Population dynamics model of Copepoda (*Neocalanus cristatus*) in the northwestern subarctic Pacific

Zooplankton production symposium

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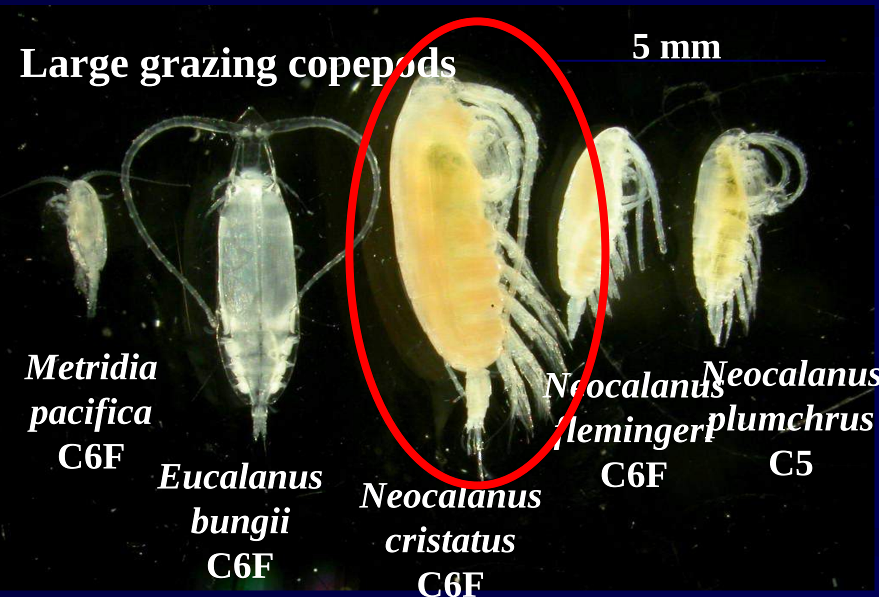
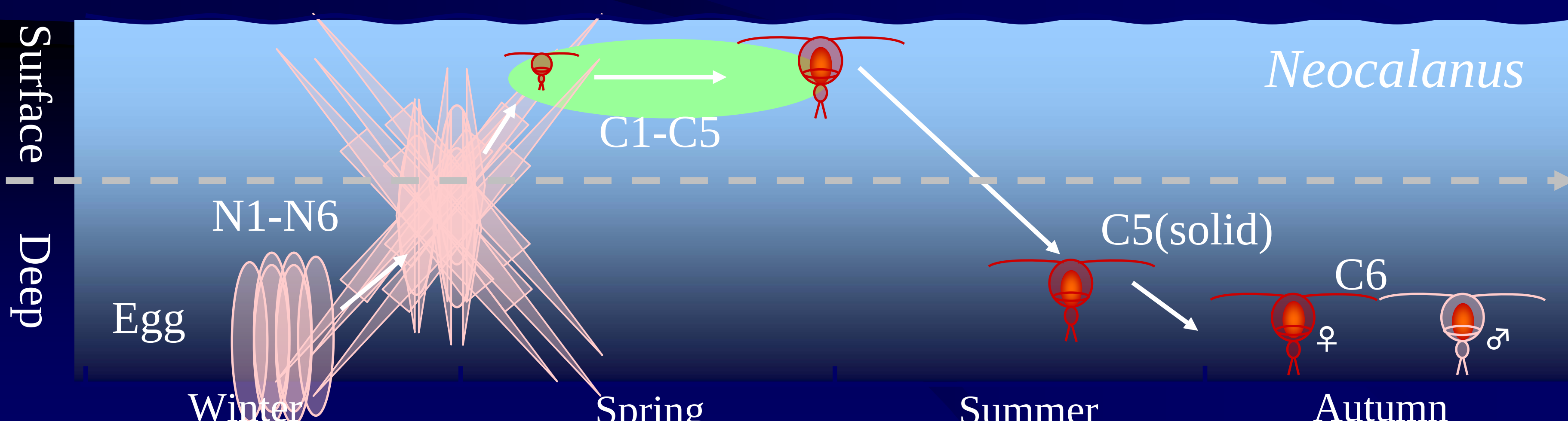
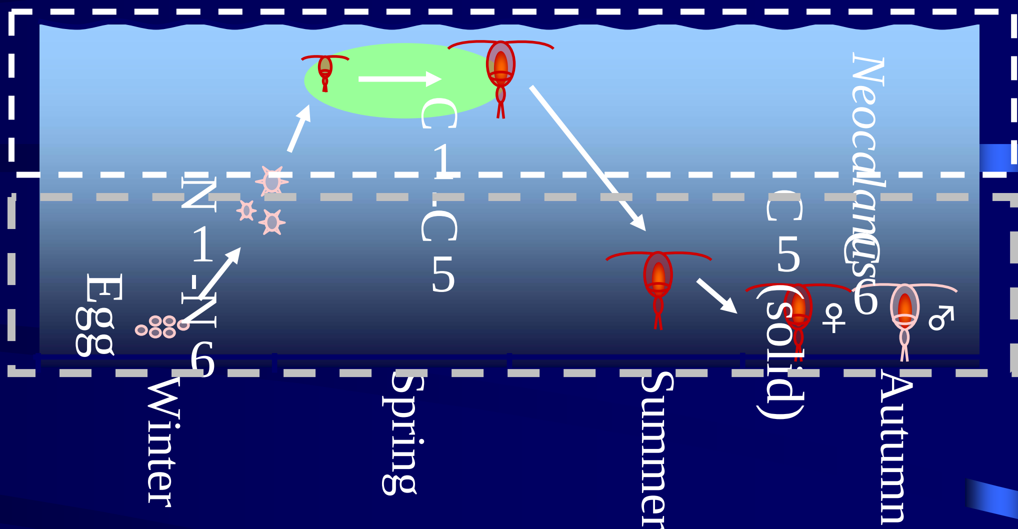
1 . Copepoda, *Neocalanus cristatus*



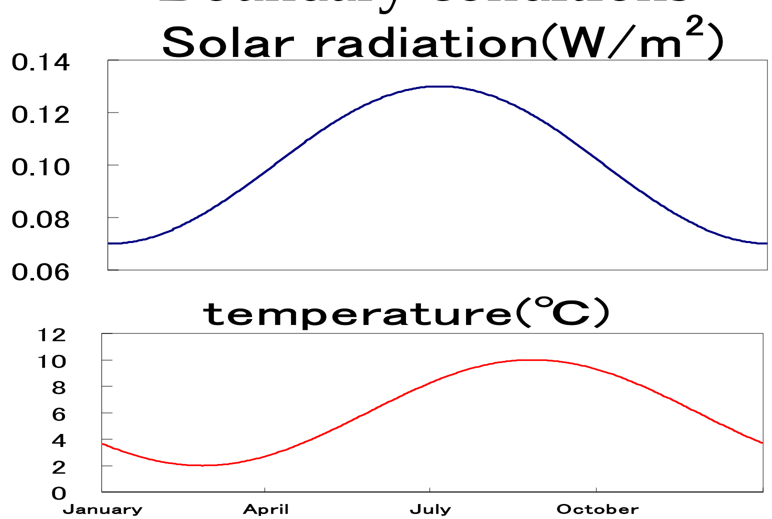
- *Neocalanus* species are the dominant large grazing-copepods in the subarctic North Pacific.
- Annual lifecycle.
- They undergo an extensive ontogenetic vertical migration (1000 ~ 2000 m).
- *N. cristatus* is the largest copepod.



