2013 PICES Annual meeting

Variation in assimilation efficiencies of dominant *Neocalanus* and *Eucalanus* copepods in the subarctic Pacific: consequences for population structure models

***Neocalanus cristatus* C5**

***N. flemingeri* C5**

***Eucalanus bungii* C5**

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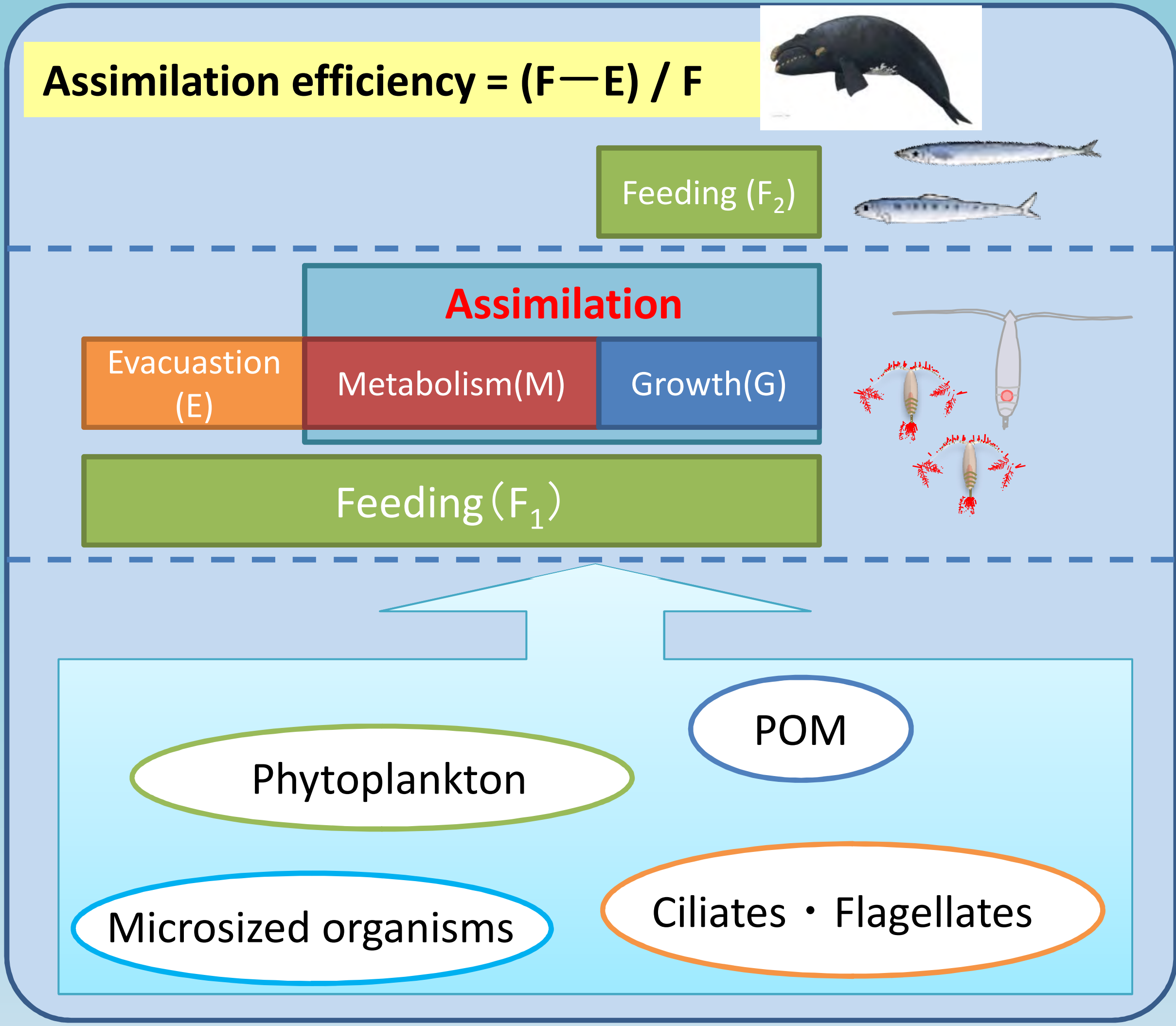
Introduction

Summer zooplankton community in the subarctic Pacific

Neocalanus spp.
Eucalanus spp.

