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ORIGINAL PAPER

Evaluating diatom community composition in the absence of marked limnological gradients in the high Arctic: a surface sediment calibration set from Cornwallis Island (Nunavut, Canada)

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Abstract Fossil diatom assemblages preserved within the sedimentary record in Arctic lakes provide the potential to reconstruct past changes in important limnological variables. During the summers of 1992 and 1993, we examined previously unstudied freshwater ecosystems on Cornwallis Island, Arctic Canada, with the specific objectives of (1) documenting the limnology and modern diatom assemblages from this region, and (2) determining which environmental variables most influence diatom species distributions. The Cornwallis Island study sites displayed the least amount of variance in measured water chemistry variables in comparison to nearly all of our labs' previous freshwater surveys in the Arctic. The small limnological gradients precluded the development of a statistically robust diatom inference model, but perhaps more importantly, allowed us to explore variations in diatom composition in the absence of marked variations in water chemistry. Diatom species turnover was minimal, with the most common diatom taxa being *Achnanthidium minutissima*, *Nitzschia perminuta*, *N. frustulum*, with lesser percent abundances of *Chaemaepinnularia soehrensis*, *Navicula chiarae*, *Psammothidium marginulata*, and *A. kryophila*. A small number of study sites differed from the majority with respect to water chemistry (e.g., coastal sites with high specific conductivities) and habitat availability (e.g., ephemeral ponds with extensive moss habitats), and these sites had markedly different diatom assemblages. These data reinforce previous observations that water chemistry and other climate-related factors are the primary environmental controls influencing diatom distributions at high latitudes.

Keywords Limnology · Diatoms · Arctic Canada · Lake sediments · Environmental reconstruction · Algal ecology

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Introduction

Until recently Arctic lakes and ponds were amongst the least studied ecosystems on Earth (Rouse et al. 1997), despite their widespread abundance and ecological importance. However, recent concerns regarding global warming and its impact on climatically-sensitive high latitude ecosystems prompted a more comprehensive research program concerning Arctic limnology (Schindler and Smol 2006), particularly after initial studies demonstrated that lakes and ponds sensitively track climatic and other environmental changes (Smol 1983, 1988; Douglas et al. 1994). As a result, over the last decade, fairly extensive datasets of chemical, physical and biological characteristics now exist for lakes and ponds in Canada and Alaska (e.g., Douglas and Smol 1994; Ludlum 1996; Gregory-Eaves et al. 2000; Hamilton et al. 2001; Lim et al. 2001a, 2005; Lim and Douglas 2003; Antoniades et al. 2003a, b, 2005a; Antoniades 2004; Michelutti et al. 2002a, b, 2006), Fennoscandia (e.g., Weckström et al. 1997a, b; Weckström and Korhola 2001; Bigler and Hall 2002), Russia (e.g., Duff et al. 1999;

Laing and Smol 2000), and Greenland (e.g., Anderson et al. 2001; Ryves et al. 2002; Cremer and Wagner 2004). In addition, long-term monitoring data now exist at several locations including the Zackenberg Research Station on East Greenland (Klitgaard et al. 2006), the Toolik Research Station on the north slope of Alaska (Arctic LTER database), and Cape Herschel on Ellesmere Island (Smol and Douglas, unpublished data).

Aside from establishing baseline water quality conditions, the above limnological survey data have been used to describe the environmental optima and, to a lesser extent, tolerances of a variety of biological organisms. This is typically accomplished by relating modern species assemblages to present-day limnological variables, a process known as constructing a calibration set. Such calibration sets are necessary for the development of transfer functions, to obtain quantitative estimates of past change based on fossil assemblages preserved within the sedimentary record (Smol 2002). Diatoms (Bacillariophyceae) are the most extensively used organisms in Arctic calibration sets because they are ubiquitous, ecologically diverse, and well-preserved in lacustrine sediments (Douglas et al. 2004a, b).

With the completion of each new regional calibration set, a clearer picture emerges of the primary limnological controls influencing diatom distributions at high latitudes. Mostly climate-related and local limnological variables such as ice-cover, pH, conductivity and nutrients are discussed as the primary drivers of ecological change in Arctic regions (e.g., Smol et al. 2005 and references therein); however, some studies also show a linkage between surface water temperature and diatom species composition (e.g., Lotter et al. 1997; Joynt and Wolfe 2001; Bouchard et al. 2004). In addition, habitat specificity (e.g., percentage of mosses, rocks, sediment) influences the composition of diatom assemblages in high-latitude environments (e.g., Douglas and Smol 1995; Lim et al. 2001b; Michelutti et al. 2003a, b). Such ecological studies have been used to reconstruct past limnological conditions based on fossil diatoms preserved within sediment cores (e.g., Antoniades et al. 2005b; Guilizzoni et al. 2006; Hodgson et al. 2006).

In this study, we report on the limnological characteristics and modern diatom composition from 38 reference lakes and ponds from Cornwallis Island, Nunavut. Located near the center of the Canadian Arctic Archipelago (Fig. 1), Cornwallis Island is an area of historical significance with respect to high Arctic limnology. The first detailed limnological studies were performed here (near Resolute Bay, Fig. 1), as part of the International Biological Programme (IBP) during 1968–1972 (e.g., Schindler et al. 1974a, b; Welch and Kalff 1974). The IBP research focused on just two lakes (Char and Meretta lakes) and provided the only comprehensive data available on high

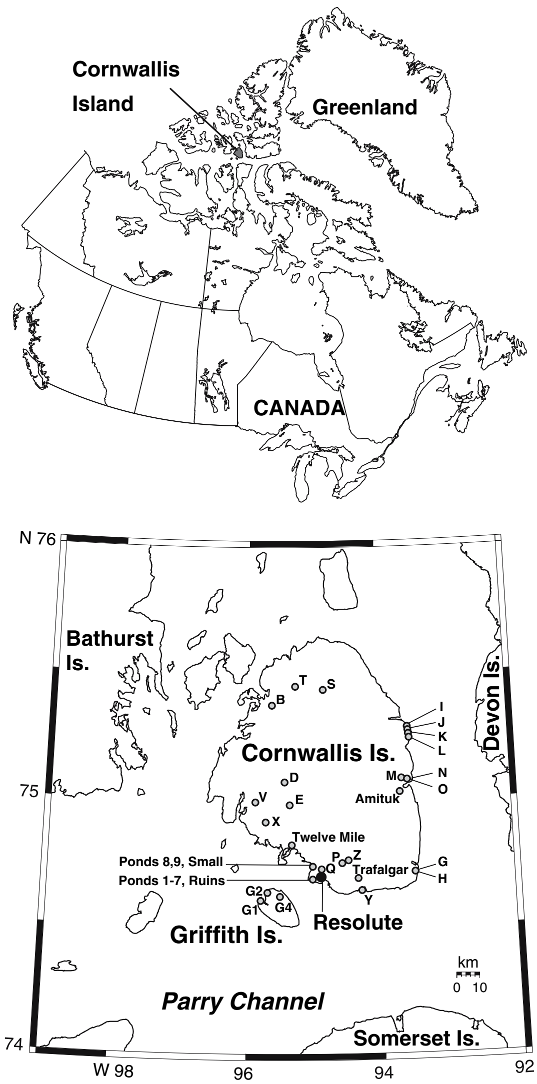

Fig. 1 The location of Cornwallis Island in the Canadian Arctic Archipelago (*upper*) and the location of the 38 lakes and ponds sampled in this study (*lower*)

Arctic limnology for several decades. Research has continued at the two IBP lakes (e.g., Sand-Jensen et al. 1999; Douglas and Smol 2000; Michelutti et al. 2003a, b; 2002c); however, apart from a few localized studies (e.g., Antoniades and Douglas 2002), very little else is known regarding limnological characteristics and algal ecology elsewhere on Cornwallis Island.

