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WATER CHEMISTRY AND PHYTOPLANKTON IN THE GYDA BAY (KARA SEA)

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Presented are water chemistry and phytoplankton (abundance and biomass) data from the Gyda Bay, an underexplored area of the Kara Sea. Water chemistry varies over the bay being controlled by the tributary rivers in its southern and central parts and by the Kara Sea in the northern part. Correspondingly, the water has extremely low total dissolved solids (32 to 250 mg/l) in the former and a much higher salinity (up to 6600 mg/l) in the latter. Phytoplankton consists mostly of diatoms. Its distribution patterns correlate with the seawater salinity, the highest abundance and biomass of algae being found in the more freshwater part of the Gyda Bay.

The Gyda Bay located in the southern Kara Sea between the Ob Bay and the Yenisei Gulf is a ~200 km long and ~62 km wide gulf that cuts deep into the Gyda Peninsula. The sea in the Gyda Bay is rather shallow (5–8 m), with many banks. This is an area of harsh Arctic climate, with an open-water season shorter than 80 days. The bay receives water from the Gyda (Nyarmesalya) River and other smaller tributaries flowing into it from the south [*Treshnikov, 1985*].

Integrate offshore studies in the Gyda Bay were carried out in September 2009. Surface and bottom waters were sampled from the more freshwater southern part (sites 16–19) and the more saline northern part (sites 11–15) of the bay (Fig. 1).

Water chemistry was analyzed following the classical procedures [*Bordovsky and Ivanenkov, 1978; Wetzel and Likens, 1991; Baram et al., 1999*]. The phytoplankton samples were collected and studied with common hydrobiological methods [*Utermöhl, 1958; Guseva, 1959; Kozhov and Melnik, 1978*] and with scanning electron microscopy (on a *Phillips SEM 525* microscope).

Water chemistry in the Gyda Bay varies over the area. Water is of low salinity in the southern part, which is fed by the Gyda and Yuribei rivers as well as by numerous brooks flowing out of lakes. Total dissolved ions measured in samples from stations in the middle of the southern profile (17, 18) varied from 32 to 56 mg/l, and the ion composition was mostly of hydrocarbonate and calcium. On the ends of the profile, the salinity was slightly higher (112 mg/l and 210 mg/l at sites 16 and 19, respectively); chloride and sodium ions predominated, possibly, due to the surface runoff input controlled by marine aerosols. The bottom water was 3–5 mg/l more saline than the surface water.

Water temperature varied along the profile from 9.6 °C (station 16) to 10.6 °C (station 19), and pH decreased from 7.65 to 7.55, respectively. The dissolved oxygen contents were similar in the surface and bottom waters being 10.88–11.30 mg/l.

The water samples from the southern bay contained low Si (0.10–0.15 mg/l) and P from analytical zero to 0.005 mg/l (higher values were measured at station 19). The nitrogen contents in nitrate and ammonium compounds were similar at all sites, in the ranges 0.10–0.14 and 0.06–0.10 mg/l, respectively; nitrate N was in trace amounts.

The northern part of the Gyda Bay is under the influence of the Kara Sea, which largely controls its water chemistry. The pH values measured in that bay part were higher (7.86–7.95) than in the south; total dissolved ions were one or two orders of magnitude higher, and the chemistry was rather chloride-sodic. In spite of quite a shallow water depth (~10 m) and a small temperature difference between the surface and bottom layers (no more than 0.3 °C), water showed density stratification. Note that steady southern wind blowing during the whole period of observations provided influx of fresher and lighter water from the bay center, which spread in the surface layer of the northern bay part. The salinity varied from 3100 mg/l (site 11) to 5970 mg/l (site 15) in the surface water but was higher (4700–6600 mg/l) near the bottom.

