal and mesopelagic mid-latitude environments (reviewed in Purcell et al. 2001), but the effects of low dissolved oxygen on Arctic organisms in extremely low temperatures are not known.

The transition to the AW, which is marked by the temperature minimum zone at ~170 m (Fig. 3), also

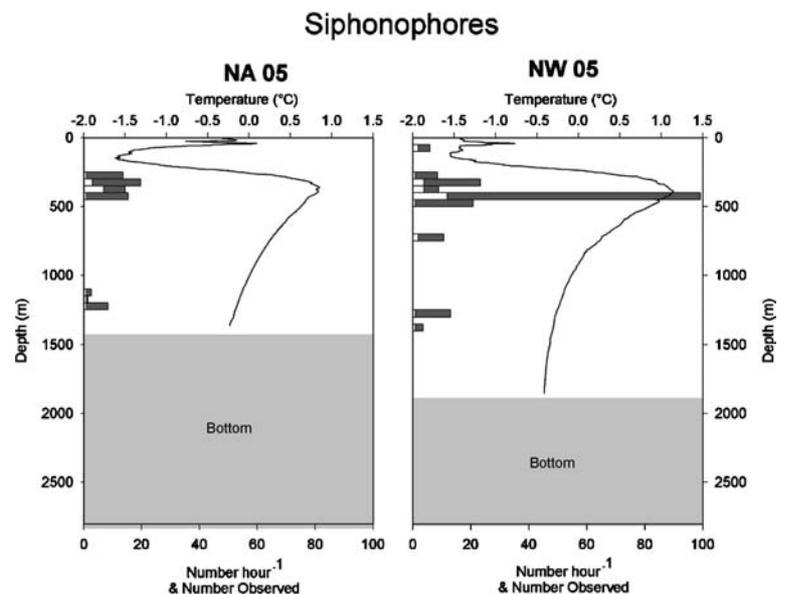
**Fig. 5** Vertical distribution of the scyphomedusan, *C. melanaster*, observed on three pelagic ROV dives in the Arctic Ocean (deep Canada Basin) in August–September 2002. The temperature profile is also shown. *Bars* as in Fig. 4



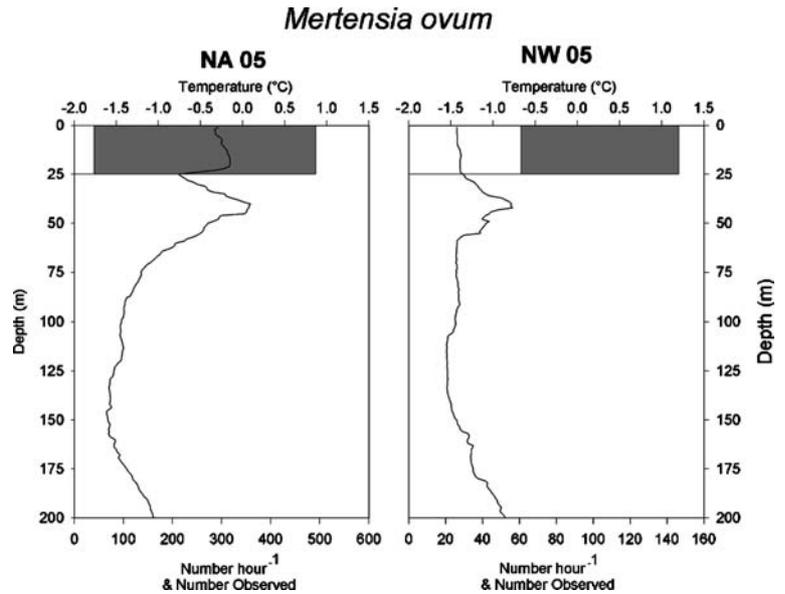
**Fig. 6** Vertical distribution of the scyphomedusan, *A. tenella*, observed on three pelagic ROV dives in the Arctic Ocean (deep Canada Basin) in August–September 2002. The temperature profile is also shown. *Bars* as in Fig. 4



