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Spatial variability in organic material sinking export in the Hudson Bay system, Canada, during fall

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ABSTRACT

Spatial variations in the sinking export of organic material were assessed within the Hudson Bay system (i.e., Hudson Bay, Hudson Strait and Foxe Basin) during the second oceanographic expedition of ArcticNet, on board the CCGS *Amundsen* in early fall 2005. Sinking fluxes of particulate organic material were measured using short-term free-drifting particle interceptor traps deployed at 50, 100 and 150 m for 8–20 h at eight stations. Measurements of chlorophyll *a* (chl *a*), pheopigments (pheo), particulate organic carbon (POC), biogenic silica (BioSi), protists, fecal pellets and bacteria were performed on the collected material. In parallel, sea surface salinity and temperature were determined at 121 stations in the Hudson Bay system. Three hydrographic regions presenting different sedimentation patterns were identified based on average surface salinity and temperature. Hudson Strait was characterized by a marine signature, with high salinity (average = 32.3) and low temperature (average = 2.1 °C). Eastern Hudson Bay was strongly influenced by river runoff and showed the lowest average salinity (26.6) and highest average temperature (7.6 °C) of the three regions. Western Hudson Bay showed intermediate salinity (average = 29.4) and temperature (average = 4.4 °C). Sinking fluxes of total pigments (chl *a*+pheo: 3.37 mg m^{-2} d^{-1}), diatom-associated carbon (19.8 mg m^{-2} d^{-1}) and BioSi (50.2 mg m^{-2} d^{-1}) at 50 m were highest in Hudson Strait. Eastern Hudson Bay showed higher sinking fluxes of total pigments (0.52 mg m^{-2} d^{-1}), diatom-associated carbon (3.29 mg m^{-2} d^{-1}) and BioSi (36.6 mg m^{-2} d^{-1}) compared to western Hudson Bay (0.19, 0.05 and 7.76 mg m^{-2} d^{-1}, respectively). POC sinking fluxes at 50 m were low and relatively uniform throughout the Hudson Bay system (50.0–76.8 mg C m^{-2} d^{-1}), but spatial variations in the composition of the sinking organic material were observed. A large part (37–78%) of the total sinking POC was unidentifiable by microscopic observation and was qualified as amorphous detritus. Considering only the identifiable material, the major contributors to the POC sinking flux were intact protist cells in Hudson Strait (28%), fecal pellets in eastern Hudson Bay (52%) and bacteria in western Hudson Bay (17%). A significant depth-related attenuation of the POC sinking fluxes (average loss between 50 and 150 m = 32%) and a significant increase in the BioSi:POC ratio (average increase between 50 and 150 m = 76%) were observed in Hudson Strait and eastern Hudson Bay. For all other sinking fluxes and composition ratios, we found no statistically significant difference with depth. These results show that during fall, the sinking export of total POC from the euphotic zone remained fairly constant throughout the Hudson Bay system, whereas other components of the organic sinking material (e.g., chl *a*, BioSi, fecal pellets, protist cells) showed strong spatial variations.

1. Introduction

Over the last few decades, there has been a growing interest in climate change and its effect on arctic and subarctic environments (e.g., Johannessen et al., 1995; Moritz et al., 2002; Serreze et al., 2007). Environmental changes already observed include a decline in the volume and extent of the sea-ice cover (Johannessen et al., 1999; Comiso et al., 2008), an advance in the melt period (Overpeck et al., 1997; Comiso, 2006), and an increase in river discharge to the Arctic Ocean (Peterson et al., 2002; McClelland et al., 2006) due to increasing precipitation and terrestrial ice melt (Peterson et al., 2006).

Hudson Bay, Hudson Strait and Foxe Basin (the Hudson Bay system) make up a large inland sea in the Canadian subarctic region (Jones and Anderson, 1994). Hudson Bay is a shallow

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embayment (average depth = 120 m; Prinsenberg, 1984) strongly influenced by riverine input, mainly from the Nelson, Severn, Churchill, Great Whale, Winisk, and James Bay rivers (Fig. 1; Déry et al., 2005). Hudson Strait, with an average depth of 400 m, links Hudson Bay and Foxe Basin with the Labrador Sea (Drinkwater and Jones, 1987; Jones and Anderson, 1994). The climate of this system is anomalously cold in comparison to other regions of similar latitudes because of the presence of a seasonally varying ice cover (Rouse, 1991). Its subarctic location and the presence of a seasonal ice cover make the Hudson Bay system particularly vulnerable to climate-related changes. Indeed, the sea-ice extent in Hudson Bay decreased by $2000 \pm 900\,km^2\,y^{-1}$ between 1978 and 1996 (Parkinson et al., 1999). An increase in the mean annual sea surface temperature, earlier ice breakup and delayed freeze-up were also detected in Hudson Bay between 1971 and 2003 (Gagnon and Gough, 2005a). The average surface water temperature projected for 2070–2099 is between 4.8 and 8.0 °C higher than the average for 1961–1990 (Gagnon and Gough, 2005b).

The global carbon cycle, and particularly the increase in atmospheric CO_2 concentrations, plays a key role in the warming trend observed over the past decades (IPCC, 2007). As part of the global carbon cycle, atmospheric CO_2 is transferred to the surface ocean by diffusion and can be converted into organic carbon by primary producers. The fate of surface primary production, i.e., channeling through grazers, recycling in the water column or sinking export to depth, is influenced by a variety of factors, including the taxonomic composition of the phytoplankton (e.g., Boyd and Newton, 1995) and zooplankton communities (e.g., Pasternak et al., 2002; Wexels Riser et al., 2002) as well as transformation processes taking place during sinking (e.g., Boyd et al., 1999). Since phytoplankton cells and fecal pellets from herbivores constitute important channels for the sinking export of organic material to depth, these constituents are typically quantified in sinking export studies (e.g., Turner, 2002; Caron et al., 2004). Nevertheless, a few studies have shown that the contribution of bacteria to the sinking export of organic material can also be important (e.g., Pedrós-Alió et al., 1989; Turley and Mackie, 1994). Hence, it is important to quantify bacteria sinking fluxes to better quantify and understand processes controlling the sinking export of organic material. The amount and composition of sinking particles are commonly characterized using particle interceptor traps, while transformation during sinking is assessed from changes in particle sinking fluxes with depth (e.g., Martin et al., 1987; Michel et al., 2002; Juul-Pedersen et al., 2008).

In the Hudson Bay system, several studies have focused on the phytoplankton (e.g., Anderson and Roff, 1980; Drinkwater and

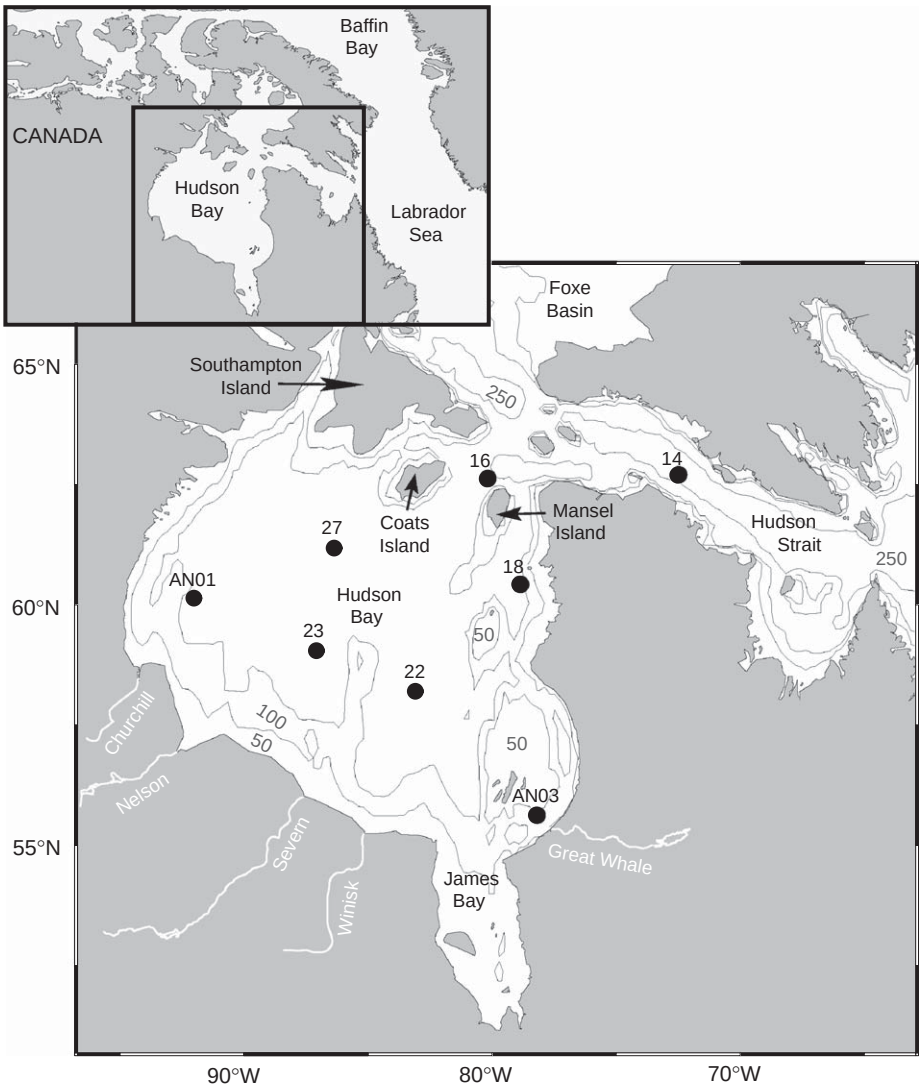

Fig. 1. Location of the sampling stations in the Hudson Bay system during early fall 2005. Isobaths are in meters.

