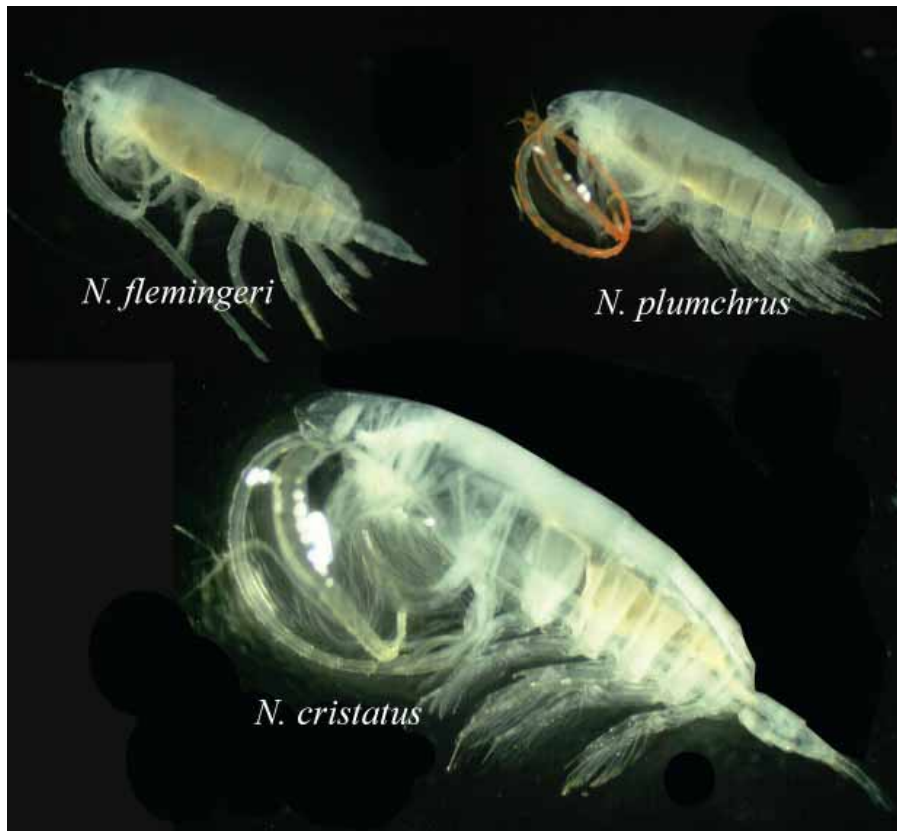


# Decadal scale variations in developmental timing of *Neocalanus* copepod populations in the Oyashio waters, western North Pacific

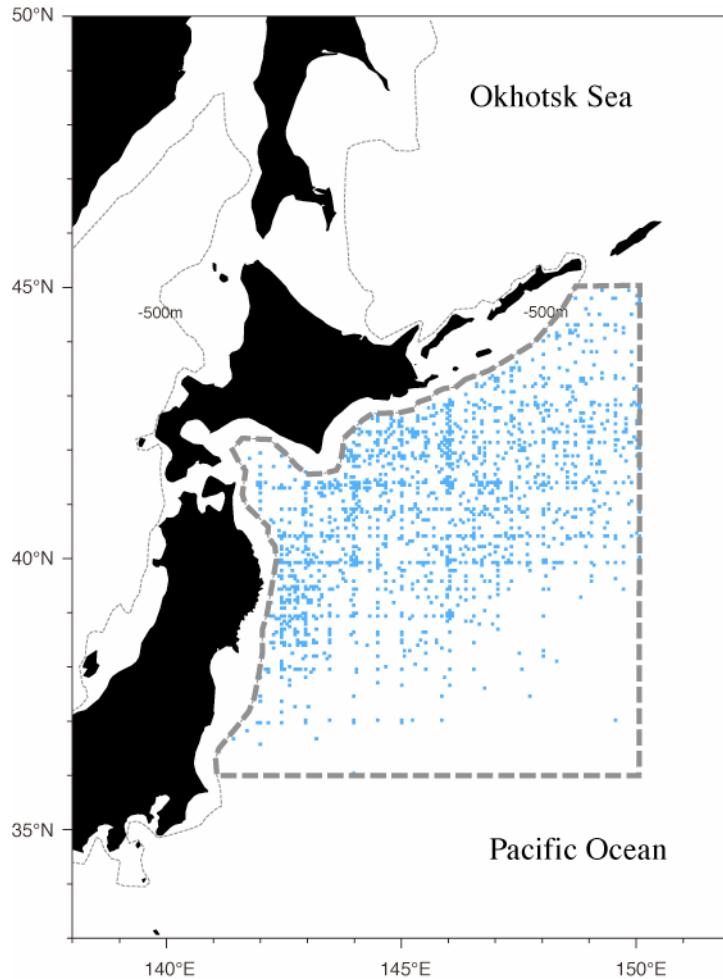
K. Tadokoro Y. Okazaki  
Tohoku National Fisheries Research Institute

H. Sugisaki  
National Research Institute of Fisheries Science



*Neocalanus* is dominant species in mesozooplankton community and a important interface between lower and higher trophic levels in the subarctic North Pacific. The change of development timing would lead to match or mismatch between trophic levels.

