

# Specific gravity measurements on mackerel eggs and larvae and implications for interannual variability in recruitment

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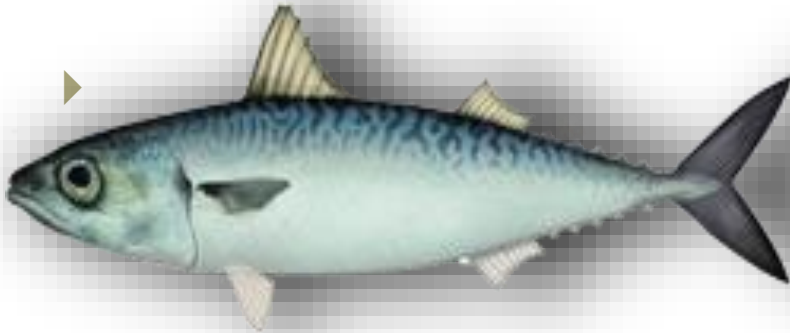
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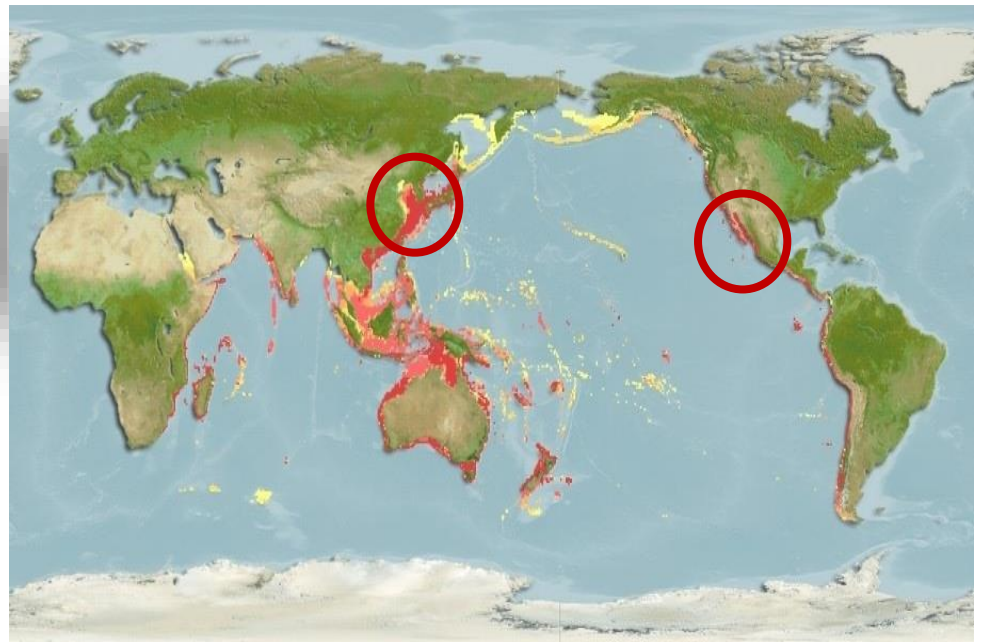
# Pacific mackerel, *Scomber japonicus*

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- ▶ Small pelagic fish and one of the most dominant commercial species in the northwestern Pacific Ocean.
- ▶ However, little is known about early life history characteristics such as transport process and recruitment variability in Korean waters.



Pacific mackerel  
= Chub mackerel



# The purposes of this study

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- ▶ To find the changing pattern of specific gravity of eggs and larvae during their development, and
- ▶ To consider how we use such information for the feeding ecology of fish larvae.

# Why are we measure specific gravity?

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- ▶ Vertical distribution is determined by the difference in specific gravity of organisms and seawater density. Some **biological** (buoyancy and size of egg and larvae) and **physical** (water density, viscosity, and turbulence) factors are involved in this process.
- ▶ Different vertical distribution of eggs and larvae result in different feeding conditions, advection processes and spatial distributions.

