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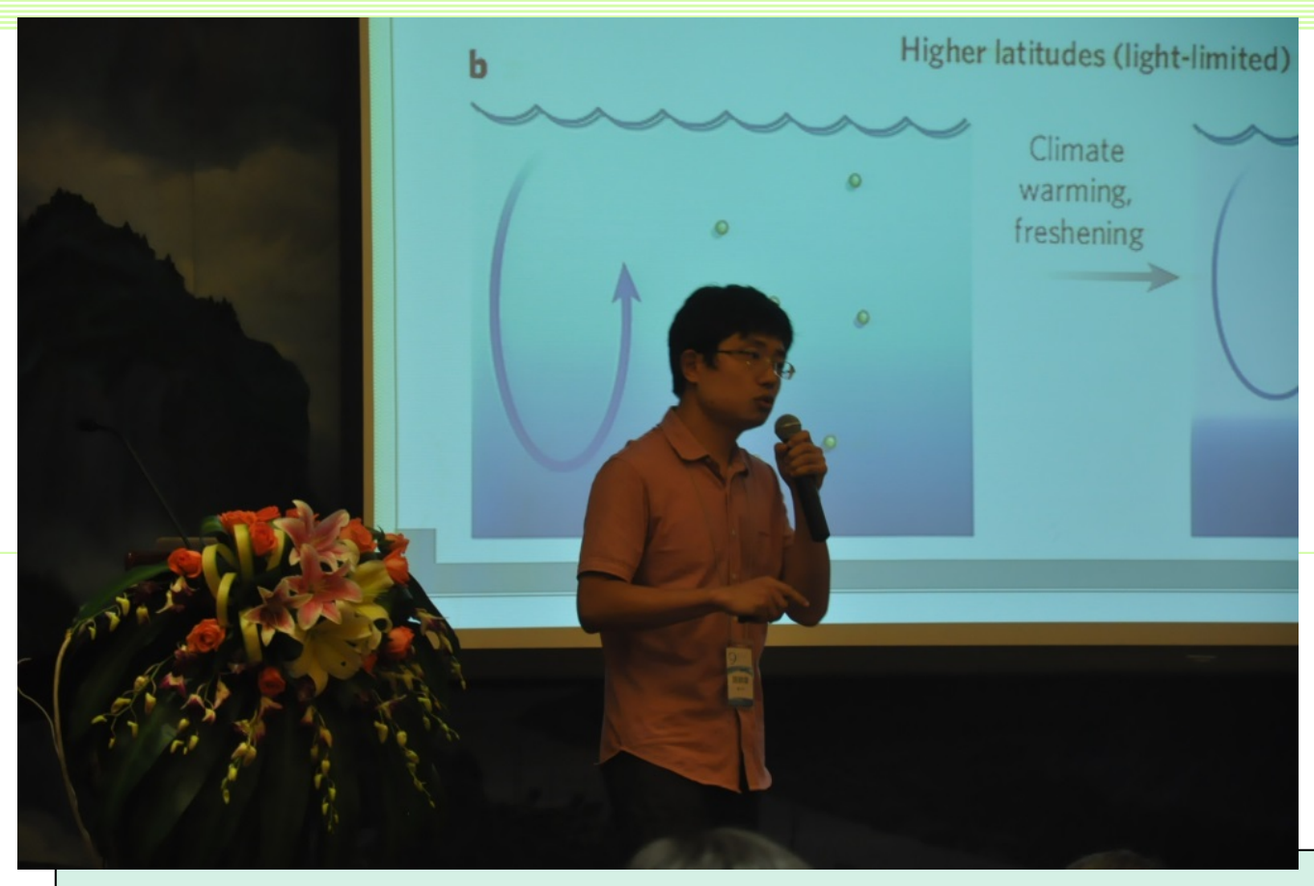
Marine Ecosystem Dynamics
Research Group

Estimating half-saturation constants of microzooplankton grazing in the sea



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Abstract

- This study is a preliminary step to estimate microzooplankton grazing half-saturation constants (***K***) from dilution experiments in which nonlinear feeding kinetics occurred.
- In 528 dilution experiments, 96 experiments show significantly concave curves and only 22 experiments show convex curves.
- The average Chl *a* concentrations in the experiments which show concave curves were significantly higher than those showing linear and convex curves.
- The estimated values of ***K*** vary three orders of magnitude and are are log–log linearly related with ambient Chl *a* concentrations.