Jones, 1987; Harvey et al., 1997) and zooplankton communities (e.g., Rochet and Grainger, 1988; Harvey et al., 2001). The only published study on the sedimentation of organic material in Hudson Bay was carried out at a land-fast ice station in the southeastern part (Tremblay et al., 1989). To our knowledge, no study on the sinking export of organic material has been published for the Hudson Bay system in open water conditions.

In the present study, we investigated the spatial variability in the sinking export of organic material in the Hudson Bay system during the open water period. The three main objectives of this work were to (1) characterize spatial variations in the sedimentation of organic material in the Hudson Bay system, (2) investigate how spatial variations in the magnitude and composition of organic material sinking fluxes may reflect hydrographic forcing in the Hudson Bay system, and (3) assess the attenuation of organic material sinking fluxes with depth and, consequently, the significance of degradation of the material exported below the euphotic zone in this shallow and cold inland sea. Our working hypotheses were that (1) the existence of different hydrographic regions in the Hudson Bay system would play a role in shaping the sedimentation patterns of organic material in this environment and (2) the degradation of organic material during sinking would be of minor importance in such a shallow subpolar sea.

2. Material and methods

2.1. Study area

The Hudson Bay system is under the influence of various water inputs, i.e., the Arctic Ocean, the Labrador Sea, river runoff and precipitation. Arctic Ocean water enters the system through Fury and Hecla strait and moves southward through Foxe Basin (Sadler, 1982; Prinsenberg, 1986a). Some of this water mass exits the system through Hudson Strait, while the remaining joins the cyclonic circulation around the bay (Prinsenberg, 1986b; Ingram and Prinsenberg, 1998). Labrador Sea water enters the bay along the north side of Hudson Strait, joining arctic water from Foxe Basin (Prinsenberg, 1986b; Jones and Anderson, 1994). In addition, Hudson Bay receives a large freshwater contribution from river runoff (ca., 562 $km^3 y^{-1}$; Déry et al., 2005). Freshwater input from rivers, sea-ice melt and precipitation contributes to a strongly stratified water column in Hudson Bay (Prinsenberg, 1984). Conversely, the strong tidal currents (>2–$3\ m\ s^{-1}$) and large tidal range (>4 m) in Hudson Strait generate strong vertical mixing that influences vertical profiles of temperature, salinity and nutrients and, consequently, primary production processes (Drinkwater and Jones, 1987; Arbic et al., 2007).

2.2. Sampling

Sampling was carried out on board the research icebreaker CCGS *Amundsen* from 23 September to 16 October 2005. Short-term free-drifting particle interceptor traps were deployed at eight stations for 8–20 h at two or three depths below the euphotic zone (from 50 to 150 m), depending on water depth at the station (Fig. 1). The deployment duration was ultimately contingent upon the expedition plan and sampling schedule. Details for each deployment are presented in Table 1. The particle interceptor traps were polyvinyl chloride (PVC) cylinders with an internal diameter of 10 cm and an aspect ratio (height:diameter) of 7. Four particle interceptor traps, centered at the mooring depth, were installed on the trap line in order to collect enough material for the analyses. Particle interceptor trap deployments and handling were performed according to JGOFS protocols (Knap et al., 1996) and following the recommendations of Gardner (2000). The free-drifting particle interceptor trap array was surface-tethered with a series of small floats to minimize vertical motion on the trap line. Before deployment, the traps were filled with seawater collected at depth and filtered through 0.22 μm polyvinyliden fluoride (PVDF) Millipore Durapore membrane filters. No poison or preservative was used during the deployments. Upon recovery, the traps were covered with a tight clean lid and placed in the dark at 4 °C for a sedimentation period of 8 h. After the sedimentation period, the supernatant was carefully removed and the bottom volume of the trap samples, which was sieved through a 450 μm mesh to remove large swimmers, was kept for further analyses. Individual samples collected from traps deployed in the same depth horizon were pooled to obtain one sample per depth, which was used for subsequent analyses. During the expedition, sea surface salinity and temperature were measured using a CTD (Sea-Bird 911 plus) and transmissiometry was measured with a WET Labs CST-558DR probe at 121 stations in Hudson Strait, Hudson Bay and at the mouth of Foxe Basin. Euphotic zone depth (i.e., depth of 1% surface irradiance) was established according to the light attenuation in the water column measured using a Secchi disc (Holmes, 1970). Benthic nepheloid layer depths were estimated from vertical transmissiometer profiles at each particle interceptor trap station (Table 1).

2.3. Laboratory analyses

Duplicate trap subsamples were filtered onto Whatman GF/F glass fiber filters for fluorometric determination of chlorophyll *a* (chl *a*) and pheopigments (pheo) after a 24 h extraction in 90% acetone at 4 °C in the dark (Parsons et al., 1984). Chl *a* and pheo were determined on board the ship using a 10-AU Turner Designs fluorometer calibrated with chl *a* extract from *Anacystis nidulans*

Table 1
Characteristics of free-drifting particle interceptor trap moorings in the Hudson Bay system during early fall 2005.

Station	Deployment date	Water depth (m)	Nepheloid depth (m)	Euphotic zone depth (m)	Deployment		Recovery		Duration (d)	Deployment depth (m)
					Latitude (°N)	Longitude (°W)	Latitude (°N)	Longitude (°W)		
14	23 September	342	212	24	62°16.62′	71°59.11′	62°14.82′	71°57.17′	0.45	50–100–150
16	26 September	220	167	50	62°39.18′	80°03.46′	62°39.83′	80°46.06′	0.38	50–100–150
18	28 September	148	117	48	60°07.52′	79°10.37′	60°10.51′	79°10.71′	0.47	50–100
AN03	30 September	86	72	25	55°20.09′	78°13.58′	56°22.60′	78°05.94′	0.86	50
22	06 October	182	150	45	58°23.83′	83°17.28′	58°22.76′	83°18.28′	0.32	50–100–150
23	11 October	200	166	37	59°00.66′	87°37.45′	59°01.92′	87°32.36′	0.38	50–100–150
AN01	13 October	104	78	40	60°00.03′	91°57.06′	60°00.03′	91°58.40′	0.31	50
27	16 October	242	221	48	61°03.72′	86°11.31′	61°04.18′	86°14.13′	0.44	50–100–150