predominant and form 85-90% of the total zooplankton biomass (Vinogradov, 1970)

play an important role in energy transfers to higher trophic organisms (Nemoto, 1963; Hunt et al., 1998; Beamish et al., 1999; Ikeda et al., 2008)



Assimilation efficiency of copepods

Assimilation efficiency is an essential parameter required to estimate the energy transfer to higher trophic levels in marine ecosystems

Introduction

little information is available for assimilation eficiency of large oceanic copepods (*Neocalanus* and *Eucalanus* species) dominated in the subarctic Pacific

Even in marine ecosystem models such as NEMURO, a constant value (70%) is applied for the copepod assimilation efficiency (Kishi et al., 2007; Terui and Kishi, 2008; Terui et al., 2012).

Objectiveof this study

Assimilation efficiencies of three large oceanic copepods (*N. cristatus, N. flemingeri* and *E. bungii*), were measured by applying the Ratio method applying eight phytoplankton species (diatoms, dinoflagellates and a raphidophycean) as food

+

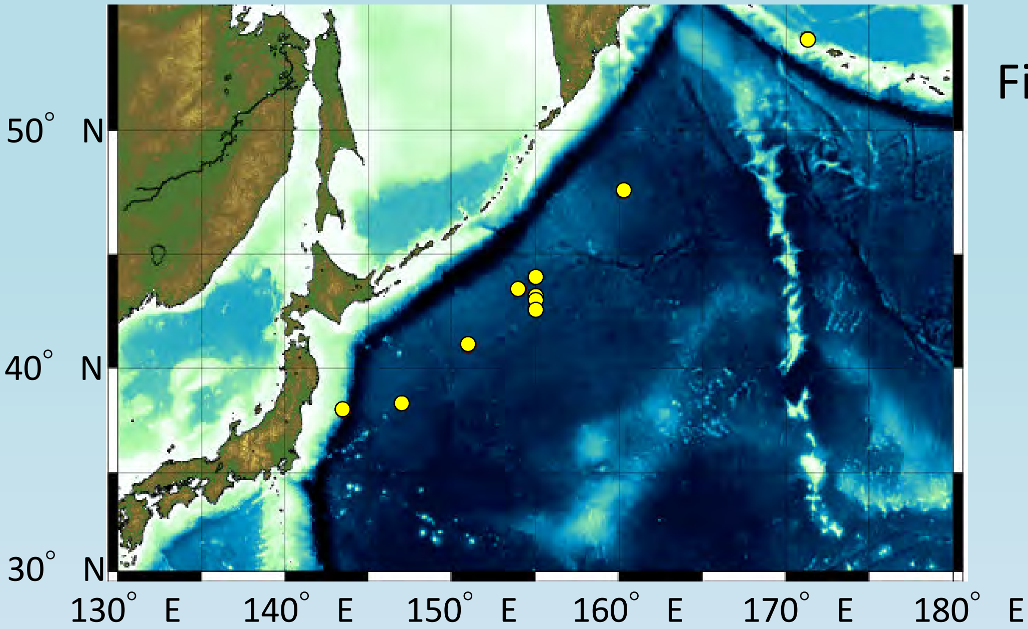
By applying the observed assimilation efficiency of *N. cristatus*, the effects of changes in the assimilation efficiency on copepod population structure were evaluated using the population model (Lagrangian ensemble model; LEM).

Material and Methods

Copepods

***N. cristatus* C5**
***N. flemingeri* C5**
***E. bungii* C5**

Collected in the subarctic Pacific during May-August of 2011 or 2012



Field sampling

80 cm ring net（80 cm mouth diameter, 330 µm mesh）
→0-30, 0-150 m vertical hauls

Live *N. cristatus*, *N. flemingeri* and *E. bungii* were sorted

- Seawater was collected from 20 m depth using Niskin bottles, filtered through a GF/F filter and used in the subsequent experiments.
- Live specimens were transferred into a 1-L bottle filled with filtered seawater (FSW)
- Up to 100 specimens of each species were kept at 2°C and then carried to the land laboratory

Material and Methods

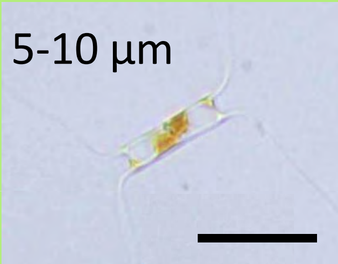
Phytoplankton

To obtain sympatric phytoplankton species, 5 ml of unfiltered seawater was added to a flask containing 300 ml of modified SWM-3 medium