3 – 2. Environmental condition and outline of model



Boundary conditions



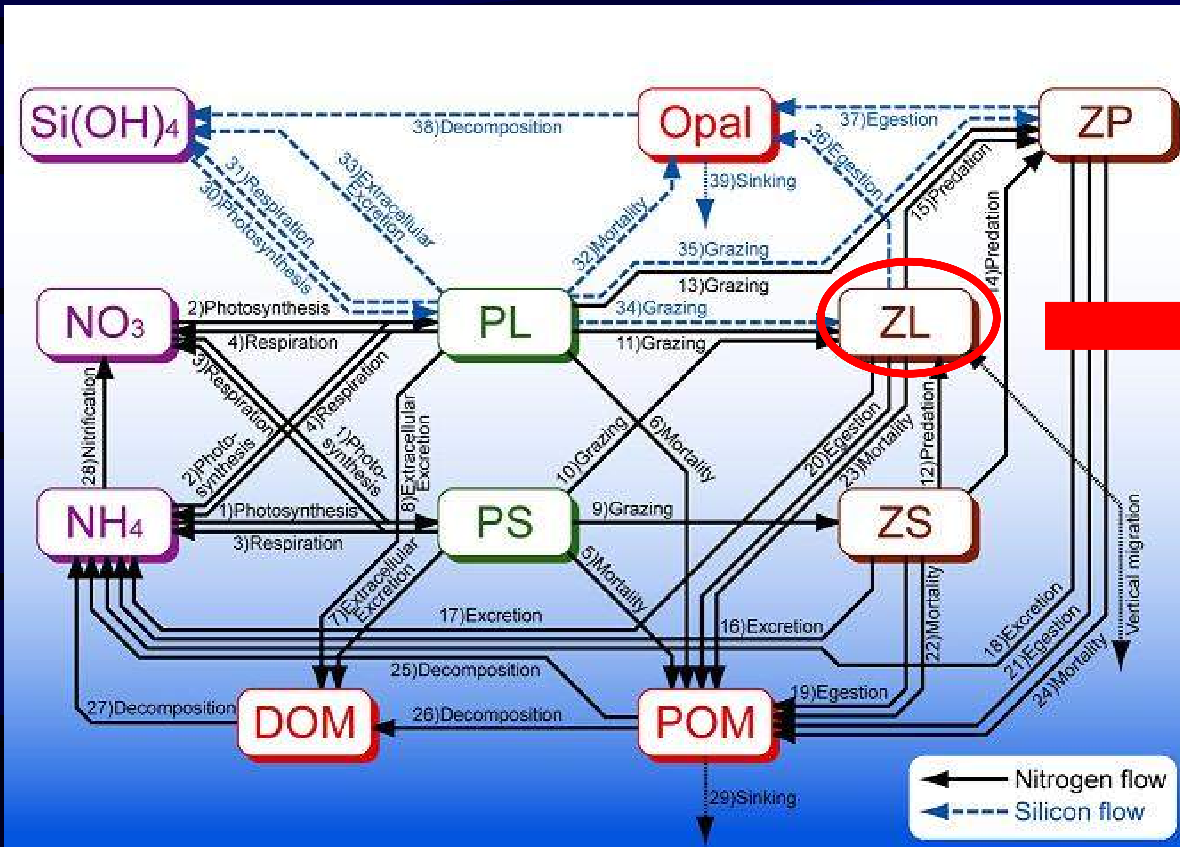
Model has two boxes,

- Surface box = NEMURO and C1-C5,
- Deep box = eggs, nauplii, solid, adult.

Simplified boundary conditions simulated observed value.

3. Ecosystem model, NEMURO

(North Pacific Ecosystem Model Used for Regional Oceanography)