# Observation area and data



Period

1960-2002

Zooplankton

ODATE COLLCECTION

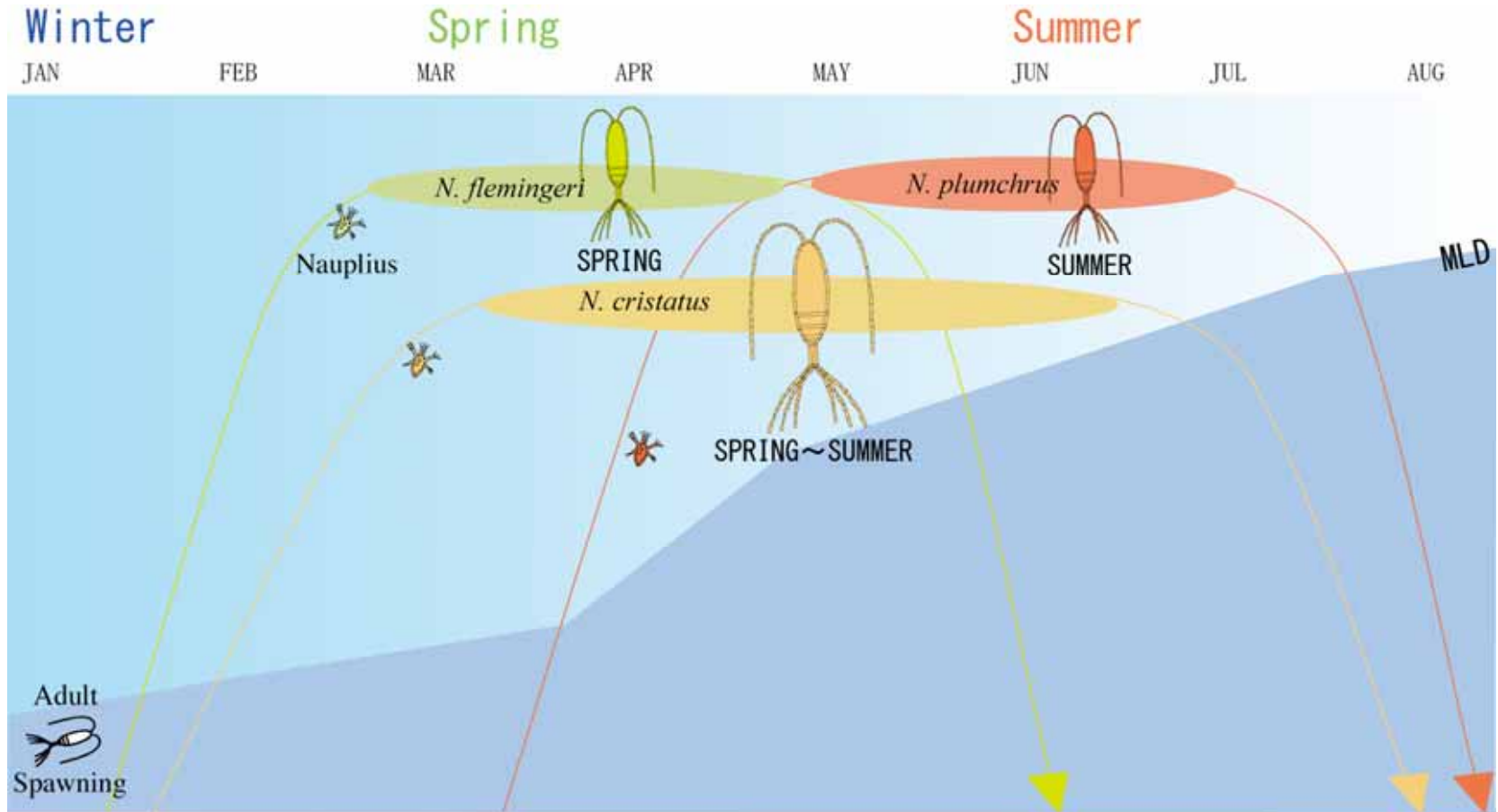
Oceanographic data

WOD2001+A-line+ JODC  
Temp• Sal• nutrients etc

Oyashio definition

< 5 °C    100m  
Kawai (1972)  
Offshore (>500m isobath)

# Life history of *Neocalanus* copepods



# Index of developmental timing

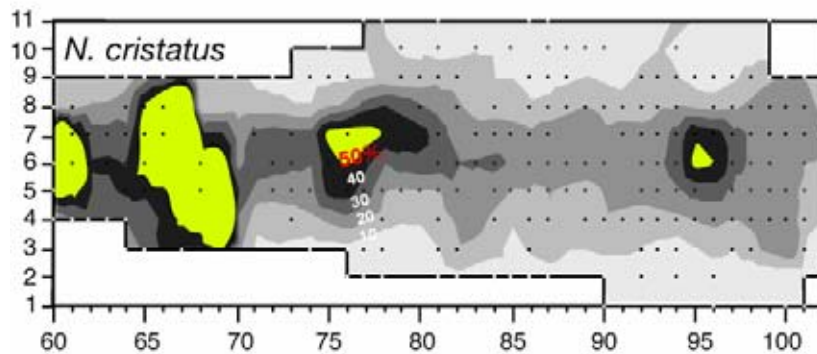
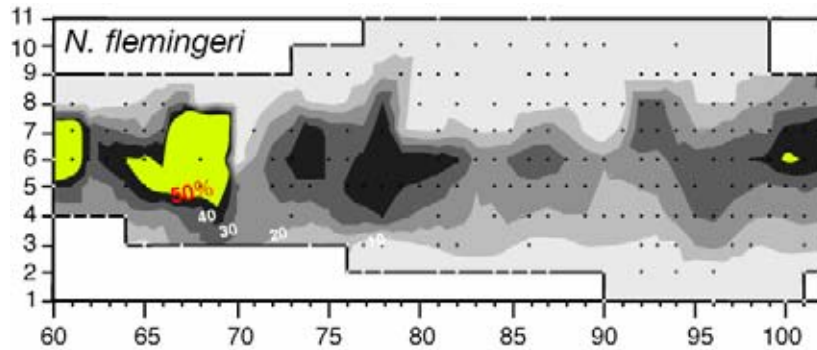
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- 1 Timing of C5 number exceed 50% of the total copepodid abundance.
- 2 Timing of C5 peak abundance.

**Mackas et al., (1998)**

**Mackas Batten & Trudel (2006)**

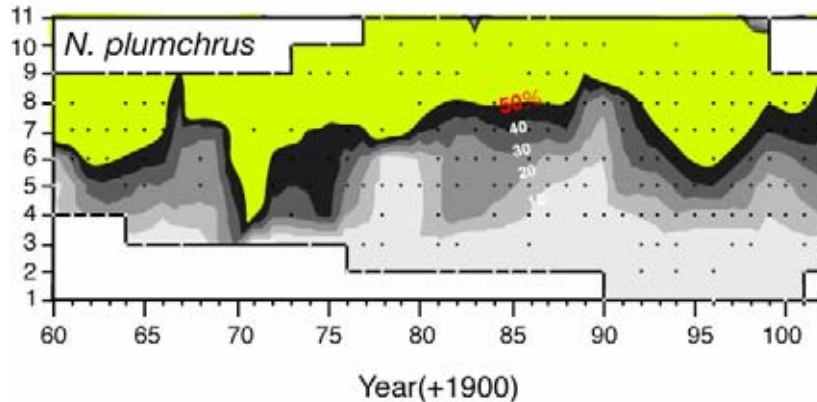
## Decadal scale variation in C5 ratio (%) to the total abundance



C5 of *N. flemingeri* and *N. cristatus* had not attained half of total abundance after mid-1970s.

