Investigating the influences of physical processes on plankton interactions and biogeochemical cycling – preliminary findings

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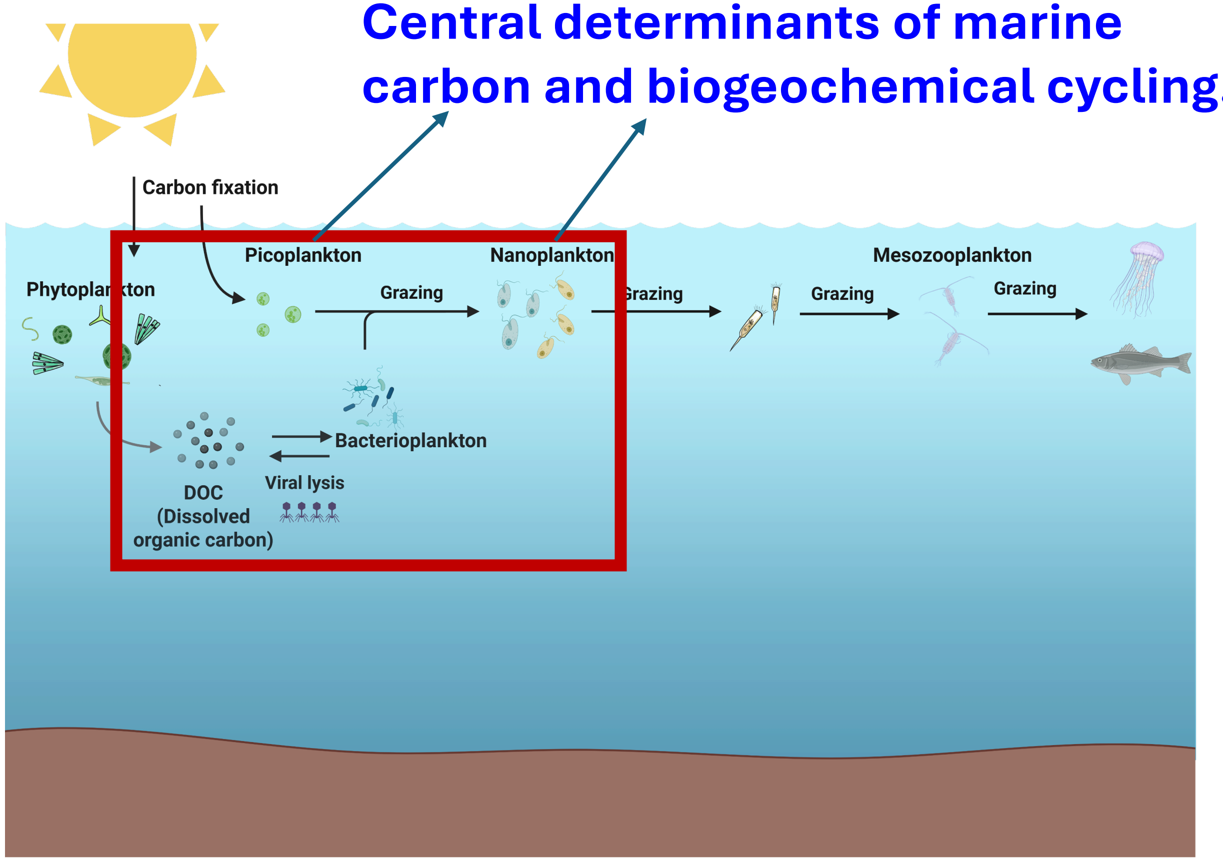
Impacts of physical processes on:
(1) Trophic interactions among pico- and nano-plankton
(2) Consequent biogeochemical cycling

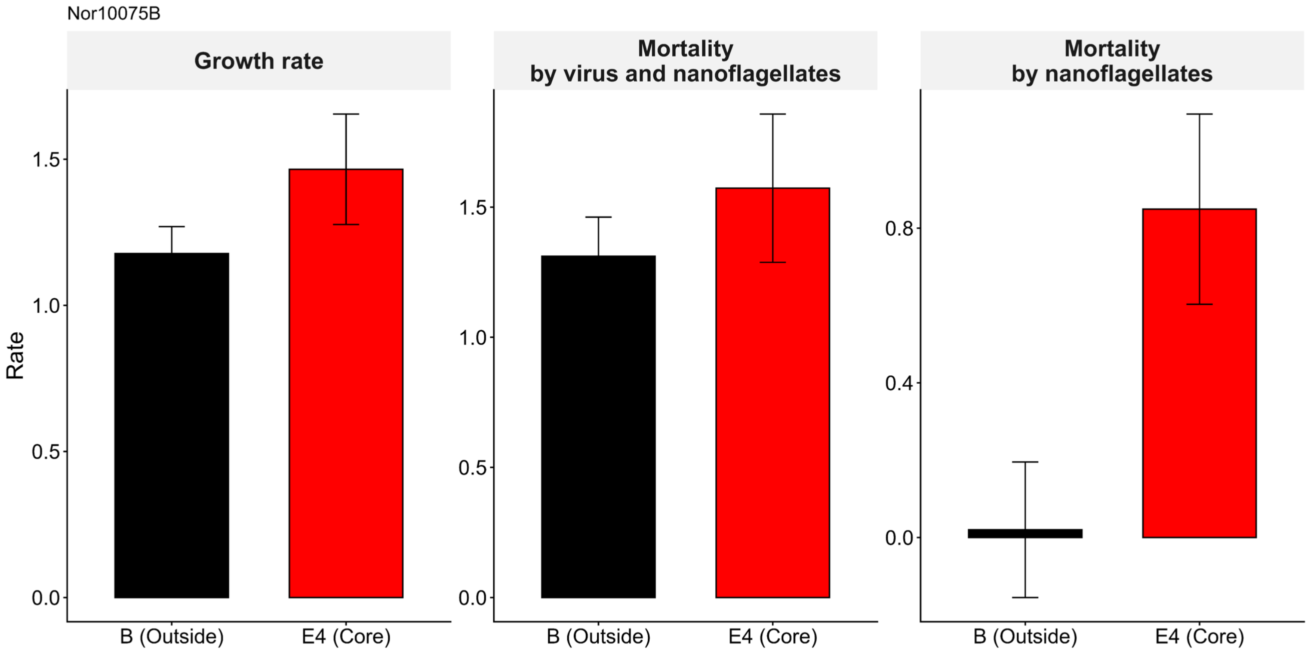
Physical processes/phenomena:
- Mesoscale eddy
- Topography and eddy-driven upwelling (NE Taiwan)
- Tide-drive upwelling (Taiwan Bank)

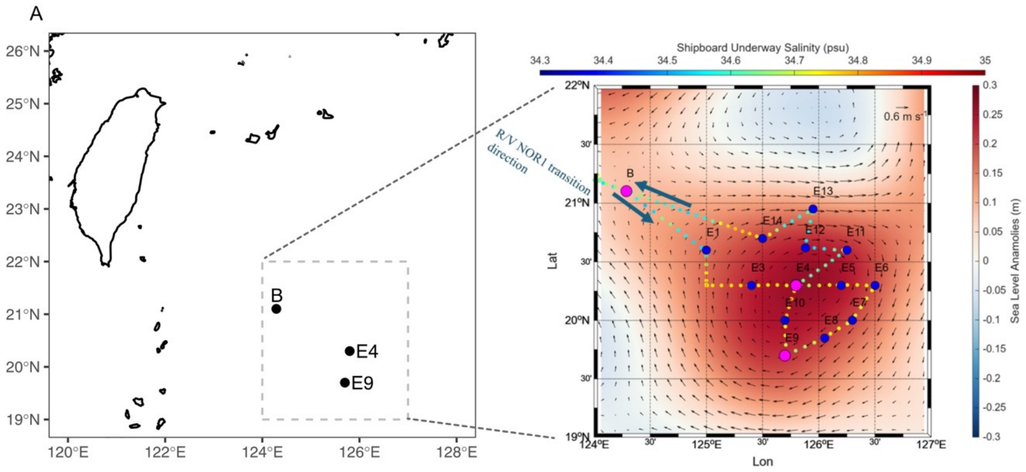
Central determinants of marine carbon and biogeochemical cycling.

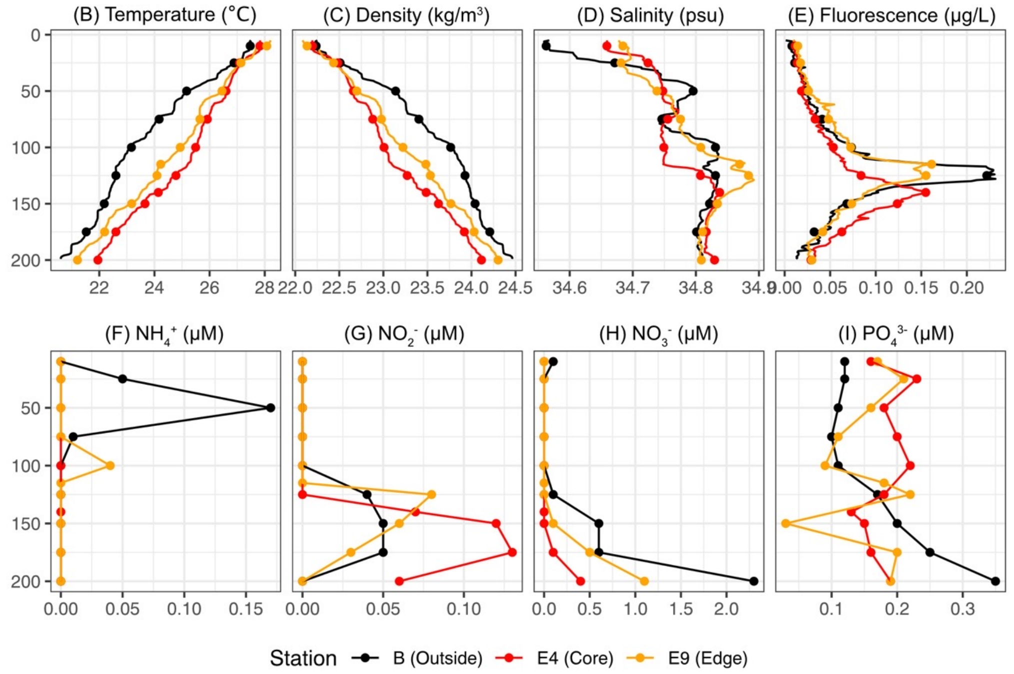


Influences of eddy on plankton trophic interactions (Joint cruise: NOR1CR0075b)

The instantaneous growth rate and mortality are higher at the center of the eddy, but not statistically significant.







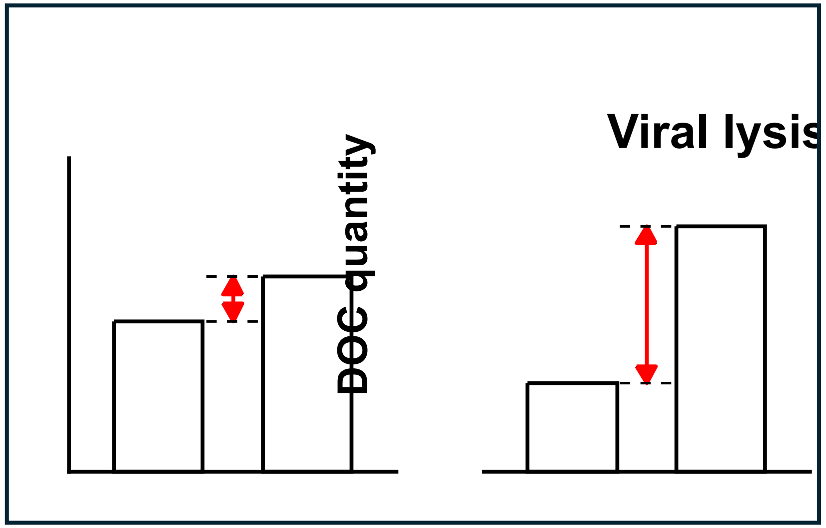
Impacts of grazing vs. viral lysis on DOC quantity (Joint cruise: LGD2602)

Hypothesis 1-1. DOC quantity response

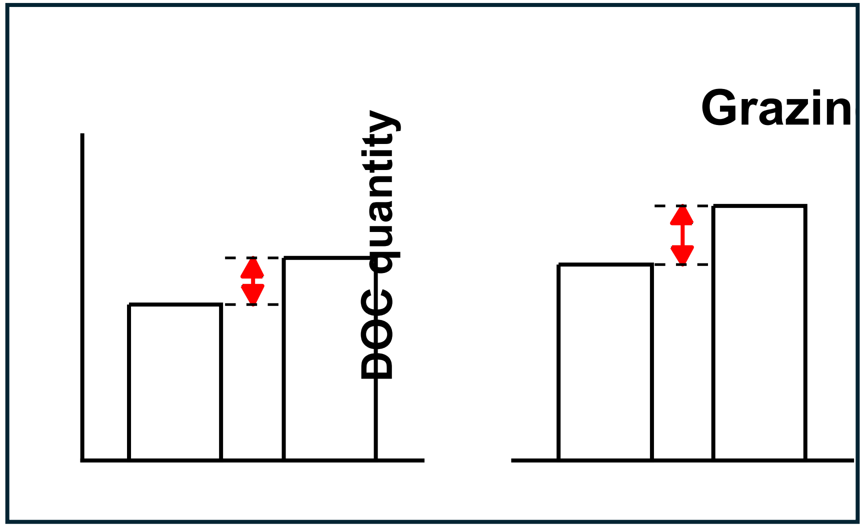
- DOC quantity response shows how strongly DOC quantity changes with viral lysis or grazing pressure, and I expect viral lysis to produce a stronger response than grazing.
- Grazing may release less DOC because small prey cells can be swallowed more completely, limiting DOC release through sloppy feeding.