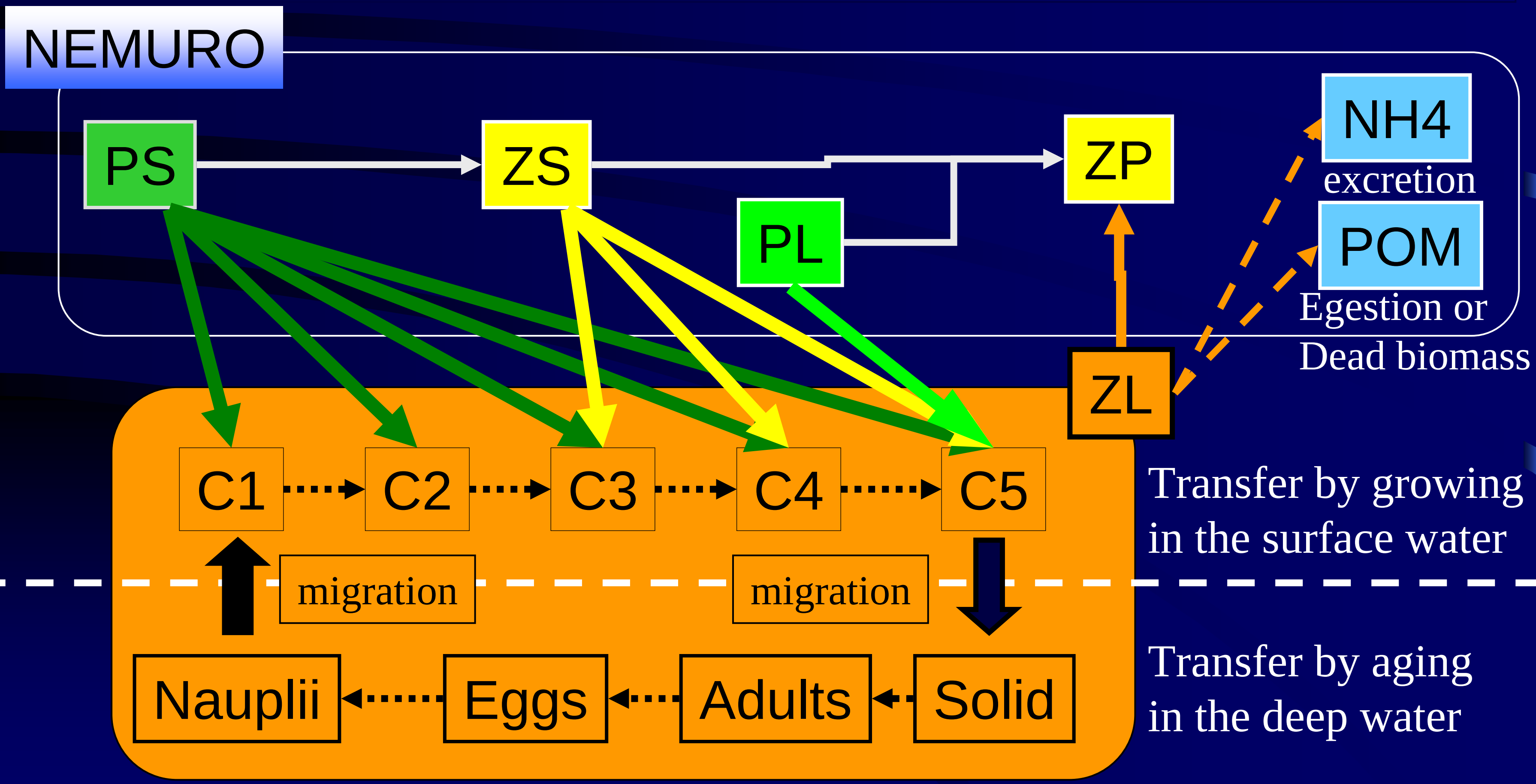


PDM

- Developed by the PICES Model Task Team (Kishi et al., 2007).
- Nitrogen based box model for the euphotic layer.
- ZL is set to descend out of the model on 31th August, and returned on 1st April every year as ontogenetic migration.

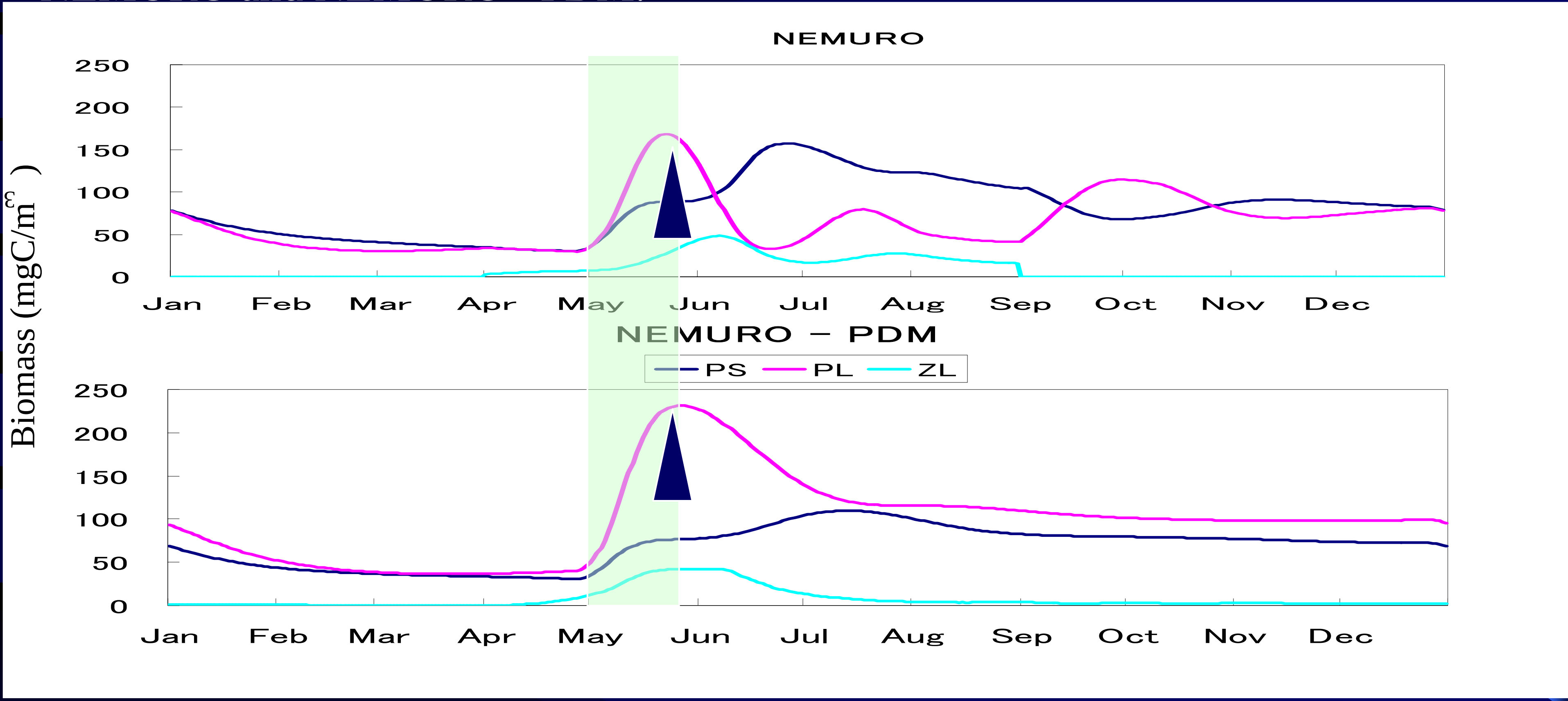
4-2. NEMURO coupled with PDM

- We consider that copepodite in larger stage can potential graze body-larger group of plankton.
- Each C1 to C5 lose by predation of ZL to ZP.
- Solved with an Euler forward scheme, with a time step of 1 hour, running for 50 years.



