INTERACTION EFFECTS OF NITROGEN FORM AND TEMPERATURE ON GROWTH, STOICHIOMETRY AND PHOTOSYNTHETIC PARAMETERS OF A COSMOPOLITAN DIATOM *CHAETOCEROS GELIDUS*

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INTRODUCTION

In Arctic, the average temperature is increasing 0.4˚ C per decade[1] → Temperature plays a key role in regulating metabolic processes

Permafrost thaw and increased river discharge → Increased export of dissolved organic nitrogen (DON)[2] and higher turbidity inshore

How does it influence the **GROWTH** and **ELEMENTAL COMPOSITION** (or **STOICHIOMETRY**) of ecologically-relevant arctic phytoplankton?

What are the consequences for biogeochemistry and organic matter fluxes (e.g., amount of carbon fixed per unit nutrient, biological CO_2 pump, nutritive value of algae)?

MATERIALS AND METHODS

- **Culture conditions :**
  - Species : *Chaetoceros gelidus* RCC2046 (**Fig. 1 ; Fig. 2**)
    - A widespread diatom that often dominates in the subsurface chlorophyll maximum[3]
  - Light : continuous (mimics summer conditions)
  - Light intensities : 200 µmol photons m^{-2} sec^{-1}
  - Temperature : 0°C / 3°C / 6°C / 9°C
  - Medium : ASW[4]
  - Nutrient concentrations :
    - 100 µM of ammonium (NH_4^+), nitrate (NO_3^-) or urea as sole N source
    - N:PO_4^{3-} ratio of 9:1 (pre-bloom conditions in the Beaufort Sea)

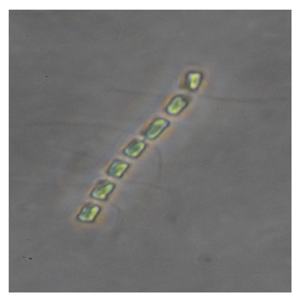


Fig. 1. *Chaetoceros gelidus* RCC2046

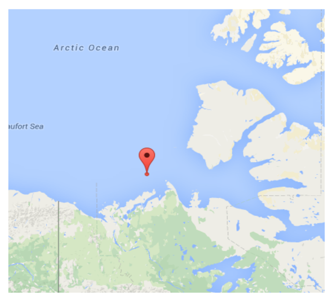
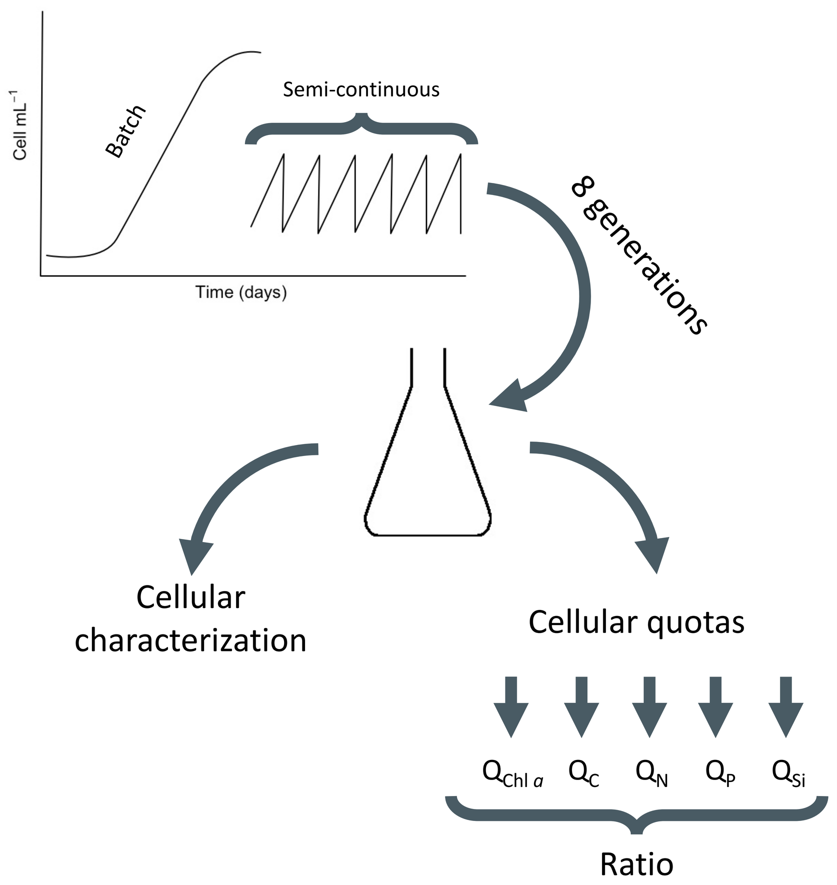