High pressure - Low pressure = DOC quantity response

Within site



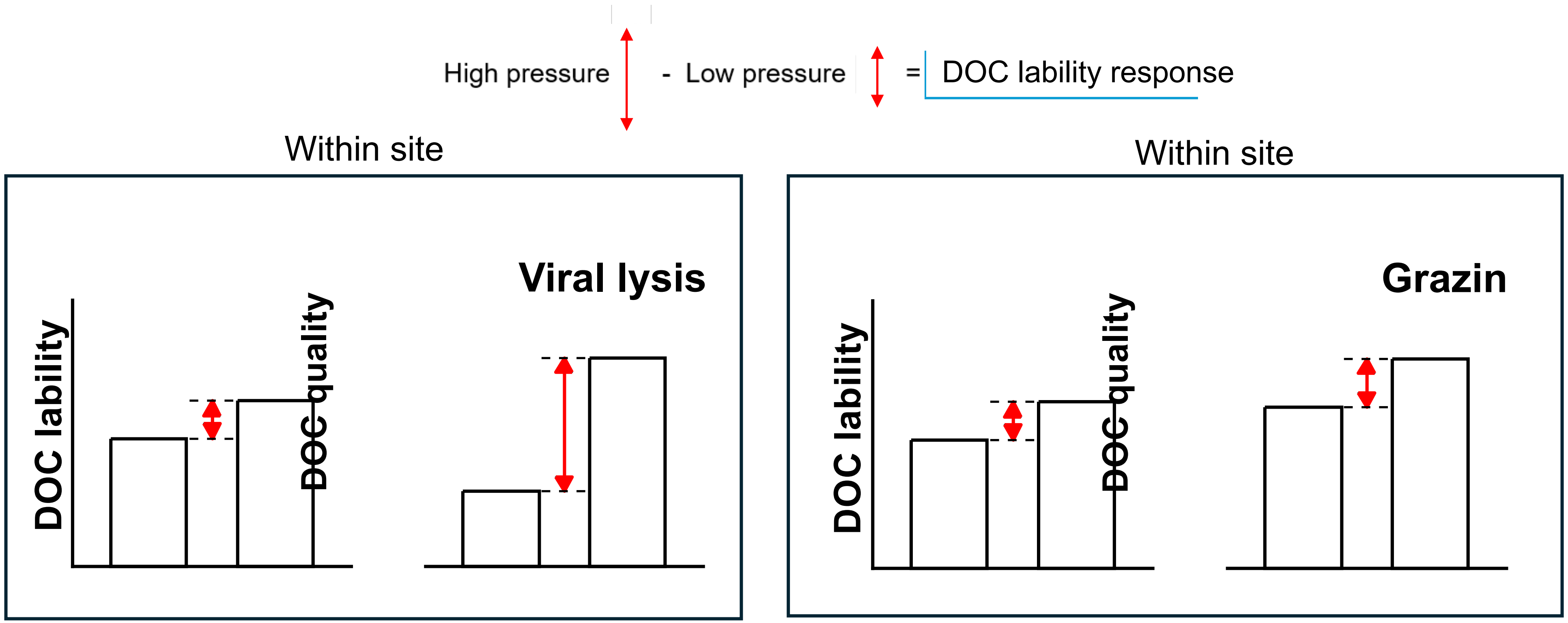
Within site



Impacts of grazing vs. viral lysis on DOC lability (Joint cruise: LGD2602)

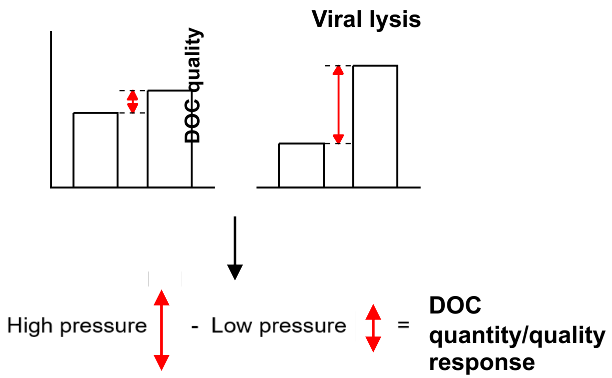
Hypothesis 1-2. DOC lability response

- DOC lability response shows how strongly DOC lability changes with viral lysis or grazing pressure, and I expect viral lysis to produce a stronger response than grazing.
- Viral Lysate has high bioavailability.

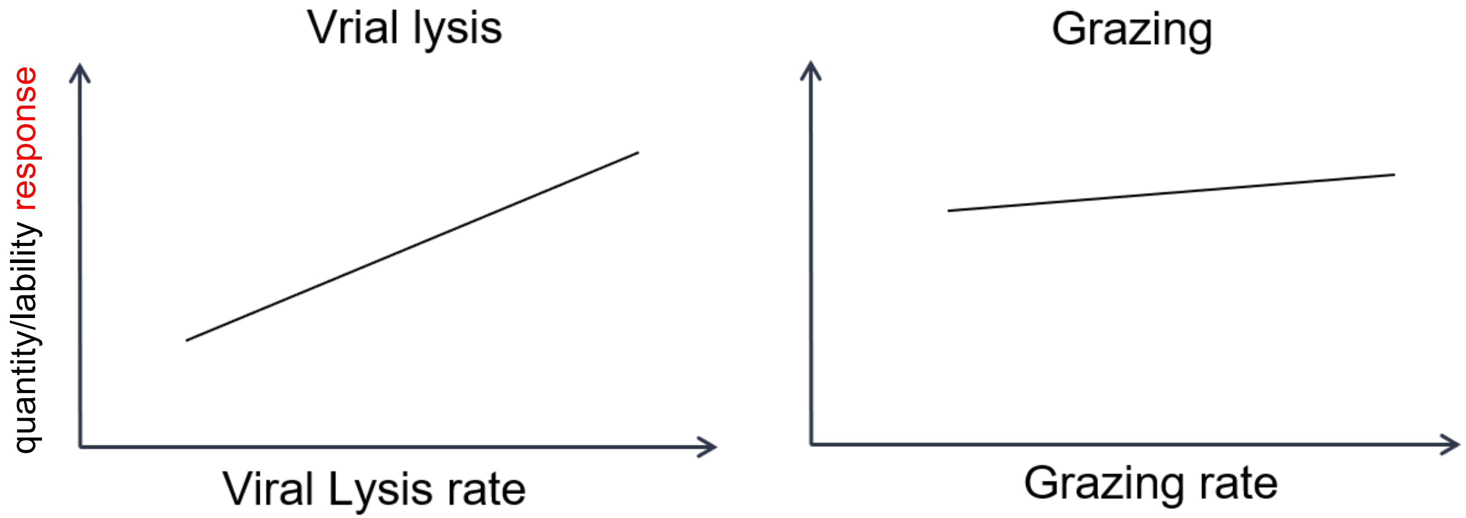


Grazing vs. Viral Lysis Controls on DOC Cycling (Joint cruise: LGD2602)

Hypothesis 2.



By comparing different stations, the influences of grazing and viral lysis on DOC quantity and lability can be quantified.



Grazing vs. Viral Lysis Controls on DOC Cycling (Joint cruise: LGD2602)

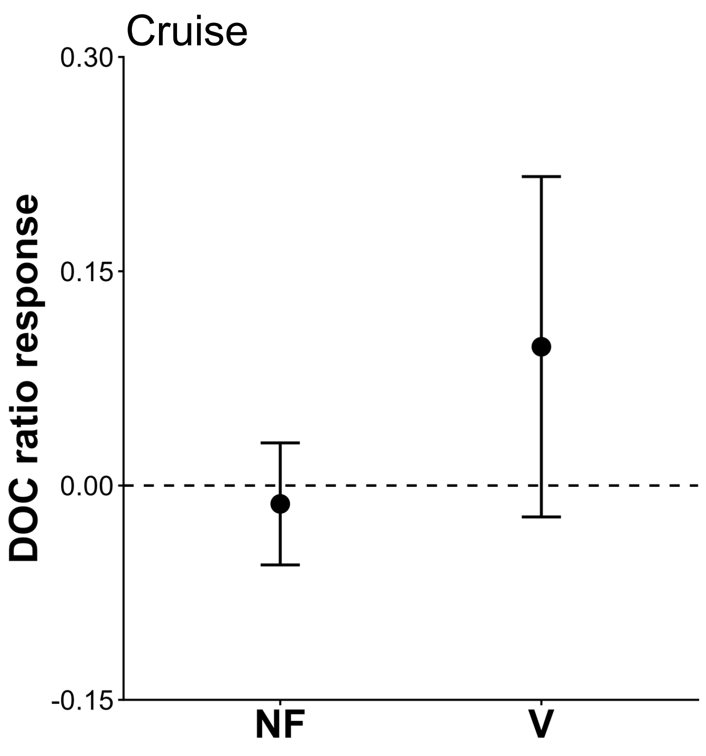
Current progress (DOC)

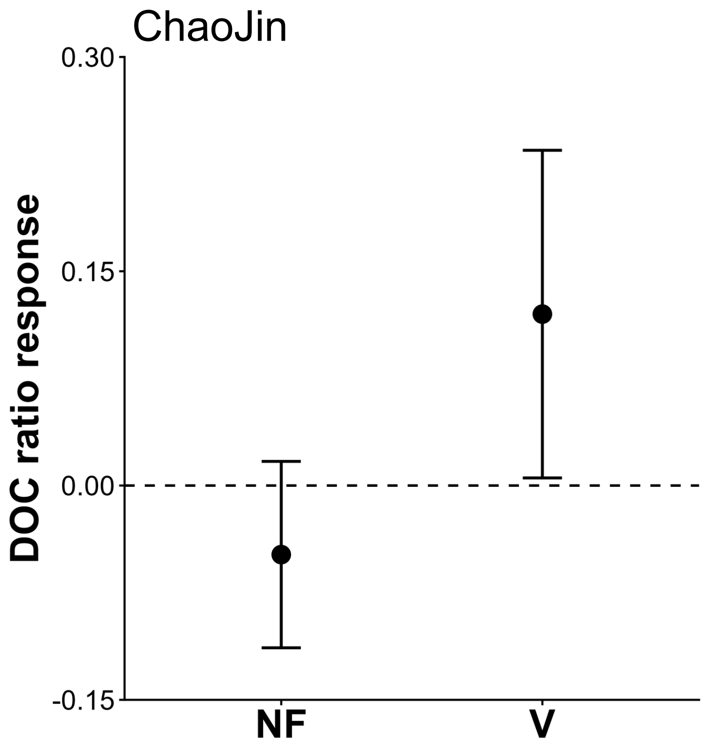
ChaoJin:
2025.12.17 ~ 2026.03.18 → 7 data points

Cruise:
1. Nor2Cr0182 (2502.11.23) → 1 data points
2. LGD2602 (2026.03.25) → 6 data points

Impacts of grazing vs. viral lysis on DOC quantity (Joint cruise: LGD2602)

- Viral lysis releases more DOC after incubation

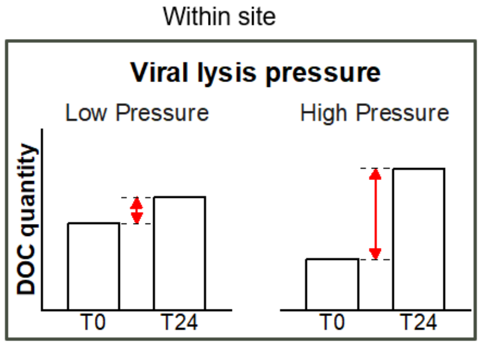


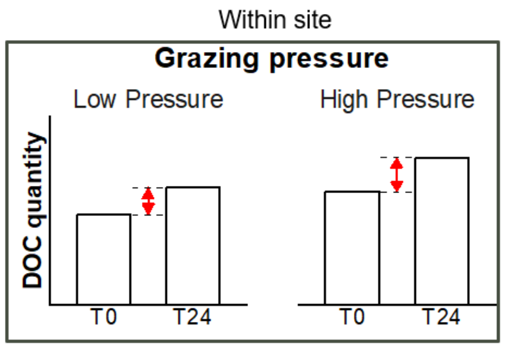


$$DOC\ quantity_{t,i} \equiv \frac{[DOC]_{T_{24}t,i}}{[DOC]_{T_0t,i}}$$

i = dilution serise (ex: NF or V)