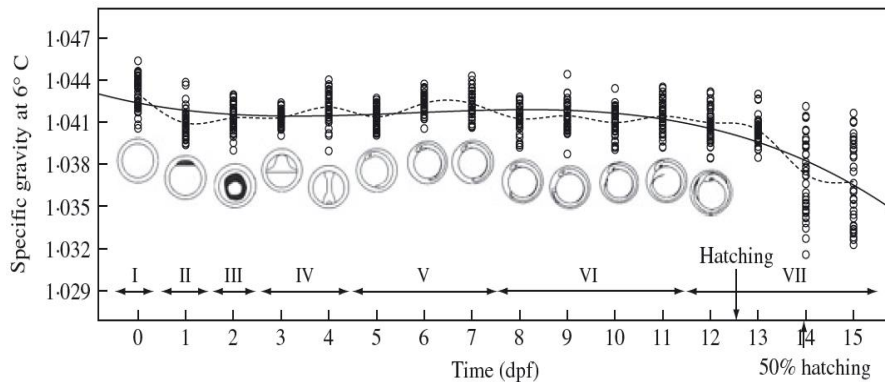


**Consequently  
various recruitment successes  
interannually**

# Examples of experiments

## ► Eggs

### ► Pacific Cod

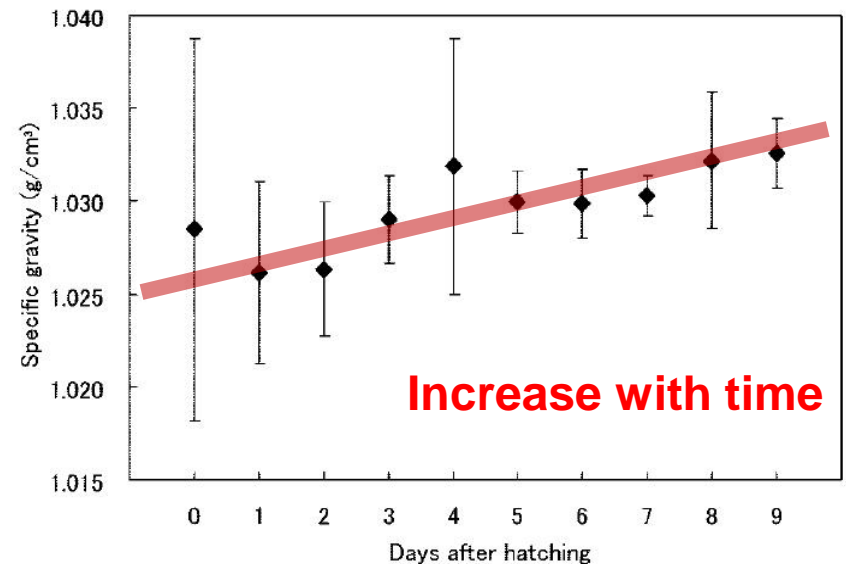


Specific gravity of fish eggs changes with embryonic development. For cod egg, it was pretty stable until mid stage, but became much light just before hatching.

Bien et al., 2014

## ► Larvae

### ► Bluefin tuna



Larval specific gravity of bluefin tuna increased as it grew (Bars: mean ± SD)

Sakamoto et al., 2005

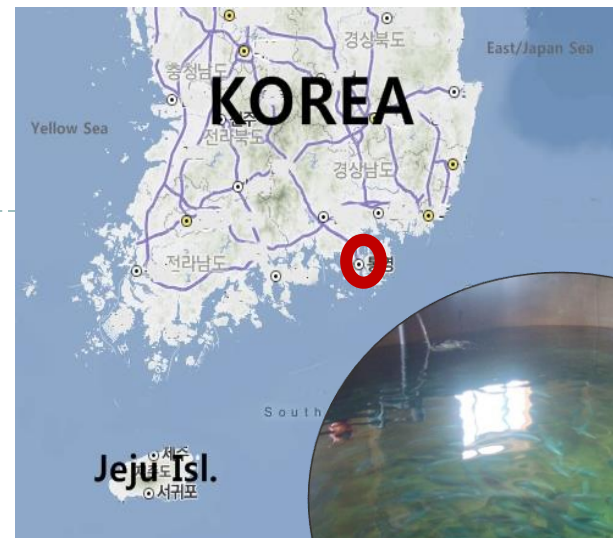
# Outline of presentation

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1. **Experiment in 2014**
2. **Experiment in 2015**
3. **Comparison of Two-Year Research**
4. **Discussion**
  - ▶ What causes changes in specific gravity within a day
  - ▶ How we use this information in marine ecology