Fig. 2. Location of natural population from which phytoplankton was isolated

- **Methodology and variables measured :**



RESULTS

1) Growth and elemental composition

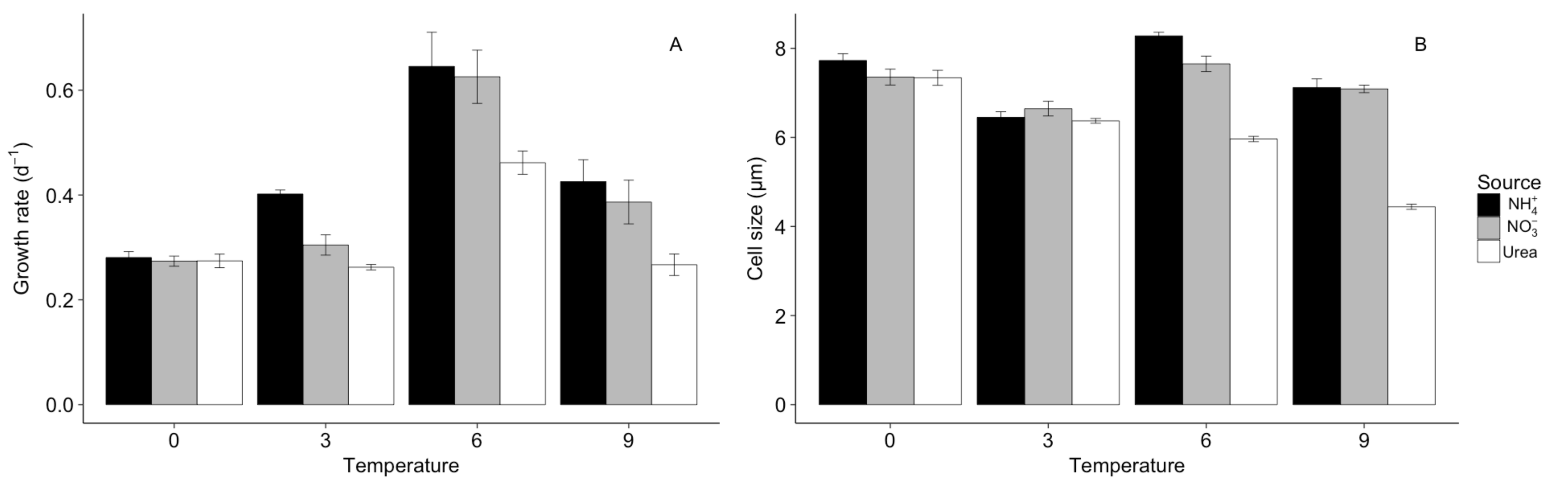


Fig. 3. Growth rate (d^{-1}) (A) and cell size (µm) (B) of *Chaetoceros gelidus* acclimated at 0˚C to 9˚C with NH_4^+, NO_3^- or urea as sole N source. The error bars indicate the standard deviation (n = 3).

- Growth rate (Fig. 3A) : **Increased** significantly with increasing temperature, then **decreased** at 9˚C for all the treatments
  - **Dependent** of N source ($NH_4^+ > NO_3^- >$ urea)
  - NO_3^- and Urea culture : increase occurred only between 3 and 6˚C
- Cell size (Fig. 3B) : **Decreased** across the temperature range, except at 6˚C for NH_4^+ and NO_3^- culture