4 – 3. Comparison between NEMURO with/without PDM

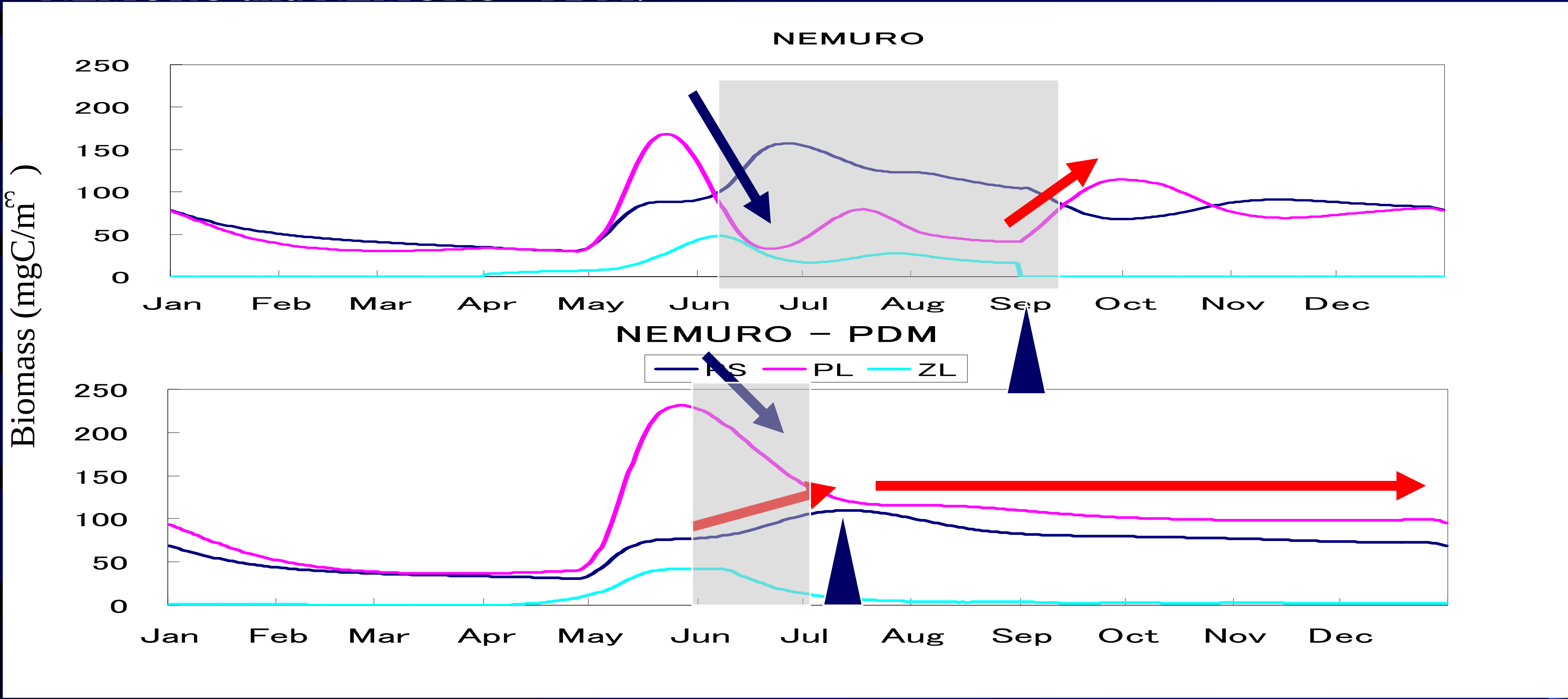
These figures represent seasonal variations of biomass of PS, PL, and ZL in the NEMURO and NEMURO - PDM.



In spring, nutrients are supplied from deep water. Thus phytoplankton blooms occurred. The peak of PL in NEMURO-PDM is greater than that in NEMURO. In NEMURO-PDM, C1-C4 mainly prey on PS, and PL is free from the grazing pressure from ZL. Grazing pressure to PL in NEMURO-PDM is weaker than that in NEMURO.

4 – 4. Comparison between NEMURO with/without PDM

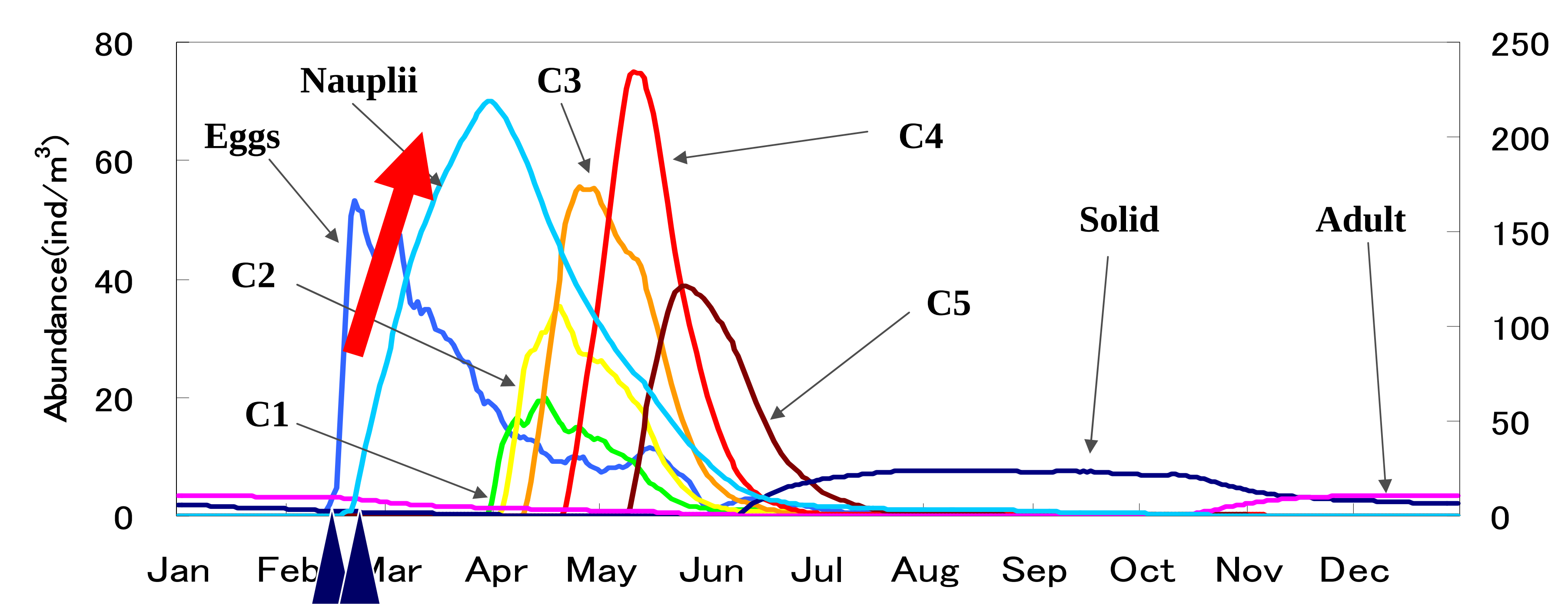
These figures represent seasonal variations of biomass of PS, PL, and ZL in the NEMURO and NEMURO - PDM.



In NEMURO, ZL graze PL and PS in a ratio of 4 to 1. This causes the oscillation of PL and ZL. and larger PS biomass from June to September. ZL descend out August, So PL increase in autumn. In NEMURO-PDM, grazing pressure by C5 is strengthened in June. the diapause begins from June and the grazing pressure on PL is weak. Thus PL biomass remains high through autumn.

4 – 5. Annual cycle of abundance of all stages

The model represented the annual cycle of abundance.



•Left vertical axis = Abundance of Eggs, Copepodites, Solid and Adult.

•Right vertical axis = Abundance of Nauplii

The number of nauplii increases exponentially. Because egg production and the transfer from eggs to nauplii continues simultaneity. The nauplii stage lasts longer than eggs, and therefore nauplii accumulated.

