Real-time monitoring for mesopelagic fish abundance using J-QUEST integrated system of echosounder and stereo TV cameras.

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The Key Point of research on the ecology of mesopelagic micronekton is the vertical distribution and migration. **Diurnal vertical migration**: Feeding in shallow layer at night and sink to deep layer during daytime. **Ontogenetic vertical migration**: Distribute shallow layer during young and sink to deep layer as they grow. 

- **Phytoplankton** may cause the vertical transportation of organic matter from surface to deep layer. 

Thorough quantitative micronekton sampling is essential!
Difficulty to evaluate the accuracy of the estimated deep-sea biomass from net sampling data

- There is no continuous recording method for observation in the deep sea
- There are very few data and information on the ecology (e.g. school size, swimming speed etc.) of deep sea creatures

**How to solve this problem?**

The first approach: Intensive samplings using different type of gears
Quantitative sampling gear for Micronekton

$4m^2$ MOCNESS
Quantitative sampling gear for micronekton

MOHT frame trawl
(5m² mouth area)
Representative mesopelagic fish in the western North Pacific

Myctophidae
- Diaphus theta

Gonostomatidae
- Sigmops gracile

Microstomatidae
- Lipolagus ochotensis
- Chauliodontidae
- Chauliodus macouni

Nemichthyidae
- Nemichthys scolopaceus
Differences of estimated biomass between sampling gears

Generally estimated biomasses of MOHT sampling were higher than that of MOCNESS
• Estimated biomasses and abundances varied highly between different sampling gears, and catchability of each gears also varied for species.

• Net sampling data of estimated abundance must be underestimated compared to acoustic data because there are high possibility for avoidance from the mouth of net.

• **Acoustic data should be helpful for quantitative study**

The weak point of acoustics is inability of species identification.
**Acoustical–optical system**

- **J–QUEST**
  - Size (Length × Dia.): 1.07m × 0.53m
  - Weight: Approx. 300kg
  - Max. depth: 250 m

- **Echosounder**
  - Freq.: 70 kHz
  - Method: Split–Beam
  - Beam width: 11.8°
  - Pulse width: 0.6/1.2/2.4ms

- **Stereo–Video Camera**
  - Image tube: B/W HARP
  - Min. Illum. Level: 0.015Lux
  - Focal length: 23 mm
  - F.O.V.: 15° (= wide angle lens)

*Japan QUantitative Echo-sounder & Stereo TV-camera system*
Mission of J–QUEST

Collect species, TS, length, tilt angle, and swimming speed information in high resolution by approaching an acoustical-optical system to fish school.

Expected income

<table>
<thead>
<tr>
<th>Installed instruments</th>
<th>Available information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echo sounder (70kHz)</td>
<td>Target strength</td>
</tr>
<tr>
<td>Stereo Video Camera</td>
<td>Length, tilt angle, speed</td>
</tr>
</tbody>
</table>
**J–QUEST Echogram**

Echogram (70kHz) recorded at the depth of J–QUEST 220m. Swimming speeds and TS were estimated from acoustic data.

J–QUEST was deployed at 220m depth.
**J-QUEST camera view**

Depth: 25m

*Gonatopsis borealis* (squid)

Mantle length 37cm

Japanese anchovy

\[\bar{L} = 12.2\text{cm}, \text{S.D.} = 1.3\text{cm}(n=24)\]
Does meso-pelagic fish dislike the light of J-QUEST?

The invisible light system for mesopelagic fish is necessary!!
Spectrum of LED of J-QUEST and visual sensitivity of *Ceratoscoperus warmingi*

- **C. warmingi** should be sensitive for white, blue and green light.
- **C. warmingi** should NOT be sensitive for red light.
The invisible light system is equipped for mesopelagic fish. The direction is adjustable.

Blue LED: sensitive for mesopelagic fish
But clear images for CCD video camera

Red LED: not or less sensitive
For mesopelagic fish
Downward direction of TV camera

Bird’s view of the fish is observed
Sidewise direction of TV camera

- Transducer
- TV camera
- LED light

87 cm
150 cm
130 cm

Side view of the fish is observed
Change of behavior of school of mesopelagic fish by the effect of lightning

Interval: 1/60[s]

<table>
<thead>
<tr>
<th>Light</th>
<th>Off 1</th>
<th>Red 1</th>
<th>Off 2</th>
<th>Blue</th>
<th>Off 3</th>
<th>Red 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level [mA]</td>
<td>600</td>
<td>600</td>
<td></td>
<td>600</td>
<td></td>
<td>920</td>
</tr>
<tr>
<td>Pulse width[μs]</td>
<td>500</td>
<td></td>
<td>500</td>
<td></td>
<td>1023</td>
<td></td>
</tr>
<tr>
<td>Average SA[dB]</td>
<td>-52.5</td>
<td>-52.4</td>
<td>-52.2</td>
<td>-55.0</td>
<td>-52.4</td>
<td>-53.5</td>
</tr>
</tbody>
</table>

Video

21:00 21:30
Diaphus + Walleye pollock

8/26 11:56 J-QUEST Depth: 191 m  Temp: 2.06 °C
Sal: 33.39 PSU Sideway Blue level 255, Interval 1/60 s, PW 1023 us
Diaphus theta

8/26 18:07 J-QUEST Depth: 151 m  Temp: 2.95 °C
Sal: 33.36 PSU  Sideway  Blue level 255, Interval 1/60 s, PW 1023 us
Many *Diaphus theta* were observed by the video camera of J-QUEST in the Oyashio area at the sideways posture.

J-QUEST can be obtain the visual and acoustic data of deep-sea creatures simultaneously.

- Still leaving problem

  - Unclear camera view especially in Red LED condition.
  - Escape from J-QUEST especially in Blue LED condition.

It is necessary to improve both lighting and camera.

J-QUEST could be a useful gear for quantitative analysis of the biomass of oceanic creatures near future.