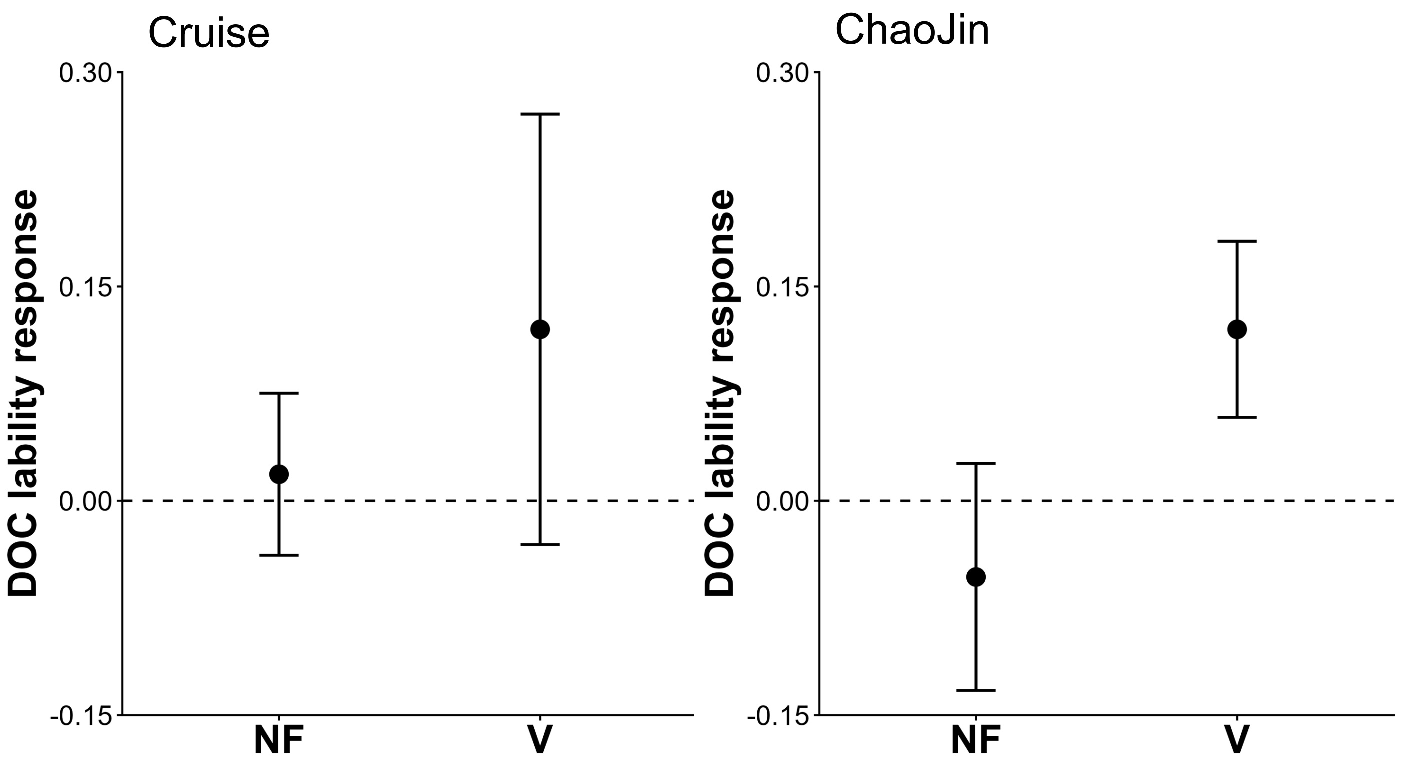
t = dilution treatments(ex: 80 or 20)

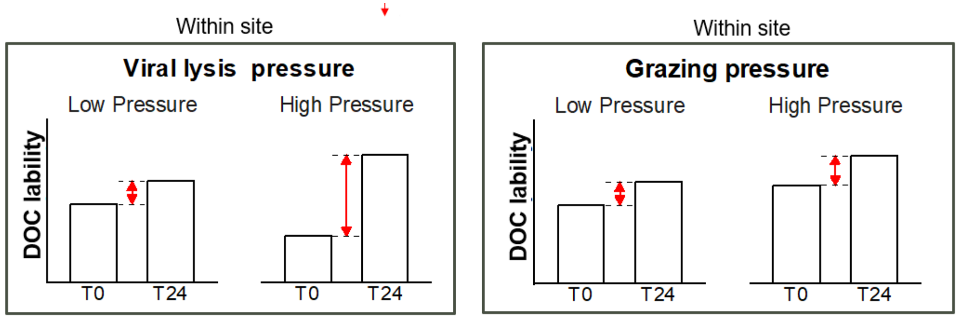




Impacts of grazing vs. viral lysis on DOC lability (Joint cruise: LGD2602)

- Viral lysis releases more labile DOC after incubation





$$DOC\ decay\ ratio \equiv DOC_{Day1}/DOC_{Day5}$$

$$DOC\ lability_{t,i} \equiv \frac{DOC\ decay\ ratio_{t,i,T_{24}}}{DOC\ decay\ ratio_{t,i,T_0}}$$

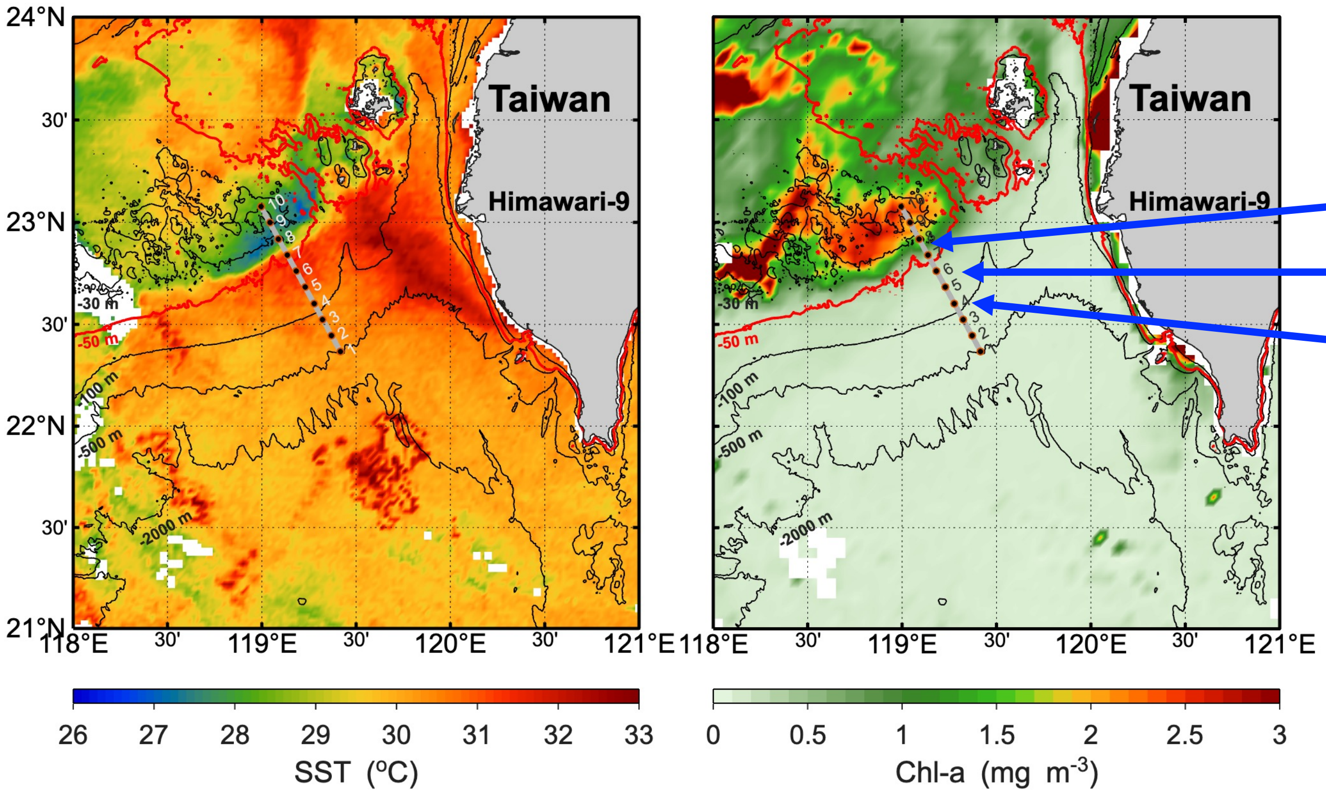
$$DOC\ lability\ response_i$$
$$\equiv DOC\ lability_{80i} - DOC\ lability_{20i}$$

i = dilution serise (ex: NF or V)

t = dilution treatments(ex: 80 or 20)

Impacts of tide-driven upwelling on plankton interactions (Joint cruise: NOR3CR0328)

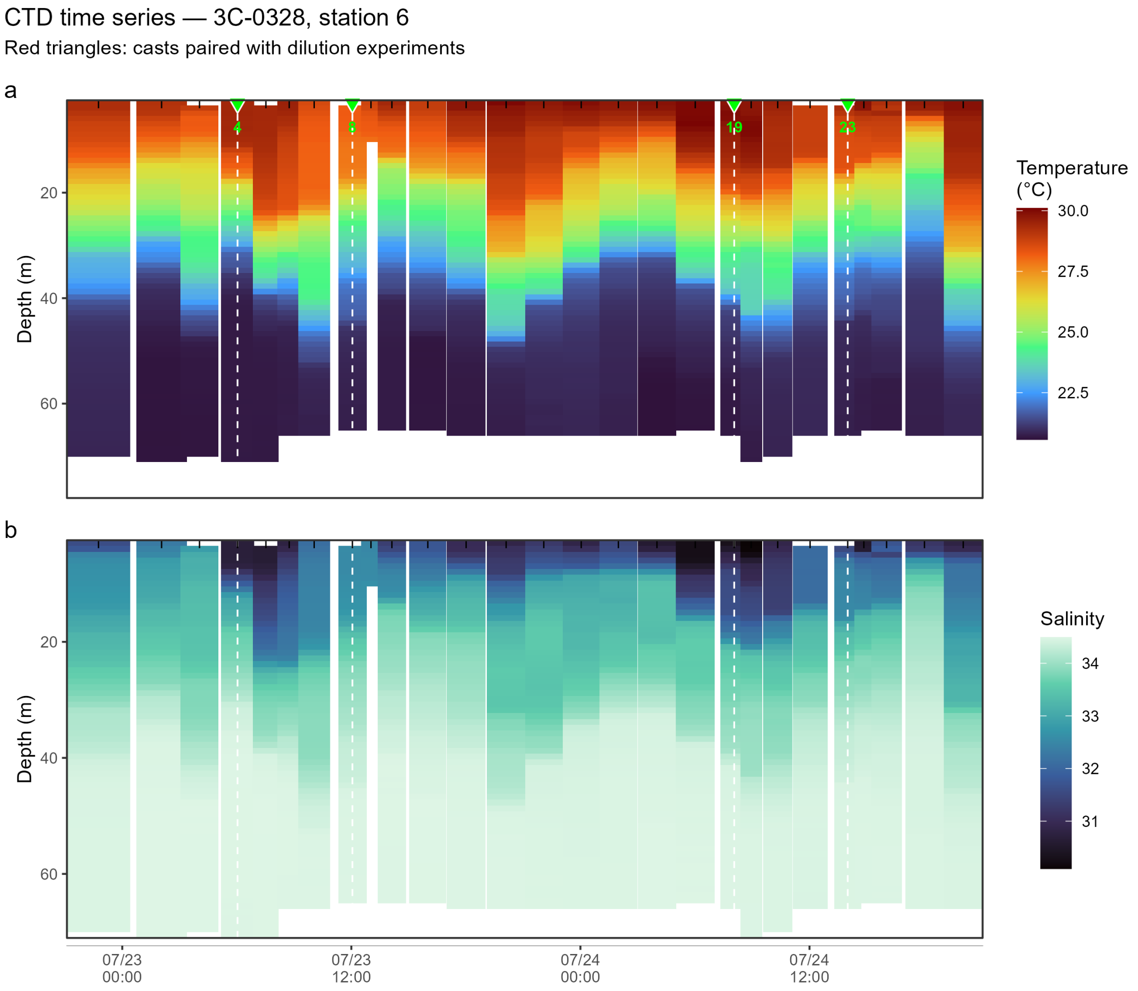
- Viral lysis releases more labile DOC after incubation



Station	Lon.	Lat.
7-8 (upwelling center)	119.1358	22.8403
6 (front)	119.1826	22.7613
4 (background)	119.4167	22.3667

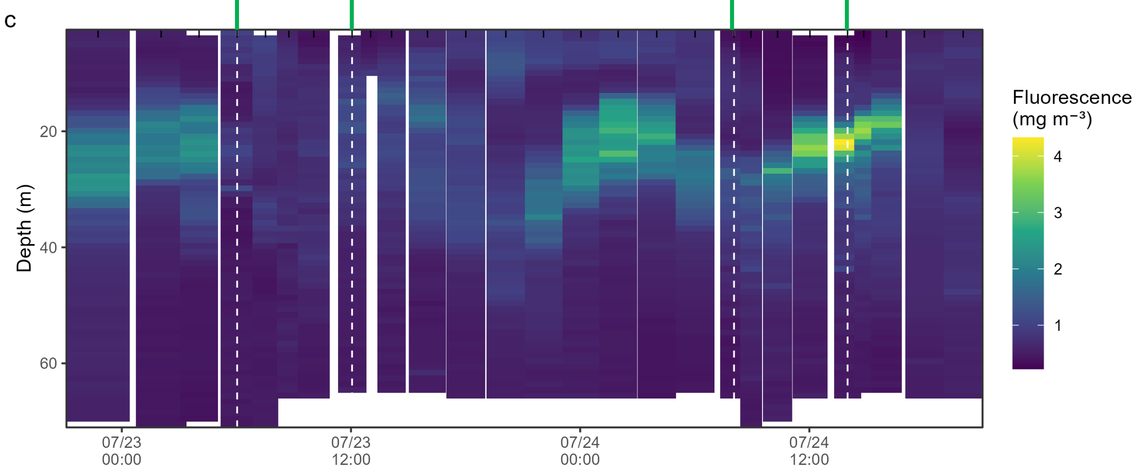
Sampling (Oscar, Chen-Han Tsai, Hsiao-Pei Lu, Wei-Jen Huang)	Sampling frequency
1. Feeding experiment (dilution experiment) coupled with DOC-decay and CDOM/FDOM measurements	background, upwelling center, and front (2 tidal phases)
2. Plankton (pico and nano) composition	Every 2 hour
3. Nutrient, DIC, TA, pH	With #1

Impacts of tide-driven upwelling on plankton interactions (Joint cruise: NOR3CR0328)