(Sigma). Total particulate carbon (TPC) and particulate organic carbon (POC) were determined on trap subsamples filtered onto precombusted (450 °C for 24 h) Whatman GF/F filters then dried at 60 °C for 24 h during the expedition. In the laboratory, we acidified filters for POC measurement. All samples were analyzed on a PerkinElmer Model 2400 CHN analyzer. Particulate inorganic carbon (PIC) was determined by subtracting POC from TPC values. Biogenic silica (BioSi) was determined on duplicate subsamples filtered onto 0.6 μm Nuclepore polycarbonate membrane filters that were then dried at 60 °C for 24 h and stored until analysis. The material retained on filters was analyzed according to Ragueneau and Tréguer (1994), with hydrolysis using a 0.2 N NaOH solution and spectrophotometric determination of a silico-molybdate complex (Varian Cary 100). Microscopic examination of our samples did not reveal the presence of lithogenic material or residual biogenic silica after hydrolysis. Subsamples (100 ml) from the 50 m depth horizon were preserved with acidic Lugol's solution (Parsons et al., 1984) for later identification and enumeration of protist cells >4 μm with an inverted microscope (Leica DM IRB) according to Lund et al. (1958). For each sample, a minimum of 400 cells and three transects were counted. The abundance of each taxon was calculated according to the equation of Horner (2002). Average cell sizes were obtained by measuring 30 individual cells from the most abundant species and average cell biovolumes were estimated using appropriate geometric equations (Hillebrand et al., 1999). For the least abundant taxa, average cell sizes were obtained from the literature (Tomas, 1997; Bérard-Therriault et al., 1999). Protist carbon biomass was estimated using the conversion factors of Menden-Deuer and Lessard (2000), except for ciliates for which we used the specific conversion factor from Putt and Stoecker (1989). All protist cells except spores and empty diatom cells were included in the total protist community carbon estimate. The number and size of fecal pellets were determined from 250 ml subsamples preserved with buffered formaldehyde (final concentration of 1%) using an inverted microscope (Leica DM IRB). The biovolume of whole and broken fecal pellets was estimated using appropriate geometric equations and the carbon contribution of the fecal pellets was estimated using the conversion factors of 0.029 mg C mm^{-3} for elliptical and round fecal pellets and 0.057 mg C mm^{-3} for cylindrical fecal pellets from González and Smetacek (1994). Most cylindrical fecal pellets were broken (>90% of pellet numbers). In order to determine if sinking fecal pellets contained diatom frustules, fecal pellets from traps deployed at 50 m were examined using scanning electron microscopy (SEM; JEOL 6460LV). At each station, subsamples were filtered onto 5 μm Nuclepore polycarbonate membrane filters to concentrate the fecal pellets and gently rinsed with distilled water to eliminate salt crystals. An aliquot of fecal pellet material was placed on an aluminium stub and air-dried before SEM examination; no coating was necessary. Five to ten fecal pellets per station were examined in order to provide qualitative information on their content. Bacteria were counted with an epifluorescence microscope (Leica DHLS). Duplicate subsamples for bacterial counts were fixed with buffered formaldehyde (final concentration of 1%), stained with DAPI (4,6-diamidino-2-phenylindole) at a final concentration of 1 μg ml^{-1}, and filtered onto 0.2 μm black Nuclepore polycarbonate membrane filters. Bacterial carbon was estimated using a conversion factor of 0.02 pg C per bacteria (Lee and Fuhrman, 1987). The bacterial carbon contribution was corrected for potential bacterial growth and mortality during the trap deployment period. We used the equation of Pedrós-Alió and Mas (1993) with the initial concentration of bacteria in the filtered seawater used to fill the traps, a specific growth rate of 0.1 d^{-1} (Rivkin et al., 1996a; Rich et al., 1997) and a specific mortality rate of 28% (Steward et al., 1996). Without this correction, bacteria sinking fluxes would have been estimated to be between 2% and 6% (average = 3%) higher than those presented here. The POC contribution of amorphous detritus was estimated by subtracting fecal pellet, protist and bacterial carbon from the total POC sinking flux.

Sinking fluxes were calculated using the following equation (Juul-Pedersen et al., 2008):

$$\text{Sinking rate (mg m}^{-2}\text{ d}^{-1}) = (C_{\text{trap}} \times V_{\text{trap}})/(A_{\text{trap}} \times T_{\text{dep}})$$

where C_{trap} (mg m^{-3}) is the concentration of the measured variable in the particle interceptor trap, V_{trap} (m^3) is the volume of the particle interceptor trap sample, A_{trap} (m^2) is the particle interceptor trap surface area and T_{dep} (d) is the deployment time.

2.4. Statistical analyses

Our spatial analysis focused on the sinking fluxes measured at 50 m, which represent the sinking export from the euphotic zone since the euphotic zone depth ranged from 24 to 50 m at all stations visited (Table 1). The R software (Casgrain and Legendre, 2000) was used to analyze the horizontal variability in sinking fluxes by spatial autocorrelation using Moran's I coefficient (Legendre and Legendre, 1998). The number of distance classes for the spatial autocorrelation analysis between stations was calculated using Sturge's rule with $\alpha = 0.05$ as the critical level of significance. A model I linear regression was used to estimate the percent contribution of PIC to TPC sinking flux throughout the sampling area (Sokal and Rohlf, 1981). The Wilcoxon signed-ranks test was used to compare paired variates and to compare composition ratios of the sinking material with values from the literature. The Mann-Whitney test was used to identify differences between two groups of stations (Sokal and Rohlf, 1981). All maps presented in this paper were produced with Ocean Data View Software (Schlitzer, 2007).

3. Results

Surface waters (≤5 m) were more saline and cooler in Hudson Strait than in Hudson Bay (Fig. 2; Table 2). In southeast Foxe Basin, the average surface salinity was 31.8 and the average temperature 1.15 °C. Surface waters were less saline and warmer in eastern Hudson Bay than in western Hudson Bay (Fig. 2; Table 2). Benthic nepheloid layer depths ranged from 72 to 221 m at deployment trap stations and were below the deepest interceptor trap deployment except at station 22 (Table 1).

Total pigment (chl *a*+pheo) sinking fluxes were significantly higher in Hudson Strait (station 14) than in Hudson Bay (Fig. 3a; Table 2). In Hudson Bay, sinking fluxes of total pigments showed a significant longitudinal gradient, with decreasing rates from east (stations 22, AN03, 18 and 16) to west (stations AN01, 23 and 27) (spatial autocorrelations, $p<0.05$) (Fig. 3a; Table 2). The highest chl *a* sinking flux was measured at station 16, near Mansel Island (0.30 mg m^{-2} d^{-1}), and the lowest at the deep offshore station 27 (0.04 mg m^{-2} d^{-1}). At station 23, the pheo sinking flux was ≤0.01 mg m^{-2} d^{-1}. POC sinking fluxes ranged from 50.0 mg m^{-2} d^{-1} (stations AN03 and 23) to 76.8 mg m^{-2} d^{-1} (station 14), with no significant spatial pattern (spatial autocorrelation, $p>0.05$) (Fig. 3b). Over the whole Hudson Bay system, PIC made up, on average, 15% of the TPC sinking fluxes (data not shown). The highest diatom-associated carbon and BioSi sinking fluxes were measured in Hudson Strait (station 14; Fig. 3c and d; Table 2). In Hudson Bay, both diatom-associated carbon and BioSi sinking fluxes decreased longitudinally from east (stations 22, AN03, 18

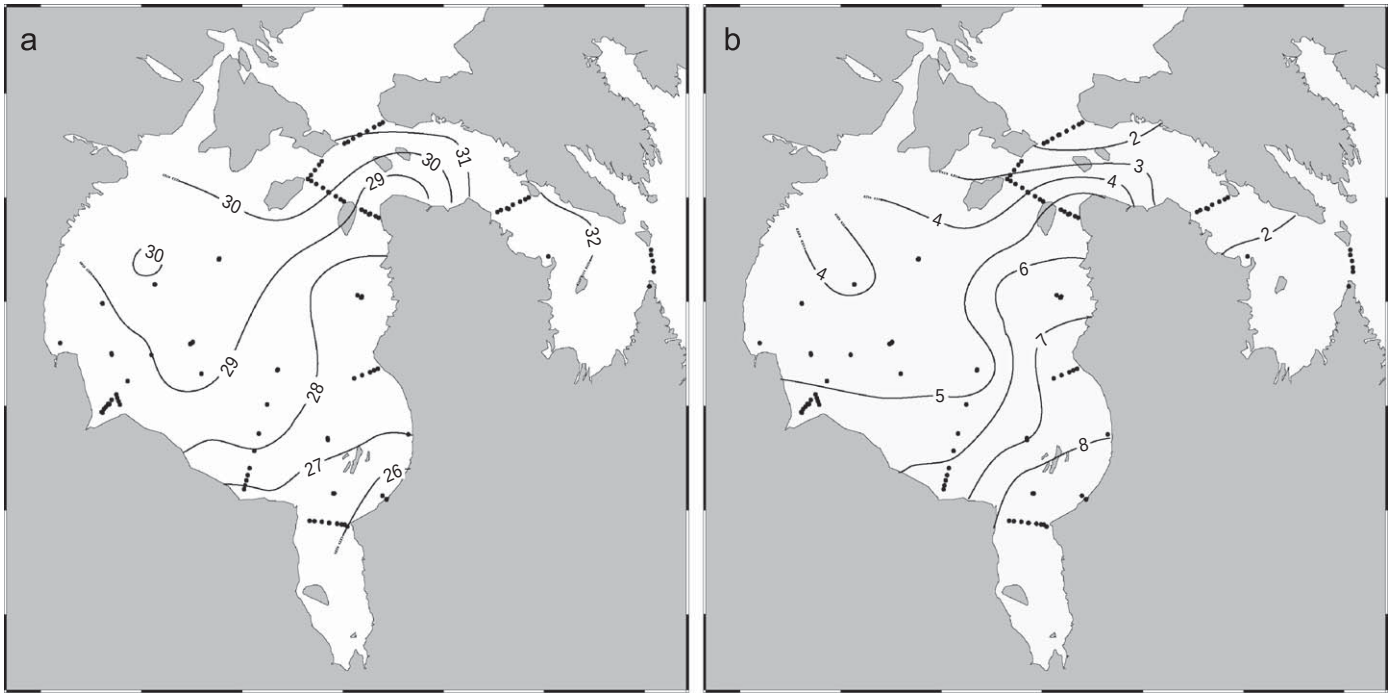

Fig. 2. Sea surface (a) salinity and (b) temperature (°C) in the Hudson Bay system during early fall 2005.

