Abundance and distribution of micronektonic, mesopelagic fish at the 2007 OECOS observation site (Northwest Pacific)

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  (Quantitative echosounder and Framed Midwater Trawl)

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・Summary
Background and Objective 1

Micronektonic mesopelagic fish role in the Marine Ecosystem

- Zooplankton feeder
- Prey organism for fish, marine mammal
- Huge biomass
- Conduct Diurnal Vertical Migration (DVM)


→ Important material transporter in the open ocean
Background and Objective 2

~Northwestern Pacific~

Intense study on zooplankton and ocean environment conducted around Site H

→Information of the next tropic level:
  mesopelagic micronekton fish lacking

**Objective**

→Quantify the density and vertical distribution
→Examine their feature of distribution during the blooming
Material and methods - Acoustic survey of the OECOS west

Quantitative Echosounder - FQ80 38kHz

R.V. Hakuhou

“A-Line”

Acoustic backscattering (dB)

2007/3/9 ~ 3/15
2007/4/5 ~ 5/1

Mar. April. off Kushiro, Hokkaido

Framed Midwater trawl (4m × 4m)
Material and methods: Framed Midwater Trawl (FMT) for biological sampling

Fixed opening. Data logger attached to measure the flow velocity at the mouth.

* Problem of net avoidance → Under estimation
Acoustic estimation several to several tens higher value (Gjøsæter 1984)
Material and methods: Quantitative echosounder

Quantitative echosounder
FQ80 38kHz

~Basic of density estimation~

Back scattering per cubic meter

Density of the Target fish

Back scattering per fish

● Obtain continual information of the vertical distribution

* For interpretation;

What mainly contributes to the acoustic backscattering?

How much is the backscattering per fish?
Results - Vertical distribution pattern observed on the echogram

4.7 Day

4.7 Night

4.29 Day

4.29 Night
Results - Vertical distribution pattern observed on the echogram

- Echoes observed deeper than 100m.
- Pattern changed, though obvious diurnal pattern was not observed.
Results - Vertical distribution pattern observed on the echogram

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Daytime mean acoustic backscattering strength
(for data available on St.5 6,7,8,9,10,11,12,13,16,26,29,30/Apr 1/May)

100-200m  $-82.2 \pm 3.7$ dB
200-300m  $-78.1 \pm 2.5$ dB
300-400m  $-75.1 \pm 1.6$ dB
Results - Biological Sampling

Most dominant species

Day 11 tow Depth 136-410m  Night 9 tow Depth 0-417m

Dominant species: *Diaphus theta, Stenobrachius leucopsarus*

| Numerical proportion of *D. theta* and *S. leucopsarus* to the total catch number |
|---------------------------------|-----------------|
| Day    | Mean 71.5% (38.3-100%) | Night | Mean 57.7% (23.8-81.8%) |

![Graph showing depth and sampling ID for day and night](image-url)

Depth sampled *Diaphus theta* and *Stenobrachius leucopsarus*
Results-Biological sampling

Other dominant species

*Lipolagus ochotensis, Leuroglossus schmidti, Gonostama gracile*

→ Numerical proportion was high in some sampling, however, proportion in weight was small

Ex.) Sampling ID F030 (Day)
    *Lipolagus ochotensis* in number 41.3% → in weight 15.0%
    Sampling ID F031 (Night)
    *Lipolagus ochotensis* in number 68.9% → in weight 32.1%

![Mean SL 47.4mm BW 0.7g Lipolagus ochotensis](Image)

![Mean SL 36.8mm BW 0.3g Leuroglossus schmidti](Image)

![Mean SL 74.2mm BW 1.4g Gonostama gracile](Image)

*Number of cephalopod was low*
Results-Biological sampling

Size of the most dominant myctophid species

**Diaphus theta**

- **Total mean**
  - Mean standard length: 67.3mm
  - BW: 5.1g

**Stenobrachius leucopsarus**

- **Total mean**
  - Mean standard length: 50.3mm
  - BW: 2.3g
Results-Density estimation

From biological sampling;

*Diaphus theta, Stenobrachius leucopsarus* are the most dominant species.

From acoustic point of view;

- Dominant species in size has must have a great contribution.
- *D. theta* carries swimbladder, which has a large contribution to the acoustic scattering.