4 – 5. Annual cycle of abundance of all stages

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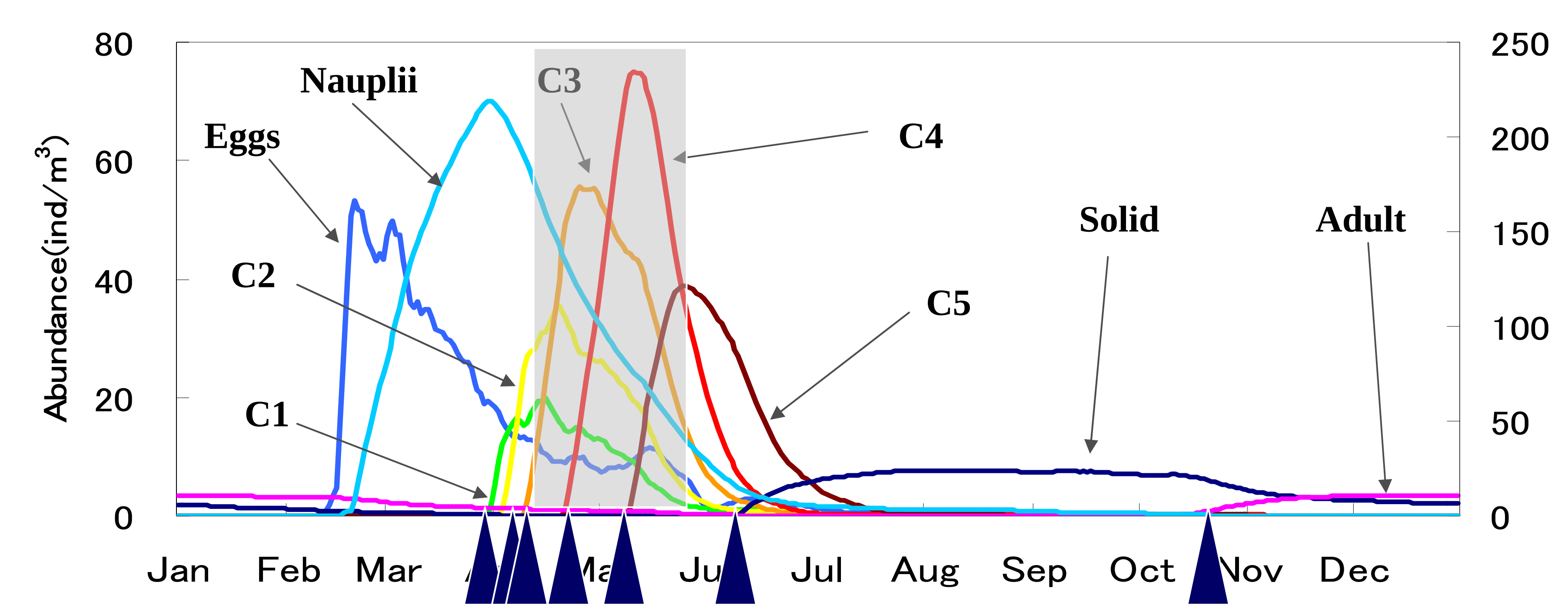
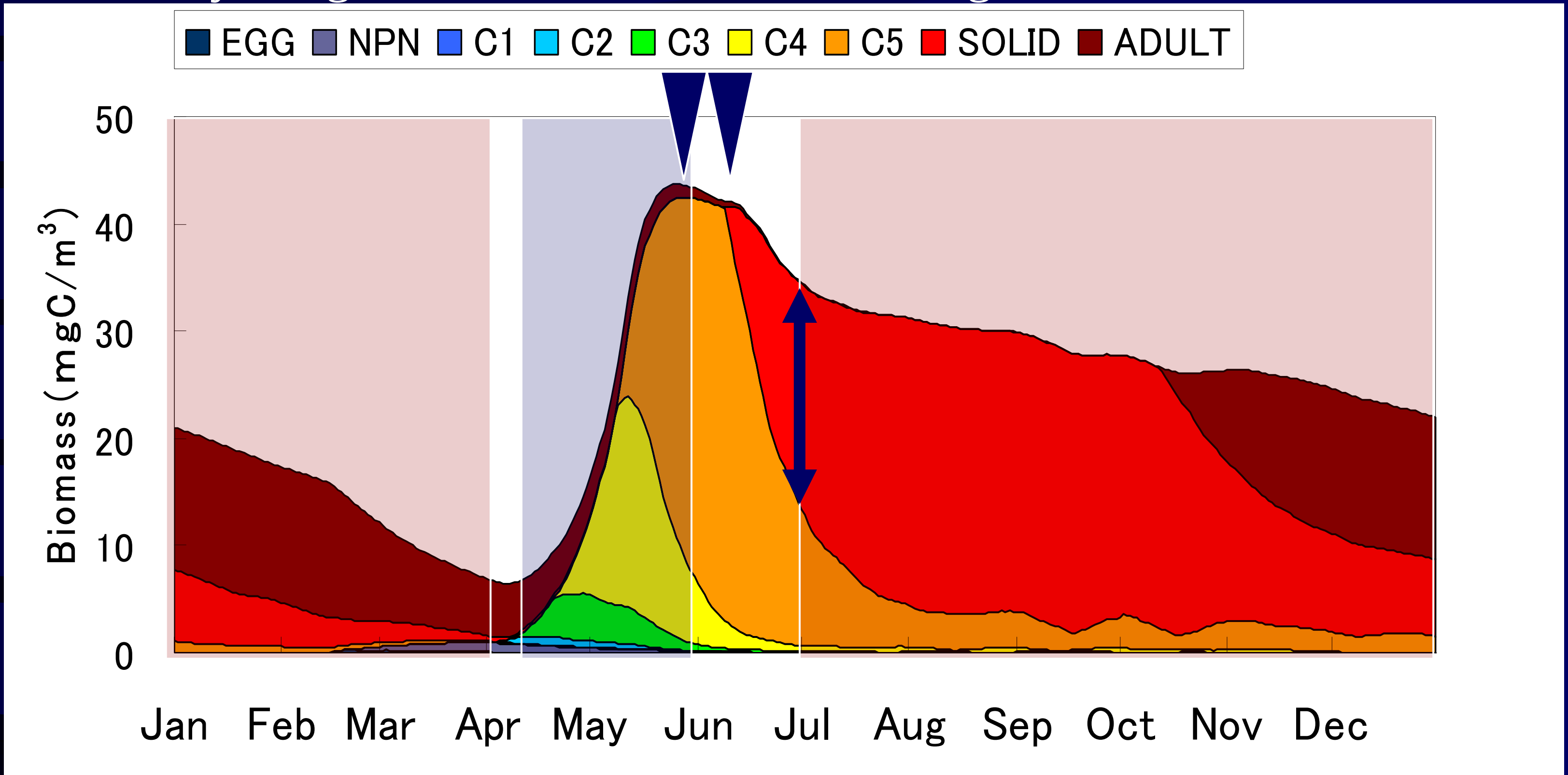


Tracing the peak, the developmental time from C1 to C5 is 41 days. The shortest developmental time estimated from sampling is 44 days at 6 ºC (Saito and Tsuda, 2000). This is due to growth rate not regulated by food limitation. That is, food was always sufficient in the model.