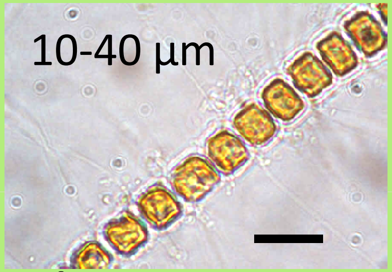
→Three diatoms were isolated.
(*Chaetoceros* sp., *Ditylum brightwellii* and *Thalassiosira nordenskioeldii*)

Diatom

Scale bars: 20 µm



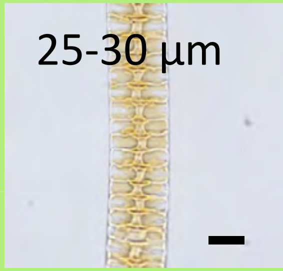
Attheya septentrionalis



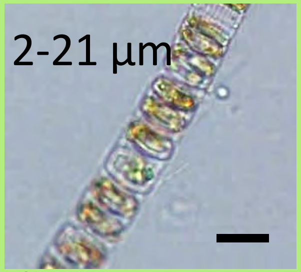
***Chaetoceros* sp.**

25-100 µm

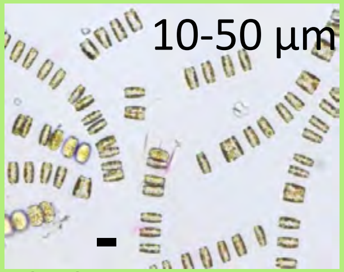
Ditylum brightwellii



Pauliella taeniata

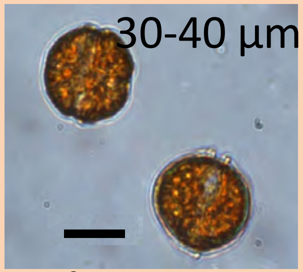


***Skeletonema* sp.**



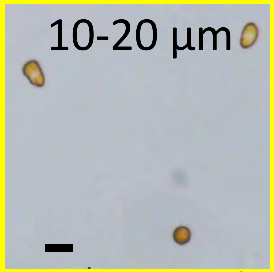
Thalassiosira nordenskioeldii

Dinoflagellate



Alexandrium tamarense

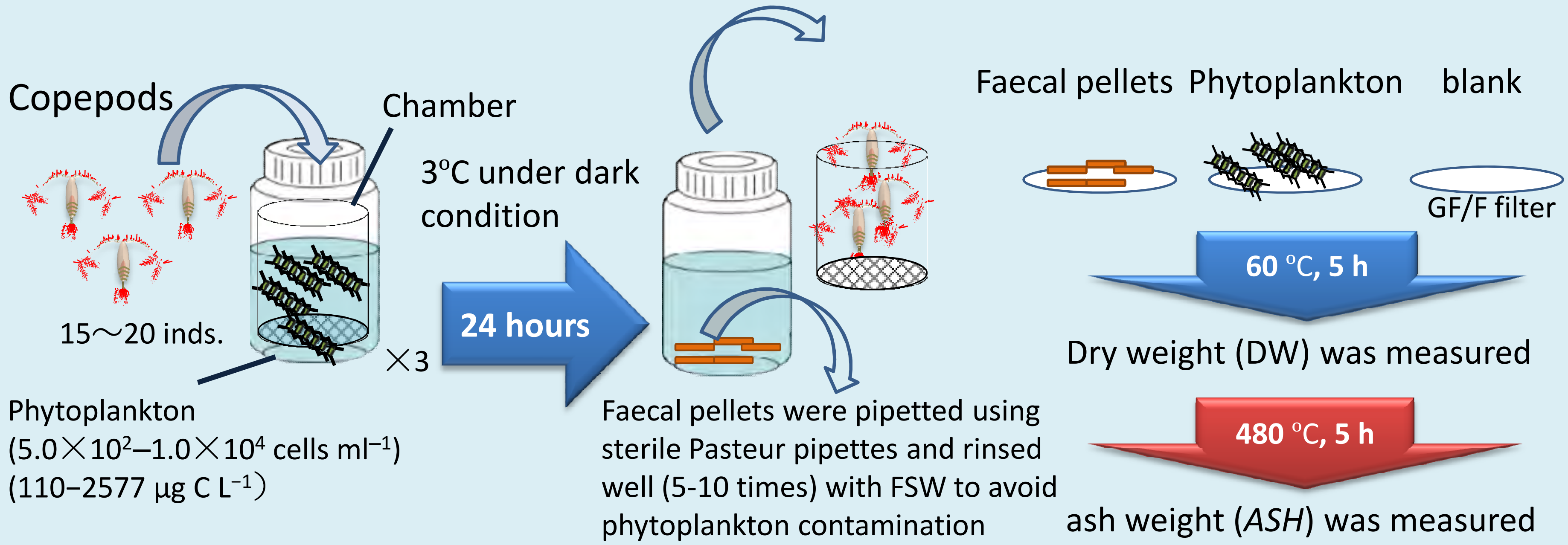
Raphidophycean



Heterosigma akashiwo

Incubate condition・・modified SWM−3 medium, 15℃, 14 h L:10 h D light/dark photocycle, illumination 100−120 µmol photons m^{-2} s^{-1}