# Experiment, 2014

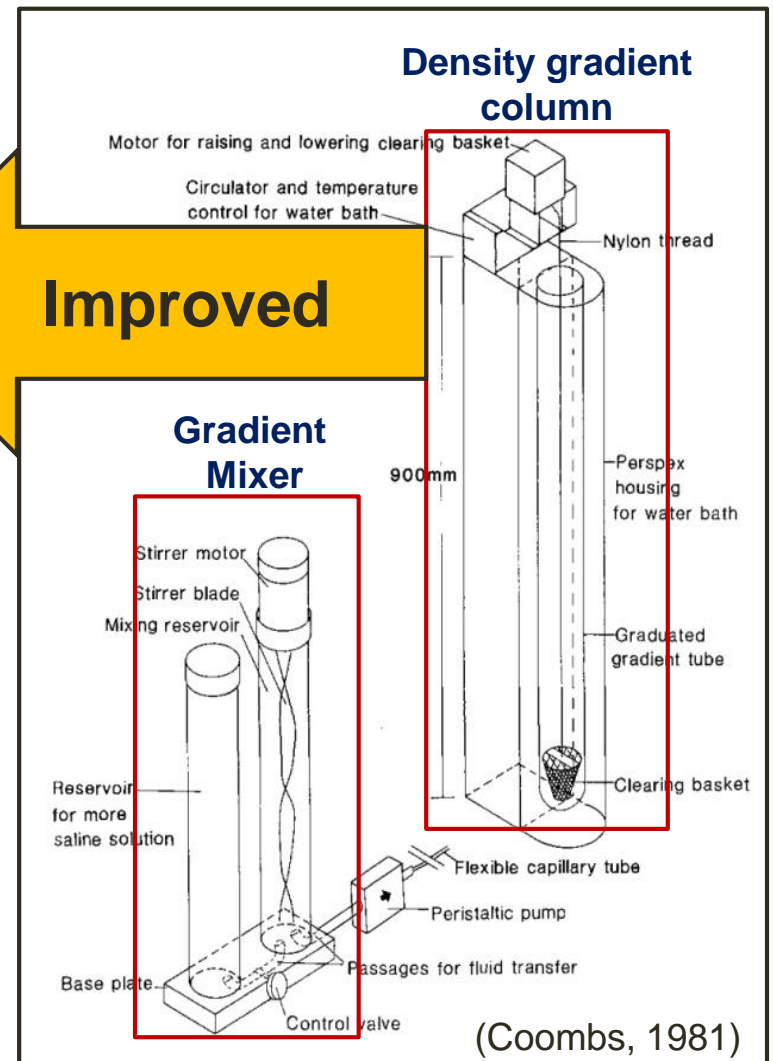
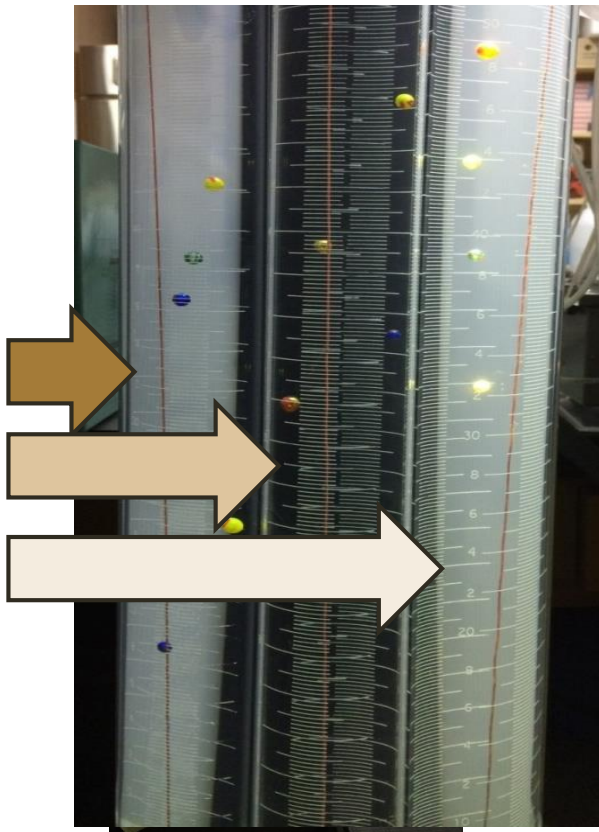
- ▶ At the Gyeongsangnam-do Fisheries Institute
  - ▶ Around 300 adults were reared in a large tank
- ▶ Rearing conditions of tank
  - ▶ Maintained by 17-18°C
  - ▶ Salinity 34-35
- ▶ Pacific mackerel eggs
  - ▶ Released by hormone injection for spawning
  - ▶ Fertilized after spawning in tank
- ▶ Spawning and egg collection
  - ▶ May 27, 2014
- ▶ Experimental duration
  - ▶ May 27 – June 12 in 2014
- ▶ Embryonic period
  - ▶ 48 hours at 20°C, 33.5
  - ▶ **50 hours at 18°C, 33.5**



# Device for specific gravity measurement

- ▶ A **Density-gradient column** for determining the specific gravity of fish eggs.

3  
columns

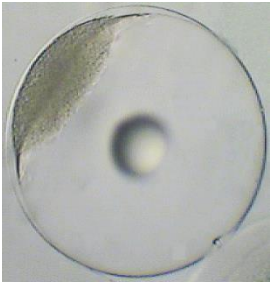




# Two types of measurements

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## 1. Continuous measurement from fertilization



- ▶ Temperature: 20 °C
- ▶ Salinity range of water column: 20-50
- ▶ Observation : every 2 hours

## 2. Instant point measurement at each development stage



- Rearing tank for larvae: 18-19 °C, 33.0-33.5
- Feed: Rotifer & Artemia, 1 hour before Anesthetized.
- Anesthesia: 20 min in 0.005% MS222
- Observation: 3 times a day - 03,10,18 hr.
- 15 – 20 Individuals were used at each observation.