Pico- and nanoplankton composition from each CTD cast

Dilution feeding experiments



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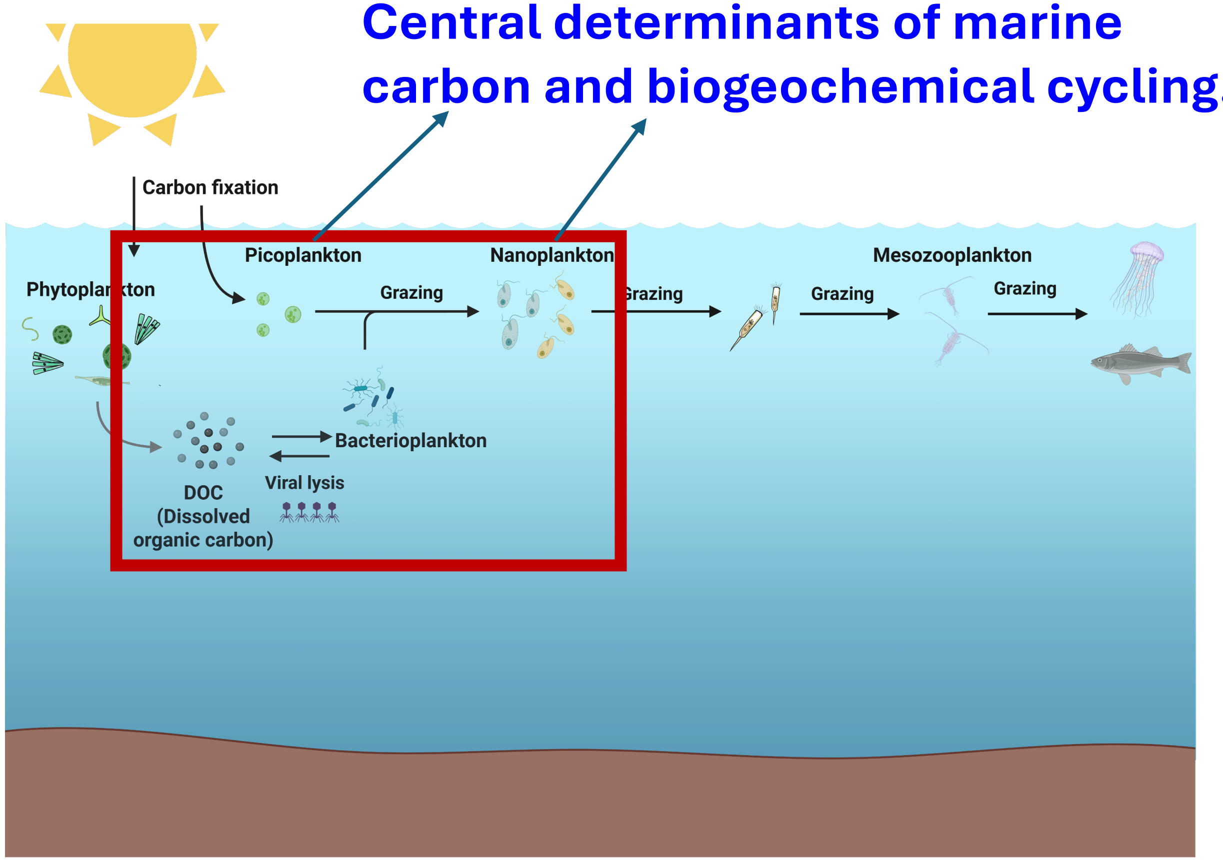
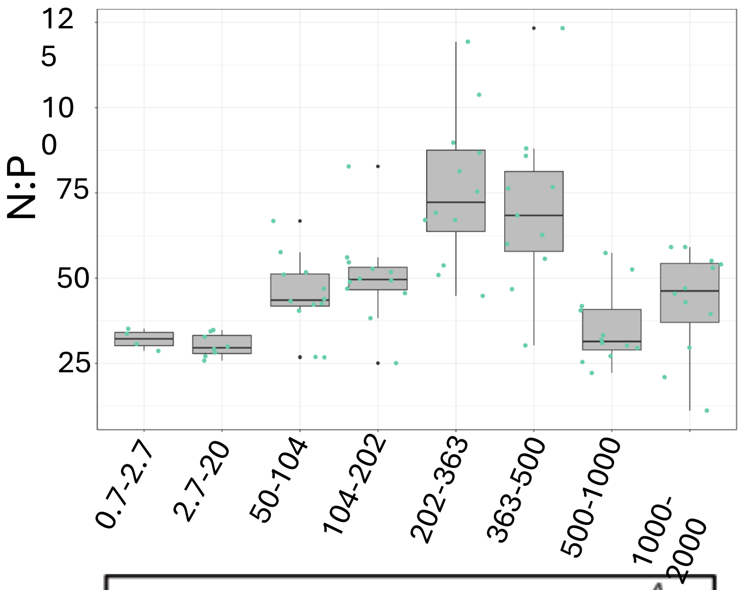


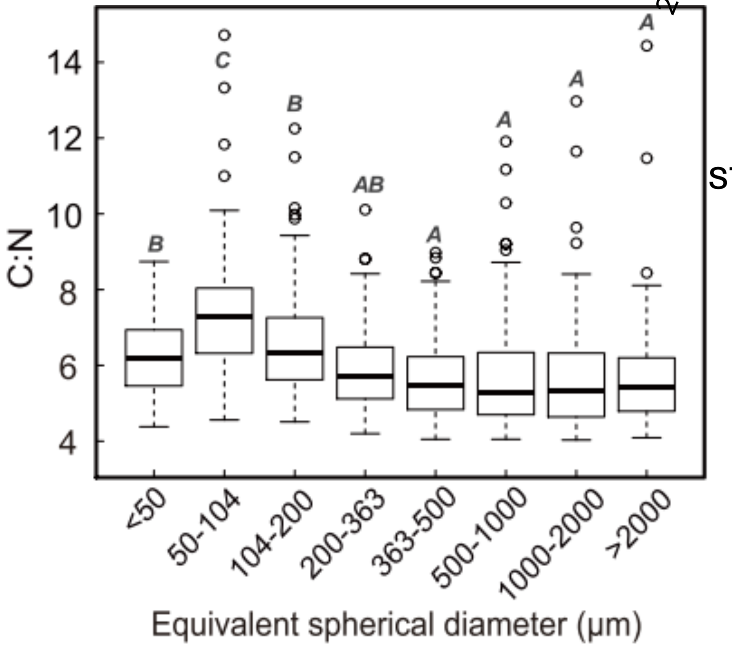
Size-fractioned euphotic particulate organic matter (POM) and zooplankton taxon-specific stoichiometry in plankton food webs near the oceanic front offshore northeastern Taiwan

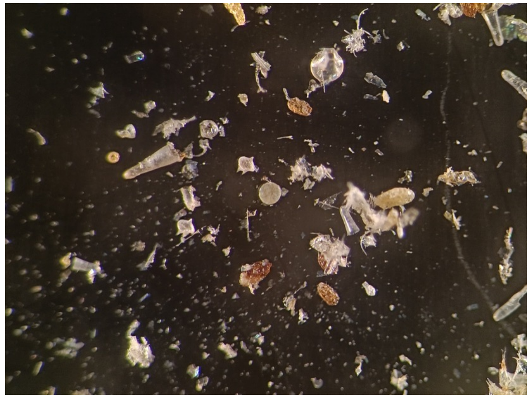
Pei-Chi Ho

Institute of Oceanography, National Taiwan University

Ecological stoichiometry and plankton ecology lab

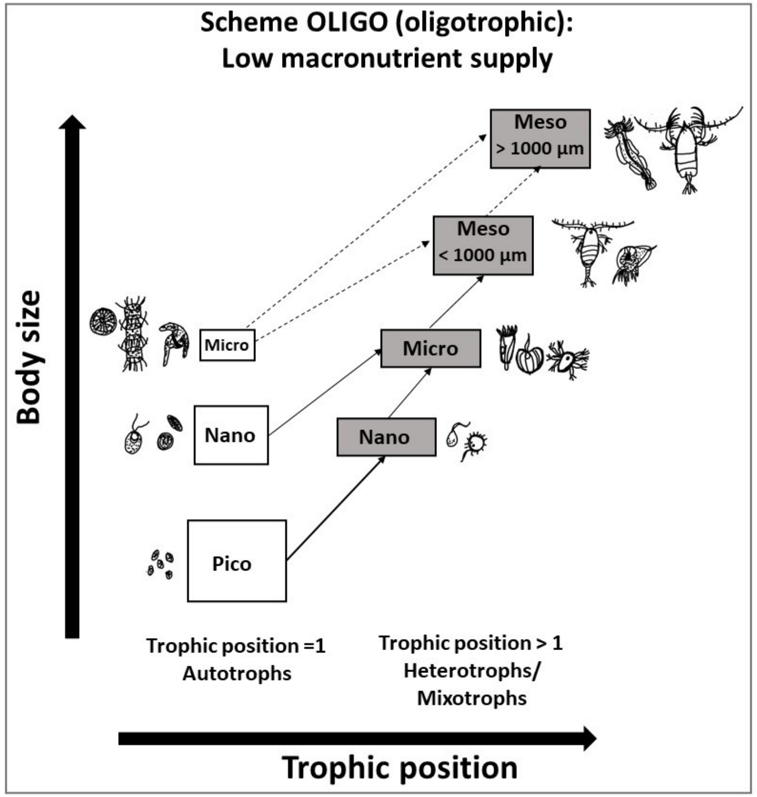






Plankton stoichiometry (C:N:P)

Plankton food web analyses



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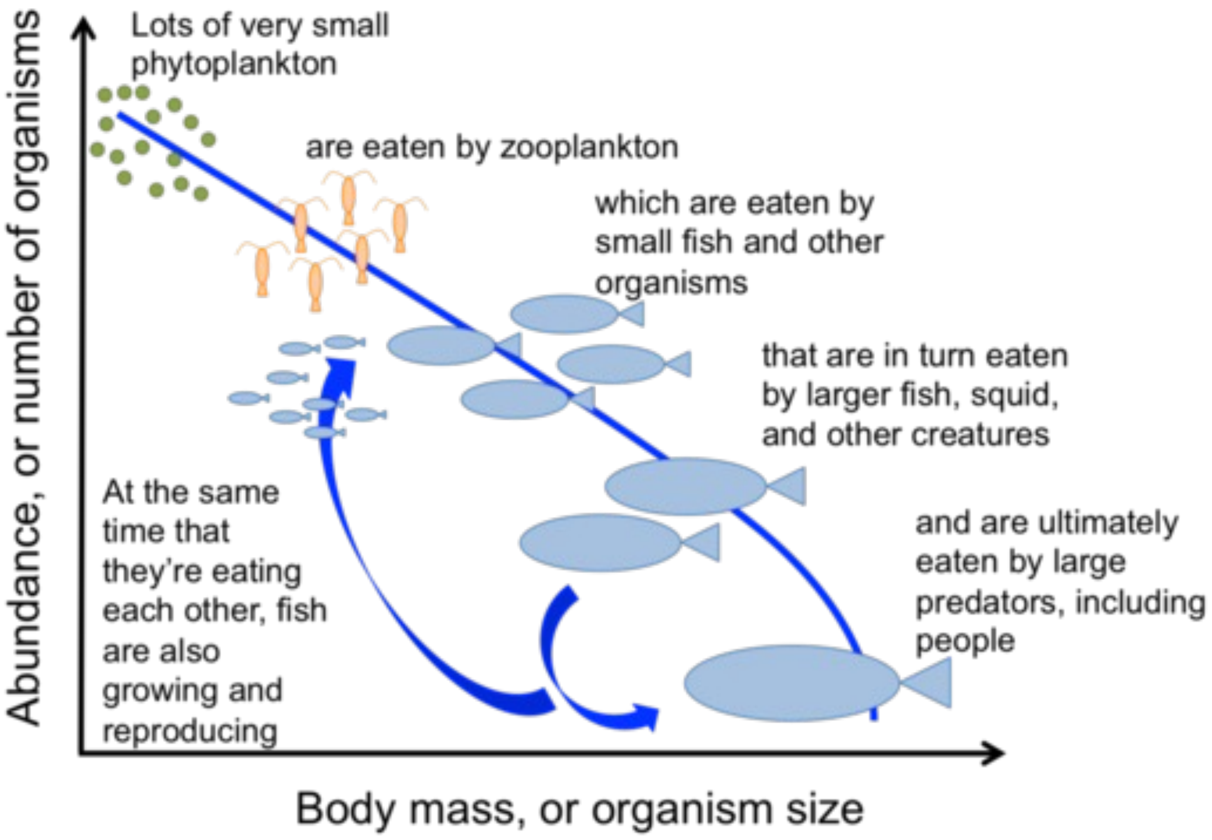
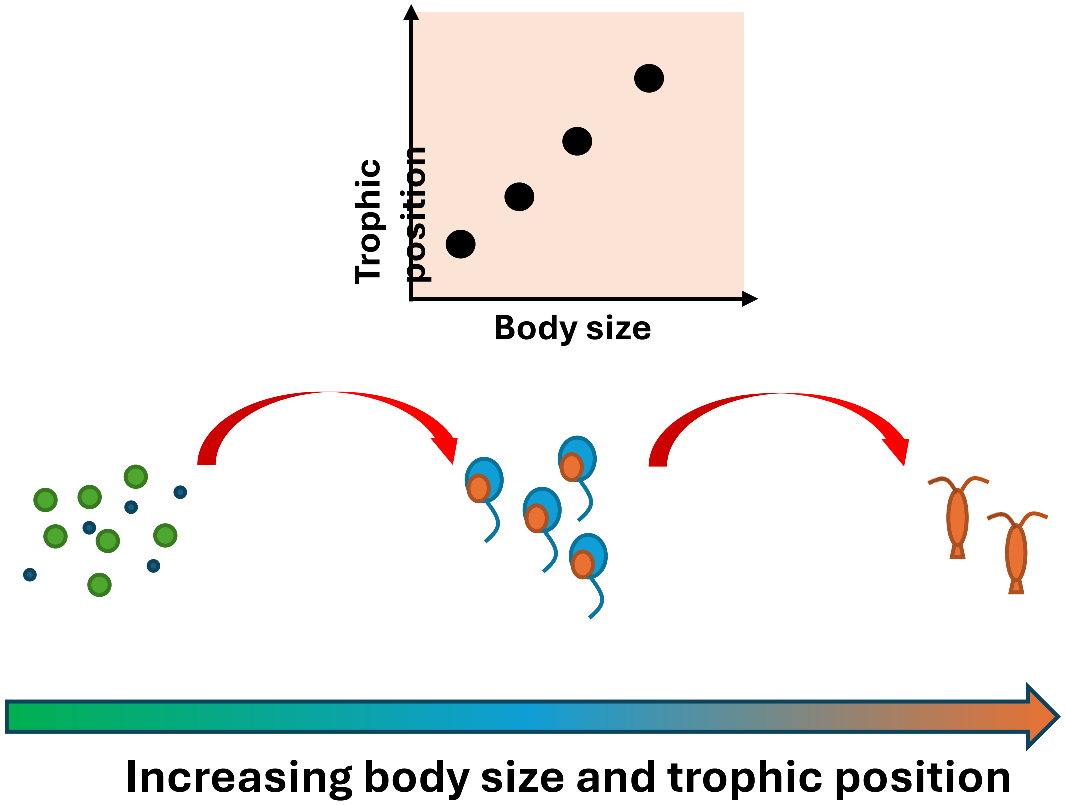
Introduction