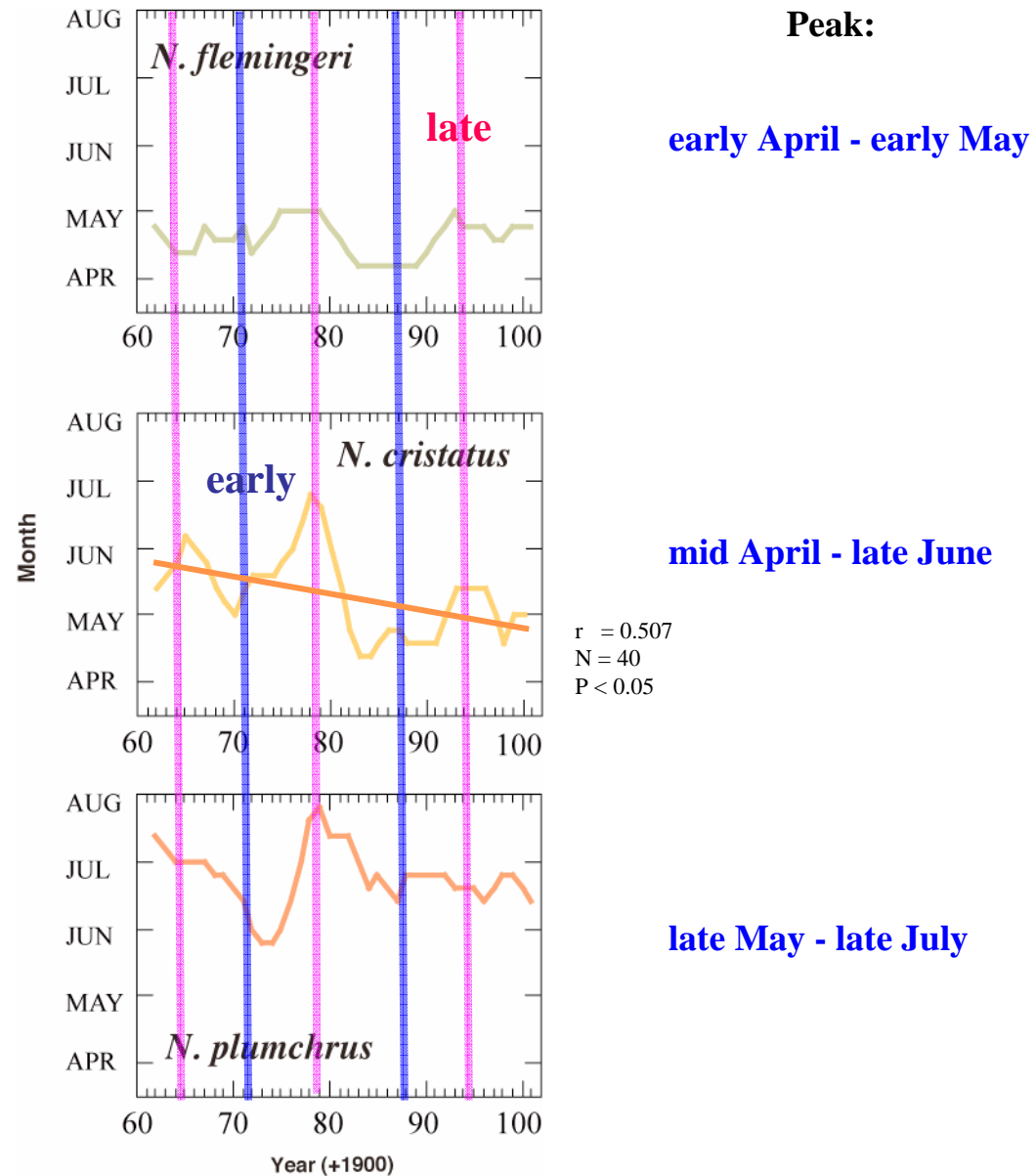
Therefore.....

We used timing of C5 peak abundance.

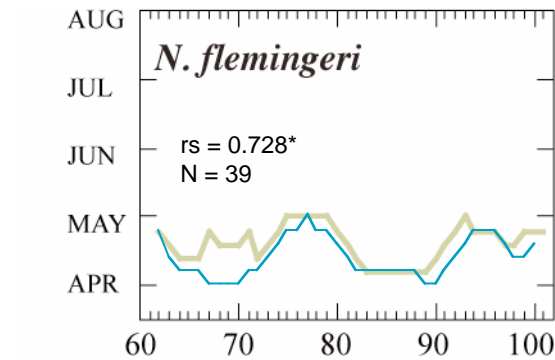


Year(+1900)

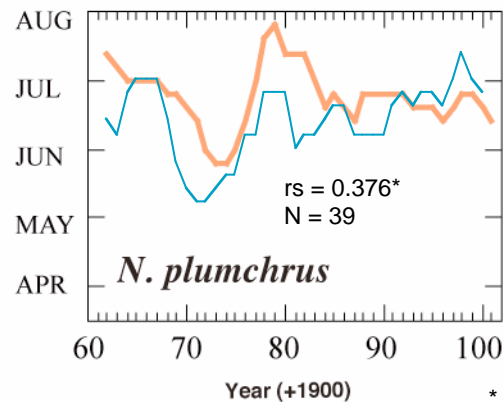
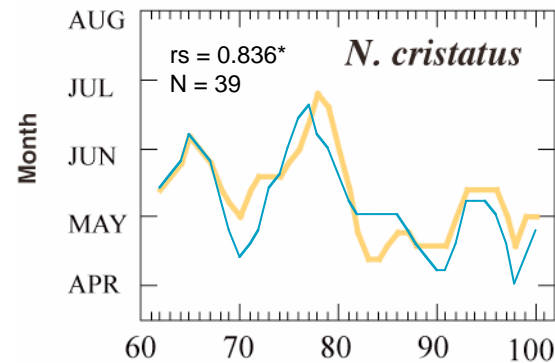
# Decadal scale variation in timing of C5 peak abundance