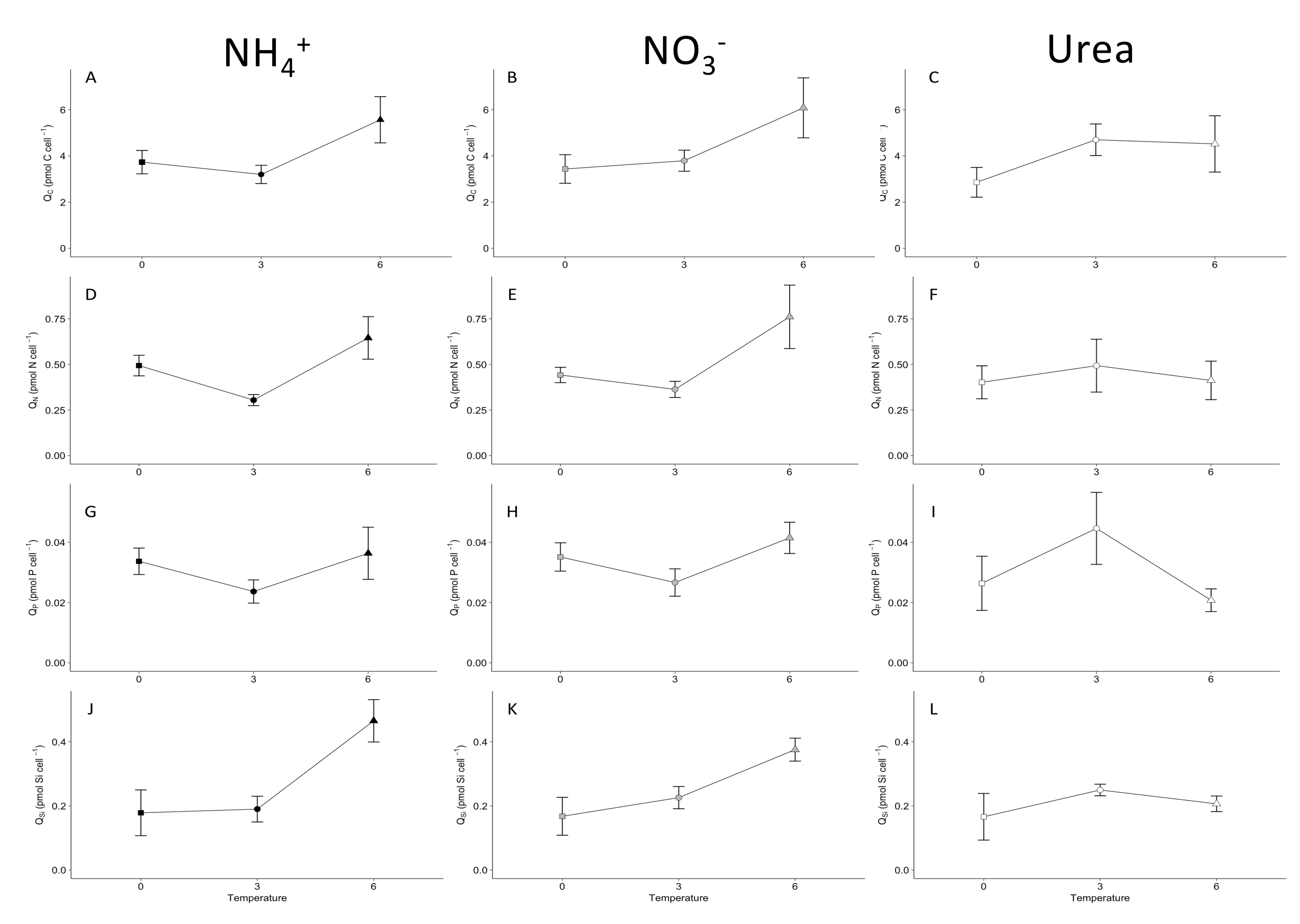


Fig. 4. *Chaetoceros gelidus* cellular quotas (pmol $cell^{-1}$) in cultures grown under continuous saturating irradiance at different temperatures and nitrogen source. (A-C) particulate carbon; (D-F) particulate nitrogen; (G-I) particulate phosphorus; (J-L) biogenic silica. Each point represents the mean (±SD) (n ≥ 18)

- NH_4^+ (Fig 4A-D-G-J) and NO_3^- (Fig 4B-E-H-K) culture : **Showed the same pattern** across the range of temperature for all the cellular quotas.
- Urea culture (Fig 4C-F-I-L) : **Moderately affected** by temperature for all the cellular quota, except for Q_P