INTRODUCTION

- Although the ***K*** of marine microzooplankton has been extensively quantified in laboratory cultures, we still have little knowledge of ***K*** of natural microzooplankton assemblages in the field.
- Previously estimated mean values of ***K*** (0.2 µg Chl L^{-1}; Li et al. MEPS 2011) seem too low and would suggest that in many places of the ocean, microzooplankton would be food satuated.
- The nonlinear curvature in dilution experiments is often attributed to satiated feeding kinetics of microzooplankton at high food concentrations. However, the occurrences of satiated grazing seem not related to the phytoplankton concentration.

METHOD

Principles of dilution experiments:

Phytoplankton dynamics in the dilution bottle can be described as:

$$\frac{dP}{dt} = \mu P - D_i Z I \qquad (1)$$

In which P is phytoplankton biomass (e.g. Chl *a*),

μ is phytoplankton growth rate.

D_i is the dilution level (fraction of undiluted water to total volume) in the ith bottle.

Z: microzooplankton biomass.

I : per capita microzooplankton grazing rate.

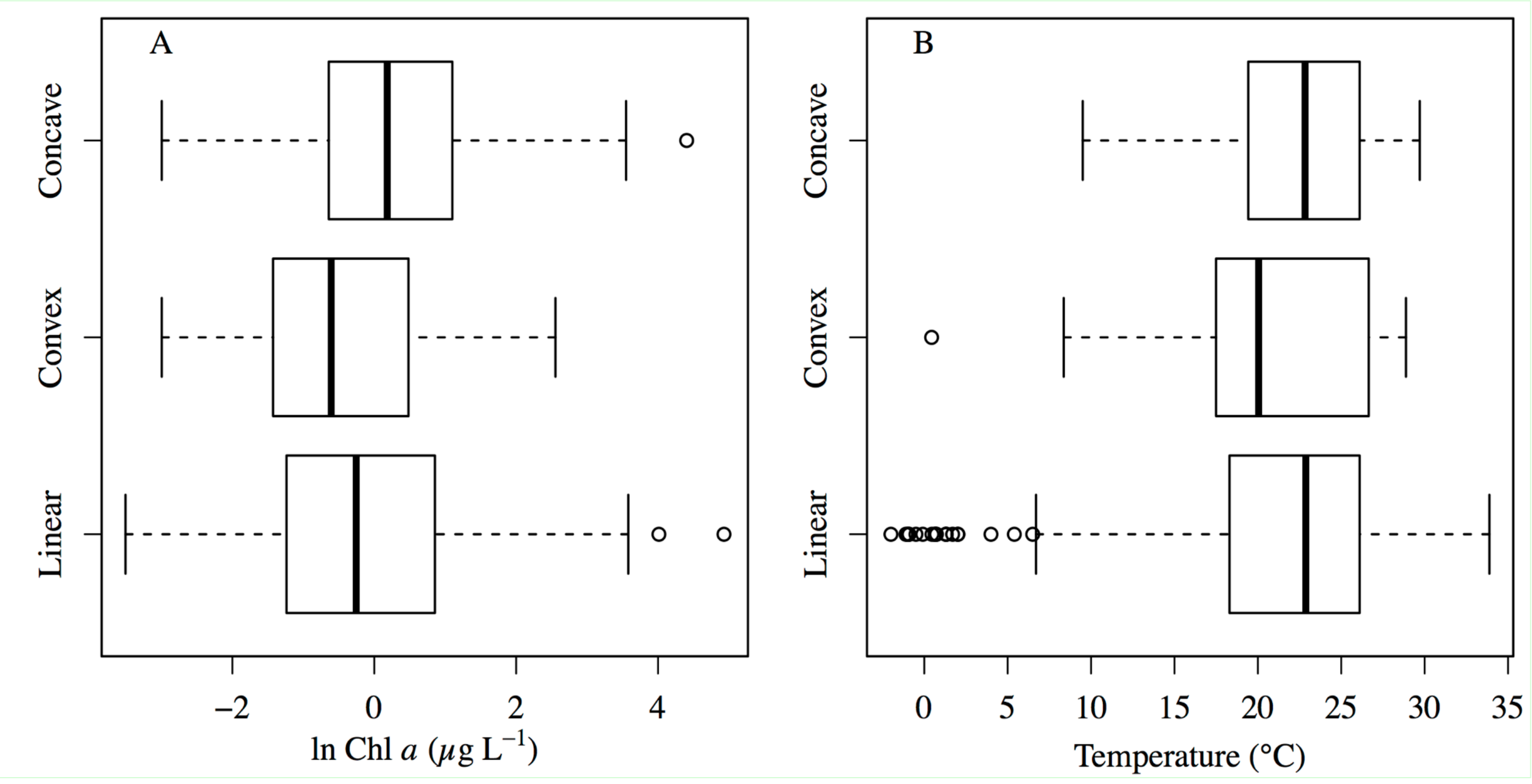
	Equations of $I \sim P$	Equations of m
1. Linear model	$I = I_m P/(2K)$	$m = Z I_m/(2K)$
2. Rectilinear	$I = I_m \min(P/(2K),1)$	$m = Z I_m \min(P_0/(2K),1)/P_0$
3. Holling type II	$I = (I_m \times P)/(P+K)$	$m = Z I_m/(P_0+K)$
4. Holling type III	$I = I_m(P^2/(P^2+K^2))$	$m = Z I_m(P_0/(P_0^2+K^2))$