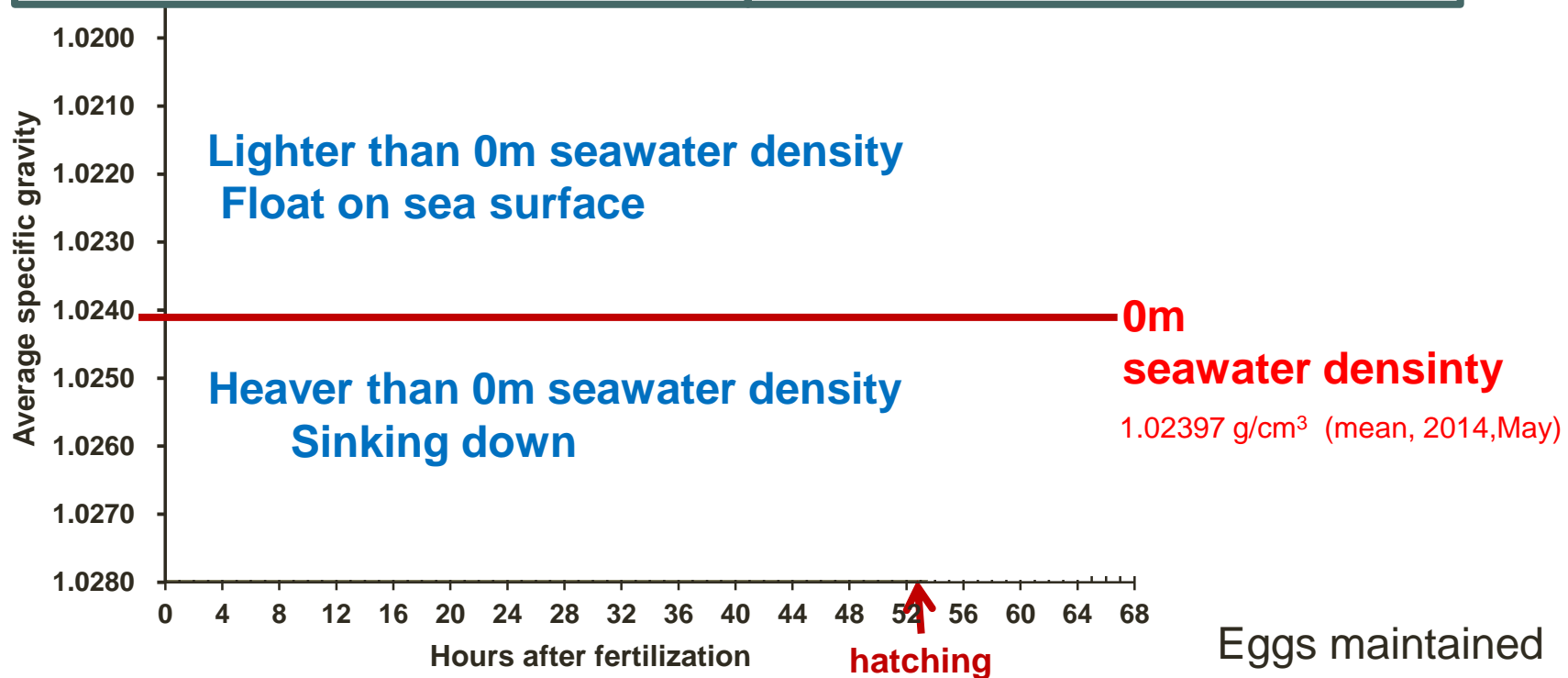
# Changes in specific gravity of mackerel eggs