# Comparison: timing of C5 peak abundance vs timing of peak biomass

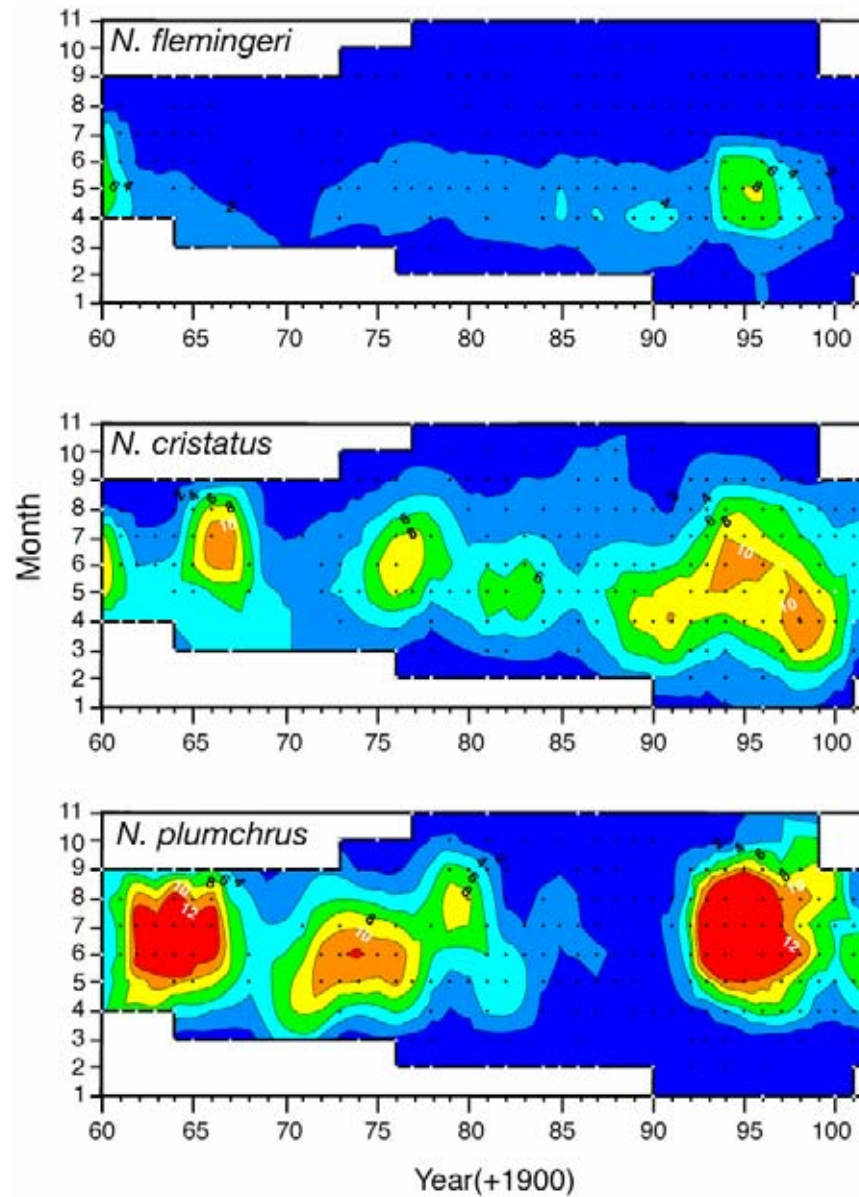


**Significant positive correlations were observed in three species.**



\* Alpha level < 0,05

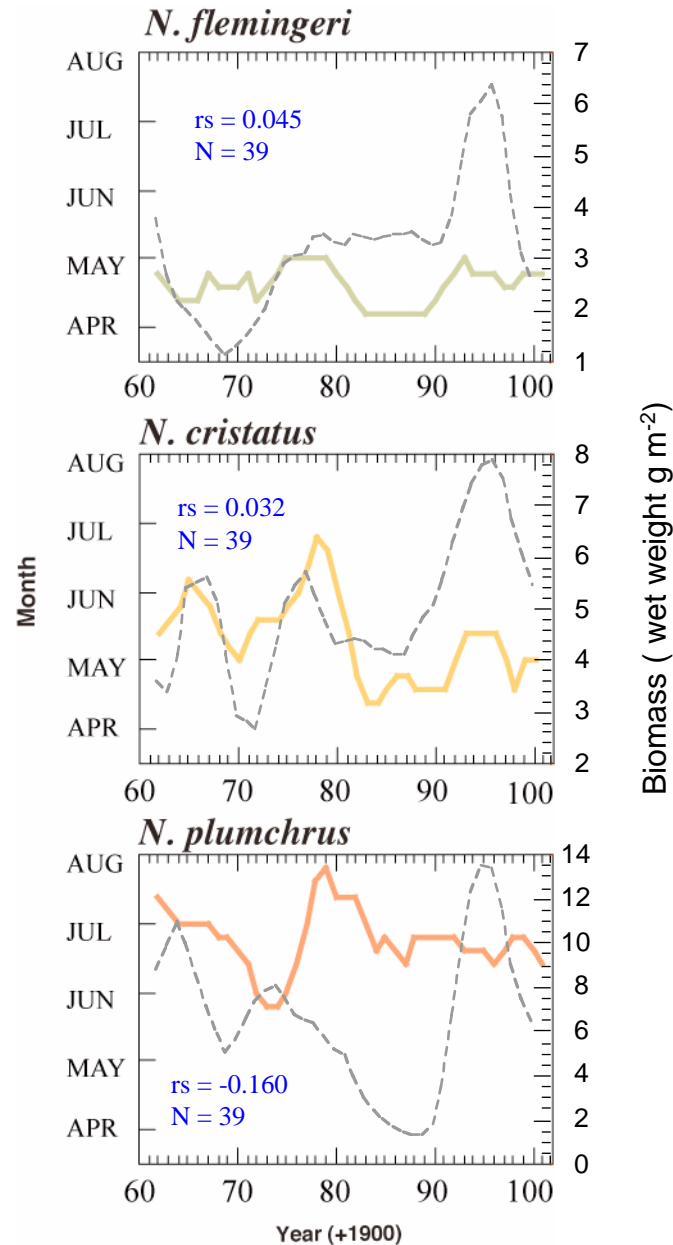
# Decadal scale variation in *Neocalanus* biomass



