Japanese Contribution to North Pacific CPR Survey

- Joined in 2009
- VJ line (west of 170E)
- Oyashio region & WNP subarctic gyre
- Sample analyzed for 2000 - 2016

Sanae Chiba
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ENP – WNP Comparison of Long-term LTL Ecosystem Change
1. Phytoplankton phenology and composition change & PDO (Chiba et al., GRL 2012)

2. East-West comparison of Zooplankton community changes (Chiba et al. 2015)
Phytoplankton Phenology and PDO (Satellite Obs)

Area Mean Chl a of Oyashio regions

Bloom Peak (Date of 40% Q-sum Chl a)

PDO and Timing of Bloom Peak WEST

r = 0.774

Early Late Early

Warm Cool Warm

SST (monthly anomaly)

(Chiba et al. 2012, GRL)
**Change in Phytoplankton Community (CPR)**

PP community changed responding to extent of seasonal warming (and ML shoaling) rather than SST value at a time.

Rapid warming (and quick stratification) in early spring benefits Diatoms and that in summer benefits Dinoflagellates.

**IMPLICATION**

To better predict phytoplankton response to future climate change, not only change in interannual/seasonal C-W cycle, but change in seasonal ML process must be understood.
OUTCOMES

1. Phytoplankton phenology and composition change & PDO (Chiba et al., GRL 2012)

2. East-West comparison of Zooplankton community changes (Chiba et al. 2015)
East-West Comparison of Zooplankton Community Changes

SST Map: 2006-2011 minus 2000-2005

Copepod Community Size (CCS)

\[
\overline{S} = \frac{\sum_{i=1}^{N} (L_i \times X_i)}{\sum_{i=1}^{N} X_i}
\]

For each sample, multiply total length \((L)\) of each species \(i\) (adult female) by its abundance \((X_i)\), sum over all species \((N)\), and divide by total abundance.
East-West Comparison of Zooplankton Community Changes

Time Series CCS & SST (Annual AVG)

WEST

SST_WEST

Cool

Warm


CCS Annual AVG WEST (Corrected)

Small

Large

EAST

SST EAST

Warm

Cool


CCS Annual AVG EAST (Corrected)

Small

Large
East-West Comparison of Zooplankton Community Changes

AVG SST of Occurrence and Size of 54 copepod spp/taxa

Large Cold Water Group (>4mm, <9°C)

Small Cold Water Group (<4mm, <9°C)

Warm Water Group (<4mm, >9°C)
Warming occurred within the optimal SST envelope for large cold water copepod species in WEST.
What I like about CPR ....

Standardized and streamlined protocol for observation
sample analysis
data processing
report to policy

Adding values on CPR survey

Monitoring Ocean Acidification Impacts on ecosystem
Monitoring of Marine microplankton pollution
Looking inside: Microfocus X-ray CT (MXCT)

Images of foraminiferan shells obtained by using microfocus X-ray computer tomography

CT value (proportional with density)

500  1000
low ← Shell density → high

pH and calcite saturation in seawater
(Wakita et al., 2013)

Surface: decreasing at the rate of -0.001 yr\(^{-1}\)
200-300m: -0.005 yr\(^{-1}\)
The highest rate in the Pacific!

Calcite saturation horizon: shoaling at 2.9 m yr\(^{-1}\)
Preliminary results:

1) Shell densities in 50-51°N were higher than those in 43-44°N
2) Variability of the shell density was large in 43-44°N
3) Shell sizes in 50-51°N were larger than those in 43-44°N

... in progress
✓ collecting additional data in the study area and from different year/season
✓ investigating environmental properties which affect the variability
Microplastic Monitoring

① data collection of material (PE, PP, PS) specific spectral signals of CPR microplastics

② algorithm to classify materials, and visualization (by artificial coloring on HSC images)

③ development of automated analyzing system

HSC (infrared spectral range: 900-1700nm)

Objective lens

CPR sample silk

Hyperspectral imaging system (example: RESONON Inc. Pika320)
Since 2019 and beyond....

Make Continuous Plankton Recorder Survey CONTINUOUS...

Hokkaido University
Plankton laboratory

Yutaka Fukai
Undergrad student

Prof. Atsushi Yamaguchi
Seasonal abundance, population structure, and diel changes in abundance of five large dominant copepods evaluated by CPR samples collected in the western subarctic Pacific

Yutaka Fukai, Sanae Chiba, Sonia Batten, Yuka Sasaki, Hiroya Sugisaki and Atsushi Yamaguchi

Fig. 2. Mean seasonal abundance of each copepodid stage of Neocalanus cristatus, N. flemingeri, N. plumchrus, Eucalanus bungii, and Metridia pacifica along with the local time. Panels are separated with season (spring [left], summer [middle], and autumn [right]). For the proportion of day (open) and night (solid in each season), see top panels.
I think we're gonna need a bigger cake.

Happy 20th Birthday!
**RESULTS**

**CCS & SST (Annual AVG)**

**WEST:** Inconsistent to the conventional theory: larger (smaller) in cooler (warmer) condition
DISCUSSION

PDO-NPGO system

Mechanisms which drive cool-warm condition and plankton community variability differ between East and West.

WEST

Wind Stress

Seasonal Mixed Layer – Bottom-up Process

Within the SST-Envelope...

Light

Nutrients

EAST

Ocean Circulation

Advection Transport by Current Dynamics

Out of the SST-Envelope...

(Mackas et al. 2005)
Biogeographical shift of zooplankton and PDO

PDO & Latitudinal Shift of Neocalanus spp.

Cool-warm spp distribution and variation of subarctic boundary

Yoshiki et al. not published

East-West Discrepancy on Cool-Warm cycle & Copepod Size

- Other Studies -

WEST

Warm & Larger

Warming could positively affect on growth/production of cold-water species, e.g. by good-match with phytoplankton seasonality (Chiba et al., 2006 & 2008).

EAST

Warm & Smaller

Regional warming and increase of warm-water (small) species could be induced by northward advection transport driven by the oceanic currents dynamics (Kiester et al., 2011).

DISCUSSION
SST – PDO related Pattern


Approx. Location of CPR obs. Line