Material and Methods: Experiments of assimilation efficiency

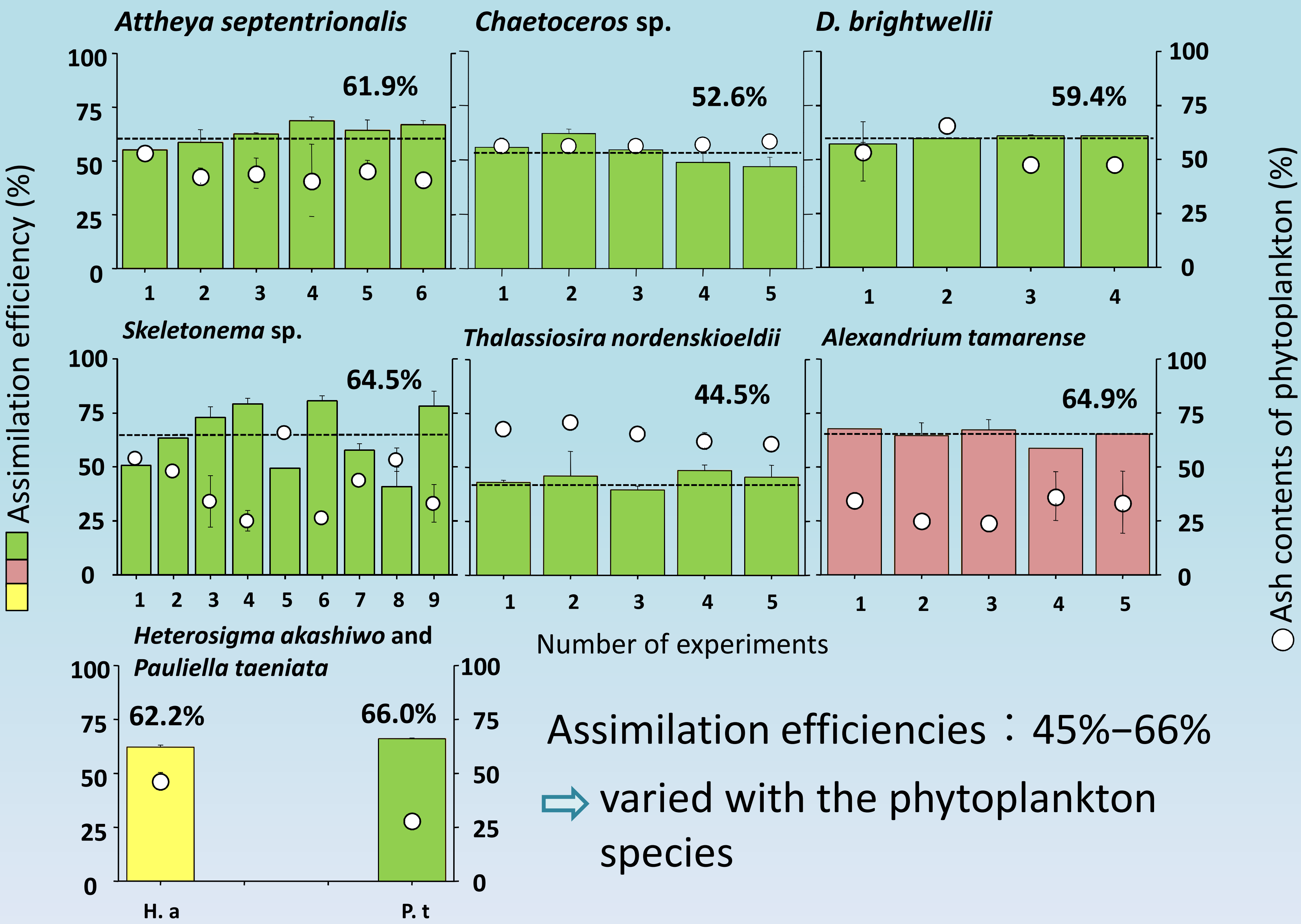


・Ratio Method（Conover 1966a, b）

$$U' (\%) = \left(\frac{(F' - E')}{(1 - E') \times (F')} \right) \times 100$$

U': Assimilation efficiency
F': the organic fraction of the food
E': the organic fraction of the faecal pellets