## Early - Middle stages

- Lighter than seawater density
- Stay in the surface layer

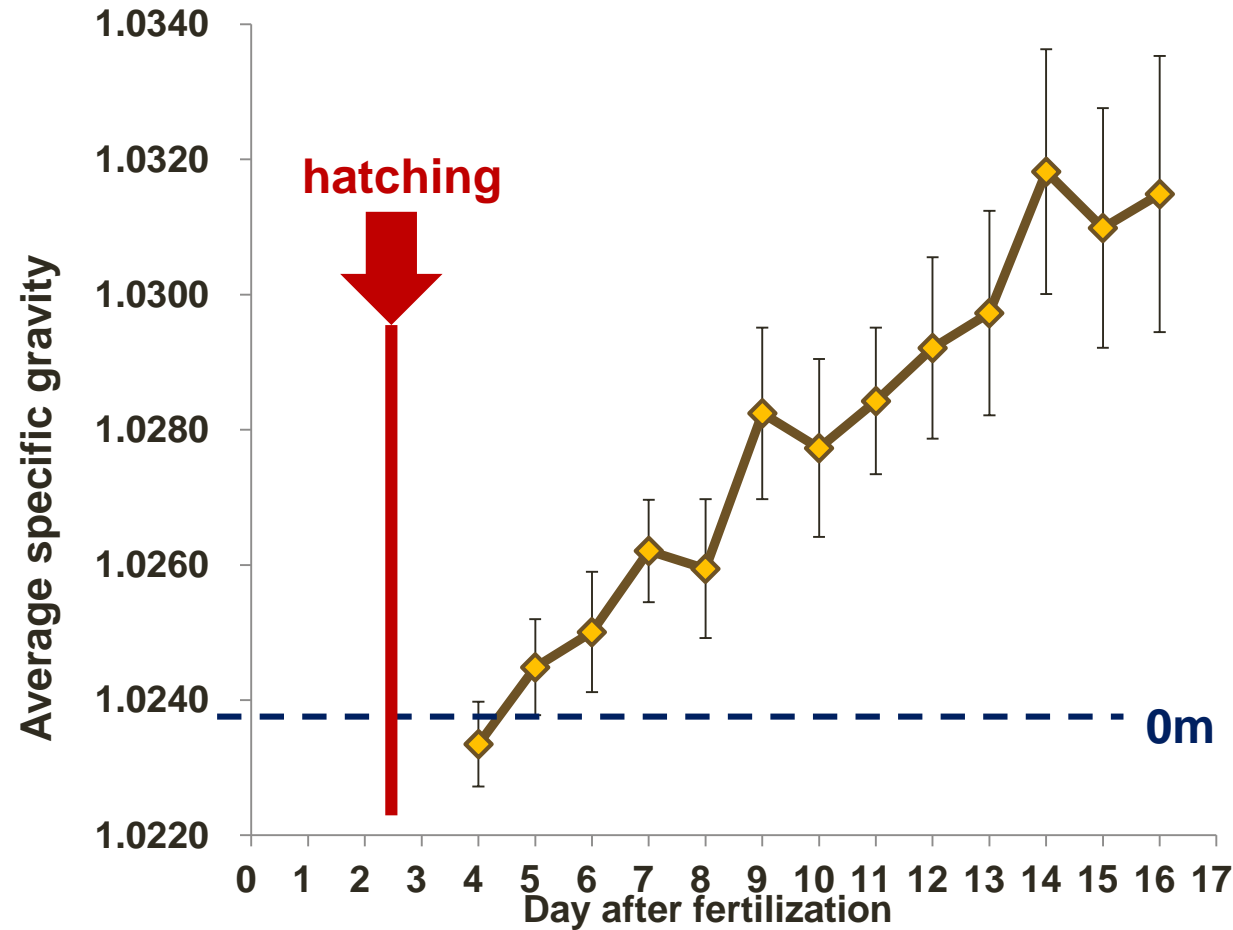
## Late stage

- Specific gravity increase,
- Heavier than seawater
- Sink toward the deeper water



Eggs maintained  
In DWC, 20°C

# Specific gravity of larvae 2014



Seawater density  
(near Jeju Island, 2014)

Depth	2014	Temp. (°C)	Salinity	Density (g/cm <sup>3</sup> )
0m	May	18.95	33.61	1.02397
10m	May	18.64	33.63	1.02407
20m	May	17.92	33.82	1.02439
30m	May	16.57	34.21	1.02501
50m	May	15.69	34.40	1.02536
75m	May	15.12	34.40	1.02548
100m	May	15.17	34.44	1.02550