Body size determines trophic interactions in oceans



https://www.fisheries.noaa.gov/pacific-islands/ecosystems/ecosystem-modeling-pacific

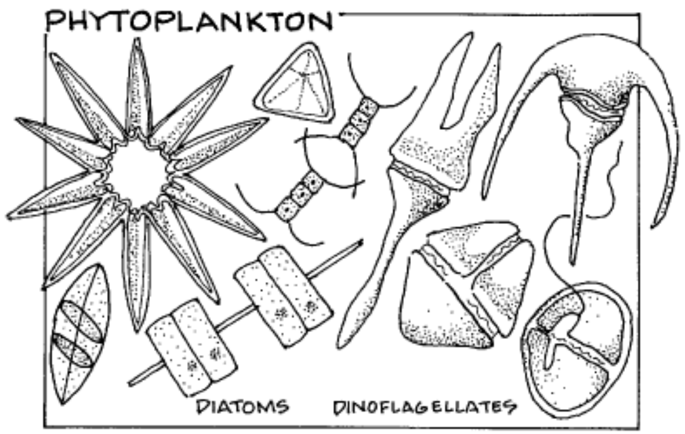


Introduction

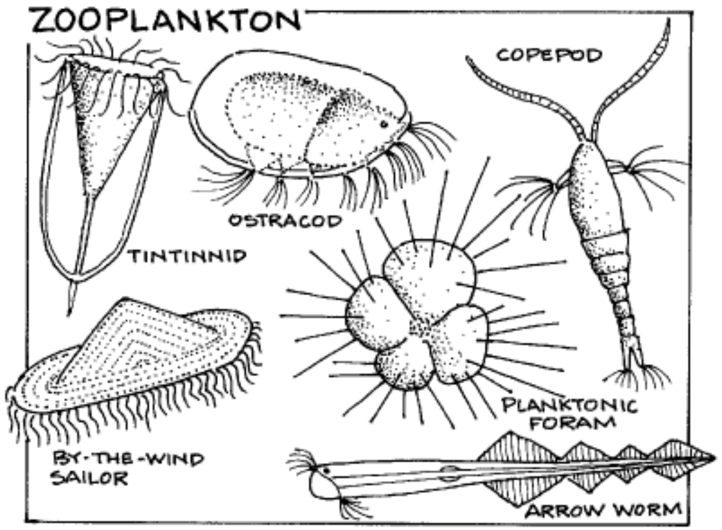
Plankton stoichiometry depends on body size

Heterotrophy/Trophic position

High — C:N or C:P ratio → Low

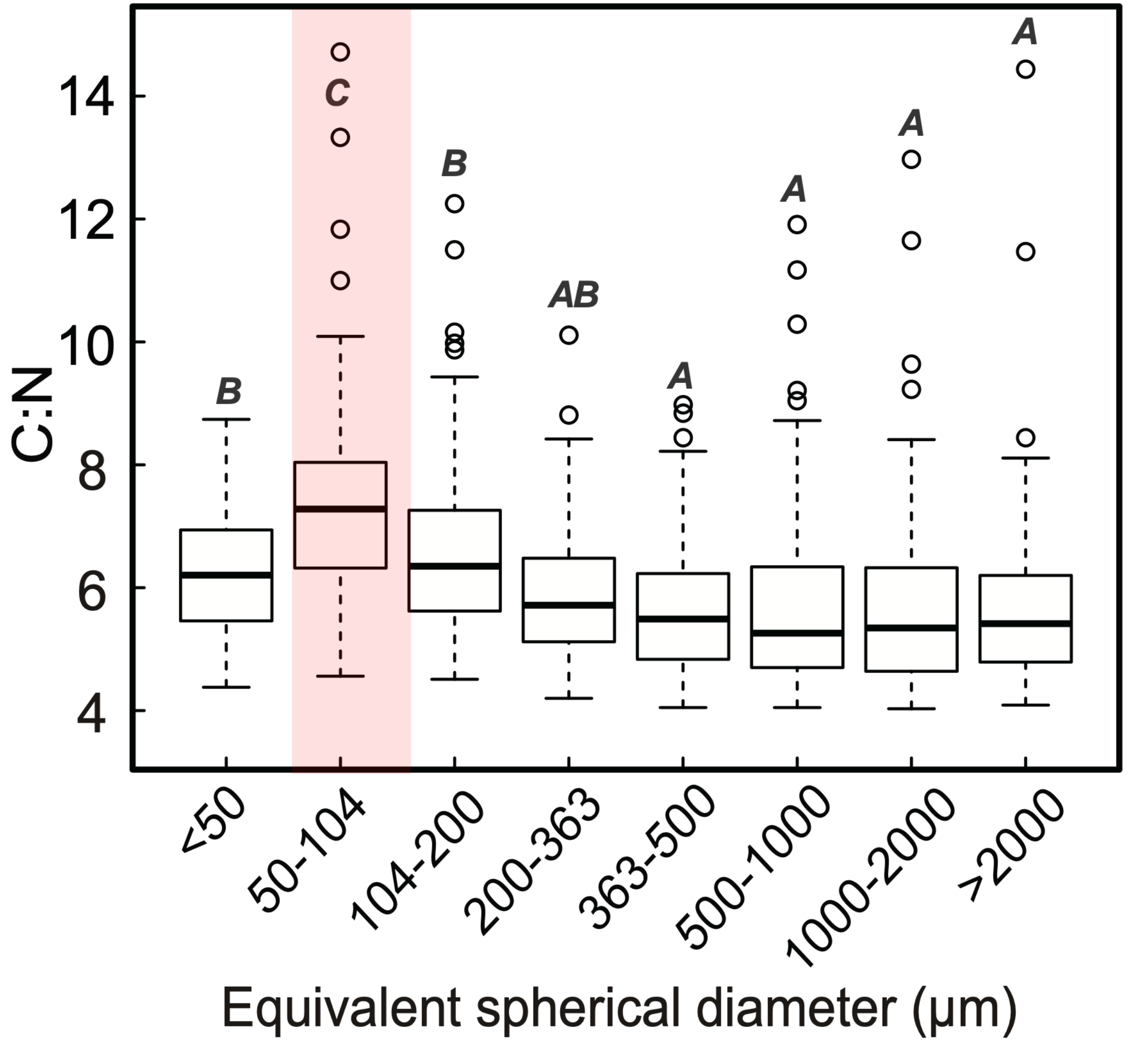


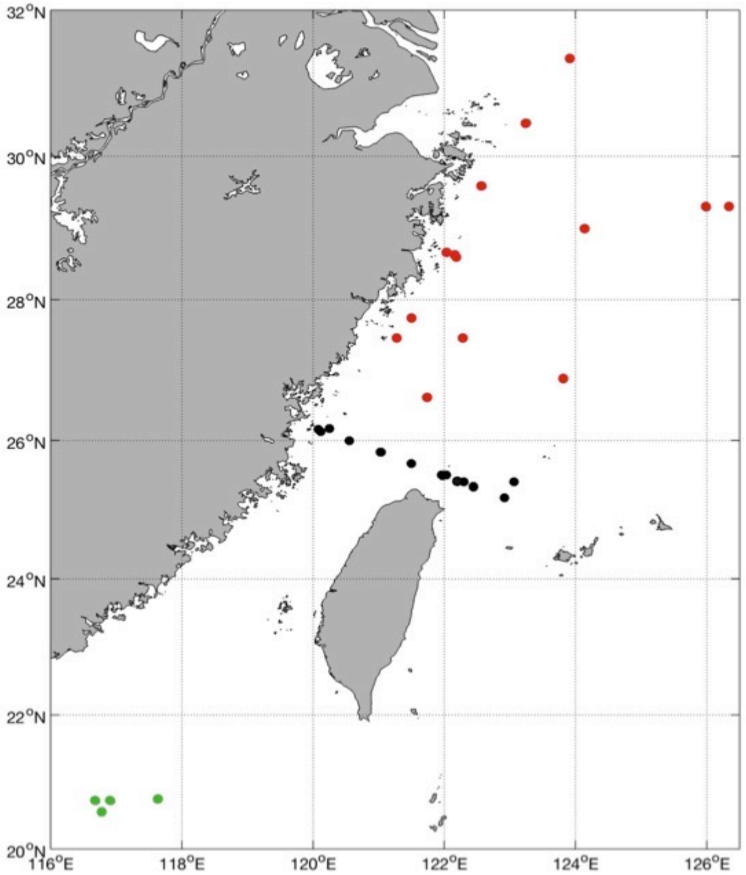
http://www.gma.org/onlocation/globecactiv.html



Small — Size → Large

Plankton stoichiometry depends on body size

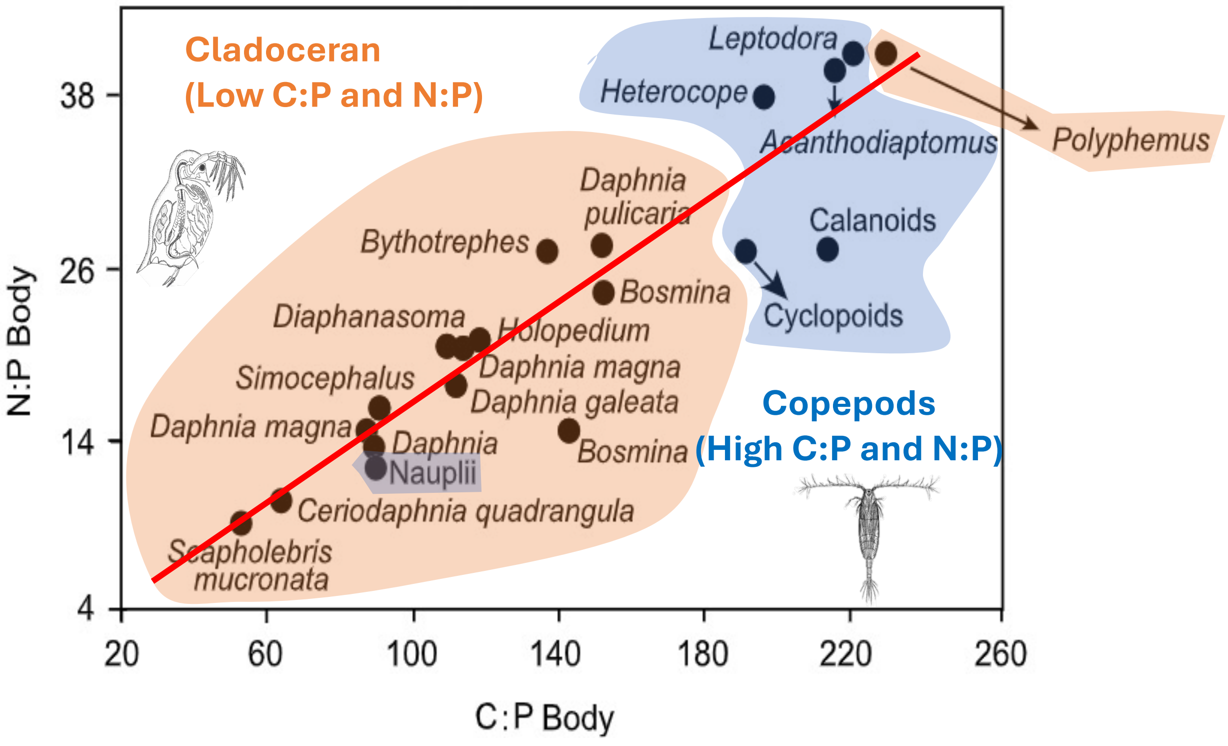




Ho et al. (2021)