Dissolved oxygen at sites of the northern profile was more or less uniform in lateral and vertical dimensions (10.7–11.15 mg/l). Biogenic elements in the north were higher than in the south. The measured Si contents were the highest in samples from the middle of the profile (1.75 mg/l) and did not exceed 0.92 mg/l near the shore. As for mineral P, its concentrations likewise increased from 0.014 mg/l at coastal sites to 0.024 mg/l farther offshore. Note that the depth distribution of silica and phosphates did not change within a site. Nitrogen occurred in the nitrate and nitrite forms (up to 0.08 mg/l NO_3^- and 0.003 mg/l NO_2^-); ammonium N was found in trace concentrations in surface water only.

Phytoplankton in the analyzed water samples from the Gyda Bay contained marine and freshwater algae species (Fig. 2), and there were some species we failed to identify. Most of the identified seventy seven species were diatoms (49 %) and green (21 %) or blue-green (10 %) algae. Fewer species found at that period belonged to cryptophytes (6 %) and dynophytes (3 %).

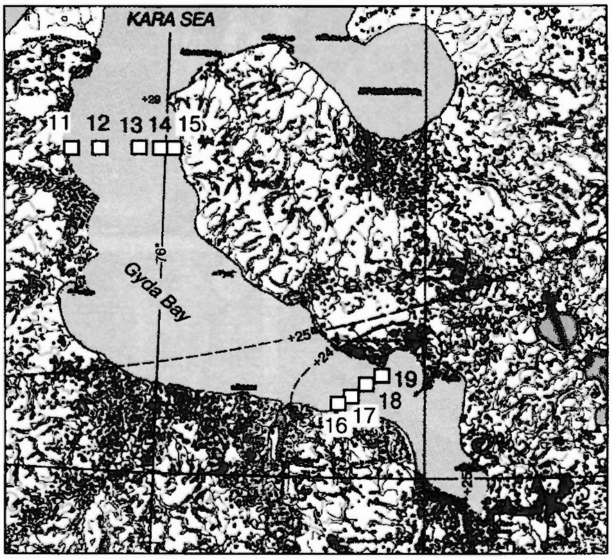

Fig. 1. Location map of sampling sites in the Gyda Bay.

The freshwater part of the bay (sites 16–19) abounded in phytoplankton. The highest abundances (43 to 36 % of total diatom count) were in freshwater species of *Aulacoseira* – *A. islandica, A. subarctica, A. ambigue* (Grun.) Sim, while the percentages of marine taxa (*Thalassiosira baltica, T. bramaputrae, T. nodenskiöldii,* and *Cyclotella choctawhatcheeana*) and spores of *Chaetoceros* Ehr were low (2.0–6.5 % in abundance and 3.5–17.0 % in biomass). Green algae abundances were likewise relatively high (15 to 24 % of total diatom count), especially the genera *Scenedesmus* Meyen, *Monoraphydium* Kom.-Leg., and *Pediastrum* Meyen. The total abundance of phytoplankton in that bay part varied from $0.495 \cdot 10^6$ to $1.153 \cdot 10^6$ and the biomass was 380 to 871 mg/m^3.

More saline water (stations 11–15) showed more depleted phytoplankton compositions, with the abundances from $0.009 \cdot 10^6$ to $0.015 \cdot 10^6$, and the biomass from 7 to 12 mg/m^3. Diatoms were the dominant phytoplankton group (55–80 % of total abundance and 90–96 % of total biomass). The diatom species were *Thalassiosira baltica* (Grun.) Ostf, *T. bramaputrae* (Ehr.) Håk. et Locker, *Cyclotella choctawhatcheeana* Prasad, *Chaetoceros decipiens* Cleve. There were also minor amounts of marine pelagic and neritic arctoboreal species *T. nodenskiöldii* Cl., and spores of *Chaetoceros*. The freshwater taxa made up 33–70 % and 10–38 % of total diatom count and biomass, respectively. They were *Aulacoseira islandica* (O. Müll.), *A. subarctica* (O. Müll.) Haworth and *Fragilaria crotonensis* Kitton species, small representatives of the *Stephanodiscus* Ehr. genus and the species *Monoraphydium*.