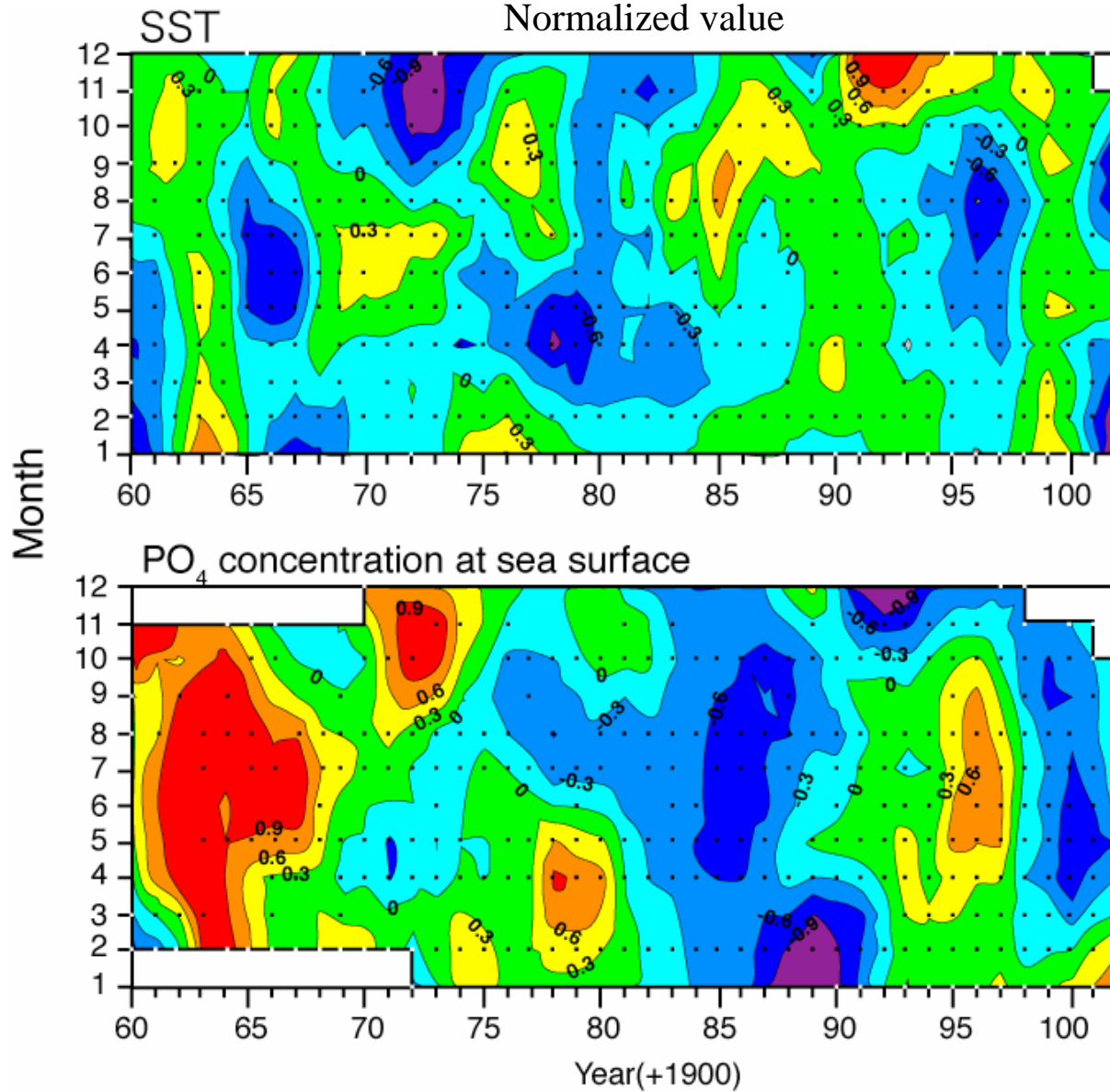


# Comparison: timing of C5 peak abundance vs mean biomass (Apr-Sep)

**No correlations**



# Comparison: developmental timing vs environments



## Comparison: developmental timing vs environments

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### SST

N = 40

	<i>N. flemingeri</i>	<i>N. cristatus</i>	<i>N. plumchrus</i>
rs	-0.087	-0.285	-0.302

### PO<sub>4</sub> concentration

N = 39

	<i>N. flemingeri</i>	<i>N. cristatus</i>	<i>N. plumchrus</i>
rs	0.354*	0.661*	0.402*