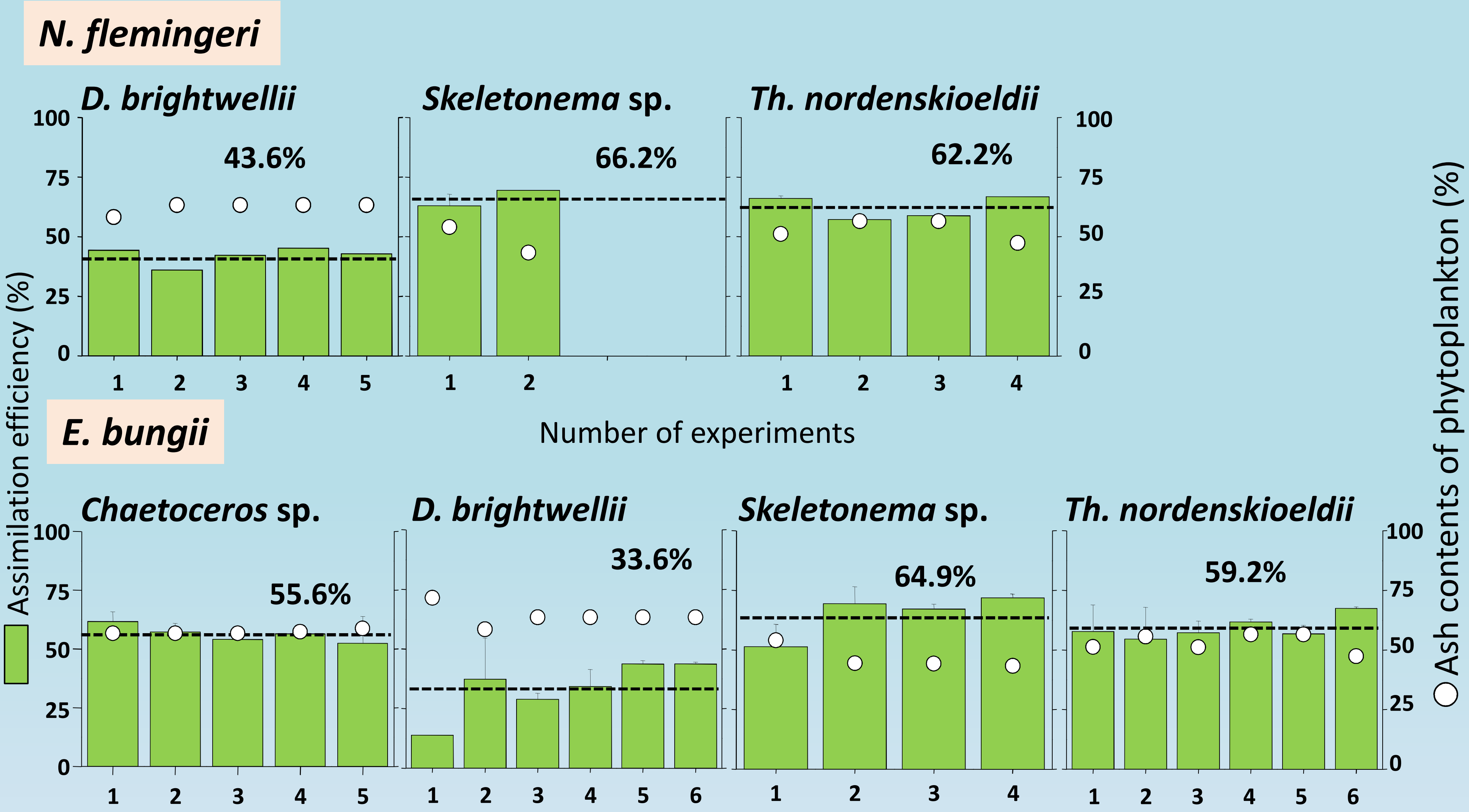
Results and Discussion：*N. cristatus*



Assimilation efficiencies：45%−66%

⇨ varied with the phytoplankton species

Results and Discussion：*N. flemingeri* and *E. bungii*



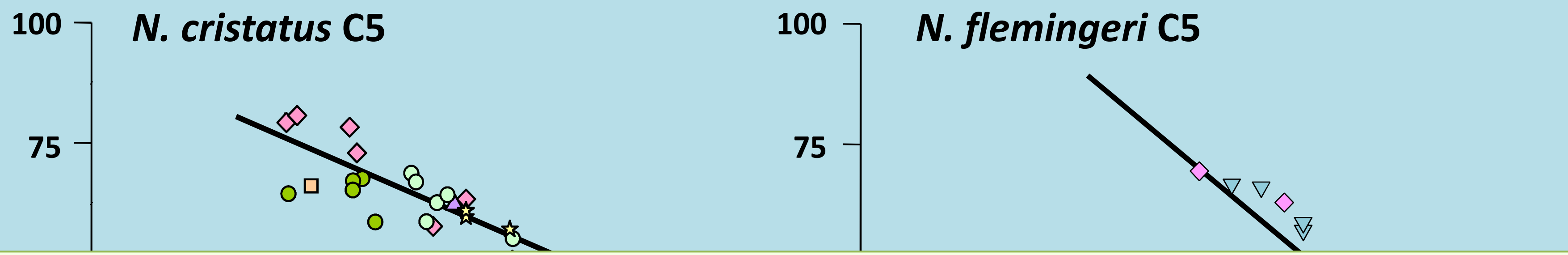
Average of assimilation efficiency

N. flemingeri：44%～66%

E. bungii：34%～65%

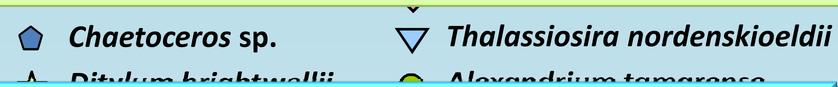
varied with the phytoplankton species