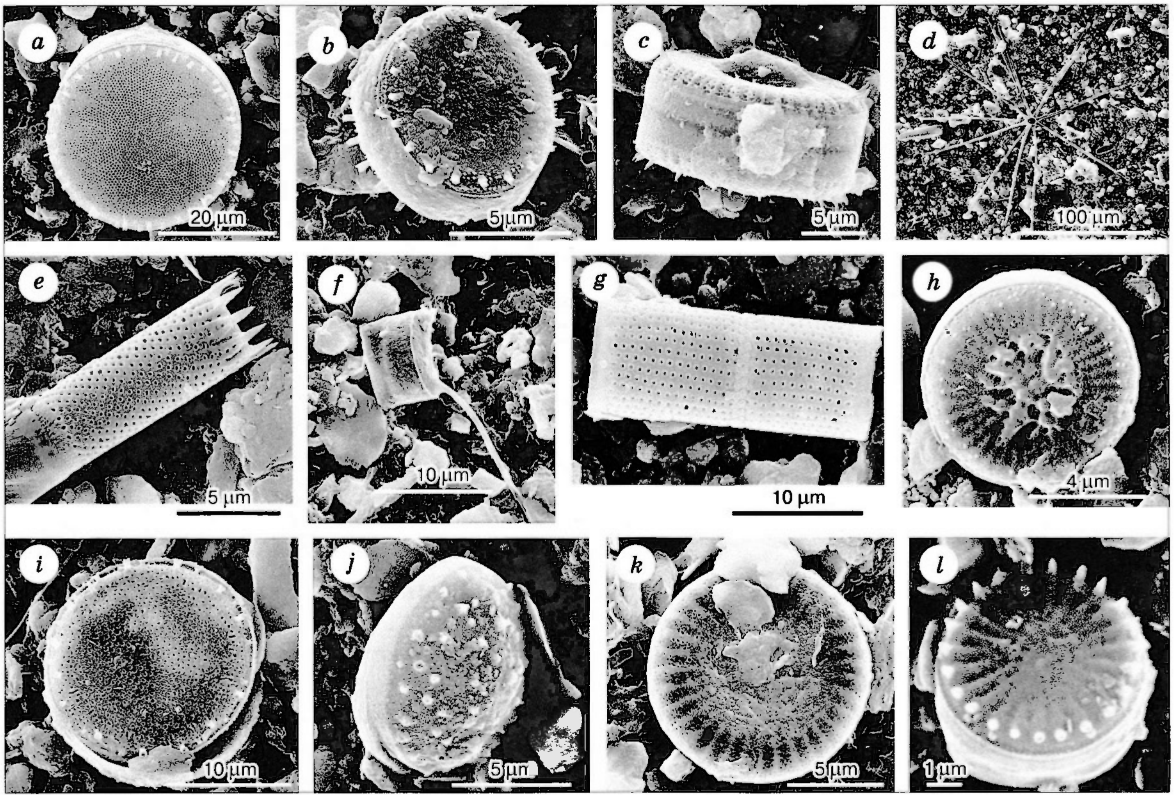

Fig. 2. Dominant phytoplankton species identified in the Gyda Bay in September 2009.

a – *Thalassiosira baltica*; *b* – *Thalassiosira guillardii*; *c* – *Cyclotella meneghiniana*; *d* – *Asterionella formosa*; *e* – *Aulacoseira subarctica*; *f* – *Chaetoceros decipiens*; *g* – *Aulacoseira islandica*; *h* – *Cyclotella tripartita*; *i* – *Thalassiosira* sp.; *j* – spore of *Chaetoceros*; *k* – *Cyclotella choctawhatcheeana*; *l* – *Stephanodiscus minutulus*.

Thus, the water salinity in the Gyda Bay increases in the northern direction, being fresher in the southern part of the bay at the account of inflowing hydrocarbonate-calcium riverine water. The coastal water is enriched in Cl, Na, and Mg ions. The northern bay part influenced by the Kara Sea has more saline water, with chloride-sodic chemistry.

Out of seventy seven identified phytoplankton species of marine and freshwater algae, 49 % are diatoms. The fresher southern part of the bay has a greater phytoplankton biomass but lower concentrations of biogenic elements than the more saline northern part. The water of the bay is well aerated in the ice-free seasons.

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