A characteristic feature of our previously published Arctic surface sediment calibration sets has been the marked environmental, and often climatic, gradients within each high Arctic island. In these studies, striking differences in diatom species composition among sites were attributed to large gradients in physico-chemical, or climate-related, variables. In contrast to previous high Arctic studies, in this paper we explore differences in diatom assemblages among sites that have remarkably similar limnological characteristics. Due to its similar surficial geological substrate, low relief, and moderate size (spanning roughly one degree of latitude), we recorded only minor gradients on Cornwallis Island in ecologically important variables such as pH, specific conductance, and dissolved organic carbon (DOC). Given the negligible gradients in physico-chemical and climatic variables, we hypothesized that only relatively minor species turnover should occur amongst our study sites. In essence, this dataset allows us to examine differences in diatom species composition, independent of major variations in water chemistry and climate within one island, providing a rare opportunity to assess if other variables that have not been measured in previous studies (e.g., biological interactions, inflows/outflows, habitat diversity, dispersal) account for important amounts of variation in diatom composition. In addition, our dataset contains a small subset of sites that are distinct in terms of water chemistry (e.g., coastal ponds with high conductivities; $n = 2$) and habitat type (e.g., ephemeral ponds with extensive moss growth; $n = 3$), which we would expect to support markedly different diatom assemblages from the majority of sites.

The main objectives of this study are to: (1) document the limnology and modern diatom assemblages of lakes and ponds on Cornwallis Island, and (2) determine which environmental variables, if any, are influencing changes in diatom species distributions. We compare the Cornwallis Island dataset to those from other Arctic regions, with a particular emphasis on the Canadian Arctic Archipelago.

Site description

Cornwallis Island (75°05′N, 95°00′W) is in the south central portion of the Queen Elizabeth formation situated north of Somerset and between Bathurst and Devon islands in the Canadian High Arctic (Fig. 1). It is a moderate sized island with an area of 6,995 km^2. The only permanent settlement is the hamlet of Resolute Bay (Qausuittuq), with a population of approximately 215 persons (2001 census data, http://www.statcan.ca).

Cornwallis Island supports no ice-caps or glaciers, and has only minor variations in topography, reaching a maximum elevation of only 411 m asl just southeast of its centre, giving it a slightly domed shape. The underlying geology is predominantly Silurian and Ordovician limestone and dolomite, with lesser amounts of gypsum and anhydrite, shale, siltstone, and sandstone (Thorsteinsson 1986). Soils are generally poorly-developed and consist mostly of gravel and sandy loam derived from limestones, shales, calcareous sandstones and dolomite sandstones (Cruickshank 1971). Very little vegetation, even by high Arctic standards, was observed near the sampling sites. A detailed overview of the vegetation of Cornwallis Island is given by Edlund (1992).

Climate normals (1971–2000) from the Resolute Bay weather station (74°43′N, 94°59′W) report a mean annual temperature of –16.4°C. Average monthly temperatures indicate the warmest month is July at +4.3°C, and the coldest is February at –33.1°C. Accordingly, lakes and ponds are characterized by extended periods of snow and ice cover, with mean dates of thaw and freeze-back of 17 June and 26 August, respectively, leaving just over 2 months of above freezing conditions (Woo and Young 2003). During extremely cool years, the ice may not completely melt off some lakes (e.g., Char Lake; Schindler et al. 1974a, b). The region is classified as polar desert, receiving only 150 mm of precipitation annually.

Methods

Water chemistry and surface sediment diatoms

Water and surface sediment samples were collected during the summers of 1992 and 1993 from 38 lakes and ponds using identical procedures to our labs' previous Arctic surveys, originally detailed in Douglas and Smol (1993, 1994). All samples were obtained near the center of each site in the shallow ponds, and as far from shore as possible in the larger lakes. Water chemistry samples were collected by hand in pre-cleaned sample bottles from approximately 20 cm below the surface, except in instances where pond depth was <20 cm. Surface sediments were obtained by removing the uppermost top centimeter by hand, as in our former Arctic surveys. Similar to our earlier work, all samples were collected during the first 2 weeks of July so as to minimize variability due to seasonal fluctuations; a strategy designed to allow for comparisons both within and among regions. A helicopter was used to collect samples from a wide geographic area (Fig. 1) to capture as much limnological and biological diversity as possible. It was difficult to obtain even spatial coverage of sites from across the entire island due to the paucity of lakes and ponds in the central portion of the island. In an attempt to increase our spatial coverage, three ponds from Griffith Island, ~20 km south of Cornwallis Island, were also sampled. All sites were given unofficial names (i.e., letter and number codes) except for 12 Mile, Small, and Ruins lakes, which had pre-existing official names. Latitude and longitude were recorded from a hand-held GPS. Elevation, where reported, was recorded from the helicopter altimeter.

All samples were kept cool (~4°C) and in the dark for the duration of the 2-week sampling season. Water samples were then transported to the National Laboratory for Environmental Testing (NLET) in Burlington, ON, Canada,