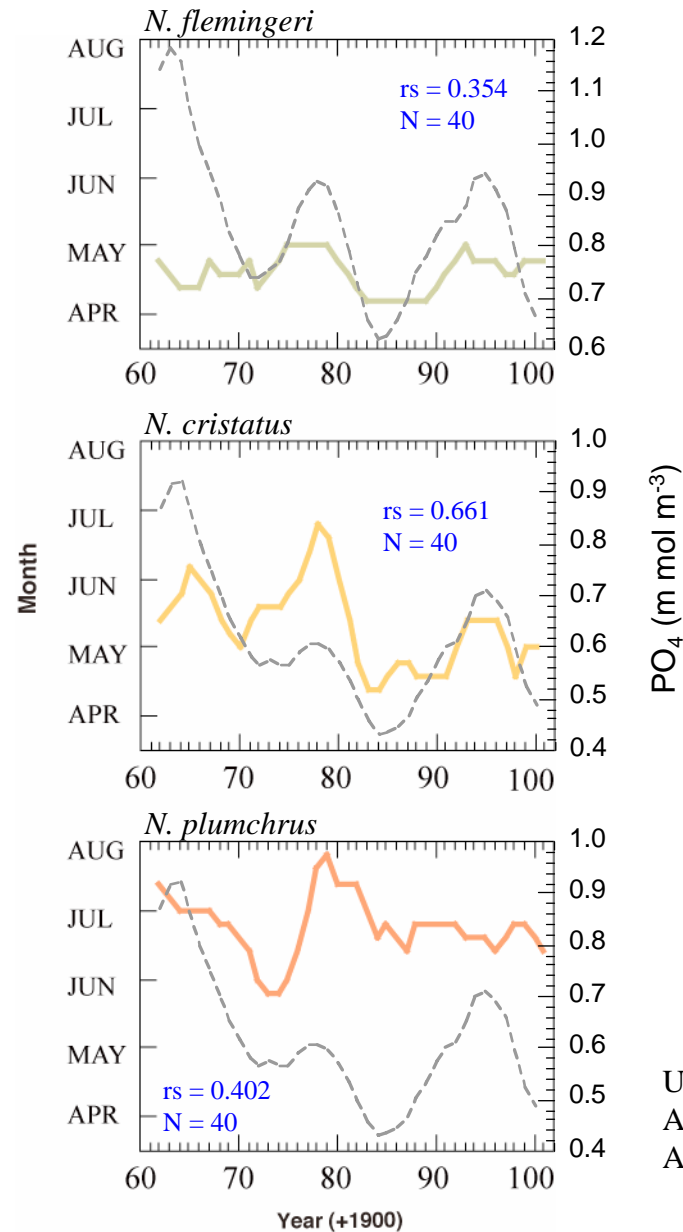
Used environmental data

Apr-Jun for *N. flemingeri*

Apr-Sep for *N. cristatus* & *N. plumchrus*

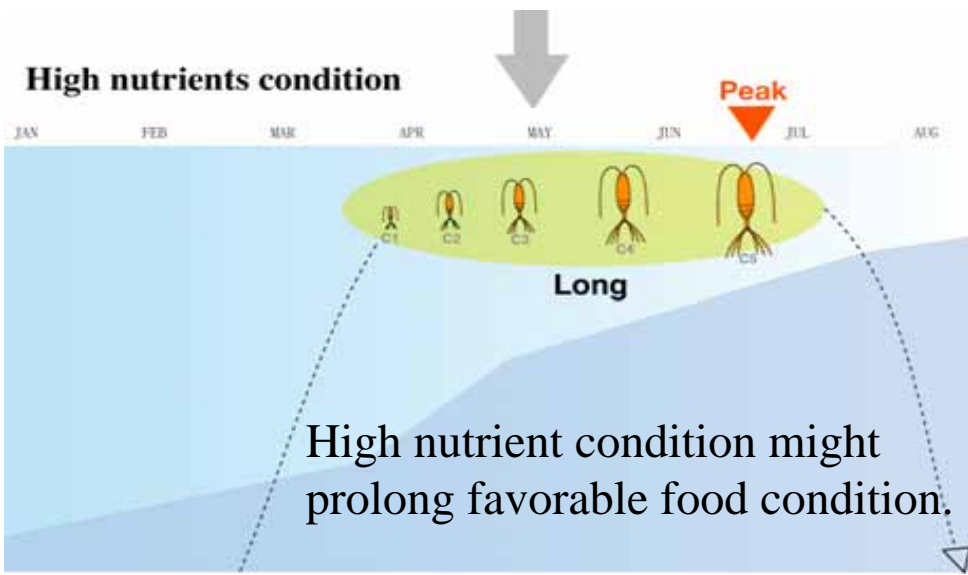
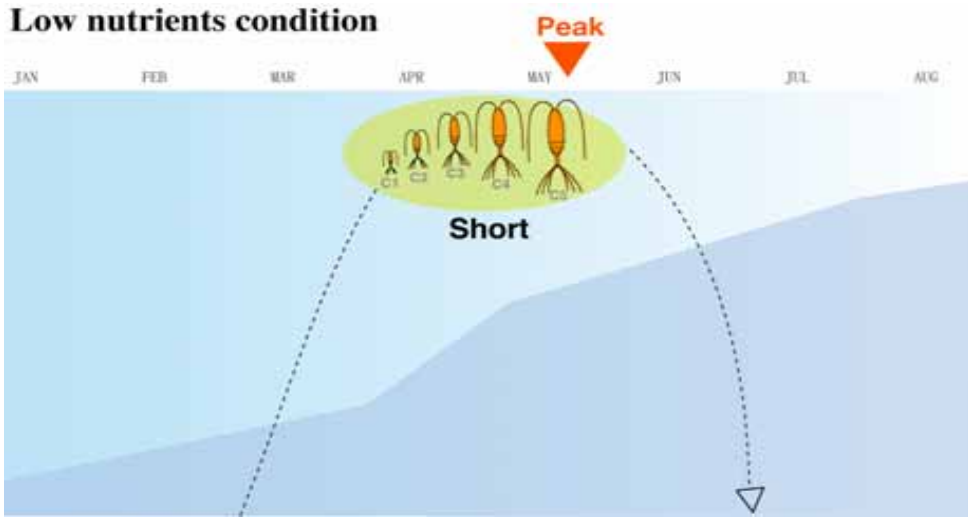
\*rs < 0.05 alpha level

# Comparison: developmental timing vs phosphate concentration



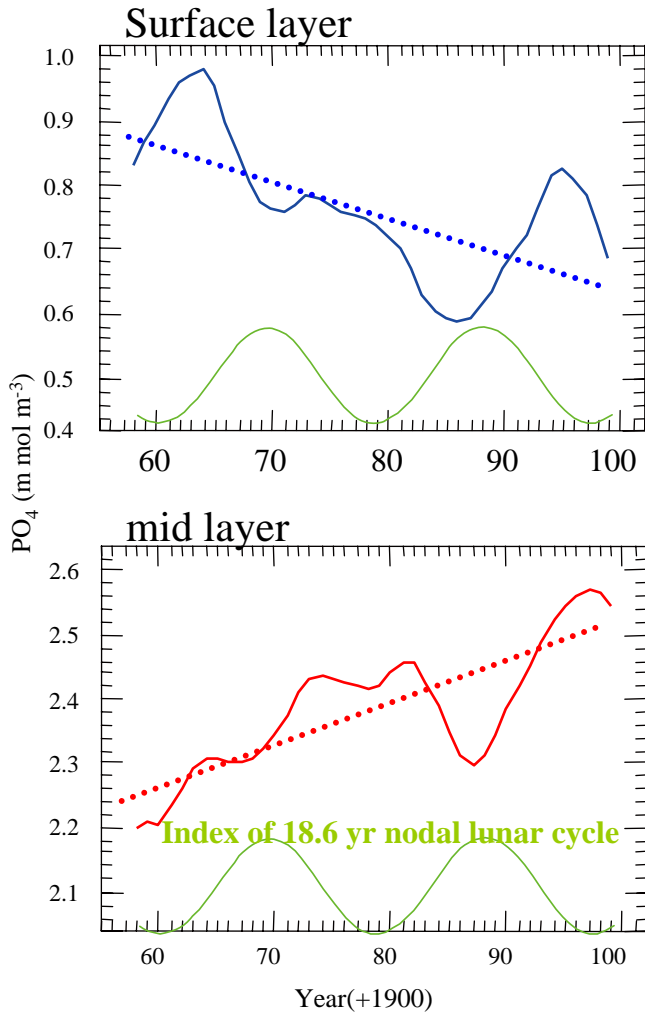
Used phosphate data  
 Apr-Jun for *N. flemingeri*  
 Apr-Sep for *N. cristatus* & *N. plumchrus*