Results and Discussion：Relationship between *AE* and Ash contents of phytoplankton

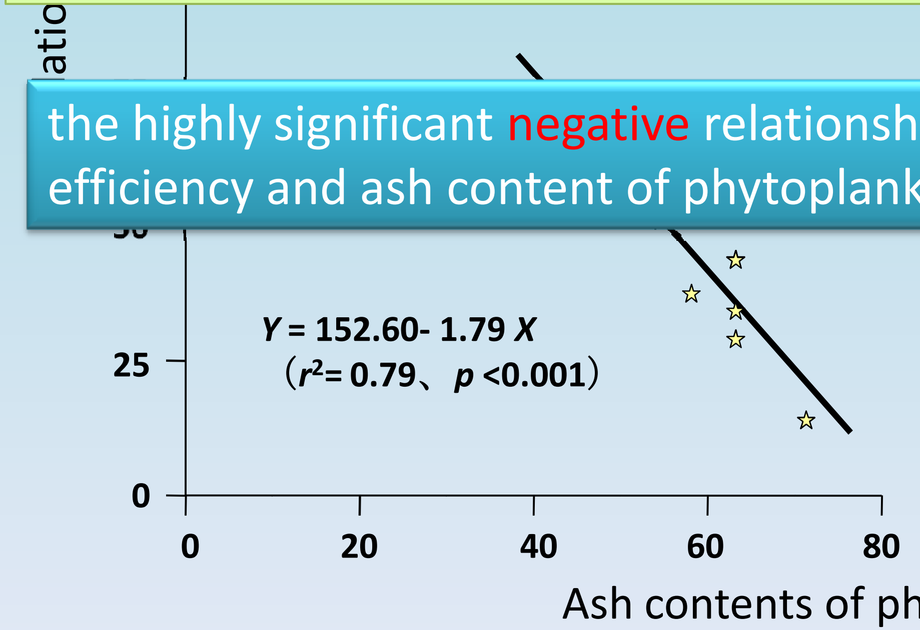


- Among the phytoplankton species, the highest ash content was observed for diatoms
- Diatom cell walls are made with silica ＝ inorganic material
- Although silica is ingested by copepods, 79-90% of the silica is egested as faecal pellets（Tande and Slagstad, 1985; Conover et al., 1986; Cowie and Hedges, 1996）