Table 2
General hydrographic conditions, sinking fluxes and composition ratios of the particulate material in particle interceptor traps deployed at 50 m in three regions of the Hudson Bay system during early fall 2005.

	Western Hudson Bay	Eastern Hudson Bay	Hudson Strait
Hydrographic condition	$n = 34$	$n = 61$	$n = 26$
Surface temperature (°C)	3.56–5.01	4.26–8.93	1.08–2.85
	4.42	*7.59*	*2.10*
Surface salinity	28.4–30.4	23.9–28.4	31.3–33.2
	29.4	*26.9*	*32.3*
Sinking flux (mg m^{-2} d^{-1})	$n = 3$	$n = 4$	$n = 1$
Chlorophyll *a* (chl *a*)	0.04–0.20	0.06–0.30	1.34
	0.12	*0.17*	
Pheopigment	0–0.16	0.20–0.50	2.03
	0.07	*0.35*	
Total particulate organic carbon (POC)	50.0–52.0	37.5–71.3	76.8
	51.1	*55.0*	
Total protist carbon	2.39–8.02	1.75–8.24	21.5
	5.29	*4.82*	
Diatom carbon	0.01–0.11	1.19–6.65	19.8
	0.05	*3.29*	
Fecal pellet carbon	2.94–6.46	1.83–32.1	7.82
	4.53	*19.3*	
Bacterial carbon	6.96–10.7	2.32–9.58	6.46
	8.68	*5.32*	
Amorphous detrital carbon	28.9–35.7	1.37–47.3	40.9
	32.6	*25.6*	
Biogenic silica (BioSi)	4.63–11.6	20.3–43.7	50.2
	7.80	*36.6*	
Ratio	$n = 3$	$n = 4$	$n = 1$
BioSi:POC (mol:mol)	0.04–0.10	0.14–0.47	0.28
	0.06	*0.31*	
POC:chl *a* (g:g)	252–1359	200–583	57.4
	683	*389*	

The range of values and mean in italics, are shown for each region. *n*: number of stations.

and 16) to west (stations AN01, 23 and 27; spatial autocorrelations, $p < 0.05$) (Fig. 3c and d; Table 2).

BioSi:POC molar ratios of the sinking material at 50 m were significantly higher than the value of 0.13 measured in light-limited diatoms (Brzezinski, 1985) in Hudson Strait and eastern Hudson Bay (stations 22, AN03, 18 and 16) but significantly lower than this critical value in western Hudson Bay (stations AN01, 23 and 27) (Wilcoxon signed-ranks tests, $p < 0.05$; Fig. 4a; Table 2).

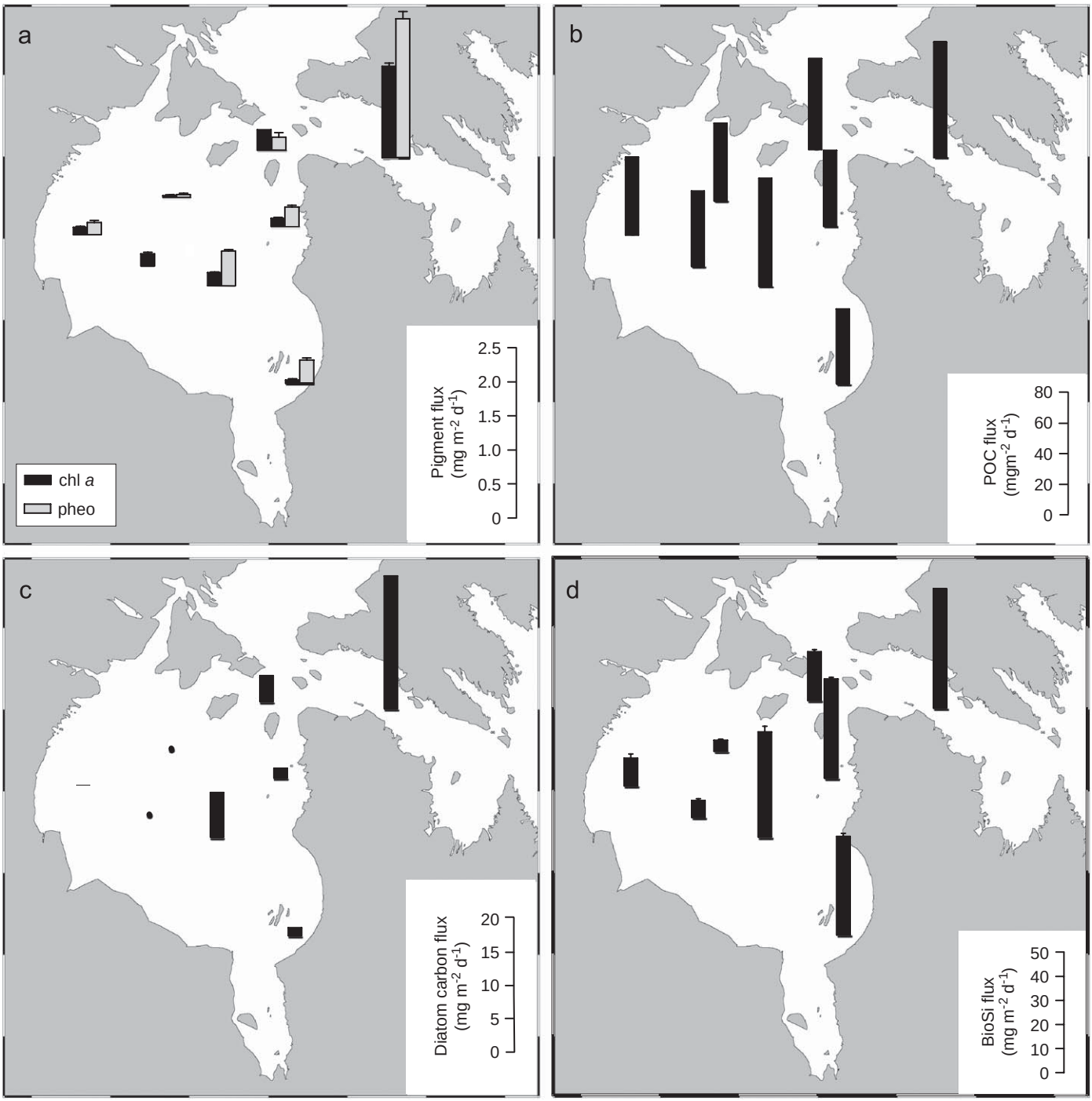

Fig. 3. Spatial variations in sinking fluxes of (a) chlorophyll *a* (chl *a*) and pheopigment (pheo), (b) particulate organic carbon (POC), (c) diatom-associated carbon, and (d) biogenic silica (BioSi) at 50 m in the Hudson Bay system during early fall 2005. In (a) pheo sinking flux at station 23 was $\leqslant 0.01$ mg m^{-2} d^{-1}. In (c) diatom-associated carbon sinking fluxes at stations 23 and 27 were $\leqslant 0.01$ mg C m^{-2} d^{-1}. In (a) and (d) mean and maximum value are shown.

POC:chl *a* mass ratios of the sinking material were consistently higher than the value of 40 observed in light-limited phytoplankton (Lorenzen, 1968) throughout the sampling area (Wilcoxon signed-ranks test, $p<0.05$; Fig. 4b; Table 2). The highest POC:chl *a* ratio was measured at station 27 (1359 g:g) in western Hudson Bay and the lowest at station 14 (57.4 g:g) in Hudson Strait (Fig. 4b).