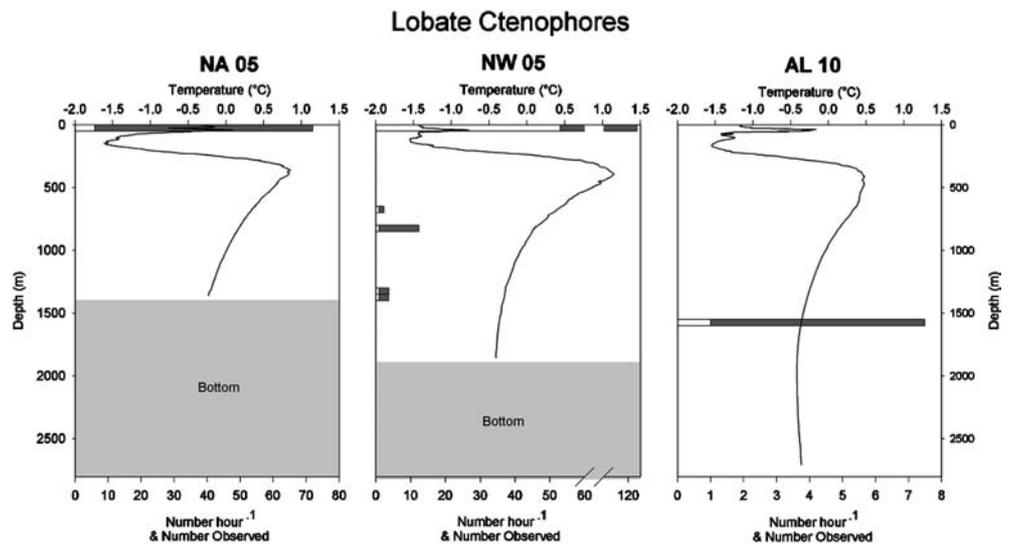
**Fig. 7** Vertical distribution of siphonophores, observed on two pelagic ROV dives in the Arctic Ocean (deep Canada Basin) in August–September 2002. Physonects were at depths of ~250–500 m, and calyphorans were at depths of ~1,100–1,300 m. The temperature profile is also shown. *Bars* as in Fig. 4



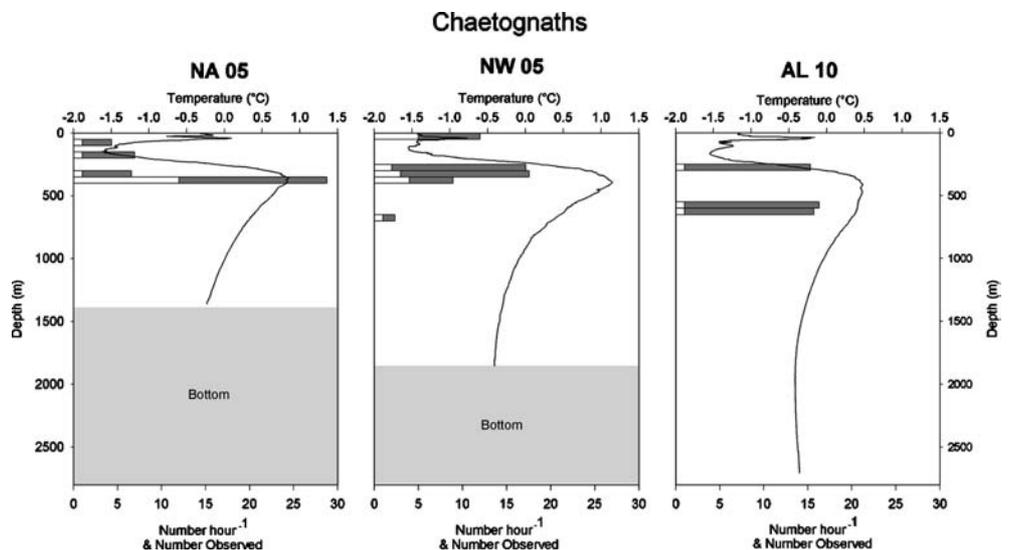
**Fig. 8** Vertical distribution of the cydippid ctenophore, *M. ovum*, observed on three pelagic ROV dives in the Arctic Ocean (deep Canada Basin) in August–September 2002. Bars as in Fig. 4. Note differing x-axis scales



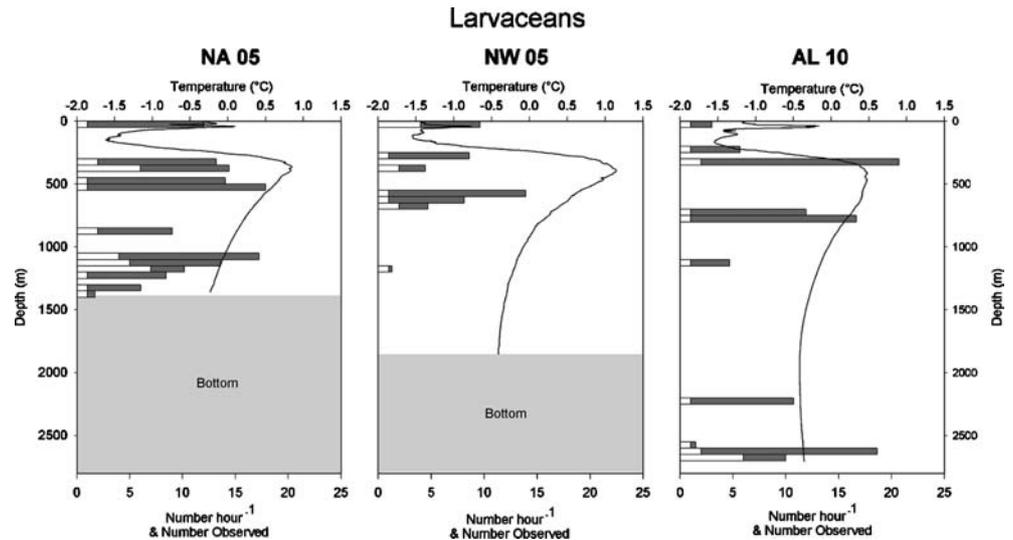
**Fig. 9** Vertical distribution of lobate ctenophores, observed on three pelagic ROV dives in the Arctic Ocean (deep Canada Basin) in August–September 2002. Shallow specimens were *B. infundibulum*. The temperature profile is also shown. Bars as in Fig. 4. Note differing x-axis scales and broken scale on site NW-05