→ copepods can not assimilate silica

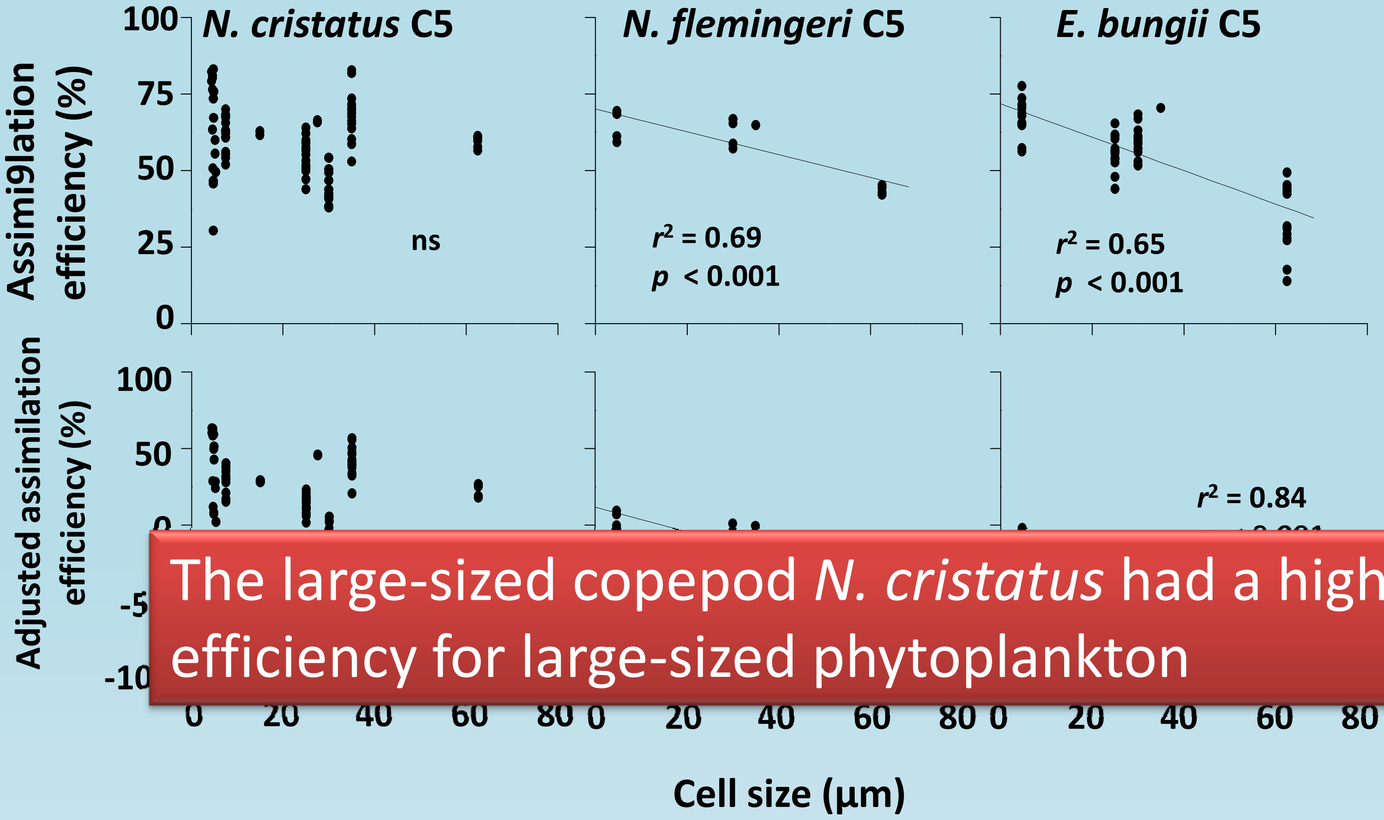


the highly significant negative relationship between copepod assimilation efficiency and ash content of phytoplankton