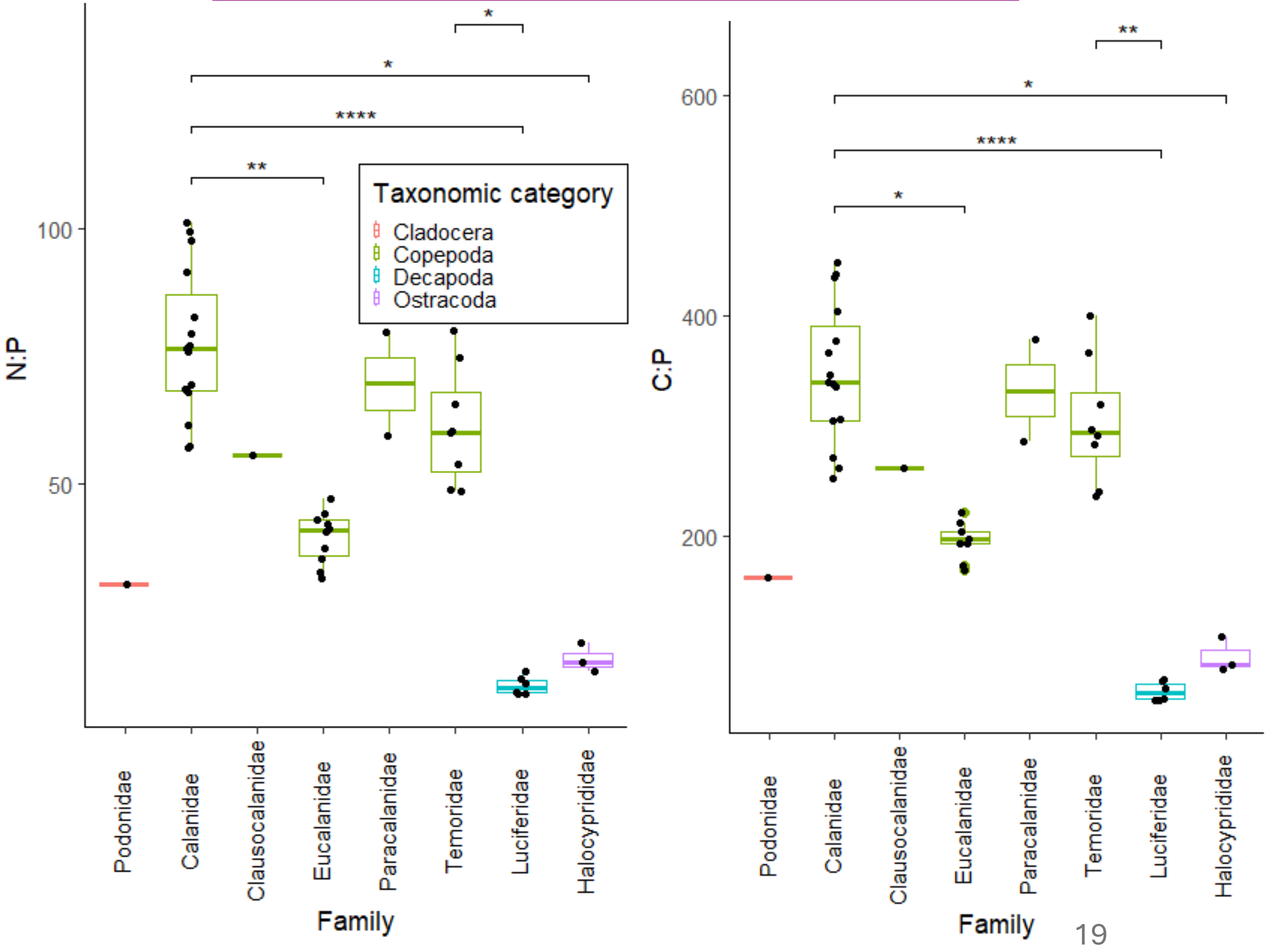
Zooplankton stoichiometry and feeding strategy are also associated with taxonomy

C:P and N:P of freshwater zooplankton



(Sterner and Elser 2002)

C:P and N:P of marine zooplankton



(Chen et al. under review)

Aims

- Investigate the stoichiometry (C:N, C:P, N:P) and stable isotope baselines of POM at the cold dome offshore northeastern Taiwan
    - Size-dependent variation
    - Variation at day and night

- Investigate the taxon-specific stoichiometry (C:N, C:P, N:P) and stable isotope-based trophic position of mesozooplankton

BO goal: Investigate the effects of physical processes on plankton dynamics (composition, stoichiometry, trophic interactions, and influences on DOM) in the same water parcel

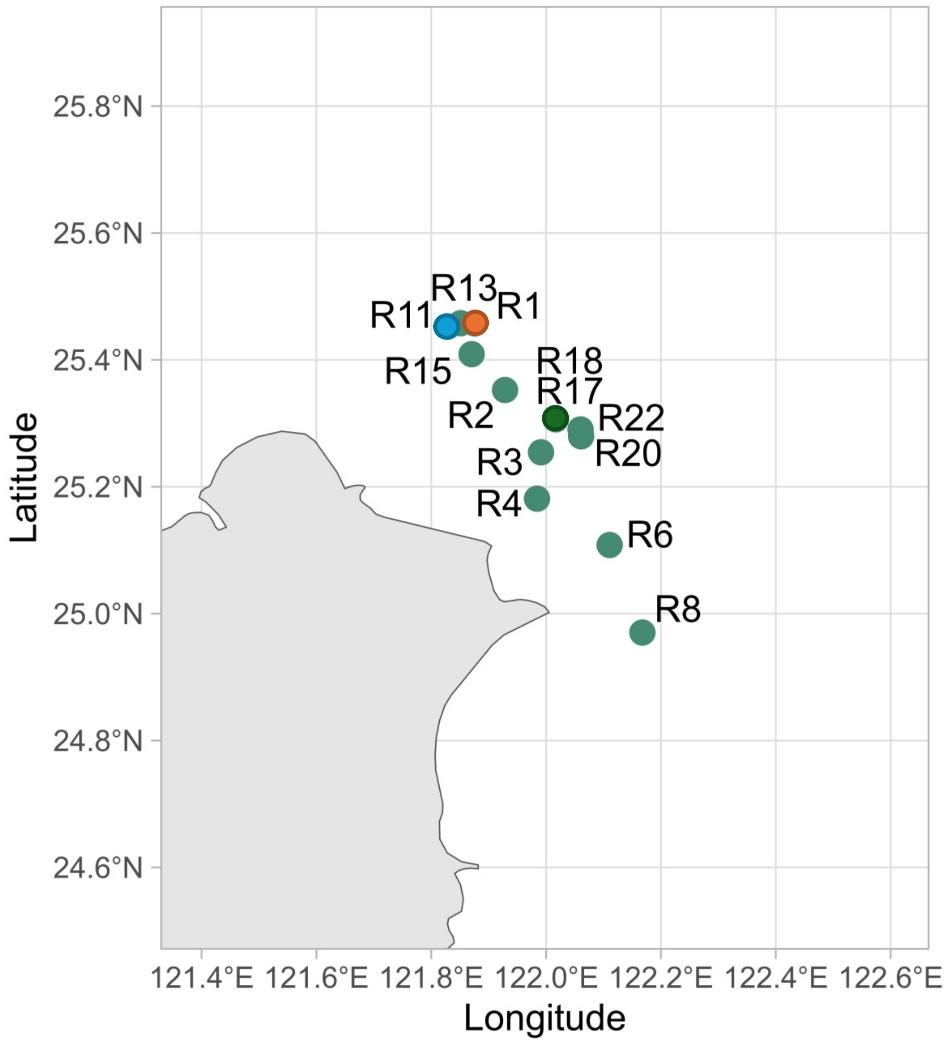
Objectives	Lab	Sampling frequency
1. Plankton composition (16S and 18S rDNA) in water profile (<200m with CTD)	Yi-Chun	Every 6 hour
2. Zooplankton composition in euphotic zone (330um plankton net in Formalin and EtOH)	Oscar, Eva	Every 6 hour
3. Size fractionated POM stable isotope and stoichiometry (with CTD)	Eva	Every 6 hour
4. Size fractionated zooplankton stable isotope and stoichiometry (with triple plankton net)	Eva	2 tows in a 48 hr cycle (day and night)
5. Feeding experiment (dilution experiment) at both daytime and nighttime (Coupling with DOC-decay and CDOM/FDOM measurements)	Brandon, Oscar	2 in a 48 hr cycle (daytime and nighttime)

Timeline for each float trip 121.9˚E, 25.45˚N

Hour	0	4	6	12	18	24	30	36	42	48	…
Work	CTD X 1	Float VMP	CTD X 1	CTD X 2	CTD X 1	CTD X 2	CTD X 1	CTD X 1	CTD X 1	CTD X 1	
Objective	Net X 2 #1~#4		Net X 1 #1~#3	Net X 2 #1~#4, #5	Net X 1 #1~#3	Net X 1 #1~#3, #5	Net X 1 #1~#3	Net X 1 #1~#3	Net X 1 #1~#3	Net X 1 #1~#3	

Materials and methods

Survey area and sampling sites



Round 1:
Started from R1 (2026/03/25, 15:00), followed the float to R8 (2026/03/27, 21:00). Retrieved the float offshore Ilan, and returned to the front area.

Round 2:
Started from R11 (2026/03/28, 9:00), followed the float to R17 (2026/03/29, 21:00) and retrieved the float