4 – 5. Annual cycle of biomass

Vertically integrated biomass for each life stage.



- Total biomass begins to increase exponentially from April
- Surface biomass transferred to deep layer from August.
- Solid and adult make up most of the zooplankton biomass for about nine months.
- We represented annual cycle of biomass, growth in surface water and life in water.

4 -6. Discussion

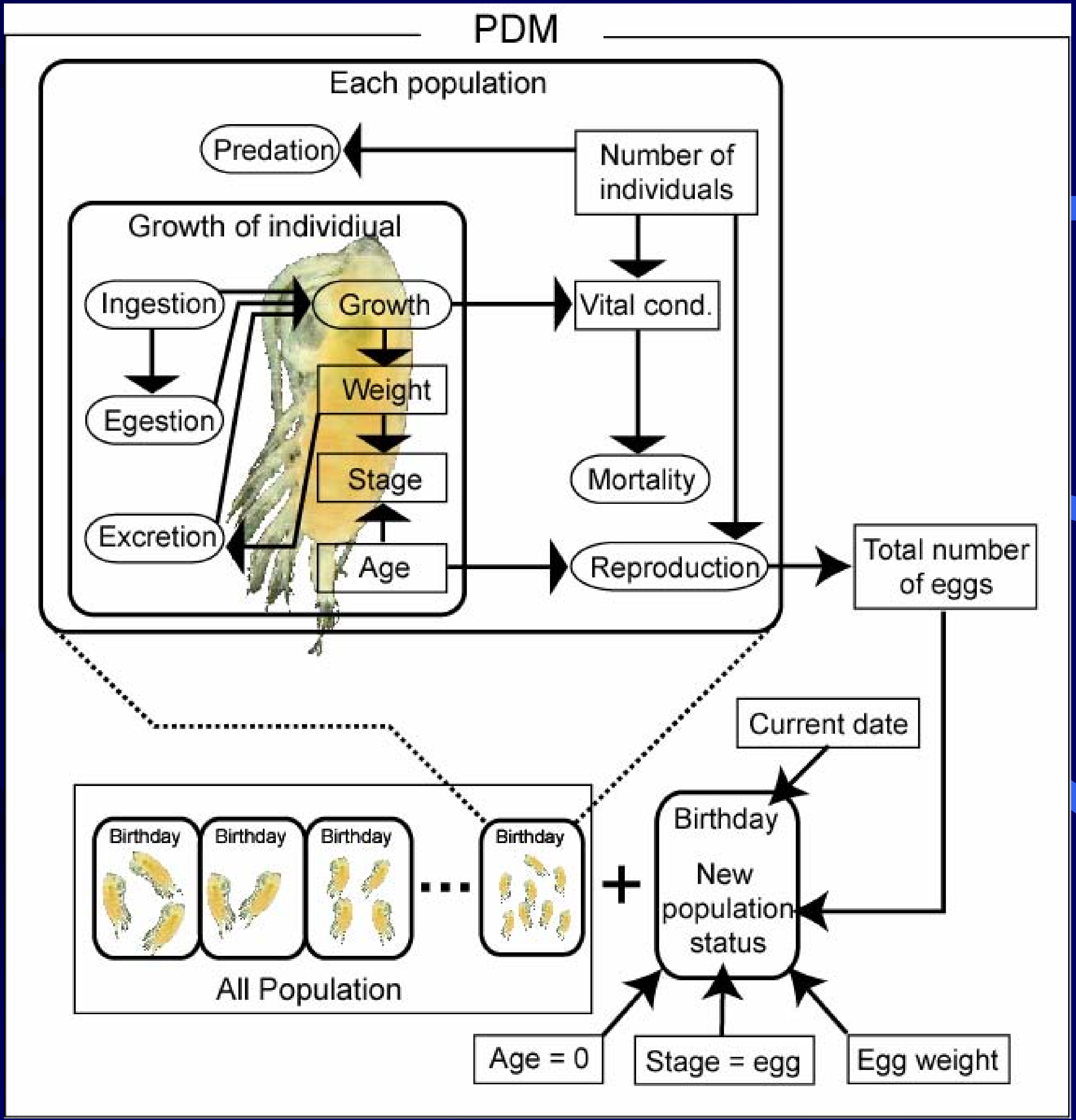
In our model, the lack of food limitation resulted in rapid growth of copepodite.

The ZL component of NEMURO is assumed to be dominant large copepods. In this study, we replaced the ZL with the PDM representing only the species *N. cristatus*. Consequently, there is no competition for foods among copepods.