A common trend for the three copepod species was that the assimilation efficiencies had a significant negative correlation with the ash contents of the food phytoplankton

Results and Discussion



- Adjusted copepod assimilation efficiency (AE_{adj}: %) with phytoplankton ash contents using the following equation (Sokal and Rohlf, 2012)

$$AE_{adj} = Y - bX$$

Y : the raw data of the copepod assimilation

of the

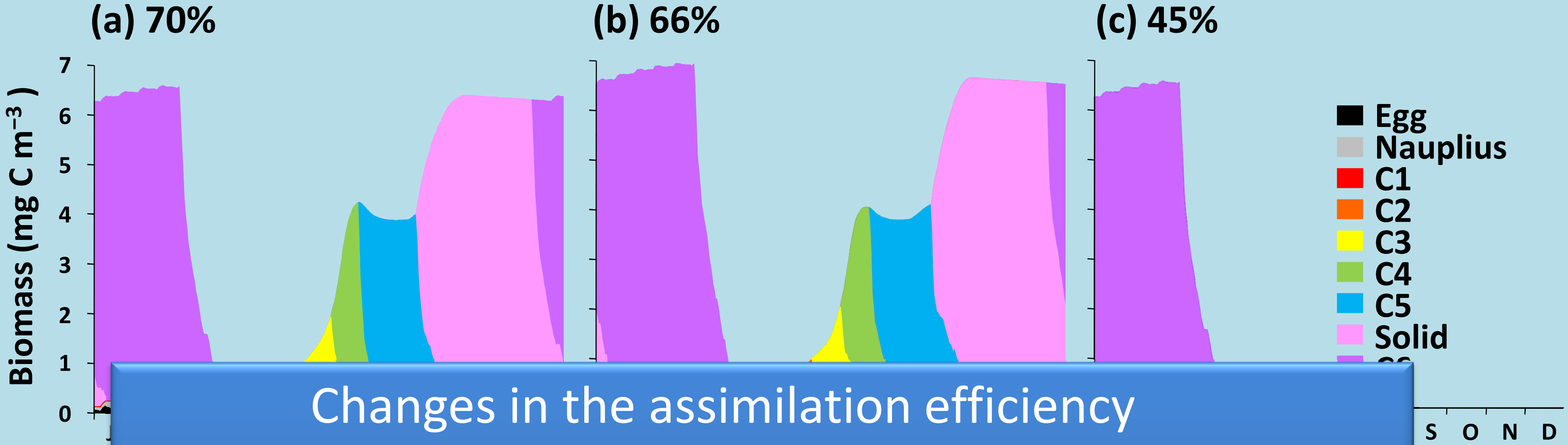
b : the fitted constant of the regression for each copepod species

The large-sized copepod *N. cristatus* had a high assimilation efficiency for large-sized phytoplankton

N. cristatus・ ・ Changes in assimilation efficiency with the phytoplankton cell size were not detected

N. flemingeri and *E. bungii* ・ ・ Negative correlation between assimilation efficiency and phytoplankton cell size was detected (p < 0.001)

Results and Discussion：Population model



Changes in the assimilation efficiency

affected development time and population maintenance

→ a constant value (70%) is applied for the copepod assimilation efficiency

The assimilation efficiency of large oceanic copepods was varied (34-66%)

We tested the effects of changes in assimilation efficiency by applying the LEM for *N. cristatus* Terui et al.（2012）

66%・・・・*N. cristatus* could maintain the population

45%・・・・ *N. cristatus* could not maintain its population

70%・・139 days were required for individuals to reach C5 (solid)

66%・・ 150 days were required for same hatch date individuals

Summary

Assimilation efficiencies of dominant *Neocalanus* and *Eucalanus* copepods in the subarctic Pacific

・had a significant negative correlation with the ash contents of the food phytoplankton

・varied with the phytoplankton species and the ash contents of the food phytoplankton

Marine ecosystem model

・Variations in assimilation efficiency should be incorporated into marine ecosystem models in the future

・Copepod assimilation efficiency is highly correlated with the inorganic content of food

Assimilation efficiency in the model should be estimated using parameters based on the composition of the food phytoplankton taxa


Thank you very much for your kind attention!
By Oshoro-Maru The 216th North Pacific Cruise