The material collected in the traps deployed at 50 m was composed of bacteria, protists, fecal pellets and amorphous detritus (Fig. 5). Amorphous detritus contributed >50% of the total POC sinking fluxes in the Hudson Bay system, except at stations 22 and AN03 in eastern Hudson Bay, where fecal pellets were the largest carbon component (38% and 85% of total POC, respectively). At three stations in eastern Hudson Bay (stations AN03, 22 and 18), the fecal pellet contribution to total POC sinking flux was significantly higher (average = 52%) than in the other two regions of the system (average = 8%) (Mann-Whitney test, $p<0.05$). Station 16 near Mansel Island showed the highest relative contribution in amorphous detritus (78%) and the lowest contribution in fecal pellet (3%) to total POC sinking flux over the sampling area. The protist contribution to total POC sinking flux ranged from 5% to 28%, with the highest value at station 14 in

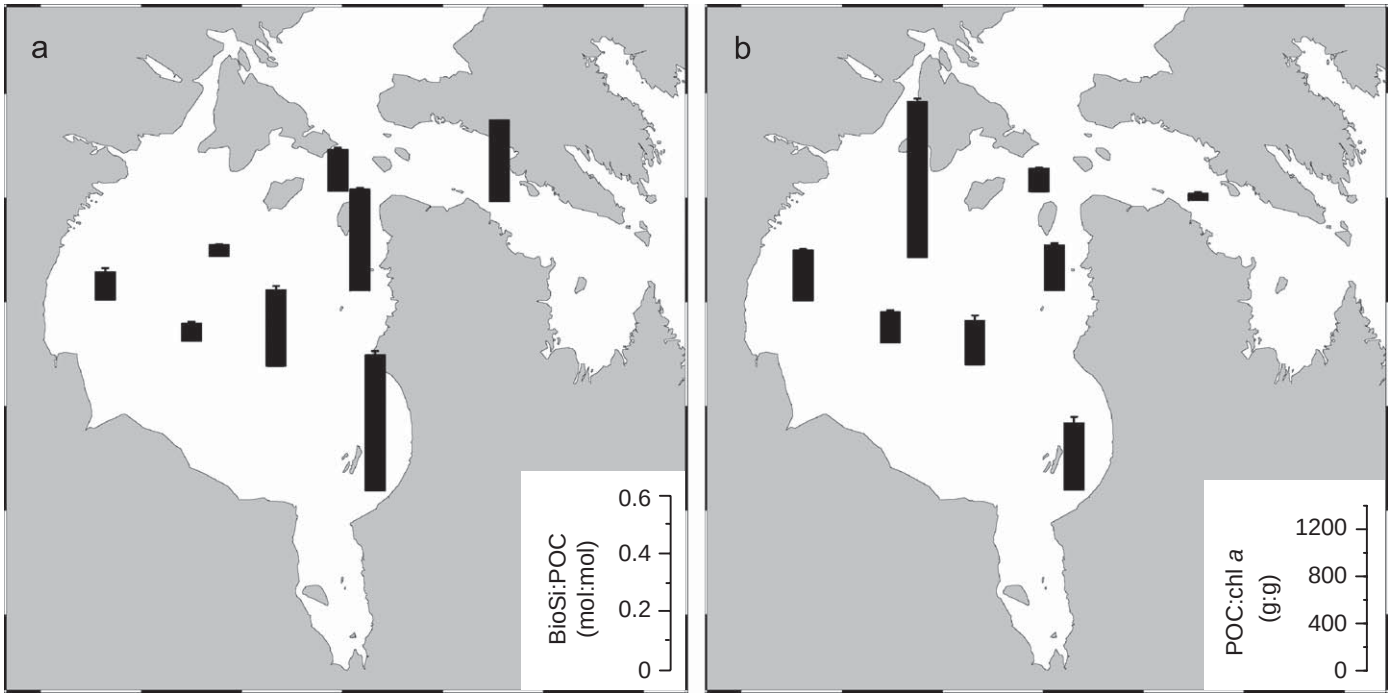

Fig. 4. Spatial variations in the ratios of (a) biogenic silica (BioSi) to particulate organic carbon (POC) and (b) POC to chlorophyll *a* (chl *a*) in particle interceptor traps deployed at 50 m in the Hudson Bay system during early fall 2005. Mean and maximum values are shown.

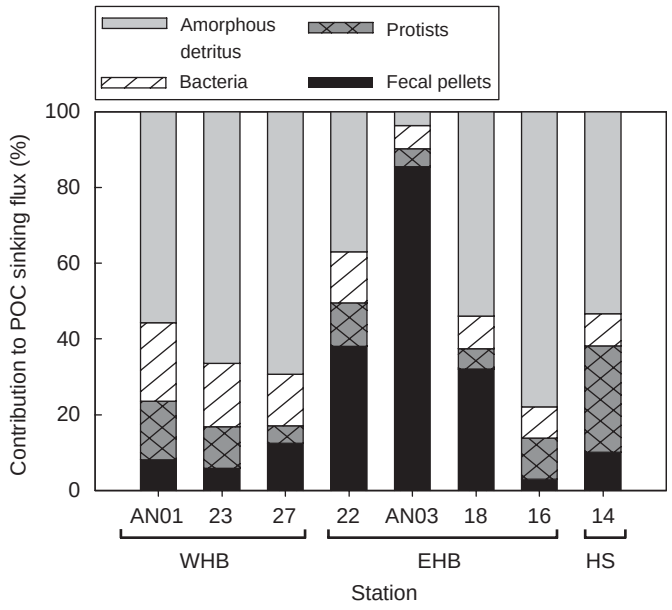

Fig. 5. Relative contribution of fecal pellets, protists, bacteria and amorphous detritus to total particulate organic carbon (POC) sinking flux at 50 m in the Hudson Bay system during early fall 2005. WHB: western Hudson Bay; EHB: eastern Hudson Bay; HS: Hudson Strait.

Hudson Strait. The bacterial carbon contribution to the total POC sinking flux was significantly higher in western Hudson Bay (stations AN01, 23 and 27; average = 17%) than in the other two regions (average = 9%) (Mann-Whitney test, $p<0.05$), with the maximum value at station AN01 (21%).

The main protist species collected in the traps deployed at 50 m were the prymnesiophytes *Phaeocystis pouchetii* and *Chrysochromulina* spp. in Hudson Strait, the pennate diatom *Cylindrotheca closterium* and the centric diatoms *Chaetoceros contortus*, *C. wighamii*, *C. furcillatus* and *Skeletonema costatum* in eastern Hudson Bay, and the dinoflagellate *Gymnodinium galeatum* in western Hudson Bay (Table 3). Unidentified nanoflagellates and other unidentified protists were present at each station and made up 33% to 71% of the total protist abundance in the sinking material (Table 3).

The relative contribution of the major protist groups to the total protist abundance in the 50 m traps is presented in Fig. 6a and the dominant protist species at each station are shown in Table 3. The main groups contributing to the total protist sinking flux, by numbers, were flagellates (88%) in Hudson Strait, intact and empty diatoms (9–38% and 15–21%, respectively) and flagellates (19–45%) in eastern Hudson Bay, and unidentified protists (21–49%) and flagellates (22–32%) in western Hudson Bay (Fig. 6a). In terms of carbon biomass, the main groups contributing to the total protist carbon sinking flux were intact diatoms (92%) in Hudson Strait, intact diatoms (54–81%) and dinoflagellates (16–40%) in eastern Hudson Bay, and dinoflagellates (43–67%) and ciliates+choanoflagellates (31–52%) in western Hudson Bay (Fig. 6b).

In the Hudson Bay system, fecal pellets sinking at 50 m were mainly long cylinders. Cylindrical fecal pellets accounted for 79–100% of the total fecal pellet abundance (data not shown); other fecal pellets were elliptical or round. The fecal pellet carbon sinking fluxes were highly variable in the Hudson Bay system, ranging from a minimum of 1.83 mg C m^{-2} d^{-1} at station 16 near Mansel Island to a maximum of 32.1 mg C m^{-2} d^{-1} at station AN03 near the Great Whale River (Fig. 7a). Fecal pellet sinking fluxes were, on average, twice as high at stations 22, AN03 and 18 compared to stations located in Hudson Strait and western Hudson Bay (Fig. 7a; Table 2). The size distribution of sinking fecal pellets at 50 m is presented for each region in Fig. 7b. Large fecal pellets (>100 μm in width) made up >92% of the total fecal pellet sinking flux in Hudson Bay whereas they represented only 61% in Hudson Strait. The sinking flux of these large fecal pellets was significantly higher in eastern Hudson Bay (average = 19.1 mg C m^{-2} d^{-1}) than in western Hudson Bay

Table 3
Percent abundance (% total intact cells) of dominant protist taxa in particle interceptor traps at 50 m in the Hudson Bay system in early fall 2005.

Taxon	Station							
	WHB			EHB				HS
	AN01	23	27	22	AN03	18	16	14
Chaetoceros contortus Schütt	n.d.	n.d.	n.d.	<5	n.d.	<5	13	n.d.
Chaetoceros furcillatus Bailey	n.d.	n.d.	n.d.	5	n.d.	<5	<5	<5
Chaetoceros wighamii Brightwell	<5	n.d.	n.d.	<5	n.d.	9	7	<5
Cylindrotheca closterium (Ehrenberg) Reimann and Lewin	<5	n.d.	n.d.	5	<5	<5	<5	n.d.
Skeletonema costatum Greville	<5	<5	n.d.	n.d.	8	n.d.	<5	n.d.
Gymnodinium galeatum Larsen	6	5	8	6	5	<5	<5	<5
Cryptophyceae spp.	<5	<5	<5	<5	20	<5	<5	<5
Chrysochromulina spp.	<5	<5	<5	<5	<5	<5	<5	19
Phaeocystis pouchetii (Hariot) Lagerheim	<5	<5	<5	<5	<5	n.d.	<5	21
Unidentified nanoflagellates	17	11	13	17	25	19	13	36
Unidentified protists	22	60	43	24	16	33	20	<5

WHB: western Hudson Bay; EHB: eastern Hudson Bay; HS: Hudson Strait; n.d.: not detected.