Eggs reared  
In water bath, 18°C

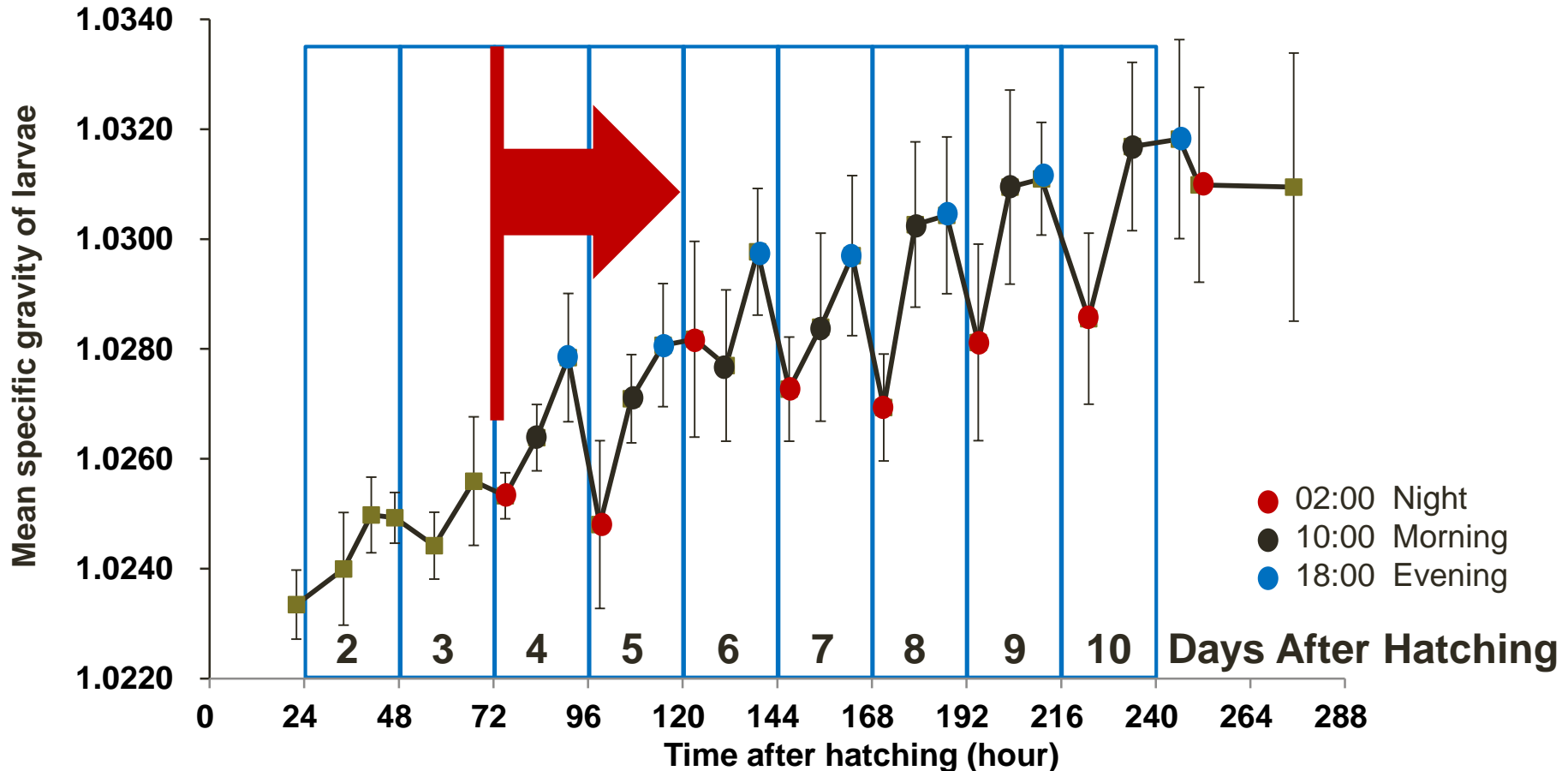
# DVM-like patterns (point estimation, 2014)