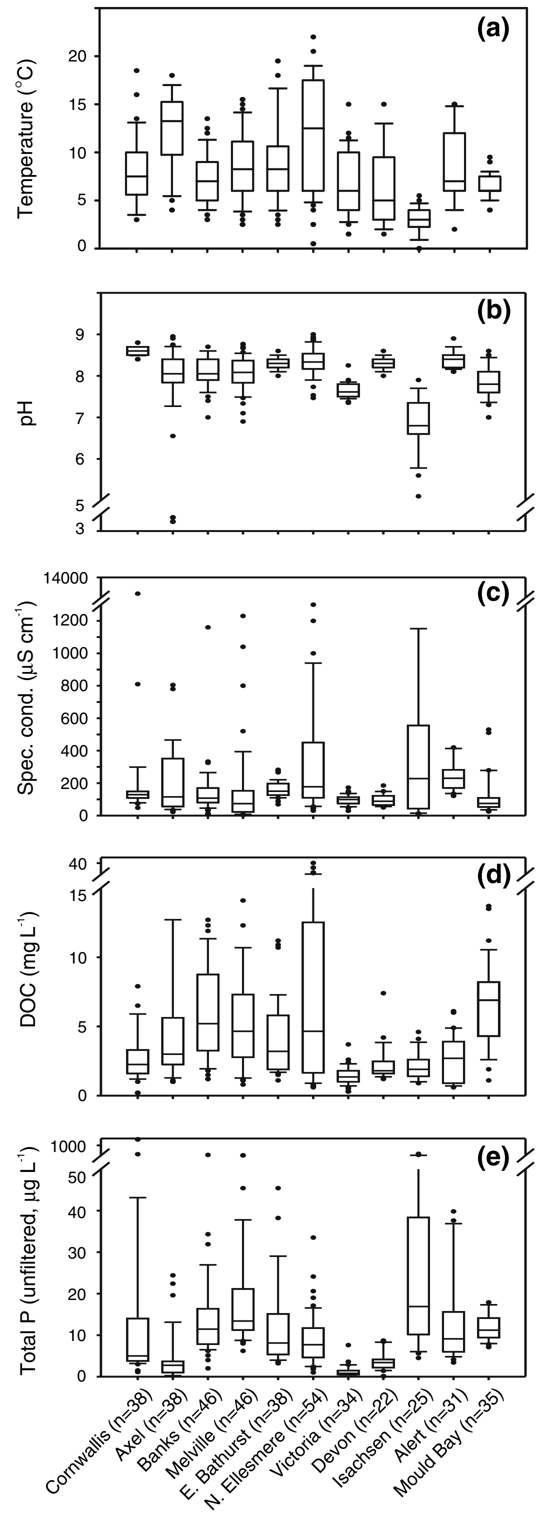

Fig. 2 Box plots summarizing the distributions of **a** temperature, **b** pH, **c** specific conductance, **d** DOC and, **e** TPU in lake surveys across ten regions in the Canadian Arctic archipelago. The *lower* and *upper portions of each box* represent the 25th and 75th percentiles, respectively. The median is shown as a *line across the box*. The *lower* and *upper 'tails'* represent the 5th and 95th percentiles, respectively. Site above or below the 5th and 95th percentiles are shown as *solid dots*. The different study regions include Axel Heiberg Island (Michelutti et al. 2002a), Banks Island (Lim et al. 2005), Melville Island (Keatley et al. 2007a); Bathurst Island (Lim et al. 2001a); northern Ellesmere Island (Keatley et al. 2007b); Victoria Island (Michelutti et al. 2002b); Devon Island (Lim and Douglas 2003); Isachsen, Ellef Ringnes Island (Antoniades et al. 2003a); Alert, Ellesmere Island and Mould Bay, Prince Patrick Island (Antoniades et al. 20003b)

where analyses were performed for major ions (Ca, Cl, Mg, K, Na, SO_4), minor ions (Ba, Li, Sr,) metals (Al, Be, Cd, Co, Cr, Cu, Fe, Pb, Mn, Mo, Ni, Ag, V, Zn), phosphorus [total filtered and unfiltered (TPU), soluble reactive P (SRP)], nitrogen [ammonia (NH_3), nitrite (NO_2), nitrate-nitrite (NO_3NO_2), particulate organic nitrogen (PON)], carbon [dissolved inorganic carbon (DIC), dissolved organic carbon (DOC), particulate organic carbon (POC)], and chlorophyll *a* [uncorrected (CHLA-U) and corrected for pheopigments (CHLA-C)]. Protocols for bottling, filtering, and methods for chemical analyses followed Environment Canada (1994a, b). Measurements of pH, specific conductance, and temperature were performed in the field.

Box plots summarizing the statistical distributions of ecologically relevant variables were constructed to facilitate comparisons among our labs' previous limnological surveys throughout the Canadian Arctic (Fig. 2). The box plots are arranged such that studies that have incorporated wide geographic areas (e.g., Cornwallis, Axel, Banks, Melville, eastern Bathurst, northern Ellesmere islands) are plotted towards the left, while those studies restricted to relatively small geographic areas [e.g., Victoria and Devon islands, Isachsen (Ellef Ringnes Island), Alert (Ellesmere Island), Mould Bay (Prince Patrick Island)] are plotted towards the right (see Fig. 2 caption for references).

Diatom slides were prepared following standard techniques for siliceous microfossils (Battarbee et al. 2001). Briefly, sediment was oxidized using equal volumes of concentrated sulfuric and nitric acids, followed by repeated rinsing with distilled water until neutral pH was reached. Subsamples of the slurries were pipetted onto coverslips and allowed to dry before being permanently mounted to slides using Naphrax®. For each site, a minimum of 500 valves was identified primarily to species level using a LEICA DMRB microscope equipped with Nomarski DIC optics under oil immersion at 1,000× magnification. Taxonomy primarily followed Krammer and Lange-Bertalot (1986–1991) and Antoniades (2004).

Exploratory ordination and inference model techniques

Principal components analysis (PCA) was used to identify outliers in the environmental and species datasets prior to use in ordinations. Sites were deemed outliers only if site scores from both species and environmental datasets fell outside the 95% confidence limits calculated from the site score means. PCA was also used to detect trends between the environmental variables and sites.

A Pearson correlation matrix with Bonferonni-adjusted probabilities was used to identify and remove groups of significantly ($P < 0.05$) correlated environmental variables. Water chemistry variables that had values below the limits of detection in greater than 50% of the study sites were removed from the dataset. This resulted in the elimination of Al, Be, Cd, Co, Cr, Cu, Mo, Ni, V, Zn, NH_3, NO_2, NO_3NO_2. Variables below detection limits in less than 50% of the study sites were replaced with a value of half the measured detection limit for statistical analyses. No transformations were applied to environmental variables prior to use in the ordinations. All taxa were included in the ordinations and the species dataset was always square root transformed and rare species downweighted.

Detrended correspondence analysis (DCA) was used to determine whether unimodal or linear ordination techniques were most appropriate, based on the gradient length expressed by the diatom dataset. Redundancy analysis (RDA) was used to explore relationships between diatom species and the measured environmental variables. Each environmental variable was run individually in a RDA in order to assess the explanatory power of each variable. All ordinations were performed using the program CANOCO version 4.0 (ter Braak and Smilauer 1998).

Results and discussion

Water chemistry

Our study sites had limnological characteristics (Table 1) typical of most other freshwater surveys from the Canadian Arctic Archipelago, including alkaline pH levels, oligotrophy, and low concentrations of dissolved ions. However, several features clearly distinguished the Cornwallis Island sites from those obtained elsewhere in the Canadian Arctic, including (1) the highest overall pH values of any limnological dataset in the Canadian Arctic, and (2) remarkably small amounts of variance in ecologically-relevant limnological variables such as pH, specific conductance, and DOC.

Physical variables

The majority of our sites ($n = 33$) were classified as ponds (i.e., $Z_{max} < 2$ m), with only five sites (Small, 12 Mile, Amituk, Ruins, Trafalgar) deep enough to be considered lakes (i.e., $Z_{max} > 2$ m). The lakes had generally cooler water temperatures (mean = 5.4°C) compared to the smaller volume ponds (mean = 8.7°C). Not surprisingly, with only a 200 m difference in elevation between the highest and lowest sites, there was no significant correlation ($P > 0.05$) between elevation and water temperature, as inferred from a Pearson correlation matrix. Likewise, water temperatures were not likely influenced by a latitudinal gradient, with only a 100 km difference between the northern- and southernmost sites (Fig. 1). Overall, the water temperatures of our study sites were comparable to those recorded elsewhere across the Canadian Arctic (Fig. 2a).

Lakewater pH

All of our study sites had alkaline pH's, which is the norm for most Canadian high Arctic limnological surveys and is a reflection of carbonate rocks that dominate most catchments. Cornwallis Island, however, remains quite remarkable in that our study sites had both the highest overall pH values and smallest range (pH 8.4–8.8) than any of our labs' previous Arctic surveys (Fig. 2b). Ca concentrations ranged from 10.7 to 52.9 mg l^{-1}, with a mean of 26.5 mg l^{-1} (Table 1), which is typical of freshwaters in close contact with carbonate rocks (McNeely et al. 1979).

Specific conductance and major ions

In general, our study sites had low specific conductances (most sites <200 μS cm^{-1}), which is typical for high latitude lakes and ponds. Despite a wide geographic sampling area of Cornwallis Island, the box plots revealed that our sites had the smallest interquartile range for specific conductance compared to all other surveys in the Canadian Arctic archipelago (Fig. 2c). Only surveys with far more limited spatial coverage (e.g., Victoria Island, Devon Island and Mould Bay) had similarly small interquartile ranges (Fig. 2c, see caption for references). Three Cornwallis Island sites (G2, P8, P9) had atypically high specific conductance's (Table 2), due to their close proximity to the ocean (Fig. 1). These sites were undoubtedly influenced by sea spray, as evidenced by extremely high concentrations of Na, Cl and SO_4 (Table 1).