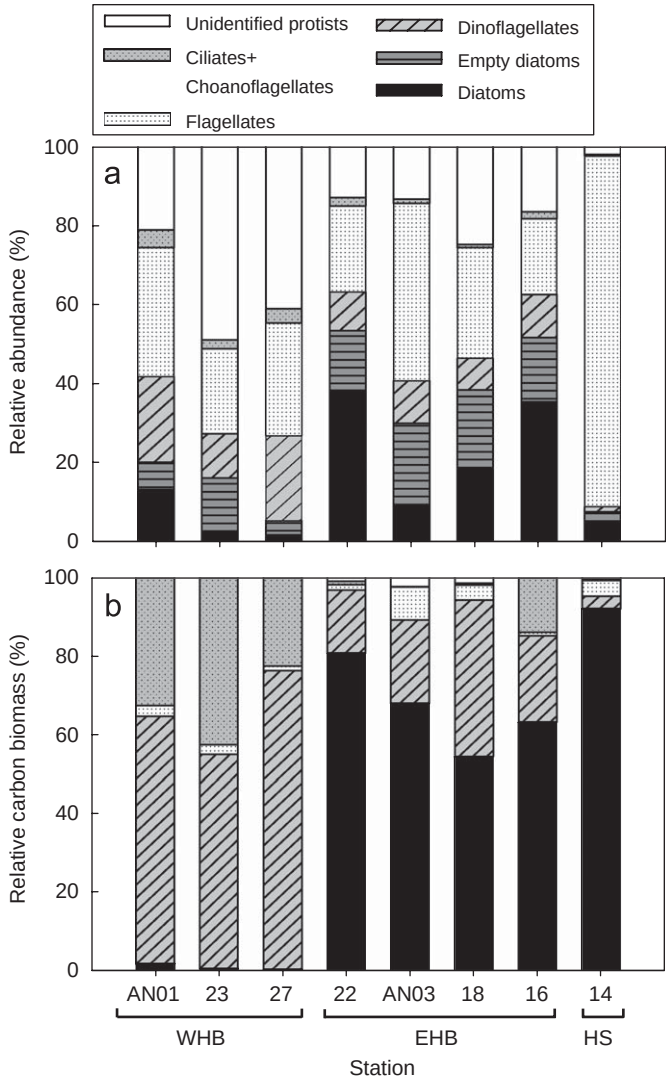

Fig. 6. Relative contribution of different protist groups to the total sinking flux in terms of (a) abundance and (b) carbon biomass at 50 m in the Hudson Bay system during early fall 2005. In (b) empty diatoms are not shown since they do not contribute to carbon biomass. WHB: western Hudson Bay; EHB: eastern Hudson Bay; HS: Hudson Strait.

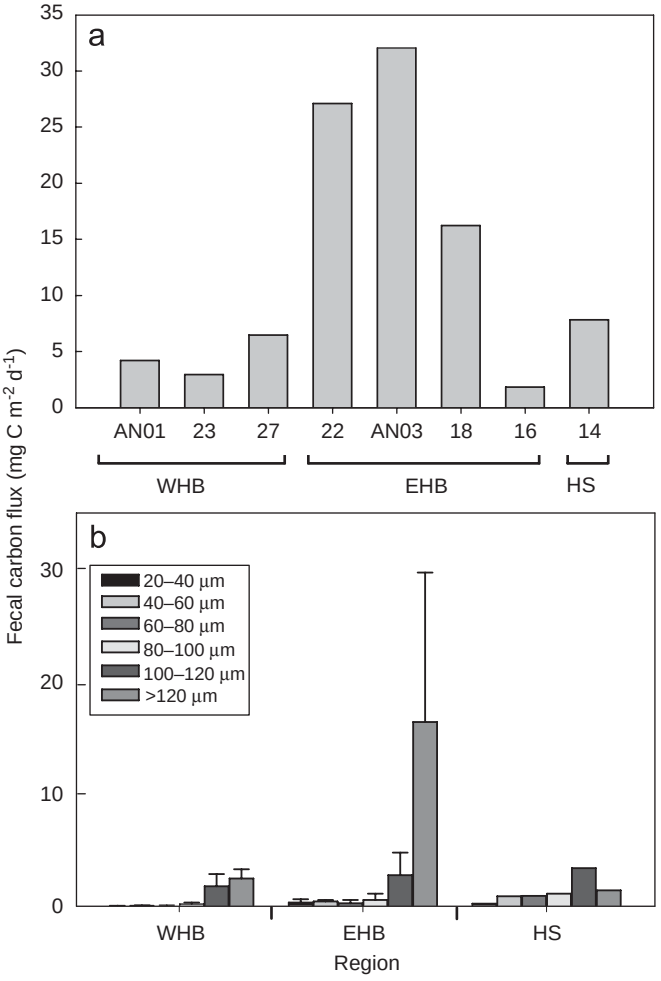

Fig. 7. Variations in (a) fecal pellet carbon sinking flux and (b) fecal pellet carbon sinking export by size class in particle interceptor traps deployed at 50 m in the Hudson Bay system during early fall 2005. In (b) mean and standard deviation are shown for WHB and EHB. WHB: western Hudson Bay; EHB: eastern Hudson Bay; HS: Hudson Strait.

(average = 4.21 mg C m^{-2} d^{-1}) and in Hudson Strait (average = 4.77 mg C m^{-2} d^{-1}) (Mann-Whitney test, $p<0.001$). It is interesting to note that fecal pellets from the two larger size classes

Table 4
Particulate organic carbon (POC) sinking flux and biogenic silica (BioSi):POC ratio of the sinking material at different depths and sampling stations of the Hudson Bay system in early fall 2005.

Station	50 m		100 m		150 m	
	POC ($mg\,m^{-2}\,d^{-1}$)	BioSi:POC (mol:mol)	POC ($mg\,m^{-2}\,d^{-1}$)	BioSi:POC (mol:mol)	POC ($mg\,m^{-2}\,d^{-1}$)	BioSi:POC (mol:mol)
Hudson Strait						
14	76.8	0.28	63.9	0.35	43.2	0.44
Eastern Hudson Bay						
16	60.7	0.14	63.4	0.17	49.0	0.37
18	50.5	0.35	37.7	0.41	n.v.	n.v.
22	71.3	0.26	70.4	0.13	47.0	0.30
Western Hudson Bay						
23	50.0	0.06	47.1	0.08	66.8	0.08
27	51.5	0.04	69.4	0.05	60.0	0.10

n.v.: no value since water depth was < 150 m.

(> 100 μm in width) were always fragmented and were more loosely packed than smaller (< 100 μm) cylindrical fecal pellets.

In Hudson Strait and eastern Hudson Bay, POC sinking fluxes were significantly lower at 150 m than at 50 m (average loss = 32%) and BioSi:POC ratios of the sinking material were significantly higher at 150 m than at 50 m (average increase = 76%; Wilcoxon signed-ranks tests, $p < 0.05$; Table 4). In western Hudson Bay, both variables were significantly higher at 150 m than at 50 m (average increase of 17% and 102%, respectively; Wilcoxon signed-ranks tests, $p < 0.05$; Table 4). There was no significant difference in the sinking fluxes between these two depths with respect to pigments, diatom-associated carbon and BioSi, or for the POC:chl *a* ratios of the sinking material (Wilcoxon signed-ranks tests, $p > 0.05$).

4. Discussion

To our knowledge, this study is the first to present results on the sinking export of organic material in the Hudson Bay system during open water conditions. Sediment trap studies are always challenging from a methodological stand-point, and one might argue that the variable duration of the trap deployments (from 8 to 20 h) introduced a bias to the interpretation of the sinking fluxes. Deployment duration was similar at all stations, with an average of 9.5 ± 1.5 h, except at station AN03 located in south-eastern Hudson Bay, where the deployment duration was 20 h (Table 1). The fluxes and the composition ratios of the sinking material at this station were very similar to those at other stations in eastern Hudson Bay (Figs. 3–7). We are therefore inclined to believe that the longer deployment period at station AN03 did not influence our interpretation of the results. Sinking fluxes estimated during our study are at the low end of sinking flux values reported from other short-term particle interceptor trap studies. For example, POC sinking fluxes (50–77 $mg\,C\,m^{-2}\,d^{-1}$ at 50 m; Table 2) were similar to background winter values observed in the Barents Sea (30–70 $mg\,C\,m^{-2}\,d^{-1}$; Olli et al., 2002). In open water conditions, Lalande et al. (2007) reported POC sinking fluxes ranging from 129 to 442 $mg\,C\,m^{-2}\,d^{-1}$ at 50 m in the Chukchi Sea in July–August and Caron et al. (2004) reported values averaging 219 $mg\,C\,m^{-2}\,d^{-1}$ at 50 m in northern Baffin Bay in August–September. Lower primary productivity in the Hudson Bay system compared to the Chukchi Sea and northern Baffin Bay (Sakshaug, 2004) likely explains the differences observed.