Round 3:
Stayed around R18 (2026/03/30, 9:00) until 2026/03/31, 9:00

Materials and methods

Size fractioned POM collection

200 µm

20 µm

GF/F

20-200 µm POM

24 L water
Surface (5m)

24 L water
Between chl-*a* max and surface

24 L water
chl-*a* max

24 L water
chl-*a* max + 10m

Diaphragm pump

GF/D 2.7-20 µm POM
GF/F 0.7-2.7 µm POM

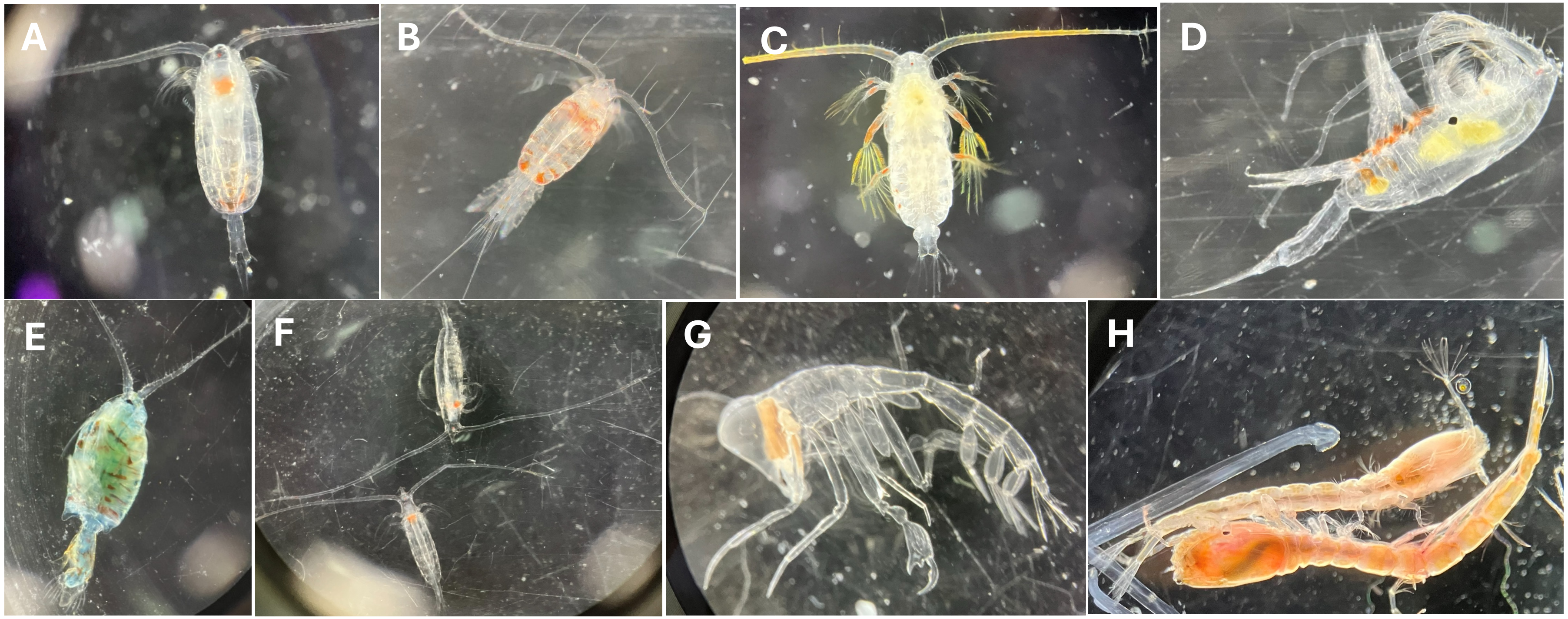
GF/D 2.7-20 µm POM
GF/F 0.7-2.7 µm POM

GF/D 2.7-20 µm POM
GF/F 0.7-2.7 µm POM

GF/D 2.7-20 µm POM
GF/F 0.7-2.7 µm POM

Materials and methods

Zooplankton taxa collection

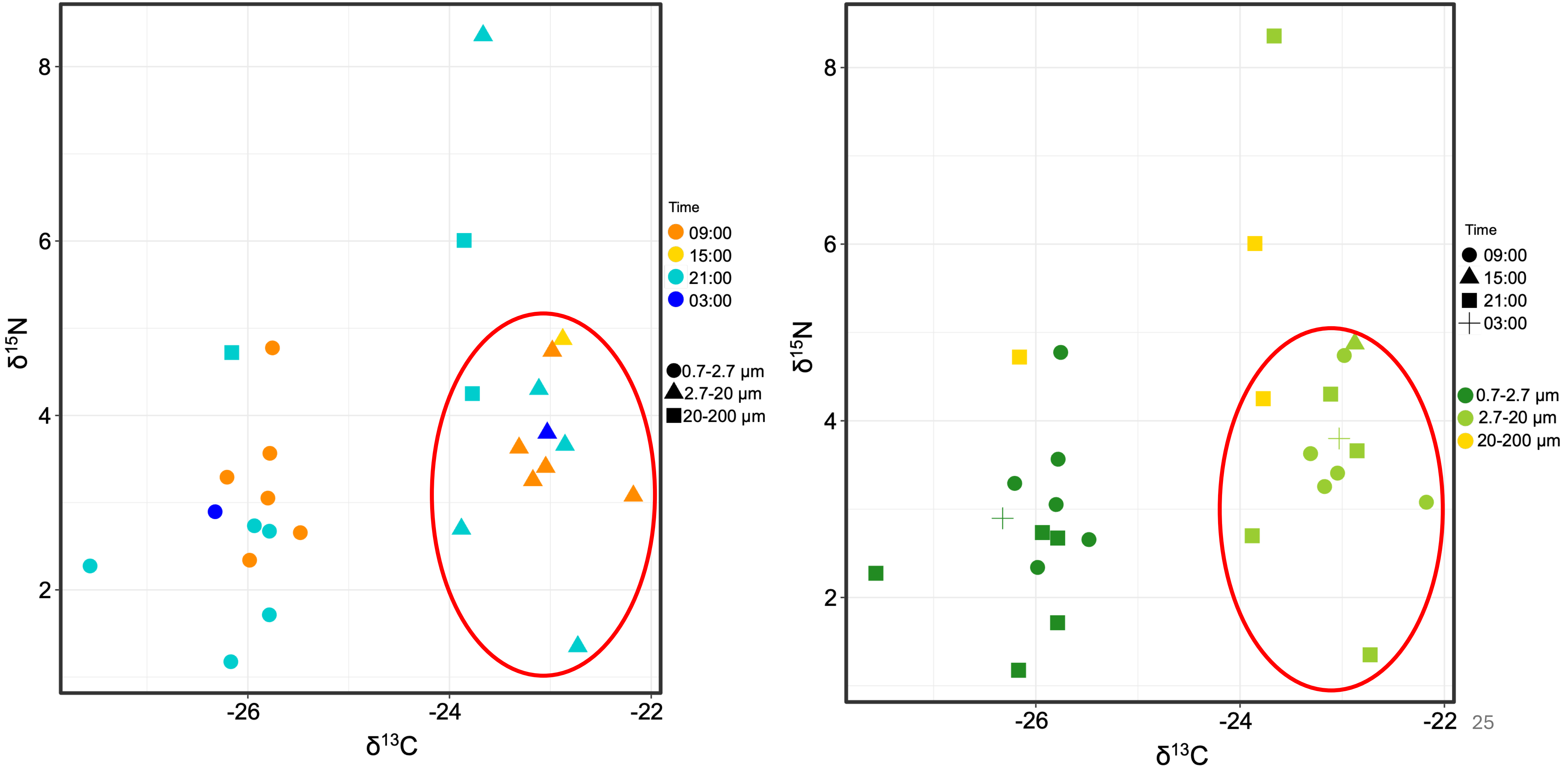


Selected mesozooplankton taxa near the Liuqui Island and northeast Taiwan.

(A) Calanidae, (B) Euchaetidae, (C) Eucalanidae, (D) Metridicidae, (E) Pontellidae, (F) Rhincalanidae, (G) Phronimidae, (H) Bodotriidae.

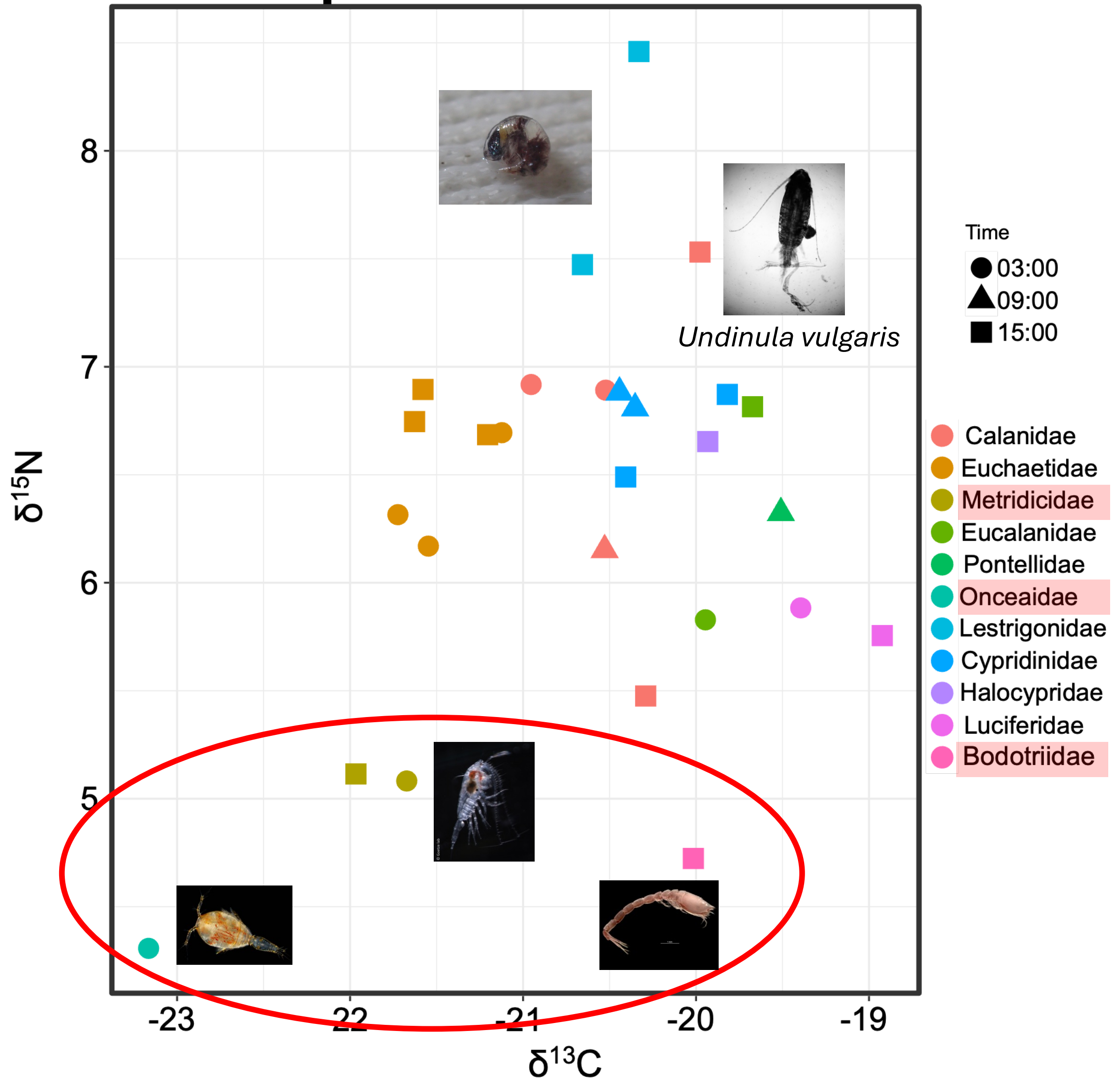
Results

Size-fractioned POM $\delta^{13}C$ and $\delta^{15}N$



Results

Taxon-specific zooplankton $\delta^{13}C$ and $\delta^{15}N$



Discussion

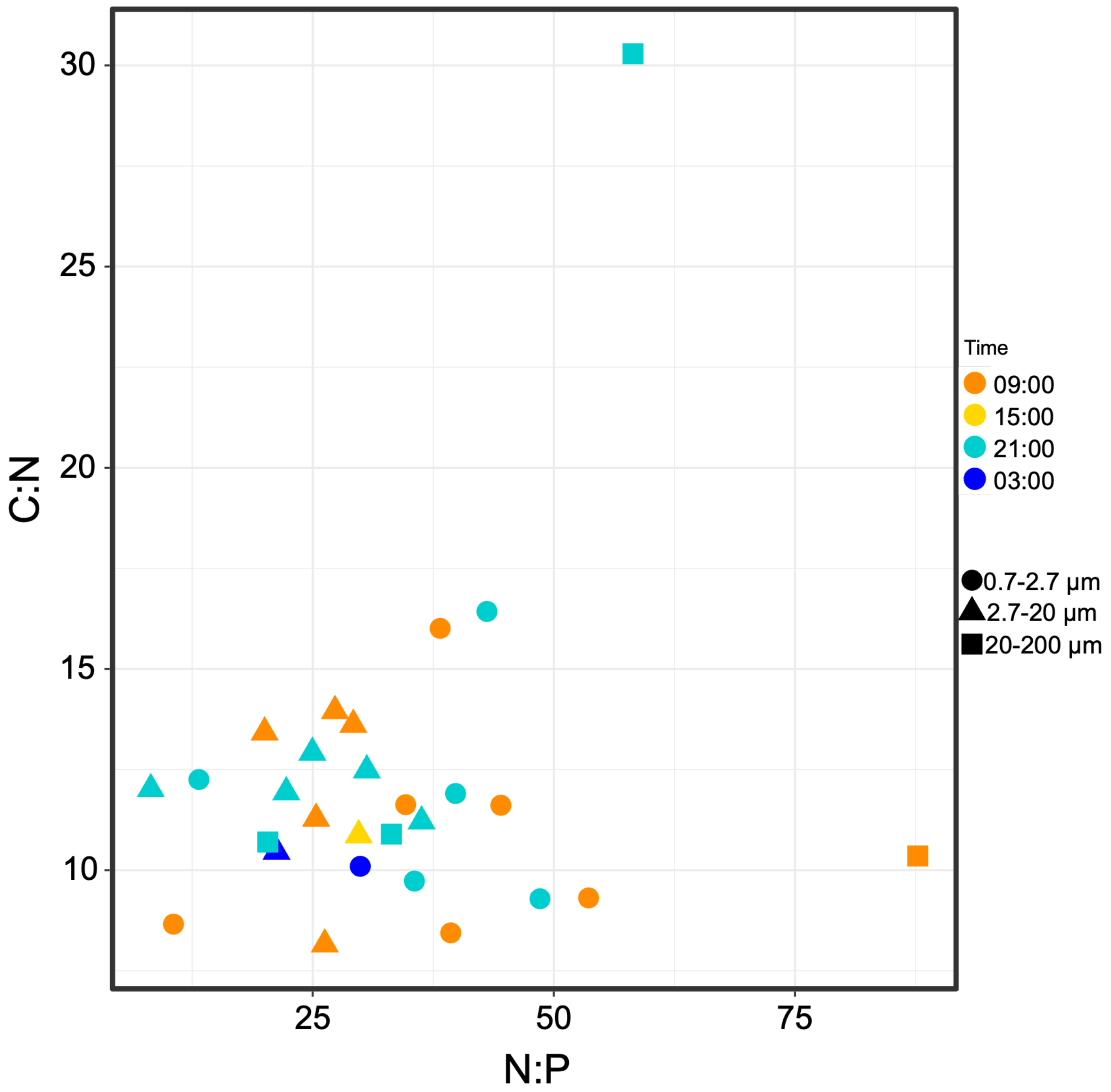
Trophic structure of plankton food webs in the cold dome

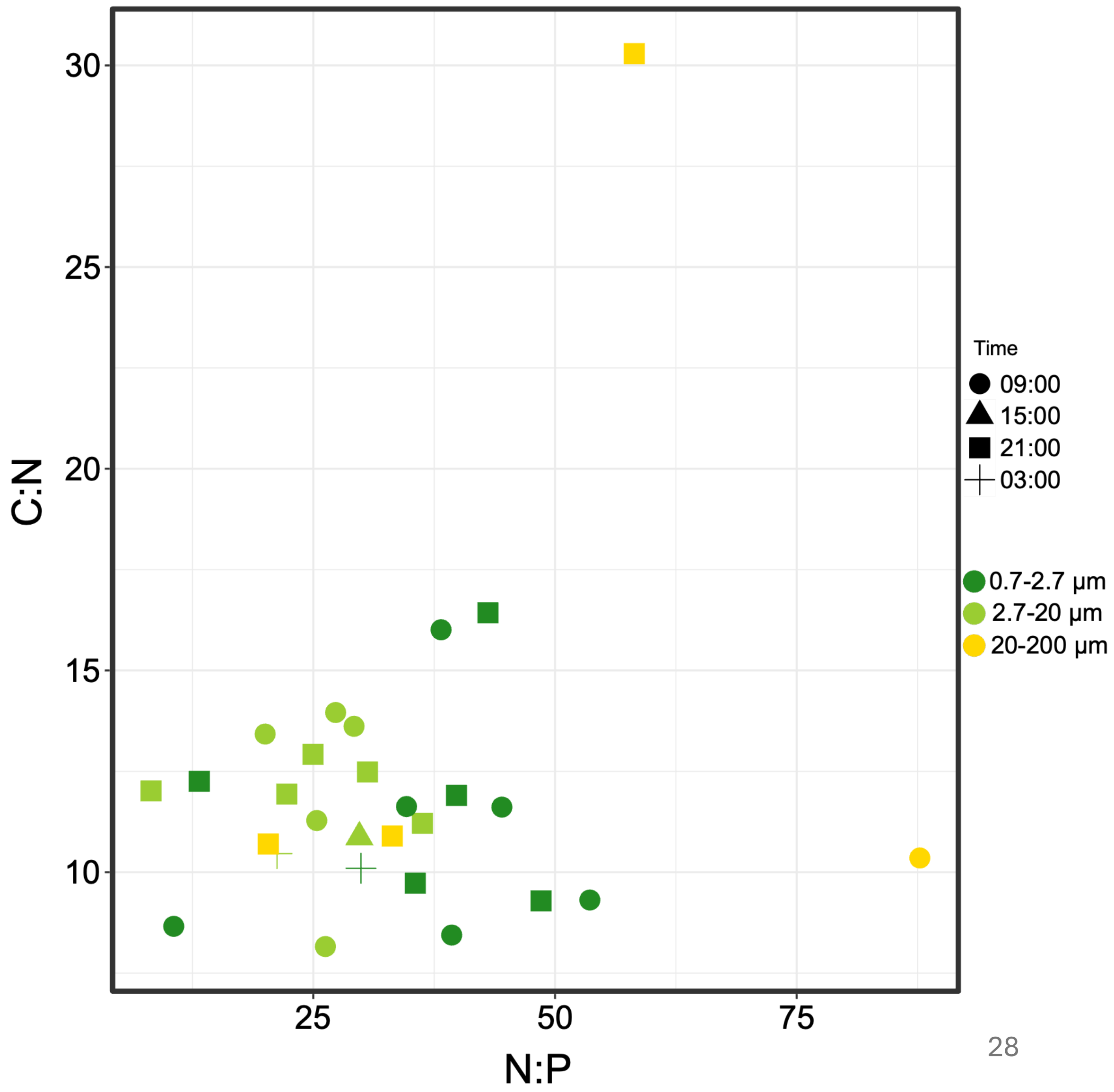
- According to $\delta^{13}C$ and $\delta^{15}N$, pelagic crustacean zooplankton mainly feed on nanoplankton