**At night**, specific gravity was **lowest**

Move up toward sea surface

**At evening**, specific gravity was **highest**

Move down toward deeper water



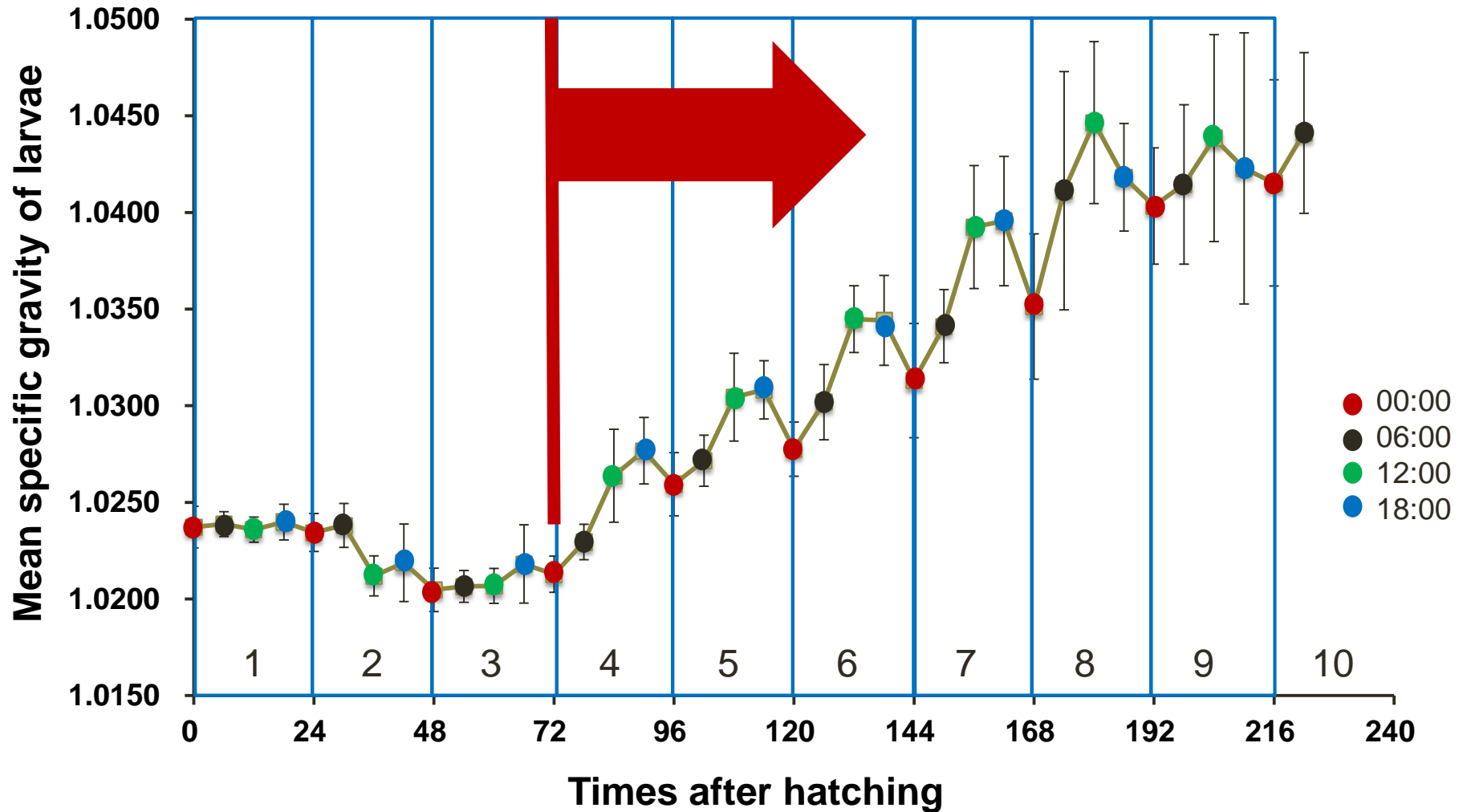
# Experiment in 2015

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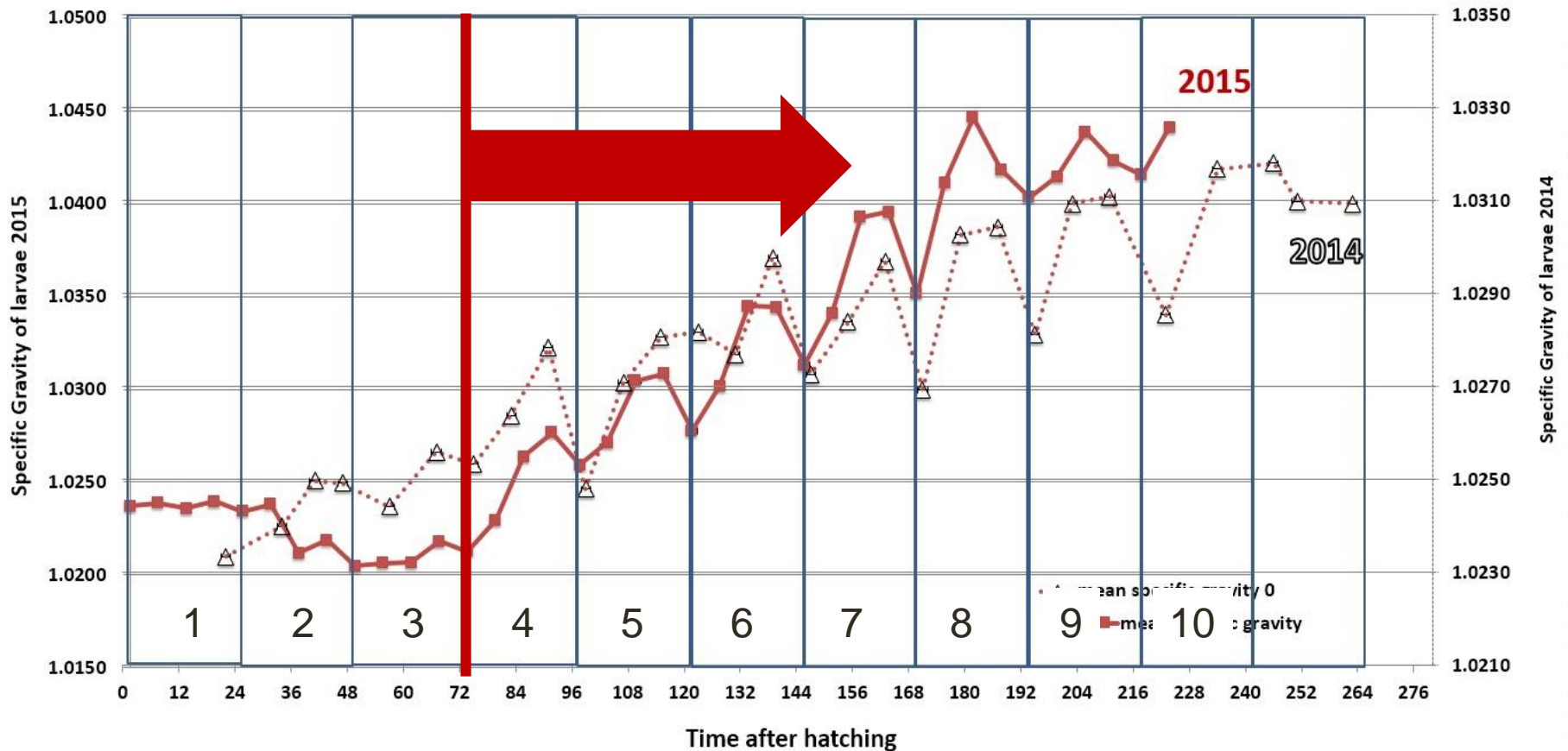
Specific gravity experiment on mackerel larvae was repeated in 2015 to confirm the DVM-like pattern.