Notwithstanding the low sinking fluxes of organic material observed, strong spatial variations were found for the Hudson Bay system during early fall. This will be discussed in the next sections.

4.1. Hydrographic regions

Sea surface temperature and salinity measurements revealed three different hydrographic regions in the Hudson Bay system: Hudson Strait, eastern Hudson Bay and western Hudson Bay. Hudson Strait was characterized by low temperature and high salinity due to the dominant marine influence in this region, while eastern Hudson Bay was characterized by high temperature and low salinity associated with strong riverine input (Granskog et al., 2007). The intermediate temperature and salinity characterizing western Hudson Bay reflect water mass modification during cyclonic circulation around the bay (Fig. 2; Table 2). These general hydrographic conditions correspond to the spatial delineations proposed by Prinsenberg (1986b). In the three hydrographic regions described, contrasting sedimentation patterns were observed, as evidenced by differences in the magnitude and composition of sinking fluxes.

4.2. Regional sedimentation patterns

4.2.1. Hudson Strait

During this study, Hudson Strait was characterized by the highest sinking fluxes of pigments, BioSi and diatom-associated carbon (Fig. 3a, c and d; Table 2). In general, high export is associated with high primary production and/or phytoplankton biomass in the euphotic zone (e.g., Betzer et al., 1984; Wassmann, 1990). These observations are consistent with the results of Harvey et al. (1997, 2006), who showed higher phytoplankton production and biomass (chl *a*) in Hudson Strait than in Hudson Bay in late summer. During our study, the most abundant protist in the sinking material in Hudson Strait was the prymnesiophyte *Phaeocystis pouchetii* (Fig. 6a). This contrasts with observations by Harvey et al. (1997), who reported a numerical dominance of diatoms in the phytoplankton assemblage during the same period of the year. Such a discrepancy may be due to spatial variability. Harvey et al. (1997) studied the southern part of Hudson Strait, whereas our station was located in the center of Hudson Strait. According to Harvey et al. (2006), suspended chl *a* biomass

decreased from the north to the south of Hudson Strait in late summer, and these variations were associated with different hydrographic conditions controlled by tidal mixing (Drinkwater and Jones, 1987). Interannual variability may also come into play to explain the differences observed. However, our results do not allow us to scale the effects of spatial versus interannual variability as this would require sampling an array of stations in Hudson Strait over multiple years. Another explanation may reside in the differential export of various phytoplankton species due to differential sinking velocities and/or the preferential grazing of one species compared to another. Nevertheless, it is interesting to note that although flagellates were the most abundant cells in the sinking material during our study, diatoms contributed the most to carbon biomass (Fig. 6). Colonial or solitary *Phaeocystis* cells are very common in arctic and subarctic regions and are frequently observed in shallow particle interceptor traps, but their contribution in terms of carbon sinking flux is usually small (e.g., Reigstad and Wassmann, 2007). In Hudson Strait, the high contribution of intact protist cells to the sinking POC (Fig. 5) and the low fecal pellet sinking flux (Fig. 7a) indicated that the protist community was dominated, in terms of biomass, by autotrophs and that the grazing pressure was low in this region.

In Hudson Strait, the intermediate BioSi:POC ratios obviously resulted from the high relative biomass of diatoms and the abundance of intact protist cells in the sinking material (Figs. 4a, 5 and 6b). The high biomass of autotrophs in the material sinking out of the euphotic zone in Hudson Strait would also explain the low POC:chl *a* ratios observed (Fig. 4b). We cannot differentiate the influence of diatoms from that of prymnesiophytes on the POC:chl *a* ratios observed. However, diatoms, with their larger biovolume (highest relative contribution to POC, Fig. 6b) and their low POC:chl *a* ratios compared to prymnesiophytes (Johnsen et al., 1992), would likely contribute to the low POC:chl *a* ratios observed.

4.2.2. Eastern Hudson Bay

Eastern Hudson Bay was characterized by higher pigments, BioSi and diatom-associated carbon sinking fluxes than western Hudson Bay (Fig. 3; Table 2). These observations are in line with those of Anderson and Roff (1980), who reported higher chl *a* biomass on the eastern side of Hudson Bay during late summer. The composition of the protist community collected in the particle interceptor traps (Fig. 6a) is also consistent with previous observations showing a dominance of diatoms and flagellates in the euphotic zone of this region (Harvey et al., 1997). In eastern Hudson Bay, the sinking protist carbon biomass was dominated by diatoms, similar to Hudson Strait, but the sinking organic carbon was mainly from fecal pellets (Figs. 5 and 6b).

The higher fecal pellet sinking fluxes measured in eastern Hudson Bay compared to the other two regions (Fig. 7a) suggests that the grazing pressure by zooplankton was higher in this region. In addition, abundant diatom frustules in the fecal pellets of this region that we observed by SEM reflect active zooplankton grazing on diatoms. The degradation of primary-produced organic material by zooplankton grazing is further supported by the higher POC:chl *a* ratios of the sinking material in eastern Hudson Bay compared to Hudson Strait (Fig. 4b).

The shape and size of fecal pellets in particle interceptor traps can provide an indication of the taxonomic composition of the zooplankton community present in the upper water column. However, it is difficult to directly link sinking fecal pellet shape and abundance to zooplankton group abundance in the euphotic zone because degradation processes (e.g., coprohexy, coprochaly; Noji et al., 1991) occur during sinking, thereby modifying the composition of the collected fecal pellets. The higher contribution of large ($>100\,\mu m$) fecal pellets to the fecal carbon sinking flux in eastern Hudson Bay (Fig. 7b) suggests a higher production/abundance of larger pellets and, consequently, a dominance of larger zooplankton organisms compared to Hudson Strait. This hypothesis is in accordance with observations of Harvey et al. (2001), who reported a higher proportion of large-sized copepods, namely *Calanus glacialis* Jaschnov and *C. finmarchicus* Gunnerus, in eastern Hudson Bay compared to Hudson Strait. The occurrence of fecal pellet fragments of 200–300 μm in width and of 800–1000 μm in length suggests that some of the fecal pellets were produced by the chaetognath *Sagitta elegans* Verrill, which was found to be particularly abundant in eastern Hudson Bay during this expedition (Gérald Darnis, Université Laval, personal communication). This zooplankton species is more abundant in eastern Hudson Bay than in Hudson Strait in late summer (Harvey et al., 2001). Even though the large pellets were not abundant, they contributed significantly to the total fecal carbon sinking flux (Fig. 7b). The fact that all large ($>100\,\mu m$ in width) fecal pellets were fragmented and loosely packed suggests that these pellets were prone to degradation in the euphotic zone. According to Dilling and Alldredge (1993), pellets of chaetognaths, which are carnivorous macrozooplankton, contain copepod exoskeletal remains and are packed less densely than copepod pellets that contain phytoplankton cells. Therefore, chaetognath fecal pellets would have longer residence time in the water column favouring degradation and recycling rather than direct sinking.

In contrast with the rest of the system, diatom-associated carbon sinking fluxes in eastern Hudson Bay showed a trend opposite to that of BioSi sinking fluxes (i.e., low diatom sinking fluxes were associated with high BioSi sinking fluxes; stations 18 and AN03; Fig. 3c and d). This decoupling was likely linked to the abundance of diatom-containing fecal pellets and empty frustules in the sinking material (Figs. 6a and 7a). This hypothesis is supported by the SEM examination of fecal pellets. Indeed, we observed diatom spores and intact or fragmented frustules in fecal pellets throughout the Hudson Bay system, but in higher proportion at stations 18 and AN03. Active grazing on diatoms would contribute to the high BioSi:POC ratios measured in the sinking material in eastern Hudson Bay (Table 2) since carbon is assimilated by zooplankton while silica is excreted (Conover et al., 1986; Brown et al., 2006).