The Pearson correlation matrix revealed that specific conductance was significantly correlated with K, Li, Mg, Na, Sr, Cl, and SO_4. With the exception of the marine-influenced sites, all major and minor ions were near the lower end of the natural ranges reported for Canadian inland surface water (McNeely et al. 1979). Similar to nearly all other limnological surveys, concentrations of major cations followed Ca > Mg > Na > K, while anions followed CO_3 (DIC) > SO_4 > Cl (marine-influenced sites P8, P9 removed).

Table 1 Cornwallis Island water chemistry data from samples collected during July of 1992 and 1993

Site name	Temp. (°C)	pH	Conductance (μS cm^{-1})	Ba (mg L^{-1})	Ca (mg L^{-1})	Fe (mg L^{-1})	K (mg L^{-1})	Li (mg L^{-1})	Mg (mg L^{-1})	Mn (mg L^{-1})	Na (mg L^{-1})	Sr (mg L^{-1})	POC (mg L^{-1})	PON (mg L^{-1})
Pond B	3.5	8.6	128	0.0266	26	0.04	0.4	0.002	6.9	0.0007	2.9	0.119	0.216	0.027
Pond D	3.5	8.5	86	0.0009	15.8	0.002	ND	ND	7.6	ND	1.0	0.0052	0.316	0.038
Pond E	5.0	8.5	120	0.0042	26	0.194	0.5	0.002	5	0.0029	2.6	0.0225	0.59	0.075
Pond G	11.5	8.7	85	0.0011	18.7	0.011	ND	ND	1.5	ND	1.3	0.046	0.07	*0.001*
Pond H	6	8.6	134	0.0017	34.3	0.004	0.2	ND	2.8	ND	2.3	0.0675	0.239	0.065
Pond I	7.5	8.8	133	0.0064	28.6	0.008	0.2	ND	4.8	ND	1.8	0.0757	0.119	0.007
Pond J	7.5	8.6	88	0.0086	17.7	0.009	ND	0.001	2.3	0.0005	1.6	0.0582	0.083	0.009
Pond K	10	8.6	147	0.0176	29.7	0.011	0.3	0.001	5	ND	6.3	0.111	0.091	0.015
Pond L	11	8.6	204	0.0229	32.6	0.001	0.6	0.001	8.2	ND	10.4	0.185	0.081	0.015
Pond M	9.5	8.6	132	0.0028	26.6	0.076	0.2	0.001	5.5	0.0036	3.5	0.0417	0.093	0.01
Pond N	13.5	8.7	130	0.0035	30.5	0.002	0.2	0.001	5.7	ND	2.9	0.0403	0.097	0.017
Pond O	13	8.7	132	0.0073	26.7	0.017	0.3	0.001	6	0.0008	3.3	0.0505	0.239	0.037
Pond P	7.5	8.5	122	0.0005	24.9	0.003	ND	ND	4.9	ND	1.0	0.0167	0.104	0.005
Pond Q	12	8.6	104	0.0042	22.2	0.07	0.2	0.001	2.6	0.0015	1.0	0.0428	0.079	0.058
Pond S	10	8.7	110	0.135	30.8	0.028	0.3	0.001	4.4	0.0007	2.7	0.0635	0.141	0.073
Pond T	11	8.7	138	0.186	37.8	0.028	0.3	0.004	6.1	0.0015	2.2	0.0673	0.159	0.041
Pond V	9	8.6	119	0.0044	27.6	0.011	ND	ND	4.5	ND	1.4	0.102	1.24	0.147
Pond X	9	8.7	114	0.0022	25.9	0.019	ND	0.001	6.9	0.0011	2.1	0.0163	0.473	0.021
Pond Y	7	8.5	162	0.0056	30.1	0.005	0.5	0.001	8.2	ND	6.5	0.0518	0.304	0.027
Pond Z	9	8.6	120	0.0037	26.9	0.002	0.2	ND	5.8	ND	1.2	0.0165	0.25	0.013
Pond 1	5.7	8.4	127	0.0099	19.5	0.003	ND	ND	6.5	ND	2.1	0.0342	0.211	0.026
Pond 2	5.5	8.6	159	0.0365	28.1	0.007	0.5	ND	6.2	0.0005	4.6	0.066	0.184	0.023
Pond 3	5.5	8.6	142	0.02555	26.05	0.021	0.4	0.002	6.7	0.0005	3.4	0.0867	0.1995	0.025
Pond 4	9.5	8.5	150	0.0146	25.7	0.012	0.3	ND	7.6	0.0005	4.2	0.0533	0.397	0.015
Pond 5	6.0	8.6	138	0.0092	25.3	0.004	0.3	ND	7.2	ND	3.4	0.0457	0.176	0.022
Pond 6	16	8.6	149	0.0057	23.1	0.012	0.2	ND	7.5	ND	3.5	0.0368	0.35	0.033
Pond 7	18.5	8.7	172	0.0149	27.6	0.004	0.3	ND	8.1	ND	4.2	0.0481	0.24	0.021
Pond 8	3	8.6	2,660	0.0043	40.2	0.016	37.8	0.029	77.5	ND	673.0	0.496	0.215	0.035
Pond 9	7	8.8	810	0.032	52.9	0.028	6.3	0.01	27.2	0.0023	156.0	0.288	0.471	0.104
Pond Snow	7.5	8.6	48	0.0054	10.7	0.025	0.2	ND	2.9	0.001	6.1	0.0151	0.377	0.028
Small Lake	3.5	8.4	75	0.0033	15.4	0.006	0.3	ND	5.3	0.0066	4.0	0.0245	0.278	0.037
12 Mile Lake	5.5	8.6	115	0.012	23.3	0.003	0.2	0.001	5.2	0.0011	2.4	0.0317	0.213	0.019
Amituk Lake	–	8.5	79	0.0033	17.7	0.01	0.2	ND	3.3	ND	1.1	0.0379	0.45	0.061
Ruins Lake	7.5	8.7	242	0.0181	33	0.01	1.5	0.002	7.4	0.0007	25.8	0.107	0.307	0.022
Trafalgar Lake	5	8.5	75	0.005	20.0	0.077	0.2	0.001	3.1	0.0018	1.2	0.0188	0.188	0.015

Table 1 continued

Site name	Temp. (°C)	pH	Conductance (μS cm^{-1})	Ba (mg L^{-1})	Ca (mg L^{-1})	Fe (mg L^{-1})	K (mg L^{-1})	Li (mg L^{-1})	Mg (mg L^{-1})	Mn (mg L^{-1})	Na (mg L^{-1})	Sr (mg L^{-1})	POC (mg L^{-1})	PON (mg L^{-1})
Pond G1	9.5	8.6	121											
Pond G2	6	8.4	13,200											
Pond G4	9	8.5	93											
Mean	8.3	8.6	554	0.0184	26.5	0.022	1.9	0.003	8.2	0.0016	27.2	0.0740	0.264	0.034
Median	7.5	8.6	129	0.0057	26.1	0.011	0.3	0.001	5.8	0.0011	2.9	0.0481	0.215	0.025
SD	3.5	0.1	2,149	0.0372	7.8	0.036	7.1	0.007	12.7	0.0015	115.4	0.0910	0.214	0.030
Max.	18.5	8.8	13,200	0.1860	52.9	0.194	37.8	0.029	77.5	0.0066	673.0	0.4960	1.240	0.147
Min.	3.0	8.4	48	0.0005	10.7	0.001	0.2	0.001	1.5	0.0005	1	0.0052	0.07	0.001