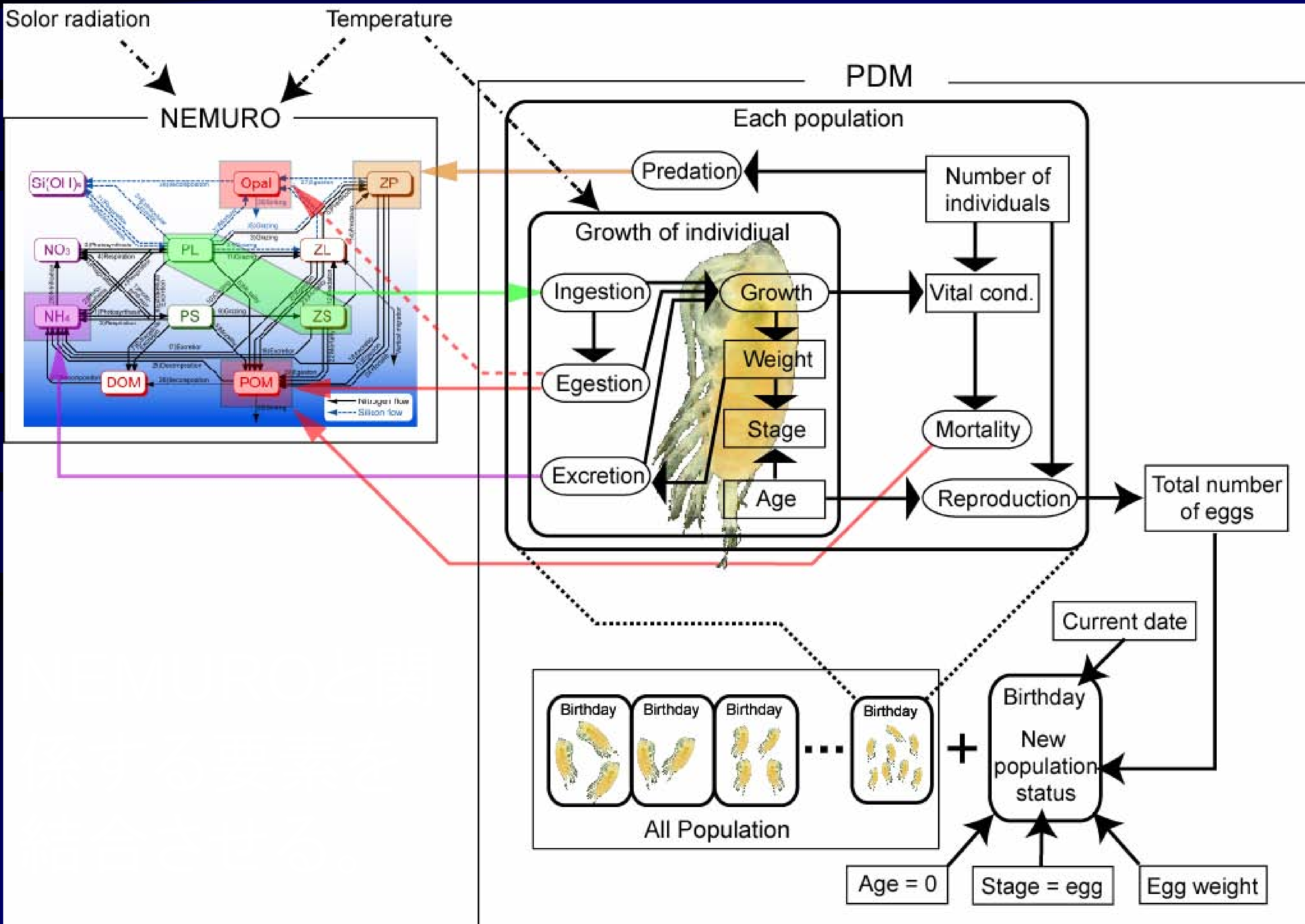
Observations suggest PL does not dominate in the Oyashio region in summer. By including the other copepods species in the PDM, the biomass of PL may decrease more during summer.