- Most of the mesozooplankton are omnivorous (consuming both phytoplankton and other herbivores)
  - Pelagic amphipods (Lestrigonidae and Hyperiidae in the subfamily Phronimoidea) that may feed on gelatinous species would have higher trophic position
  - Oncaeidae has $\delta^{15}N$ similar to benthic cumacea and lower $\delta^{13}C$ than the other crustaceans, reflecting that it may feed on other food sources
  - Metridicidae (*Pleuromamma* spp.) may also feed on food sources other than phytoplankton

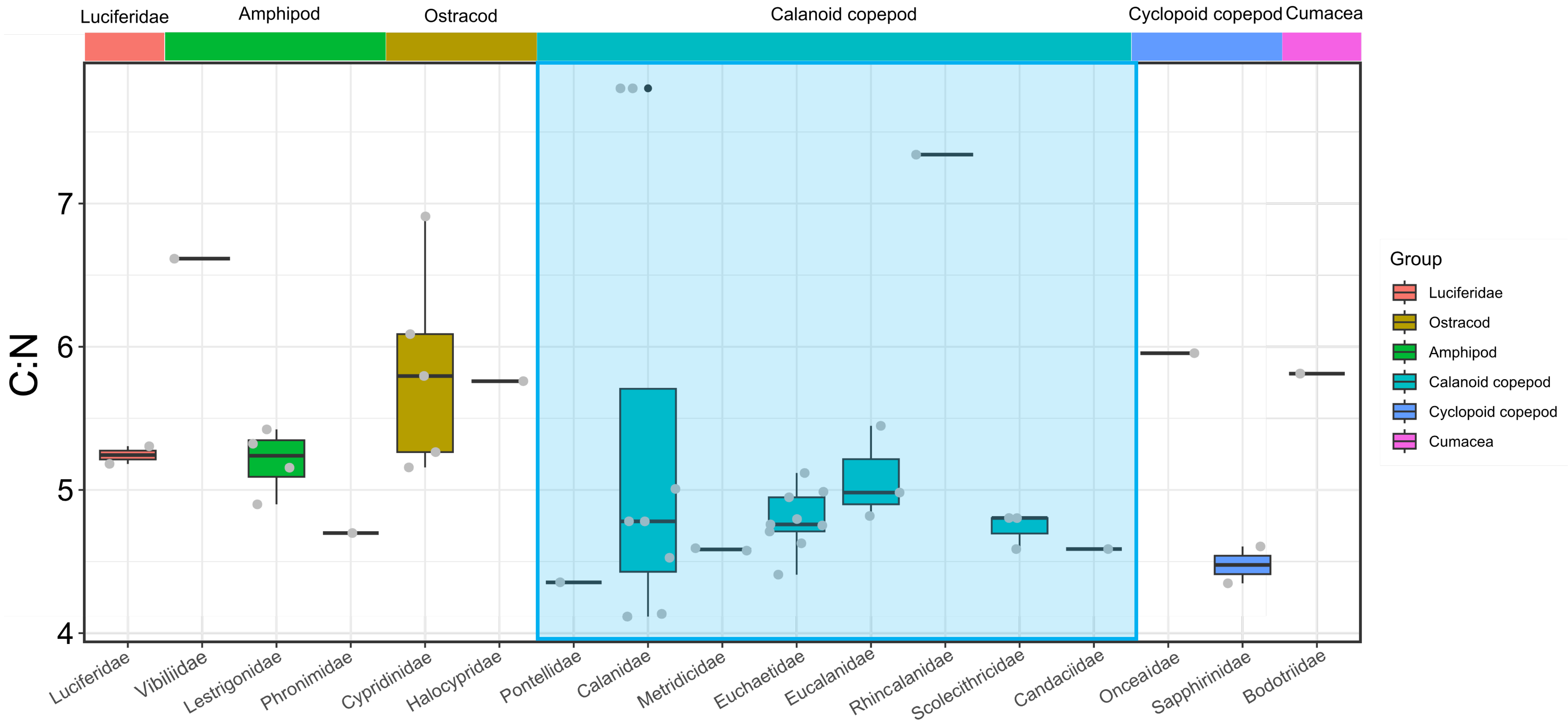
Results and discussion

Size-fractioned POM C:N:P

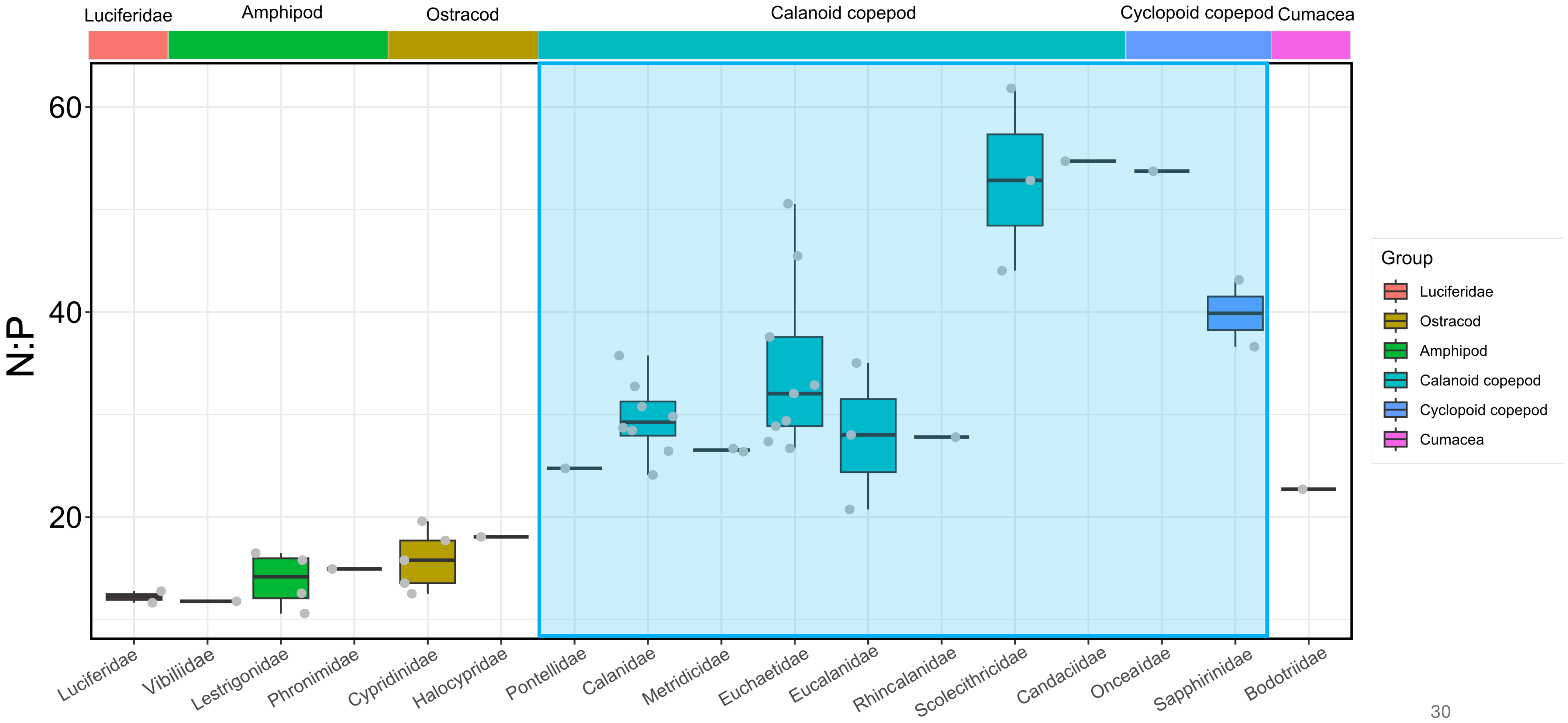




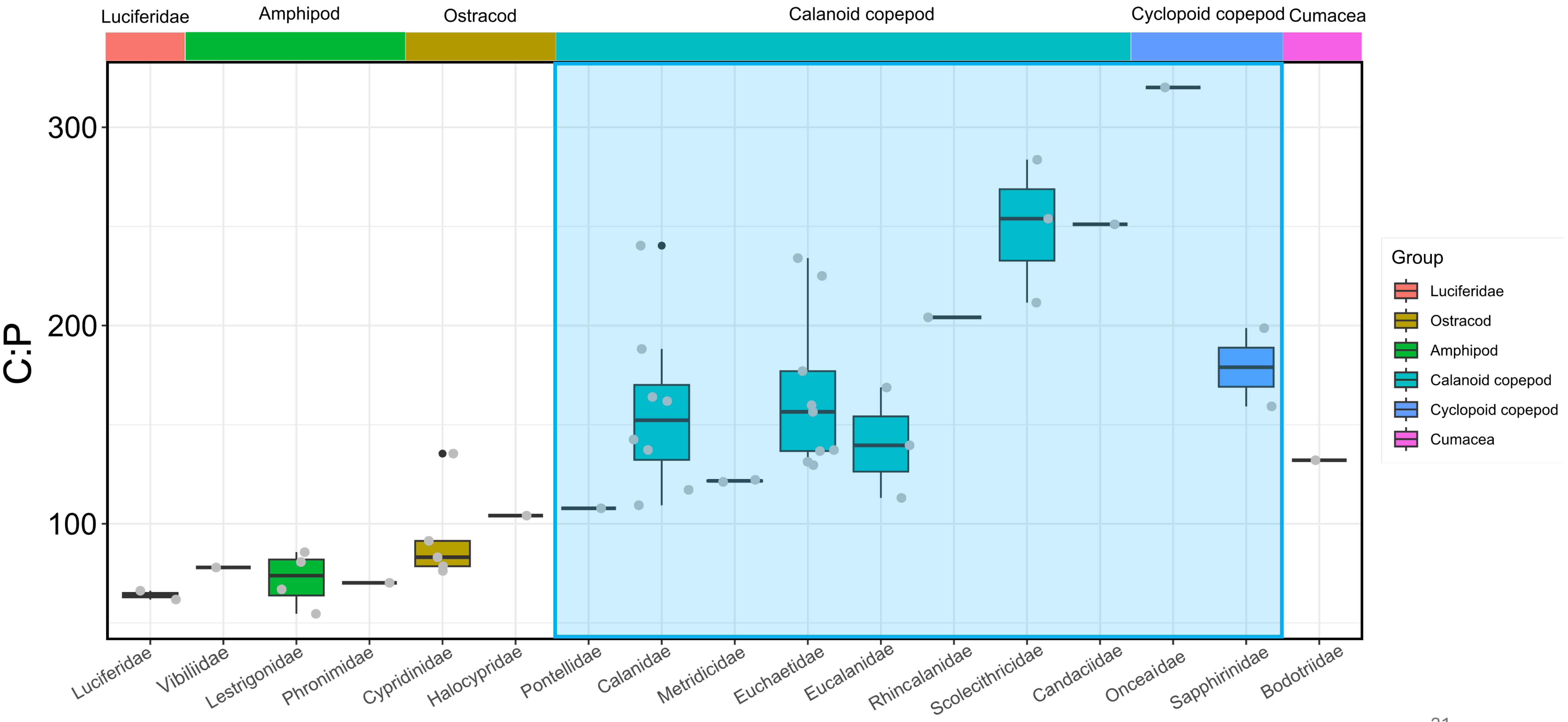
Taxon-specific C:N (Southern ECS and Liuqiu Island)



Taxon-specific N:P (Southern ECS and Liuqiu Island)



Taxon-specific C:P (Southern ECS and Liuqiu Island)



Stoichiometry of POM varies in the cold dome in a short timescale

- Though we sampled the POM within the same water mass, the C:N:P varied in two or three days
  - Variation of ambient concentrations and/or diffusive fluxes of dissolved N and P nutrients
  - Light intensity variation
- POM C:N and N:P are higher than the Redfield ratio (C:N:P =106:16:1)
  - Even in the upwelling region, N and P nutrients are limiting

Discussion

Mesozooplankton stoichiometry is taxon-specific

- C:N of crustacean zooplankton ranged from 5 to 6, with less variation than the N:P and C:P molar ratios

- N:P and C:P ratios of calanoid and cyclopoid copepods were higher than those of other zooplankton families, reflecting their relatively higher N requirements and lower P requirements

- Amphipods, euphausiids, and ostracods had lower N:P and C:P ratios, suggesting that their growth may be more susceptible to P limitation

Future directions

- Variations of POM stoichiometry in different water masses
  - Dissolved nutrient concentrations
  - Nutrient fluxes through mixed layer depth (based on vertical nutrient profiles and VMP observation)

- Variation of zooplankton community composition in different water masses

- How does the trophic structure of plankton food webs vary with hydrology by
  - Alternation of community structure
  - Adaptation of different trophic and feeding strategies