If assuming the linear model (1), Eq. (1) can be solved to:

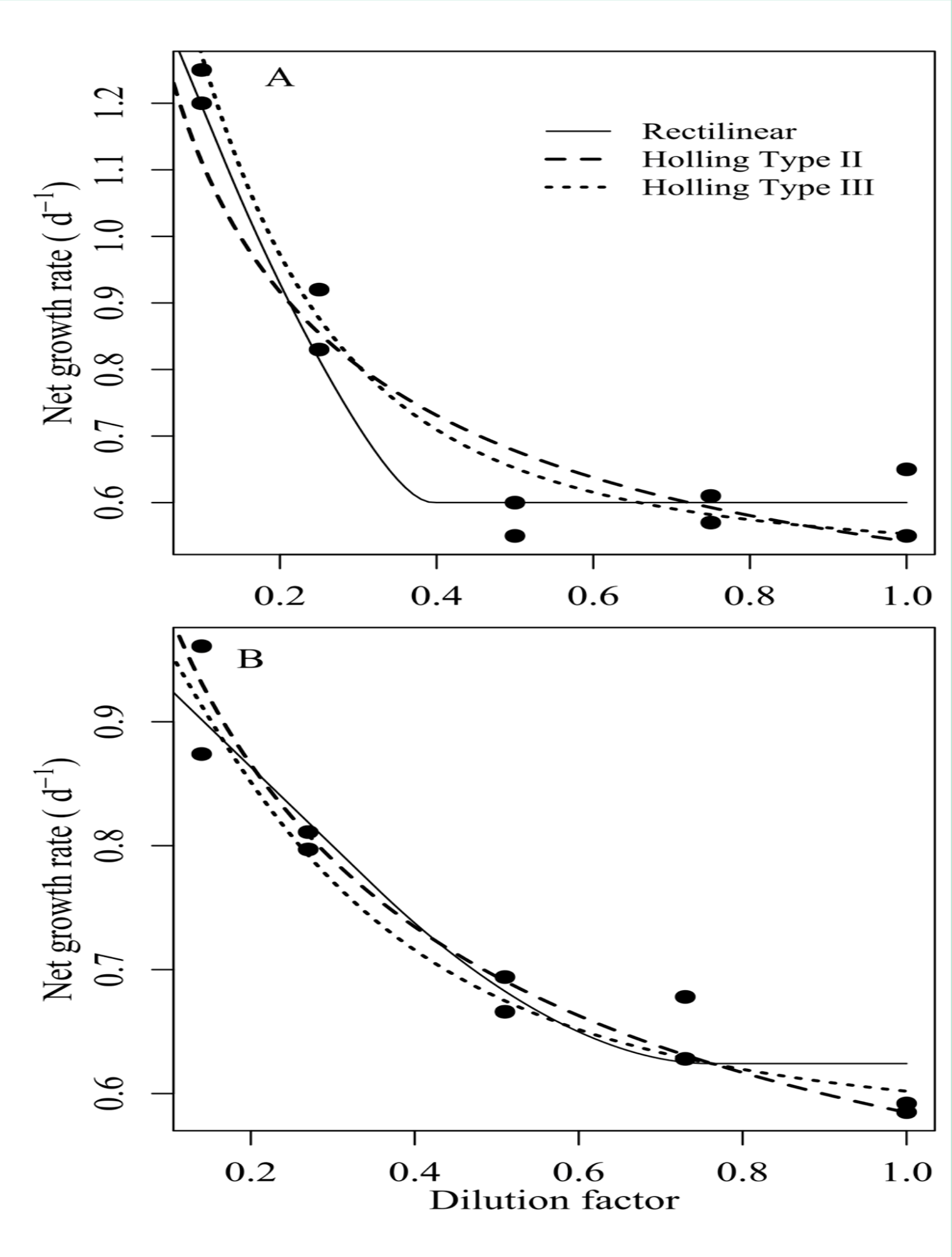
$$\ln(P_{1,i}/P_{0,i}) = \mu - D_i Z I_m/(2K)$$

If nonlinear functions (2–4) are used, Eq. (1) can be solved numerically.