**Fig. 10** Vertical distribution of chaetognaths observed on three pelagic ROV dives in the Arctic Ocean (deep Canada Basin) in August–September 2002. The temperature profile is also shown. Bars as in Fig. 4



**Fig. 11** Vertical distribution of larvaceans observed on three pelagic ROV dives in the Arctic Ocean (deep Canada Basin) in August–September 2002. The temperature profile is also shown. Bars as in Fig. 4



showed an increase in the number of gelatinous organisms. Siphonophores, larvaceans, and chaetognaths were all numerous in the top of the AW layer, below the temperature and oxygen minimum zone (Figs. 7, 10, 11). In the deeper waters of the AW layer were found several species of trachymedusae and narcomedusae, including *S. arctica*, the most common deep-water gelatinous organism (Fig. 4). The coronate scyphomedusan, *Atolla tenella*, was seen in great numbers at station NW-05 (Fig. 6).

Most of the gelatinous species in the deep Canada Basin were holoplanktonic species that do not rely on an attached phase in their life cycle. The trachymedusae, narcomedusae, and the scyphomedusa *A. tenella* are thought to be holoplanktonic; however, a complete study of their life histories is lacking. The other gelatinous taxa found in high numbers over deep waters were the ctenophores, chaetognaths, and larvacean, which also are holoplanktonic groups. The large scyphomedusae, *C. melanaster*, and *C. capillata* are the exceptions to this trend. The locations of their benthic polyps are not known, but they are probably long-living species that may be transported long distances during their lives. Overall, the vertical distributions observed for *Aglantha digitale*, *Aeginopsis laurentii*, *B. ellinorae*, and *S. arctica* are consistent with recent observations from the Lomonosov Ridge (Kosobokova and Hirche 2000). Stable isotope research on the trophic feeding level of *S. arctica* has just been completed from the Arctic (Iken et al. 2004). Several benthic cnidarian polyp tubes were collected by the benthic team (Bluhm et al. 2004). The hard tubes resembled those known from coronate scyphomedusae, and have been tentatively identified as *Nausithoe* sp. (G. Jarms, personal communication), which appears to be a new record for the area (Bluhm et al. 2004).

With the exception of the new species of narcomedusae collected, none of the identified zooplankton found in this study is a new record for the Canada Basin

or Beaufort Sea. However, several deep-water species of medusae, siphonophores, and larvaceans were observed but could not be identified or collected. With only three ROV dives spread over a very large area of the basin, we expect future work in these areas to find additional species. This study provides the highest resolution data ever published regarding the vertical distributions of the gelatinous zooplankton in the Arctic Ocean.

Current dogma predicts that jellyfishes will have low diversity, wide distribution, and low abundance in the Arctic Ocean, principally because of the permanent cover of ice, the short season for primary production, and the limited amount of inter-ocean exchange. This work has shown that most of the gelatinous zooplankton, including herbivorous and carnivorous species, have been inadequately sampled with nets in the Arctic, as in other oceans. Recent studies have indicated that rates of primary production are much larger than reported previously (Wheeler et al. 1996; Lee and Whitledge 2004), and consequently, the biomass of consumers should be larger as well (Thibault et al. 1999; Hopcroft et al. 2004). Alternatively, the relatively slow growth rates of many Arctic species may allow for significant accumulation of gelatinous predator biomass even if the biomass of their prey appears low.

Since gelatinous zooplankton can be major consumers of primary and secondary production, the consequences of their trophic activities, and changes in them, are likely to have major effects on the Arctic pelagic food webs, and, through sedimentation of particulate matter, on pelagic–benthic coupling. There is a diverse “jelly web,” that has important effects on structuring the planktonic community (Robison 2004). Clearly, a more complete understanding of not just the distributions of gelatinous zooplankton, but also studies on their physiologic and trophic biology is needed. The biomass and diversity observed in just these three ROV dives underscores the importance of the role these soft-bodied organisms play in the Arctic ecosystem. With the ever

increasing threat of loss of sea ice cover due to global warming and other factors, more attention must be paid to the gelatinous plankton of the Arctic Ocean.

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