- ▶ **Increased observation frequency**
  - ▶ from 3 times(2, 10, 18 hr.) a day to **4 times (0, 6,12,18 hr.)**
- ▶ **Consider why this pattern appears**
  - ▶ Length vs specific gravity.
  - ▶ Stomach contents vs specific gravity

# Changes in larval specific gravity, 2015



# Comparison of two-year research



- ▶ Fluctuation start: 4 Day old larvae
  - ▶ Lowest: midnight (02:00, 00:00)
  - ▶ Highest: Daytime (18:00, 12:00)

**We don't know**

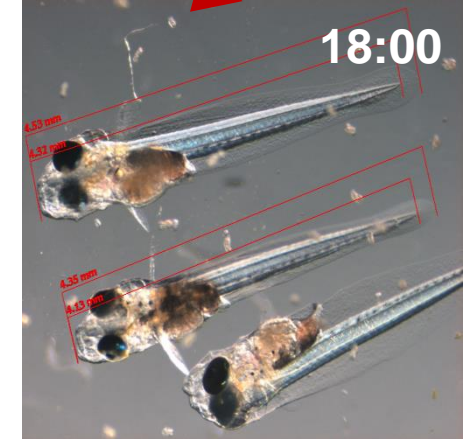
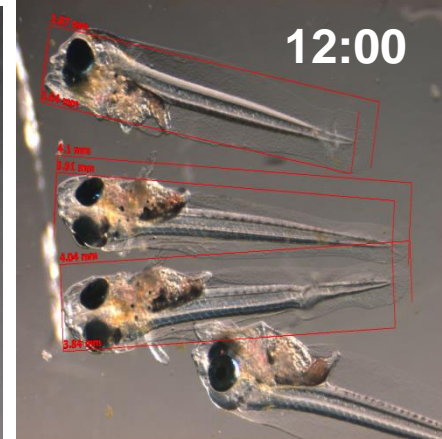
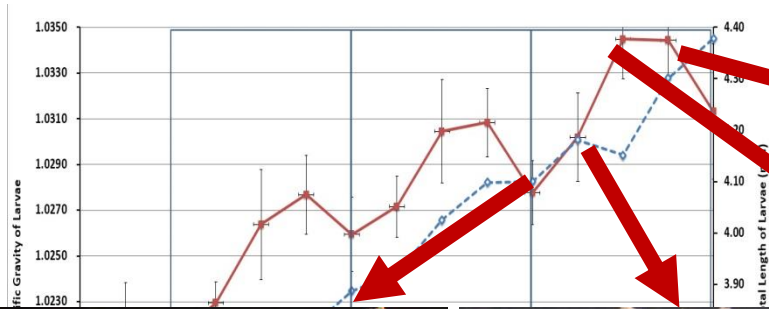
**“Why and How they move up and down during a day?”**

- ▶ What cause the larval specific gravity changes during a day?
  - ▶ Light?
  - ▶ Following food?
  - ▶ Stomach fullness?
  - ▶ Bladder formation effect?
  - ▶ Metabolic process?



# Food contents

2015.06.21.  
5 day old larvae



Observation time	00:00	06:00	12:00	18:00
Mean Specific gravity	1.0278 ± 0.00140	1.0302 ± 0.00194	1.0345 ± 0.00173	1.0344 ± 0.00233
Total length (mm)	4.10 ± 0.21	4.18 ± 0.09	4.15 ± 0.19	4.30 ± 0.18

# Still we are in struggling in that...

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## ➤ **Heavy in Day-time**

- ✓ Could move to deeper water, easily
- ✓ Reside more deeper water(subsurface)
- ✓ Benefit of avoidance from predators

## ➤ **Light in Night-time**

- ✓ Could move to upper water, easily
- ✓ Might help find more food

**However, we had no information on vertical distribution of mackerel larvae in ocean.**



# Summary

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- ▶ Specific gravity of mackerel eggs and larvae were measured in 2014 and 2015 using density gradient water column.
- ▶ Egg specific gravity was compared to seawater density, and vertical movement of eggs was depicted. Egg specific gravity was lighter than seawater during early through middle stages, so that they should float on sea surface. Then, eggs sink down just before hatching due to enhanced specific gravity.
- ▶ Larval specific gravity was increased with time. At hatching, their specific gravity was lower than surface water density, so that they move toward the surface.
- ▶ After third day of hatching, however, the specific gravity became heavier than surface water density.
- ▶ We also observed the day-and-night difference in specific gravity. It showed “Low in night” and “High in day” pattern during 4 though 10 days after hatching.
- ▶ So far, we don't know why they show such different specific gravity within a day.

**Thank you**