4.2.3. Western Hudson Bay

The lowest pigments, BioSi and diatom-associated carbon sinking fluxes of the system were measured in western Hudson Bay (Fig. 3). To our knowledge, the only biological oceanographic study encompassing western Hudson Bay showed low chl *a* biomass in this part of the Hudson Bay system in late summer (Anderson and Roff, 1980). In contrast with other regions, the sinking protist carbon biomass in western Hudson Bay was dominated by dinoflagellates, ciliates and choanoflagellates (Fig. 6b), and consequently low BioSi:POC ratios were observed (Figs. 4b and 6b). Interestingly, bacteria contributed more than fecal pellets or protists to the total POC sinking flux in western Hudson Bay (Fig. 5), challenging the view that bacteria are minor contributors to the sinking flux of particles. According to Stokes' Law, the sinking velocity of small cells like bacteria is negligible (Pedrós-Alió and Mas, 1993). However, increased bacterial carbon sinking export can be explained by the attachment of bacterial cells to other particles or aggregates (e.g., Kiørboe et al., 2002; Grossart et al., 2003). Indeed, bacterial attachment to particles was observed during microscopic observation of our samples. Our values of bacterial carbon sinking fluxes for western Hudson Bay ($7.0–10.7\,mg\,C\,m^{-2}\,d^{-1}$) are in the range of values reported by Ducklow et al. (1982) at 10 m in the Hudson River plume of the New York bight in March ($1.5–10.0\,mg\,C\,m^{-2}\,d^{-1}$), but higher than

those measured by Turley and Mackie (1994) at 50 m in the northeast Atlantic in May (0.03–0.99 mg C m^{-2} d^{-1}). These two studies also used unpoisoned short-term free-drifting particle interceptor traps. Collected bacteria entered interceptor traps by sedimentation, but since the traps were not poisoned, bacterial growth during the deployment period could bias sedimentation estimates. We corrected our bacteria sinking fluxes using potential growth and mortality rates from literature, whereas Ducklow et al. (1982) used a specific growth rate directly measured from bacteria collected in their traps. The correction of Ducklow et al. (1982) was more precise, but in both cases the bacterial growth in interceptor traps was insignificant when compared to bacteria sinking flux. The low contribution of algal carbon to sinking POC explains the low pigment sinking fluxes and, consequently, the high POC:chl *a* ratios observed in western Hudson Bay, especially at station 27 (Figs. 3a and 4b; Table 2).

While sinking fluxes of pigments, BioSi and diatom-associated carbon all showed strong horizontal patterns at 50 m, spatial variations in POC sinking fluxes were modest throughout the Hudson Bay system (Fig. 3). As shown above, it is the composition rather than the magnitude of the sinking POC that varied regionally during our study. Rivkin et al. (1996b) reported similar results, showing a strong variability in chl *a* and fecal pellet sinking fluxes while the POC sinking flux remained fairly constant during the bloom and post-bloom periods in the Gulf of St. Lawrence. These authors proposed that, over the duration of their study, neither food web structure nor new production could be used to predict the magnitude or patterns of POC sinking export from the euphotic zone. This hypothesis is supported by our results. However, further studies integrating primary production, plankton community structure and export data are needed to test this hypothesis in the Hudson Bay system. The potential implications of spatial variations and depth-transformation of the sinking material with respect to benthic communities will be treated in the next section.

4.3. Linkages with the benthos

A decrease in POC sinking fluxes with depth was only observed in regions characterized by a high sinking export of algal material (i.e., chl *a*, diatom-associated carbon and BioSi), i.e., Hudson Strait and eastern Hudson Bay (Table 4). In contrast, an increase in sinking POC with depth was observed in western Hudson Bay. Close examination of the benthic nepheloid layer depths (Table 1) did not show clear evidence of resuspension in the deepest particle interceptor traps throughout the Hudson Bay system. We therefore hypothesize that lateral advection of POC may have occurred in western Hudson Bay, although further investigation is required to confirm this process. Lateral advection may also have influenced chl *a* sinking export at depth since our results did not consistently show depth attenuation of chl *a* sinking fluxes at the stations visited. Lalande et al. (2007) also reported depth-related attenuation of POC but not of chl *a* sinking fluxes in the Chukchi Sea during ice-free conditions, although the cause for such discrepancy was not fully elucidated.

Little dissolution of BioSi in sinking particles appeared to take place during the fall in the Hudson Bay system since no significant decrease in BioSi sinking fluxes was observed with depth. This, together with longitudinal differences in the sinking export of diatom-associated material (i.e., more diatom-associated material in the east compared to the west) and in POC attenuation (i.e., higher POC attenuation in the east than west) resulted in very different BioSi:POC ratios at depth in eastern and western Hudson Bay (Table 4). Clearly, a combination of factors including the amount and composition of the material leaving the euphotic zone and degradation processes during sinking shaped the composition of the material reaching the benthos, producing high BioSi:POC molar ratios at depth in the east (BioSi:POC >0.30) and low ratios in the west (BioSi:POC <0.13).

It is well established that the distribution and composition of benthic communities are influenced by a combination of abiotic (e.g., hydrographic conditions, ice cover, light regime, temperature, bottom substrate, water depth) and biotic (e.g., magnitude of primary production, pelagic food web structure) factors (Grebmeier and Barry, 1991). The food supply to the benthos, which is entirely dependent upon the sinking of organic matter originating in the euphotic zone, is generally considered to be the most important factor for a vast majority of benthic communities (Piepenburg, 2005). Therefore, although our results provide only a snapshot of sedimentation patterns during a short period in the fall, we surmise that the spatial variations in the magnitude and composition of the sinking fluxes of organic material observed are likely to be linked to the abundance and composition of benthic communities. To our knowledge, there are only a few studies on benthic communities in Hudson Bay. Cusson et al. (2007) documented strong differences among macrofaunal communities in various regions of the Hudson Bay system. Benthic communities were also studied in Hudson Strait and along a longitudinal transect in Hudson Bay in 2003 (Philippe Archambault, UQAR, unpublished data). Macrobenthic communities were more abundant and diverse in Hudson Strait than in Hudson Bay, and within Hudson Bay, macrobenthic communities were more abundant although less diverse in the west compared to the east (P. Archambault, UQAR, unpublished data). In addition, crustacean Tanaidacean, known to be consumers of pelagic-sedimented diatoms (Blazewicz-Paszkowycz and Ligowski, 2002), were mainly found in Hudson Strait and in eastern Hudson Bay (Philippe Archambault, UQAR, unpublished data). The spatial trends observed during our study, i.e., higher sinking fluxes of pigments, POC and diatom-associated carbon, and higher BioSi:POC composition ratios in the east compared to the west, agree with these studies. These initial comparisons, which need to be substantiated with additional studies of vertical export and benthic communities, suggest that the prevalent spatial patterns in the sedimentation of organic material in Hudson Bay may be indicative of the taxonomic composition and abundance of benthic communities in this large inland sea.

In the Hudson Bay system, different export pathways emerged in the three distinct regions. In Hudson Strait, direct sinking of intact diatoms played an important role in the sinking export of POC. Regions dominated by large phytoplankton, in particular diatoms, are usually high export environments (Buesseler, 1998). In contrast, in western Hudson Bay, the high contributions of flagellates and bacteria to the sinking material are characteristic of an environment dominated by a microbial food web, where POC is exported to depth in the form of amorphous detritus. Therefore, this region is more typical of a high recycling environment and, as a corollary, a low export environment. Finally, eastern Hudson Bay appeared to be intermediate to the other two regions, with diatoms being transferred to pelagic grazers and a large contribution of diatom-containing fecal pellets to the POC sinking export.

5. Conclusion

This study presents the first results on the sinking export of organic material and its vertical degradation in the Hudson Bay system in open water conditions. The Hudson Bay system, which is considered to be a region of low primary production, showed low organic material sinking fluxes compared to other arctic and subarctic regions. Nevertheless, spatial heterogeneity in the magnitude and composition of organic material sinking fluxes

was observed. Three regions characterized by different hydrographic conditions and contrasting sinking export pathways were identified: Hudson Strait, eastern Hudson Bay and western Hudson Bay. Hudson Strait emerged as the region of highest sinking export of the system, including a high contribution of intact diatoms to the POC sinking export. Western Hudson Bay was characterized by the lowest sinking fluxes of organic material and a POC export mainly in the form of amorphous detritus and bacterial carbon, therefore pointing to an environment of high recycling. Finally, eastern Hudson Bay was somewhat intermediate between these two systems, being characterized by a significant transfer of diatoms to pelagic grazers and sedimentation of fecal pellets. These results support our first hypothesis, which was that different hydrographic regions in the Hudson Bay system play a role in shaping the sedimentation patterns of organic material in this environment. However, our results do not indisputably support our second hypothesis, which proposed that degradation of organic material during sinking would be of minor importance in this system, given that we observed a variable loss of organic matter during its sinking in different regions of the Hudson Bay system.

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