Comparative life cycle patterns of interzonal migrating copepods in the North Pacific

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Objective

(1) to establish life cycle patterns of interzonal migrating copepods in the Oyashio-Kuroshio Mixed region

(2) to compare these patterns among species and among populations in the North Pacific
Sampling Station P

Oyashio-Kuroshio Mixed region
(38°N, 142°30’E or 142°50’E)

Zooplankton samples

A: Monthly population structure
0-1000 m
March 2000 - March 2001

B: Yearly population structure
0-150m
April 1996 - March 1999

Station P
Interzonal migrating copepods

“Surface spawners”
- C. pacificus
- M. pacifica
- E. bungii

“Deep spawners”
- N. cristatus
- N. flemingeri
- N. plumchrus
Seasonal abundance of Neocalanus (0-1000m)

- **N. cristatus**
  - C1: Abundance for N. cristatus (*10^3 inds m^-2)
  - C2
  - C3
  - C4
  - C5: Abundance for N. cristatus (*10^3 inds m^-2)
  - C6 Male
  - C6 Female

- **N. flemingeri**
  - Abundance for N. flemingeri (*10^3 inds m^-2)

- **N. plumchrus**
  - Abundance for N. plumchrus (*10^3 inds m^-2)

Gonad conditions of Neocalanus

- **N. cristatus**
  - Composition (%)
  - Abundance of spawning females (inds m\(^{-2}\))
  - Spawning
  - Spent
  - Newly mature

- **N. flemingeri**
  - Composition (%)
  - Dormant
  - Developing
  - Spawning
  - Spent

- **N. plumchrus**
  - Composition (%)
  - Spawning
  - Spent

Month:
- MAJJASONDJFMM

Abundance of spawning females (inds m\(^{-2}\))
- 0
- 25
- 50
- 75
- 100

Composition (%)
- 0
- 25
- 50
- 75
- 100
Seasonal abundance of Eucalanus (0-1000m)

Abundance (*10^3 inds m^-2)

Month:
- M: March
- A: April
- M: May
- J: June
- J: July
- A: August
- S: September
- O: October
- N: November
- D: December
- J: January
- F: February
- M: March

C1, C2, C3, C4, C5, C6 Male, C6 Female
Interannual abundance of Eucalanus (0-150m)

Abundance ($10^2$inds m$^{-2}$)

Month


C6 Female

C6 Male

C5

C4

C3

C2

C1
Seasonal abundance of Metridia (0-1000m)

Abundance (*10^3 inds m^-2)

Month

C1
C2
C3
C4
C5
C6 Male
C6 Female

M A M J J A S O N D J F M
Gonad conditions of Metridia

Abundance of C6 female with mature gonad (inds m$^{-2}$)

Month

Composition (%)
Seasonal abundance of Calanus

Abundance (*10^3 inds m^-2)

<table>
<thead>
<tr>
<th>Month</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>C6 Male</th>
<th>C6 Female</th>
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Comparison of life cycle patterns

C. pacificus
- Spawning: Mixed, Stn P
- Dormant: 1g/year (partly 1g/2year)
- Development: 3g/year

E. bungii
- Spawning: Mixed, Stn P
- Dormant: 1g/2-3year
- Development: 2g/year

M. pacifica
- Spawning: Mixed
- Development: Stn P
- Dormant: 1g/year

N. cristatus
- Spawning: Mixed
- Dormant: 1g/year (partly 1g/2year)

N. flemingeri
- Spawning: Mixed
- Dormant: 1g/year

N. plumchrus
- Spawning: Stn P
- Dormant: 1g/year
Adaptive significance of dormant

C. pacificus    M. pacifica

Avoidance in time
from unfavorable environmental conditions

E. bungii

Optimization of the life cycle timing
to seasonal cycle of environments

Neocalanus spp.
## Comparison of life cycle patterns

<table>
<thead>
<tr>
<th>Parameters</th>
<th>WN Pacific</th>
<th>EN Pacific</th>
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<tbody>
<tr>
<td></td>
<td>Mixed</td>
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<td>Environments</td>
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<tr>
<td>SST (°C)</td>
<td>2.3-25.4</td>
<td>0.2-22.0</td>
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<td>Surface Chl-a (mg m⁻³)</td>
<td>0.1- 2.5</td>
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<td>Phytoplankton bloom</td>
<td>Mar-Apr</td>
<td>Apr-May</td>
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<td>Number of generations per year</td>
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<td>Metridia pacifica</td>
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<td>Eucalanus bungii</td>
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<td>Neocalanus cristatus</td>
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<td>N. flemingeri</td>
<td>1g/year *</td>
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<tr>
<td>N. plumchrus</td>
<td>1g/year</td>
<td>1g/year</td>
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</tbody>
</table>

* partly 1g/2year
Stage composition of deep spawners
Stage composition of surface spawners

- EB
- MP
- CP

Month

Stage composition (%)

C1
C2
C3
C4
C5
C6M
C6F

0 25 50 75 100

Month