Site name	Cl (mg L^{-1})	SiO_2 (mg L^{-1})	SO_4 (mg L^{-1})	DIC (mg L^{-1})	DOC (mg L^{-1})	SRPF (μg L^{-1})	TPF (μg L^{-1})	TPU (μg L^{-1})	Chla-u (μg L^{-1})	Chla-c (μg L^{-1})	Elevation (m asl)	Latitude (°N)	Longitude (°W)	Sampling date
Pond B	5.9	0.58	5.0	19.1	2.5	1	9.7	232	1.4	0.5	–	76 22.28	96 37.50	10 July 1992
Pond D	2.2	0.74	0.5	14.9	1.7	0.7	1	1.1	1.3	0.5	–	75 05.18	95 09.11	10 July 1992
Pond E	2.5	0.19	0.9	18.0	3.2	2.1	17.4	11	2.3	1.1	–	74 58.46	95 07.34	10 July 1992
Pond G	2.3	0.3	0.2	11.8	1.5	0.7	5.6	5.7	0.3	ND	201	74 42.29	93 28.91	8 July 1993
Pond H	4.2	0.33	1.9	21.5	1.5	0.5	8.8	3.5	ND	ND	152	74 41.73	93 29.04	8 July 1993
Pond I	3.2	0.51	1.3	19.8	1.2	0.5	1.5	18.1	ND	ND	140	75 15.57	93 30.44	9 July 1993
Pond J	3.6	0.24	0.4	12.2	1.0	0.4	16.2	3.3	0.3	ND	116	75 15.17	93 30.83	9 July 1993
Pond K	14.9	1.06	1.7	19.7	2.4	0.5	2.8	5.4	0.8	0.6	12	74 13.98	93 31.89	9 July 1993
Pond L	23.1	0.72	4.9	23.6	1.5	0.5	1.5	3.3	1.2	0.9	0	75 14.04	93 30.63	9 July 1993
Pond M	7.0	0.37	1.2	19.7	1.9	0.5	2.2	4.3	1.2	1	110	75 04.35	93 40.58	9 July 1993
Pond N	5.0	0.22	0.7	22.4	2.5	0.3	2	5	1.3	1	183	75 04.29	93 35.20	9 July 1993
Pond O	5.1	0.27	0.5	19.9	5.9	0.5	2.8	8.1	1.3	1	183	75 04.29	93 35.20	9 July 1993
Pond P	2.3	0.29	1.5	18.5	1.8	0.2	1.5	3	1.1	0.9	186	74 45.24	94 28.06	9 July 1993
Pond Q	2.0	0.42	1.3	14.3	2.0	0.1	1.3	4.4	1.1	0.8	101	74 43.11	94 51.66	9 July 1993
Pond S	4.9	0.31	1.5	20.8	6.5	0.5	3.7	20.5	1.3	0.8	64	75 25.13	94 48.02	11 July 1993
Pond T	4.4	0.32	2.3	27.0	5.9	0.5	4.2	11.3	0.7	ND	116	75 26.28	95 17.13	11 July 1993
Pond V	2.4	0.4	0.6	19.8	3.3	0.9	8.6	4.7	0.8	ND	37	74 58.85	95 51.49	11 July 1993
Pond X	1.9	0.81	4.9	11.8	1.5	0.6	2.2	3.5	ND	ND	11	74 53.96	95 41.41	11 July 1993
Pond Y	10.9	0.52	8.0	22.9	2.6	0.3	3.4	13	0.4	ND	–	74 39.32	94 18.59	13 July 1993
Pond Z	1.8	0.2	1.6	20.1	1.8	0.3	1.4	1.5	0.5	ND	158	74 45.83	94 21.86	13 July 1993
Pond 1	4.4	0.43	1.0	15.6	1.8	1.2	2	4.9	1	0.3	–	74 42.587	95 00.215	9 July 1992
Pond 2	7.7	0.54	5.0	19.5	2.8	0.6	3.1	24	2	1	–	74 42.495	95 00.235	9 July 1992
Pond 3	7.9	0.425	4.3	19.2	2.3	1.1	5.85	20.6	2.25	0.95	–	74 42.488	95 00.444	11 July 1992
Pond 4	8.4	1.02	2.7	20.1	3.9	2.3	3.6	3.8	0.7	ND	–	74 42.497	95 03.387	7 July 1993

Table 1 continued

Site name	Cl (mg L^{-1})	SiO_2 (mg L^{-1})	SO_4 (mg L^{-1})	DIC (mg L^{-1})	DOC (mg L^{-1})	SRPF (μg L^{-1})	TPF (μg L^{-1})	TPU (μg L^{-1})	Chla-u (μg L^{-1})	Chla-c (μg L^{-1})	Elevation (m asl)	Latitude (°N)	Longitude (°W)	Sampling date
Pond 5	5.6	0.39	0.9	19.1	2.8	0.7	2.2	1,520	3.3	2	–	74 42.491	95 03.337	11 July 1992
Pond 6	7.0	0.5	0.8	18.6	3.3	1	4.2	3.9	0.3	ND	–	74 42.269	95 03.198	7 July 1993
Pond 7	8.9	0.66	1.4	22.2	4.2	1	3.3	3.6	0.7	0.5	–	74 42.286	95 03.240	7 July 1993
Pond 8	1,525.0	0.44	107.0	16.0	0.2	4.1	9.9	11.4	ND	ND	–	–	–	13 July 1993
Pond 9	231.0	0.09	60.9	35.2	7.9	1.4	No data	14	0.8	0.2	–	–	–	13 July 1993
Pond Snow	3.6	0.47	20.7	7.0	3.4	2.8	6.2	28.4	0.8	ND	–	74 42.828	95 02.39	7 July 1993
Small Lake	7.6	0.53	1.3	13.0	2.1	1.1	4.1	65.2	0.5	ND	–	74 45.465	95 03.874	8 July 1992
12 Mile Lake	4.4	0.26	3.3	17.0	1.8	0.3	2.7	4.5	0.5	ND	6	74 49.22	95 19.40	13 July 1993
Amituk Lake	7.1	0.26	2.2	10.8	1.6	0.4	1.4	10.3	1.5	0.8	–	–	–	10 July 1992
Ruins Lake	48.8	0.32	10.3	20.4	2.5	0.3	4.5	5	1.7	0.9	–	–	–	14 July 1993
Trafalgar Lake	1.5	0.26	1.0	12.9	1.2	0.3	2.3	4.9	1.2	0.95	60	74 41.34	94 19.39	13 July 1993
Pond G1											79	74 36.91	95 42.21	9 July 1993
Pond G2											8	74 36.25	95 48.79	9 July 1993
Pond G4											98	74 33.08	95 28.74	9 July 1993
Mean	56.8	0.44	7.5	18.4	2.7	0.9	4.5	59.6	1.1	0.8	96			
Median	5.0	0.40	1.5	19.2	2.3	0.5	3.2	5.0	1.1	0.9	101			
SD	258.4	0.22	20.3	5.1	1.7	0.8	4.0	257.1	0.7	0.4	67			
Max.	1,525.0	1.06	107.0	35.2	7.9	4.1	17.4	1,520.0	3.3	2.0	201			
Min.	1.5	0.09	0.2	7	0.2	0.1	1	1.1	0.3	0.2	0			

Variables that have >50% of sites below detection limits are removed (i.e. Al, Be, Cd, Co, Cr, Cu, Mo, Ni, V, Zn, NH_3, NO_2, NO_3NO_2). All variables below detection limits are denoted by ND (not detectable)

Metals

Typical of most Arctic limnological surveys, concentrations of metals were low and below the average values for Canadian surface waters (McNeely et al. 1979). In fact, only three of the thirteen metals analyzed (Fe, Mg, and Mn) were recorded in concentrations above detection limits in greater than half of the sites (Table 1). The metal concentrations for Al, Be, Cd, Co, Cr, Cu, Mo, Ni, V, and Zn were below detection limits in more than half of the study sites.