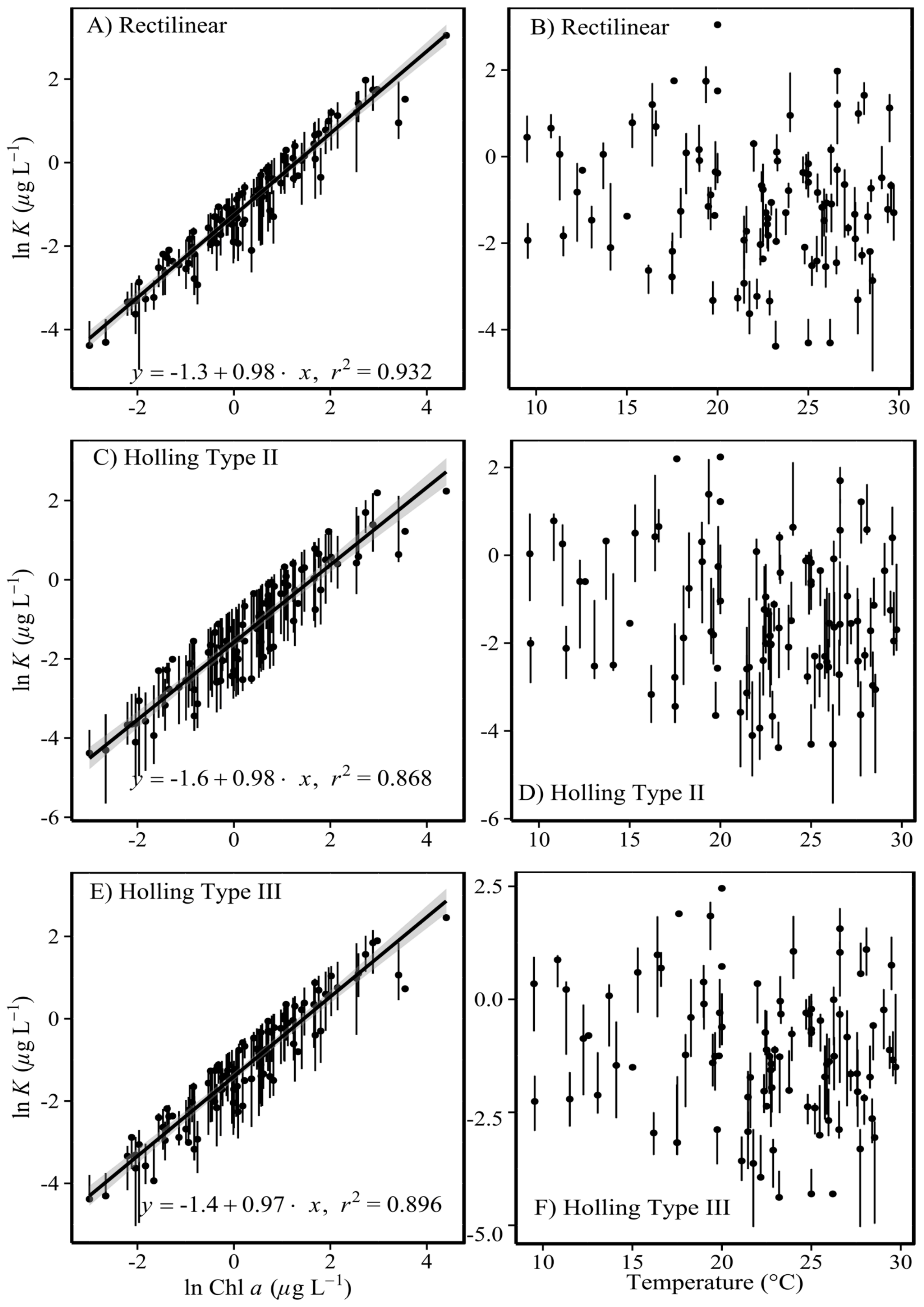
RESULTS



The Chl *a* concentrations in the dilution experiments with concave curvatures are significantly higher than other experiments.



Examples of nonlinear dilution experiments fit with three Holling-type functions.



The values of *K* estimated by three nonlinear models linearly increase with Chl *a* concentrations in the log-log plot, but not relate with temperature. In these experiments, microzooplankton were feeding at, on average, around 80% of the maximal rate in these experiments.

CONCLUSION

The microzooplankton grazing half saturation constant may not be a real ‘constant’.

Mechanisms underpinning the variations of ***K*** are needed.

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