# Possible process of change in the developmental timing due to change in $PO_4$

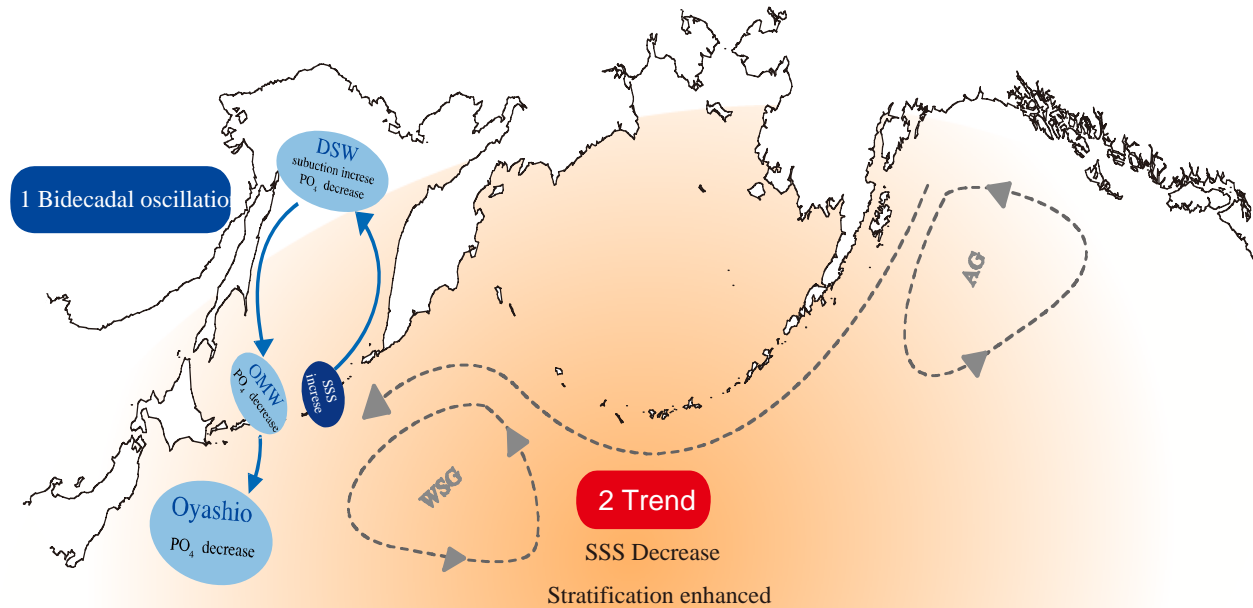


High nutrient condition might prolong favorable food condition.