Dissolved inorganic and organic carbon

Dissolved inorganic carbon concentrations provide some indication of the buffering capacity of lakes to changes in pH. The concentrations recorded in this study (mean = 18.4 mg l^{-1}, range = 7.0–35.2 mg l^{-1}) were typical of Arctic lakes and ponds in well-buffered, carbonate catchments (e.g., Antoniades et al. 2005a; Lim et al. 2005). In contrast, poorly-buffered lakes located on granitic bedrock typically have DIC concentrations below 1 mg l^{-1} (Michelutti et al. 2005).

Dissolved organic carbon concentrations were low even by Arctic standards, ranging from 0.2 to 7.9 mg l^{-1}, with a mean of 2.7 mg l^{-1}. The only locations with lower mean DOC concentrations were Victoria Island (1.5 mg l^{-1}), Devon Island (2.2 mg l^{-1}), and near Isachsen on Ellef Ringnes Island (2.1 mg l^{-1}), and all of these surveys were restricted to relatively small geographic areas (Fig. 2d, see caption for references). The box plots revealed that Cornwallis Island had the smallest interquartile range for surveys conducted across wide geographic regions (Fig. 2d). The low DOC concentrations on Cornwallis Island were expected given the low productivity of the sites and minimal vegetation in the catchments.

Nutrients

Approximately 50% of our sites would be classified as ultra-oligotrophic (i.e., TPU < 5 μg l^{-1}), according to the classification scheme of Vollenweider (1968: modified in Wetzel 1983) based on surface water TPU concentrations. As illustrated in the box plots (Fig. 2d), ultra-oligotrophy is a common characteristic of Arctic lakes and ponds; however, elevated TPU concentrations (e.g., >30 μg l^{-1}) are also recorded. In this dataset, TPU concentration was the one measured variable that covered a relatively large gradient, at least by Arctic standards. For example, although 60% of our sites had TPU concentrations <10 μg l^{-1}, 20% had values between 10 and 20 μg l^{-1}, and 20% had values >20 μg l^{-1}. There are three sites that had particularly high TPU concentrations, including Pond 5 (1,520 μg l^{-1}), Pond B (232 μg l^{-1}), and Small Lake (65.2 μg l^{-1}). These elevated levels are undoubtedly due to resuspended particulate phosphorus, as evidenced by their respective TPF concentrations, which were all <10 μg l^{-1} (Table 1)—a problem that has been identified in other similar high Arctic surveys (e.g., Antoniades et al. 2003b).

Total nitrogen (TN) values could not be determined because total Kjeldahl nitrogen (TKN) was not analyzed on our waters samples (TN = TKN + PON). Nitrogen species, NH_3, NO_2, and NO_3NO_2 were recorded below detection limits in more than half of the sites, and thus are not discussed further. PON concentrations were one to two orders of magnitude lower compared to all previous limnological surveys in the Canadian Arctic Archipelago, ranging from 0.001 to 0.147 mg l^{-1}, with a mean of 0.034 mg l^{-1} (Table 1).

Chlorophyll a

Typical of our previous Arctic limnological surveys, CHLA-U values were low, ranging from 0.3 to 3.3 μg l^{-1}, with a mean of 1.1 μg l^{-1}. CHLA-U values were not significantly correlated with TPU, as inferred from a Pearson correlation matrix, indicating that factors other than P are controlling phytoplankton in these sites. However, the lack of a correlation between CHLA-U and TPU is more likely a reflection of the fact that benthic photosynthesis accounts for the vast majority of production in Arctic lakes (Welch and Kalff 1974), and our samples reflect chlorophyll *a* concentrations in the water column.

PCA ordination

Typically, the first two axes in a PCA account for at least 50% of the variation in Arctic limnological datasets. In this study, PCA axes 1 and 2 accounted for only 39.4% of the cumulative variance in the dataset, the lowest of any prior survey in the Canadian Arctic archipelago. This low percentage of explained variance is a direct result of the small limnological gradients recorded in our study. As would be predicted, the majority of our sites clustered close to one another near the center of the PCA bi-plot (Fig. 3); however, some relationships between sites and environmental variables can be discerned. For example, all of the lakes in this study (with the exception of Ruins Lake) plotted near one another, indicating that these deeper bodies of water have somewhat distinct limnological characteristics from the much smaller ponds. In this instance, the lakes generally had lower temperatures, conductivities, and nutrients than the ponds (Table 1).

The remarkable similarity of limnological characteristics shared by our study sites foretells that any gradients identified by the PCA are likely to be weak. The variables

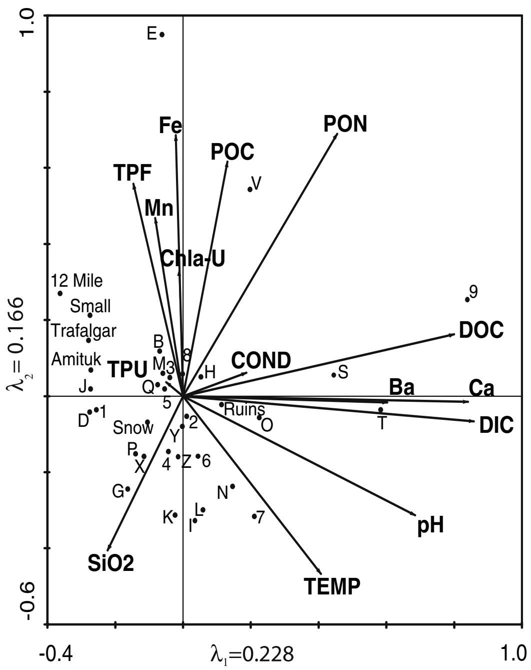

Fig. 3 PCA bi-plot illustrating the relationships between measured water chemistry variables (n = 15) and study sites (n = 38) on Cornwallis Island

with the strongest correlation to axis 1 (i.e., those variables that represent the dominant limnological gradient identified by the PCA) were DIC, Ca, and DOC. This first axis appears to be primarily influenced by a single site, Pond 9, and to a lesser extent Ponds S and T, which had the highest concentrations of DIC, Ca, and DIC in our survey (Table 1). Axis 2 was most influenced by PON, Fe, and POC, however, this gradient appears to be heavily influenced by just two sites, Ponds E and V, which had concentrations of Fe and PON, respectively, that were several-fold higher than the overall means for those variables (Table 1).

Description of diatom flora and inference model development

A total of 217 diatom taxa were identified in this survey. *Navicula sensu lato* was the dominant genus comprising 26% of the taxa, followed by *Cymbella sensu lato* (17%), *Nitzschia* (13%), *Achnanthes sensu lato* (10%), and *Fragilaria sensu lato* (5%). All other genera accounted for less than 5% of the total taxa. Planktonic taxa were rare in this study, accounting for <2% of all observed taxa. Low abundance of planktonic taxa is a common feature of most high Arctic surveys and is directly related to the shallowness of the ponds and extended ice-coverage on many of the lakes, which effectively precludes the establishment of large planktonic populations (Smol 1988).