2 Cohort structured PDM

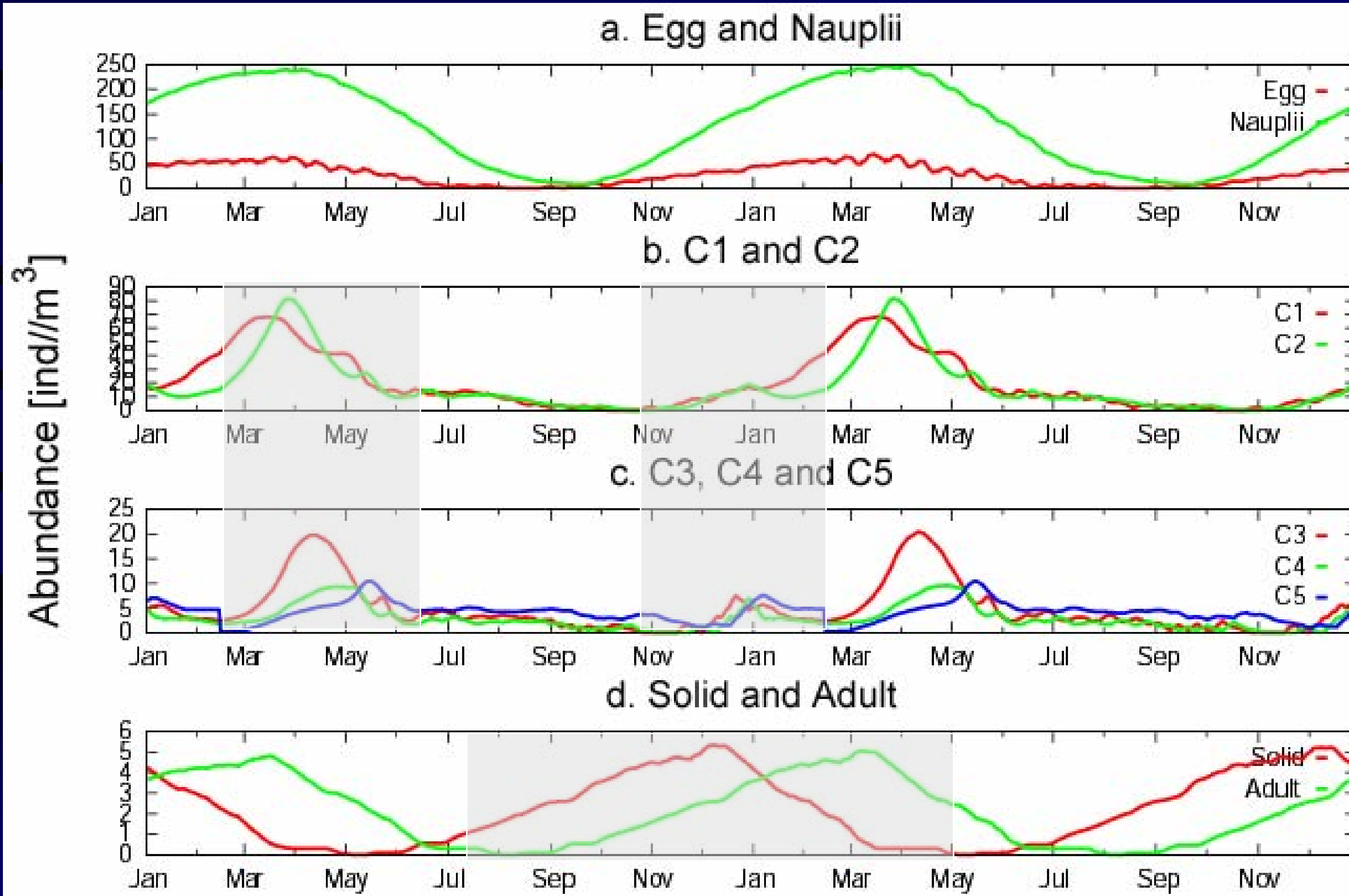
Sum of eggs
Spawned date



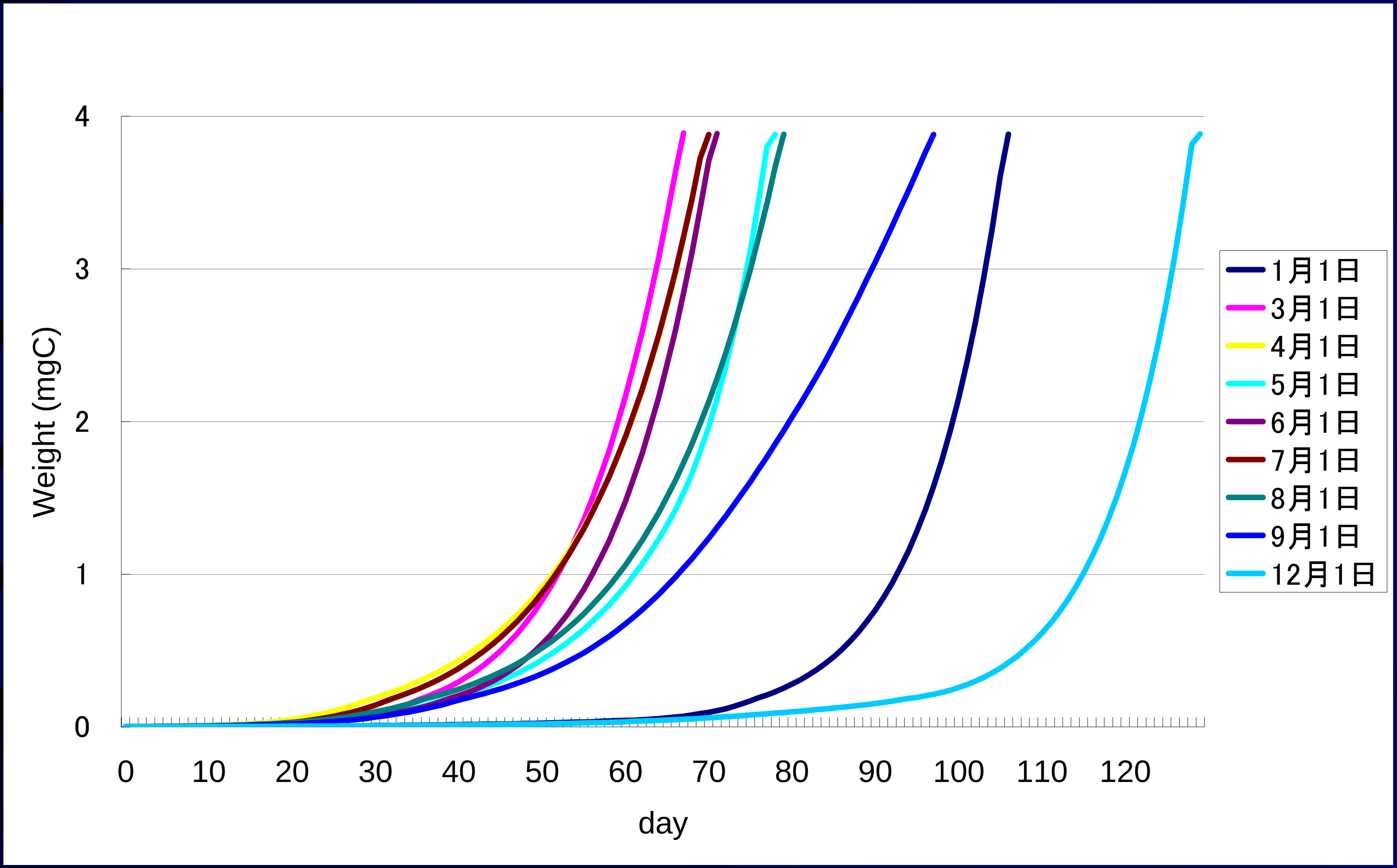
2-2Cohort structured PDM



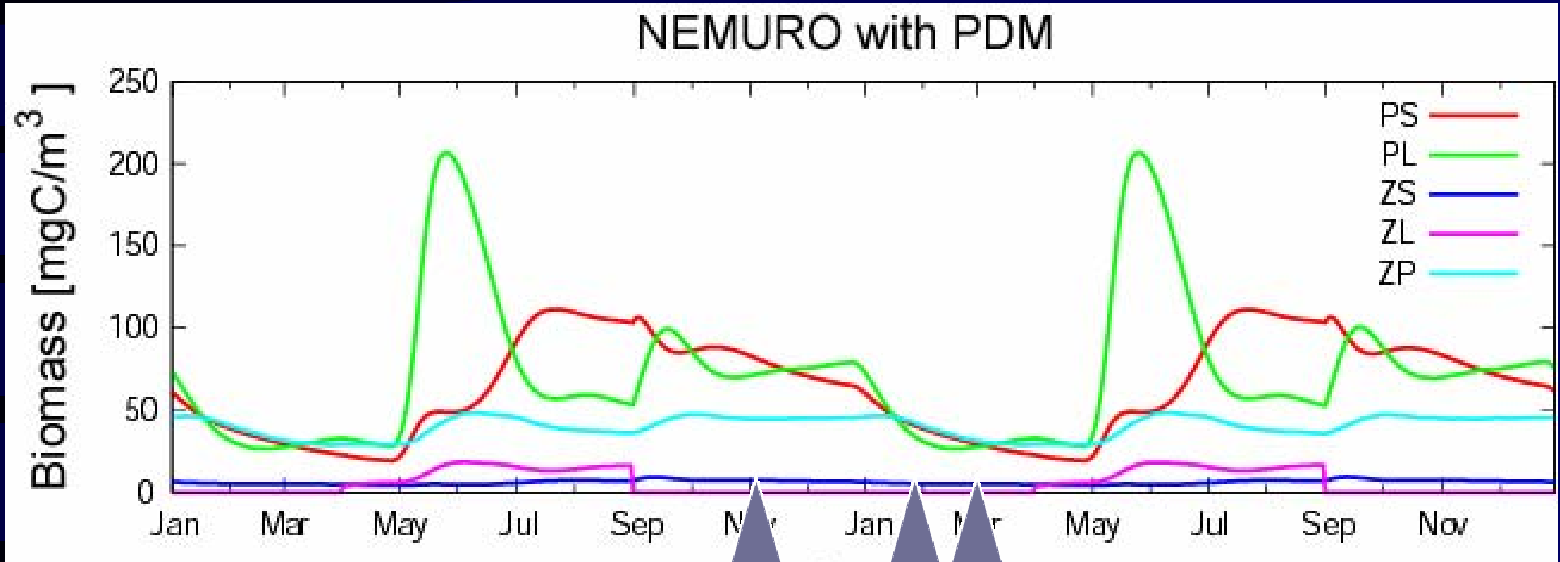
Annual cycle of abundance of all stages



Difference of growth by birthday



Time dependent value of wet weight from C1 to C5



誕生日	C1への移行日	Copepodid期間	Solidへの移行日
1月1日	2月28日	106	6月14日
3月1日	4月28日	67	7月4日
4月1日	5月29日	70	8月7日
5月1日	6月28日	78	9月14日
6月1日	7月29日	71	10月8日
7月1日	8月28日	70	11月6日
8月1日	9月28日	79	12月16日
9月1日	10月29日	97	2月3日
12月1日	1月28日	129	6月5日


Thank you
See you tomorrow