# Hypothesized processes of decadal scale variation in $\text{PO}_4$ concentration

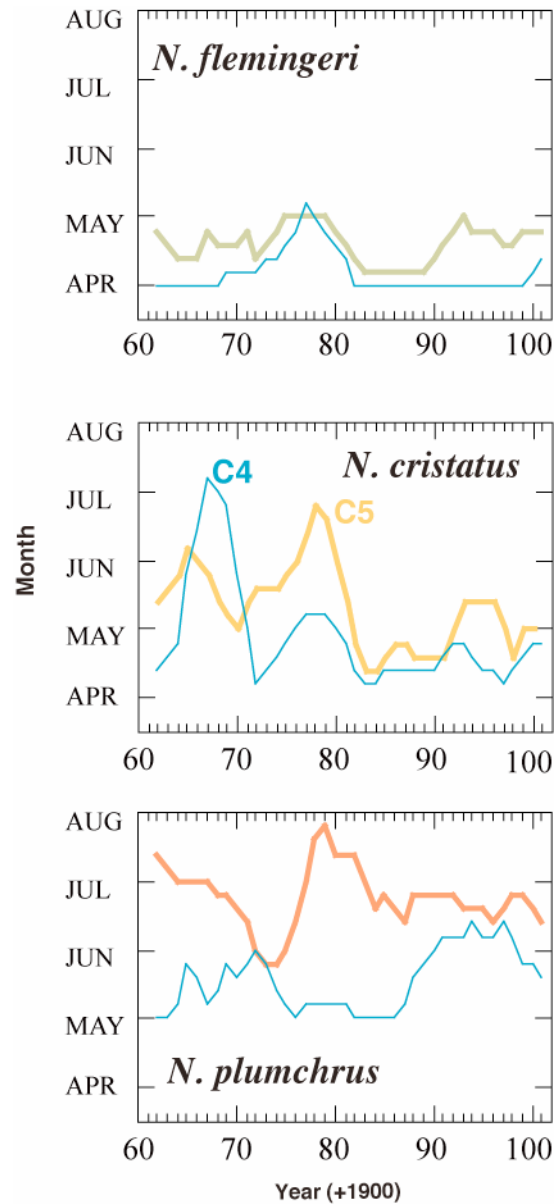


## Bidecadal oscillation: 18.6 yr tidal oscillation by nodal lunar cycle



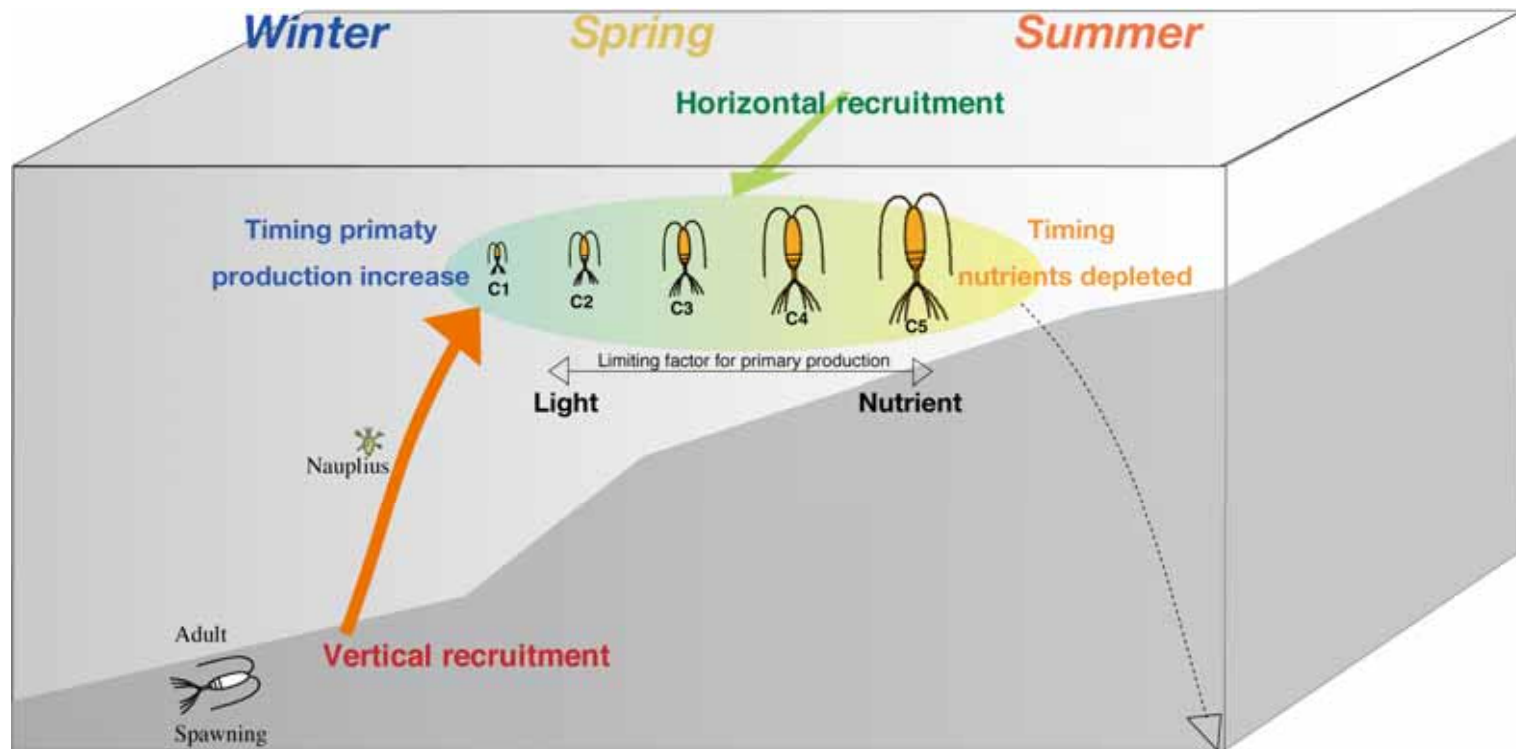
**Trend: decrease trend of SSS.**

## Comparison of peak abundance timing between C5 and C4

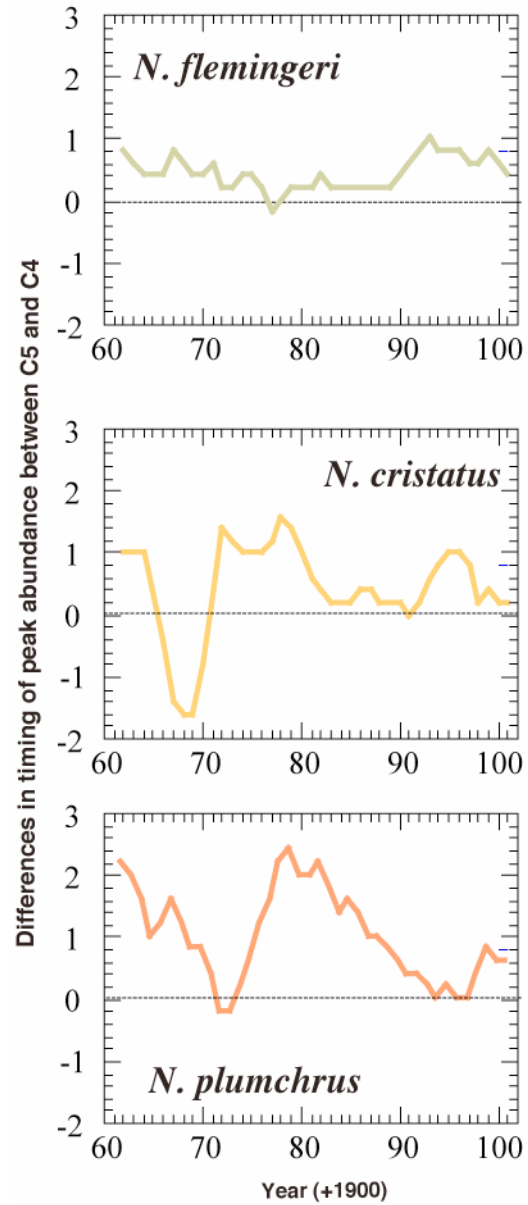


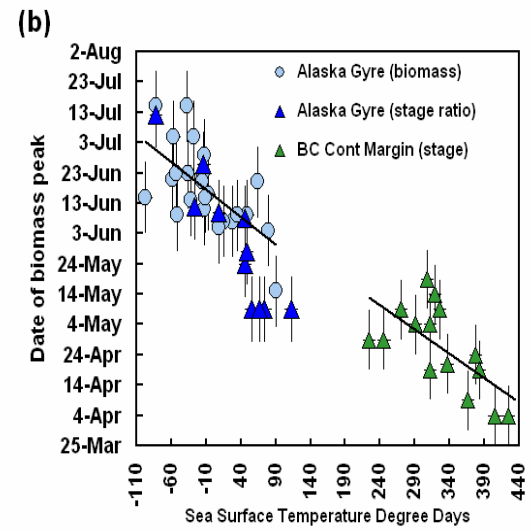
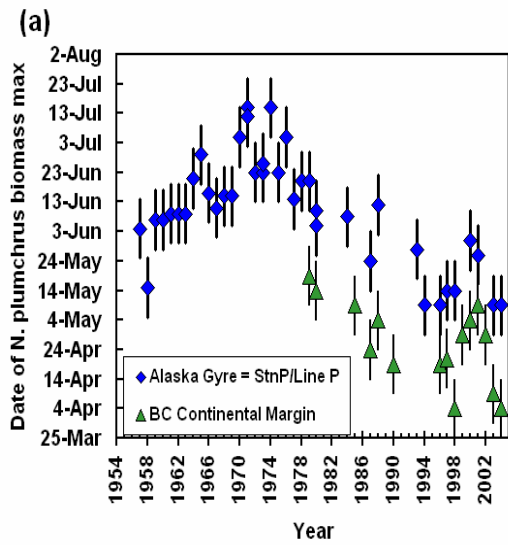
## Possible causes of change in developmental timing

1. Length of favorable food condition period
2. Ambient temperature
3. Start timing of favorable food condition
4. Recruit timing from mid-deep layer to surface
5. Recruit timing and/or amount from upstream water (WSG & The Sea of Okhotsk)









# C5abundanceのpeakと50%のタイミングの関係

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