A list of the common taxa (defined here as having at least 5% relative abundance at any site or 1% relative abundance in three sites) and their number of occurrences, maximum abundances, and Hill's N2 diversity values are given in Table 2. A complete taxa list can be found in electronic supplementary material, S1. Relative frequencies of the dominant taxa (defined here as having ≥10% abundance at any interval) are plotted in Fig. 4. Sites are arranged in order of ascending DCA axis 1 scores, which represents the primary ecological gradient as inferred from species composition data.

None of the measured environmental variables explained significant ($P \leq 0.05$) proportions of the diatom variance, as determined by RDA. This result was entirely expected given the short environmental gradients in our survey, particularly in ecologically important variables such as pH and conductivity (Fig. 2). Nonetheless, this dataset is useful to answer another important ecological question: Do high Arctic diatoms show marked compositional changes in the absence of major limnological gradients?

In general, our sites had relatively similar diatom assemblages, in terms of both species composition and relative abundances (Fig. 4). Although not quantified, microhabitats (e.g., percentage of rock, moss, sediment) were largely uniform, with most sites having rocky bottoms and minimal aquatic vegetation. The similarity of microhabitats among our sites implies that water chemistry was the most influential factor governing diatom distributions. DCA, which can be used to obtain quantitative estimates of species turnover, or β-diversity, showed that the species gradient length along axis 1 was only 0.88 SD, which is considerably smaller compared to any of our previous studies.

The most common and abundant taxa were, *Achnanthidium minustissima*, *Nitzschia perminuta*, *N. frustulum*, and, to a lesser extent, *Chaemaepinnularia soehrensis*, and *Navicula chiarae*. These taxa, particularly *A. minutissima* and *N. perminuta*, are common in circum-neutral, low conductivity sites throughout the circumpolar Arctic. Small, benthic fragilaroid taxa (*Staurosirella pinnata*, *Staurosira construens*) reached their highest abundances in the deeper, colder, ice-covered lakes (similar to other Arctic regions); however, they rarely exceeded 5% relative abundance in any site. Likewise, *Fragilaria capucina*, a taxon common in slightly alkaline, dilute Arctic ponds, occurred in nearly 50% of our study sites but rarely in excess of 5% relative abundance (Table 2).

Although the majority of sites had similar diatom assemblages there were exceptions. Most notable were sites P8 and G2 (bottom of Fig. 4), which contained high abundances of taxa unique to this dataset. As mentioned previously, marine aerosols impact these two sites and, as a

Table 2 List of diatom taxa from the Cornwallis Island study sites showing number of occurrences, maximum abundance, and Hill's N diversity values

Taxa name	Synonym	No. occur.	Max. abund.	Hill's N2
Achnanthes sensu lato				
Achnanthes broenlundensis Foged		26	31.14	5.3
Psammothidium chlidanos (Hohn and Hellerman) Lange-Bertalot	*Achnanthes chlidanos* Hohn and Hellerman	16	3.39	8.8
Eucocconeis flexella (Kützing) Cleve	*Achnanthes flexella* Kützing	34	4.37	20.0
Planothidium granum [(Hohn and Hellerman) Lange-Bertalot]	*Achnanthes grana* [Hohn and Hellerman]	2	22.03	1.6
Achnanthidium kryophila (Petersen) Bukhtiyarova	*Achnanthes kryophila* Petersen	32	60.61	7.8
Eucocconeis laevis (Oestrup) Lange-Bertalot	*Achnanthes laevis* Oestrup	33	6.15	20.0
Psammothidium marginulata (Grunow) Bukhtiyarova and Round	*Achnanthes marginulata* Grunow	33	45.96	10.4
Achnanthidium minutissima Kützing	*Achnanthes minutissima* Kützing	38	37.94	25.0
Rossithidium sp. [cf. *petersenii* (Hustedt) Round and Bukhtiyarova]	*Achnanthes* sp. [cf. *petersenii* Hustedt]	29	10.47	14.4
Amphora				
Amphora inariensis Krammer		22	5.75	14.0
Amphora libyca Ehrenberg		22	2.35	14.2
Amphora spitsbergensis Van Landingham		8	5.19	3.7
Amphora sp. [cf. *spitsbergensis*] Van Landingham		1	12.34	1.0
Amphora veneta Kützing		8	2.66	3.8
Amphipleura sensu lato				
Berkeleya kriegeriana (Krasske) Hustedt	*Amphipleura kriegeriana* (Krasske) Hustedt	5	4.42	3.4
Caloneis				
Caloneis sp. [aff. *hendeyi* Lange-Bertalot]		15	2.79	10.0
Caloneis sp. [aff. *tenuis* (Gregory) Krammer]		6	8.84	2.1
Caloneis sp. [cf. *tenuis* (without central gap) (Gregory) Krammer]		29	5.13	16.7
Caloneis sp. [cf. *tenuis* (with central gap) (Gregory) Krammer]		14	3.23	8.0
Caloneis silicula (Ehrenberg) Cleve		15	2.28	7.9
Cyclotella				
Cyclotella comensis Grunow in Van Heurck		5	4.11	3.1
Cymbella sensu lato				
Cymbella lapponica Grunow ex Cleve		31	4.42	21.1
Cymbopleura amphicephala (Naegeli) Krammer	*Cymbella amphicephala* Naegeli	20	1.78	12.2
Cymbopleura angustata (W. Smith) Krammer	*Cymbella angustata* (W. Smith) Cleve	32	5.65	21.0
Cymbella arctica (Lagerstedt) Schmidt		26	1.52	19.0
Cymbella botellus (Lagerstedt) Schmidt		31	11.46	16.7
Encyonopsis cesatii (Rabenhorst) Krammer	*Cymbella cesatii* (Rabenhorst) Grunow	16	3.04	10.3
Cymbella descripta Krammer and Lange-Bertalot		14	6.38	6.7
Cymbopleura designata (Krammer) Krammer	*Cymbella designata* Krammer	28	12.55	9.7
Encyonema fogedii Krammer		18	14.97	5.8
Encyonema gaeumannii (Meister) Krammer	*Cymbella gauemannii* Meister	4	5.02	1.4
Encyonopsis microcephala (Grunow) Krammer	*Cymbella microcephala* Grunow	29	16.41	11.9
Encyonema silesiacum (Bleisch in Rabenhorst) Mann	*Cymbella silesiaca* Bleisch	25	2.04	16.8
Cymbopleura sp. [aff. *hybrida* (Grunow) Krammer]	*Cymbella* sp. [aff. hybrida (Grunow) Cleve]	19	2.75	10.3
Denticula				
Denticula kuetzingii Grunow		29	29.62	4.4
Diploneis				
Diploneis oculata (Brébisson) Cleve		19	4.45	12.8
Fragilaria sensu lato				
Fragilaria capucina spp. Desmazières		18	8.92	8.6