2) Stoichiometry

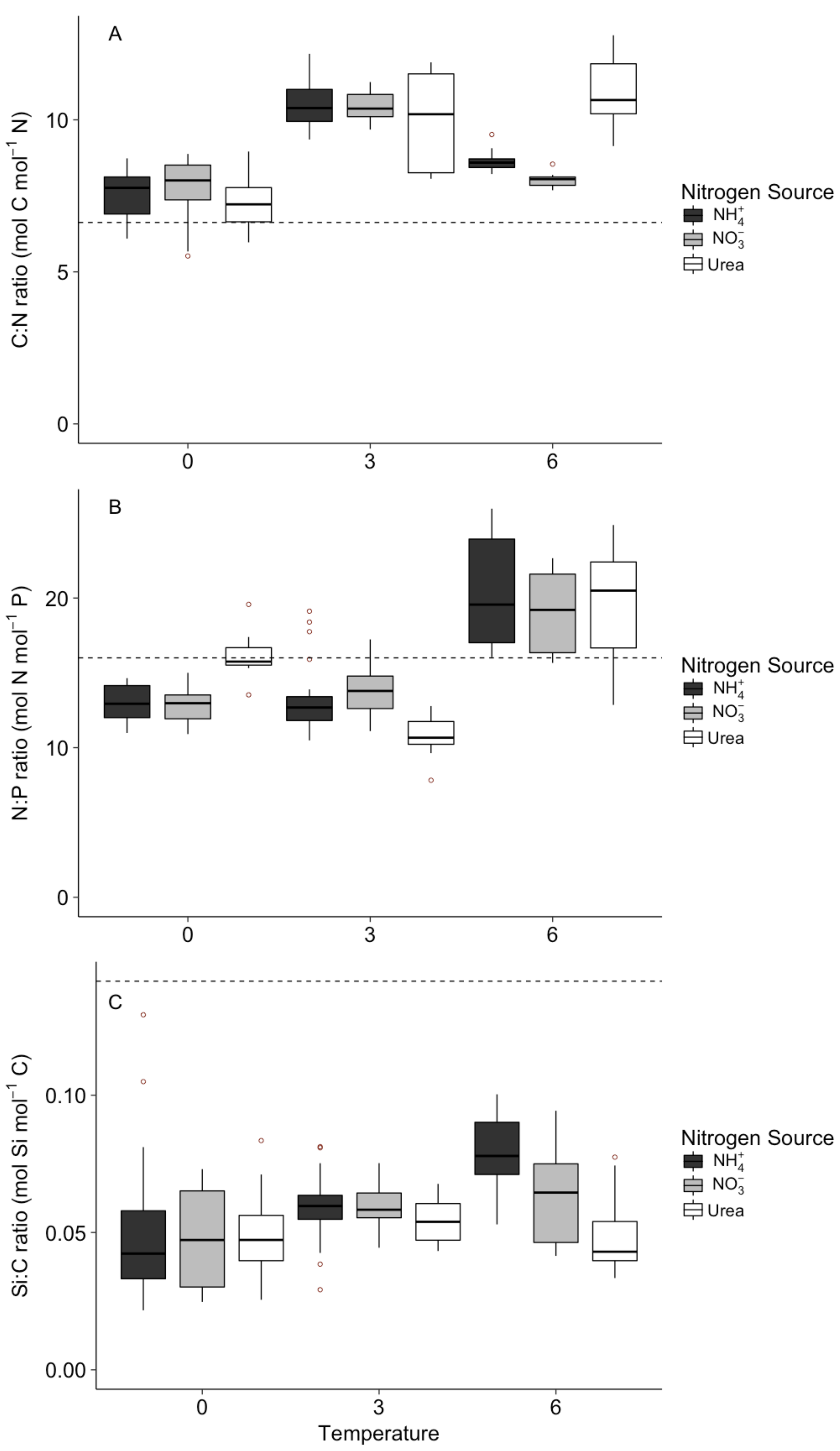


Fig. 5. Box plots of C:N ratio (A), N:P ratio (B) and Si:C (C) of *Chaetoceros gelidus* in cultures grown under continuous saturating irradiance at different temperatures and nitrogen source. The black dashed line indicates the Redfield ratio. (n ≥ 18)

C:N ratio (Fig. 5A):

- **Dependent** of temperature and N source.
- **Higher** than Redfield above 0˚C. Changes in C:N ratio track changes in cell size
- These results contrasts with those previously obtained with a cold-water diatom[5].

N:P ratio (Fig. 5B):

- **Dependent** of temperature and N source.
- **Higher** than Redfield above 3˚C
- For each N sources, changes in N:P ratio are associated with changes in growth rate

Si:C ratio (Fig. 5C):

- **Dependent** of temperature and N source.
- Systematically lower than the average Redfield value.
- Changes in Si:C ratio are associated with changes in growth rate and cell size, consistent with prior observations in temperate diatom[6]

CONCLUSION

- Clear interaction effects between temperature and N sources on growth, cell size and stoichiometric composition of *C. gelidus* RCC2046
- Data suggests that several key parameters in stoichiometry are more variable at higher temperature
- **The results suggest that *C. gelidus* RCC2046 and its biogeochemical function in the Arctic Ocean are highly altered to changes in nitrogen source under various temperature**

REFERENCES

[1]. ACIA, Impacts of a Warming Arctic: Arctic Climate Impact Assessment, Cambridge University Press, UK, 2004. **[2].** Frey, K. E. et *al.* .: Impacts of climate warming and permafrost thaw on the riverine transport of nitrogen and phosphorus to the Kara Sea, J Geophys Res-Biogeo, 112, G04S58, 2007; **[3]** Martin, J., et *al.* .: Nutritive and photosynthetic ecology of subsurface chlorophyll maxima in Canadian Arctic waters, Biogeosciences, 9, 5353-5371, 2012.; **[4].** Berges, J. A., et *al.* : Evolution of an Artificial Seawater Medium: Improvements in Enriched Seawater, Artificial Water over the Last Two Decades, Journal of Phycology, 37, 1138-1145, 2001. **[5].** Spilling, K., et *al.* : Interaction Effects of Light, Temperature and Nutrient Limitations (N, P and Si) on Growth, Stoichiometry and Photosynthetic Parameters of the Cold-Water Diatom *Chaetoceros wighamii*, PLoS One, 10, e0126308, 2015. **[5].** Brzezinski, M. A. 1985. The Si:C:N ratio of marine diatoms: interspecific variability and the effect of some environmental variables. *Journal of Phycology* 21:347-57.