→ Acoustic data most likely reflects the density of the dominant myctophid species

- Acoustic back scattering strength of *D. theta* and *S. leucopsar* is investigated by Yasuma et al. (2006) and Yasuma et al. (2003).
Results-Density estimation

Considering *D. theta*, *S. leucopsaratus* contributes most of the acoustic scattering,

Daytime 100-400m depth interval
Mean backscattering strength per 1 square meter = -52.8 dB
*D. theta* Mean target strength = -56.6 dB (SL 67.3 mm)
*S. leucopsaratus* Mean target strength = -75.4 dB (SL 50.3 mm)

Mean density per 1 square meter (100-400m);

*D. theta* 5.4 g/m²  
*S. leucopsaratus* 1.5 g/m²
Discussion - Comparison of density with other reports

~Other reports of density derived from Acoustic Methods~

April (Present study)
- *D. theta* 5.4 g/m² (Mean 6.3cm 4.2g)
- *S. leucopsarus* 1.5 g/m² (Mean 5.0cm 2.3g)

Cost of Atka Island - East Hokkaido
- February (Yasuma 2004)
  - *S. leucopsarus* 55.5 – 132.6 g/m² (Mean 8.5cm 10.1g)

Cost of East Hokkaido
- January (Yasuma 2004)
  - *D. theta* 35.8 g/m² (Mean 6.3cm 4.2g)

> Relatively low abundance at the OECOS west survey point
Discussion - Comparison of density with other reports

Possible reason of the relatively low abundance

- Regional difference between the shelf slope and open ocean
- Effect of the Spawning migration (Subarctic → Transition region)

<Spawning season>

*D. theta*: Late March ~ Early September, Peek in May ~ July

  Moku et al. (2003)

*S. leucopsarus*: February ~ March

  Tanimata (2008)
Discussion - Comparison of density with other reports

Possible reason of the relatively low abundance

- Regional difference between the shelf slope and open ocean
- Effect of the Spawning migration (Subarctic → Transition region)

Schematic of migration of *D. theta* by Moku et al. (2002)
Discussion - Vertical distribution

Watanabe et al. 1999 off Tohoku (Northwestern Pacific) in July

**D. theta**

Daytime 300-500m, Nighttime 20-100m (Midwater migrants)

**S. Leucopsarus**

Daytime 400-700m, Nighttime 20-200m / 400-700m (Semi-migrants)

In this study; *D. theta* and *S. Leucopsarus* was caught

Daytime 136-410m, Nighttime 0-417m

- Shallower Swimming depth
- No obvious diurnal vertical migration
Discussion - Vertical distribution

Stomach Content – *D. theta* (Sampling range 150m / 250m)

Yamaguchi (in prep.)
Discussion - Vertical distribution

Stomach Content

- **Major prey organisms** (of *D. theta*) has a shallower swimming depth at the Blooming Seasons.
- **Size**:
  - *Metridia pacifica*: 2.0-3.5 mm
  - *Metridia okhotensis*: 4.5-4.8 mm
  - *Eucalanus bungii*: 4.8-8.0 mm
  - *Euphausiids*: 13-20 mm

Fig. Monthly plankton biomass on Site H by depth (0-150m, 150-500m)
Discussion - Vertical distribution

Stomach Content

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**Size**:
- *Metridia pacifica*: 2.0-3.5 mm
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- **Shift of the biomass to shallower depth in April (to 0-150m)**

**Fig. Monthly plankton biomass on Site H by depth (0-150m, 150-500m)**

**Composition by Depth** (0-150, 150-500 m):
- 3.0-4.0 mm
- >4.0mm

**Biomass Composition (%):**
- 0-150 m
- 150-500 m

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*Ohgi and Yamaguchi (in prep.)*
**Discussion - Vertical distribution**

**Stomach Content**

Mesopelagic fish may have followed the characteristic vertical distribution of their prey.

Fig. Monthly plankton biomass on Site H by depth (0-150m, 150-500m)
Summary: Mesopelagic micronekton on the Northwestern pacific (open ocean) at the Blooming season

- Most dominant species: *D. theta / S. leucopsarbus*

- **Density estimation** (100-400m Day) by acoustic method:
  - *D. theta* 5.4 g/m² (Mean 6.3cm 4.2g)
  - *S. leucopsarbus* 1.5 g/m² (Mean 5.0cm 2.3g)

  →reasonable value considering the location (open ocean) and possible effect of the spawning migration to the subarctic transition zone.

- **Relatively shallow swimming depth,**
  - no obvious diurnal vertical migration

  →Effect by the zooplankton (prey organism) which has a shallow swimming depth at the blooming season (Obvious effect from the lower tropic level)
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Information!

Mesopelagic fish “SASHIMI”

EATABLE! Try once!

1. Select a large fresh *D. theta*

2. Dress with great care!

3. Serve on a dish and pour some Soysauce!

Soft texture, but tastes not so different from a pelagic fish!
Other species

Stenobrachius nannochir

Protomyctophum thompsoni

Chauliodus sloani
Density estimation by acoustics and FMT

Acoustic estimation is larger than FMT estimated density for

D. Theta  $4.3 \pm 3.3$  S. leucopsarus  $4.6 \pm 3.7$
Fluctuations of the backscattering

Mean SV
-73.3dB
-80.9dB
Mean SV

March
April

200-300m  March ≡ April
300-400m  March > April

MannWhitney U test
Relationship with the blooming

Acoustic backscattering

Chlorophyll

Mean density of depth
0, 5, 10, 20, 30, 40, 50, 75, 100, 150 m

April