Table 2 continued

Taxa name	Synonym	No. occur.	Max. abund.	Hill's N2
Staurosira construens var. *subrotunda* Mayer	*Fragilaria construens* var. *subrotunda* Mayer	1	8.28	1.0
Staurosirella pinnata (Ehrenberg) Williams and Round	*Fragilaria pinnata* Ehrenberg	7	5.16	4.3
Navicula sensu lato				
Navicula bjoernoeyaensis Metzeltin, Witkowski and Lange-Bertalot		2	7.35	1.2
Adlafia bryophila (Petersen) Moser, Lange-Bertalot and Metzeltin	*Navicula bryophila* Petersen	31	7.84	18.0
Navicula chiarae Lange-Bertalot and Genkal		36	10.39	25.0
Diadesmis contenta (Grunow) Mann	*Navicula contenta* Grunow	8	9.96	3.3
Navicula gerlofii Schimanski		7	2.13	4.7
Navicula gregaria Donk.		3	7.66	1.3
Navicula hilliardii Manguin		6	1.26	5.2
Navicula kuelbsii Lange-Bertalot		1	11.01	1.0
Navicula perminuta Grunow In Van Heurck		2	11.32	1.4
Navicula phyllepta Kützing		15	39.22	2.4
Chamaepinnularia soehrensis (Krasske) Lange-Bertalot	*Navicula soehrensis* Krasske	35	15.69	24.1
Navicula sp. [cf. *cryptocephala* Kützing]		9	6.15	6.5
Navicula sp. 1		10	11.11	2.9
Navicula sp. 2		9	5.29	4.2
Neidium				
Neidium bergii (Cleve-Euler) Krammer		17	4.49	8.3
Nitzschia				
Nitzschia perspicua Cholnoky		12	2.88	8.0
Nitzschia dissipata var. *media* (Hantzsch) Grunow		12	5.64	3.8
Nitzschia frustulum (Kützing) Grunow in Cleve and Grunow		34	51.77	12.5
Nitzschia inconspicua Grunow		17	15.44	9.0
Nitzschia palea (Kützing) W. Smith		17	7.14	5.1
Nitzschia perminuta (Grunow) M. Peragallo		35	38.70	18.8
Nitzschia pura Hustedt		23	3.61	13.7
Nitzschia pusilla Grunow		3	39.25	1.7
Pinnularia				
Pinnularia balfouriana Grunow		5	25.58	1.3

Only taxa with at least 1% relative abundance in three sites, or with at least 5% relative abundundance in any site, are shown. A complete taxa list can be found as Electronic Supplementary Material, S1

result, they had the highest specific conductances in our survey at 13,200 and 2,660 μS cm^{-1}, respectively, which is far above the overall mean of 554 μS cm^{-1}. The dominant taxa in these high conductivity sites were *Nitzschia pusilla*, *Navicula phyllepta*, *Planothidium granum*, and *Amphora* cf. *spitsbergensis* (Fig. 4), all of which are commonly found in Arctic lakes and ponds with elevated conductivities (e.g., Antoniades et al. 2004; Michelutti et al. 2006).

Although Ruins Lake (third from bottom in Fig. 4) contained some of the more common taxa, it remained distinct from others in this survey as being the only site with large percentages (25%) of *Pinnularia balfouriana*. The high abundance of *P. balfouriana* in Ruins Lake is undoubtedly related to the lush vegetation (primarily bryophytes and grasses) that occurs both within its catchment and nearshore environment, as *P. balfouriana* is commonly observed in moss-rich Arctic ponds (e.g., Douglas et al. 1994; 2004a, b).

Diatom assemblages from ponds D, N, and I (top of Fig. 4) were also distinct from others in this survey as they were dominated largely by *Achnanthes sensu lato* taxa including *Achnanthes broenlundensis*, *Psammothidium marginulata*, and *A. kryophila*. These taxa, particularly *P. marginulata* and *A. kryophila*, are well-known aerophiles, commonly observed growing on wet and moist substrates (Petersen 1915; Foged 1955; Van Dam et al. 1994). The physical characteristics of Ponds D, N, and I are entirely consistent with providing conditions amenable for aerophilic diatom growth as they all have predominantly rocky bottoms and are extremely shallow (Z_{max} < 20 cm). In fact,

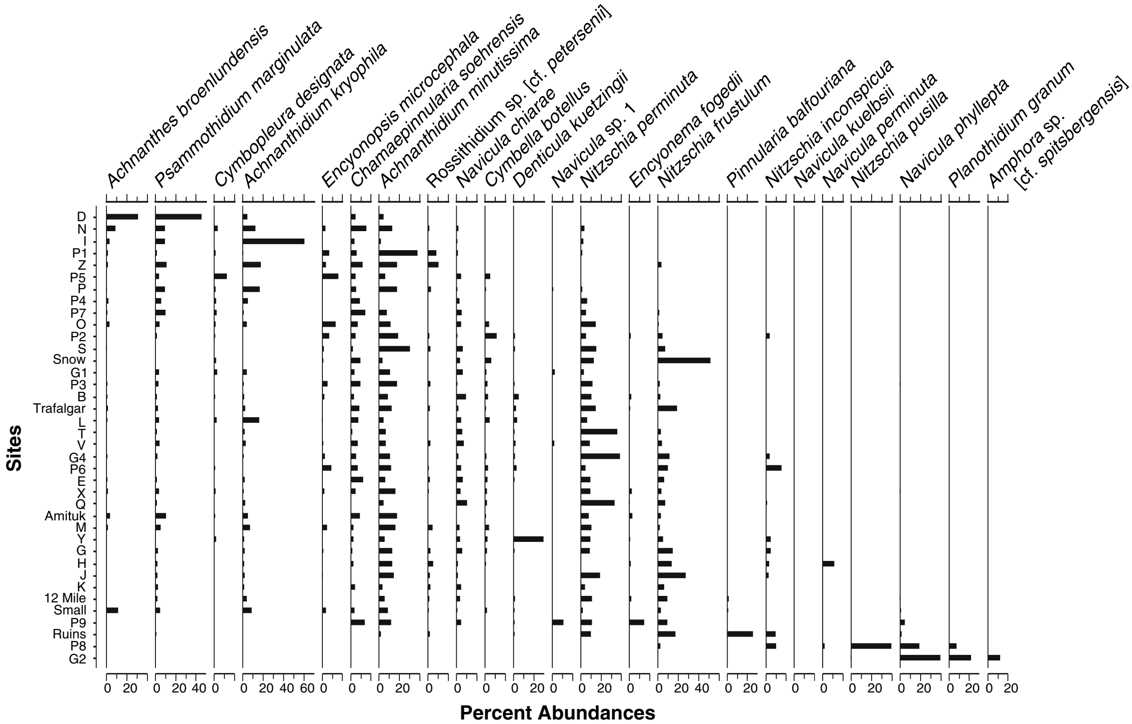

Fig. 4 Percent abundances of the dominant (>10%) diatom taxa in the 38 lakes and ponds from Cornwallis and Griffith islands. Sites are arranged in order of ascending DCA axis 1 scores

at the time of sampling, Pond N appeared to be merely a collection of water draining locally that would be subject to water level changes.

Conclusions

The most unique aspect of this study was the ability to explore differences in diatom species composition across a High Arctic island that is quite distinct from previous Arctic island surveys. In particular, this island's lakes and ponds have remarkably uniform microhabitats and water chemistry and, due to the relatively low relief, experience similar climatic conditions. In short, Cornwallis Island serves as an excellent reference area to assess the importance of water chemistry and climate variables versus other unmeasured factors, on diatom species composition in Arctic lakes and ponds. The remarkable similarity of diatom assemblages amongst the majority of our sites across Cornwallis Island reinforces assertions from previous surveys that variations in climate and water chemistry variables, particularly pH and specific conductance, are the main drivers influencing diatom assemblages in Arctic lakes and ponds. In fact, the only instances in which diatom species composition varied to any great extent were when water chemistry differed markedly (as in the case of the high conductivity sites, G2 and P8), or when there were major differences in habitat types (as in the cases of the moss-rich environment of Ruins Lake and the aerophilic habitats in ponds D, N, and I). By acting as a type of ''negative control'', the Cornwallis Island dataset confirms that, although many physical, chemical and biological factors may influence diatom distributions, the limnological variables that we routinely measure in our Arctic surveys appear to capture and explain the majority of the variation in the species assemblages.

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