Buoyancy and vertical distribution of Pacific mackerel eggs and larvae and its implication to the recruitment variability.

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Specific gravity of fish egg and larvae

- **Specific gravity is changing during their developmental stages.**

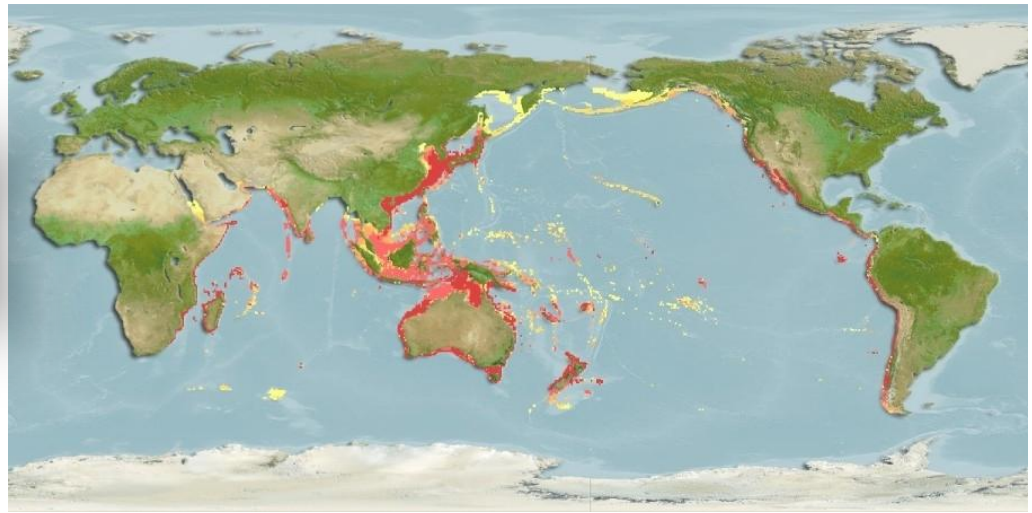
- **Vertical distribution in sea is determined by the interaction between biological** (buoyancy and size of egg and larvae) **and physical** (water density, viscosity, and turbulence) **factors** (i.e., difference between organism's specific gravity and seawater density)

- **Different vertical distribution of eggs and larvae result in different advection process and spatial distributions, and consequently various recruitment success interannually.**

Pacific mackerel, *Scomber japonicus*

- **It is small pelagic fish and one of the most dominant commercial species in northwestern Pacific Ocean.**

- **However, little is known about early life history characteristics such as transport process and recruitment variability in Korean waters.**



Objectives of our research

- **To measure the changes of specific gravity during egg and larval stages in laboratory**

- **To identify the patterns of sinking or upward movement through their developmental stages in field**

Materials

- At the Gyeongsangnam-do Fisheries Institute
  - Around 300 adults were reared in a large tank
- Rearing conditions of tank
  - Maintained by 17-18℃
  - Salinity 34-35
  - From March to spawning
- Spawning and egg collection
  - May 27, 2014

Materials

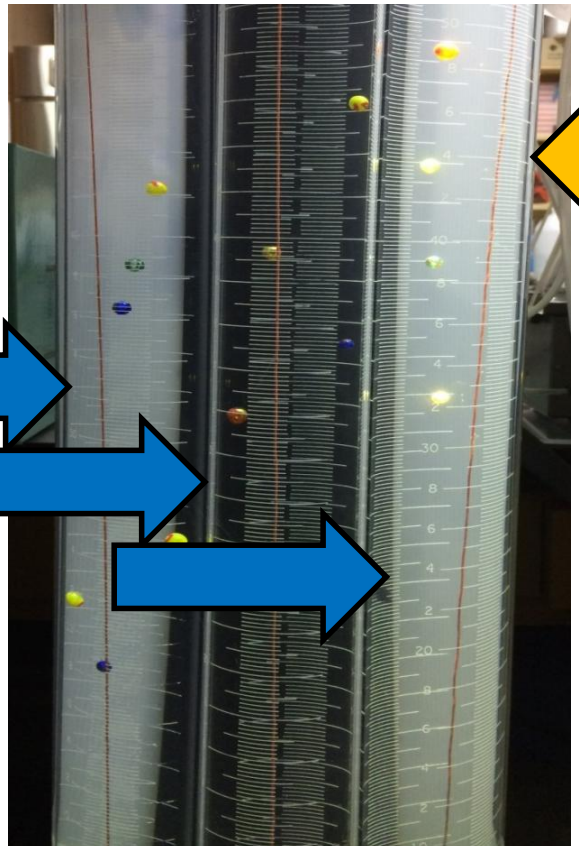
- Pacific mackerel eggs
  - were released by hormone injection for spawning and,
  - were fertilized after spawning in tank

- Experimental duration
  - May 27 – June 12

- Embryonic period
  - 48 hours at 20℃, 33.5
  - **50 hours at 18℃, 33.5**

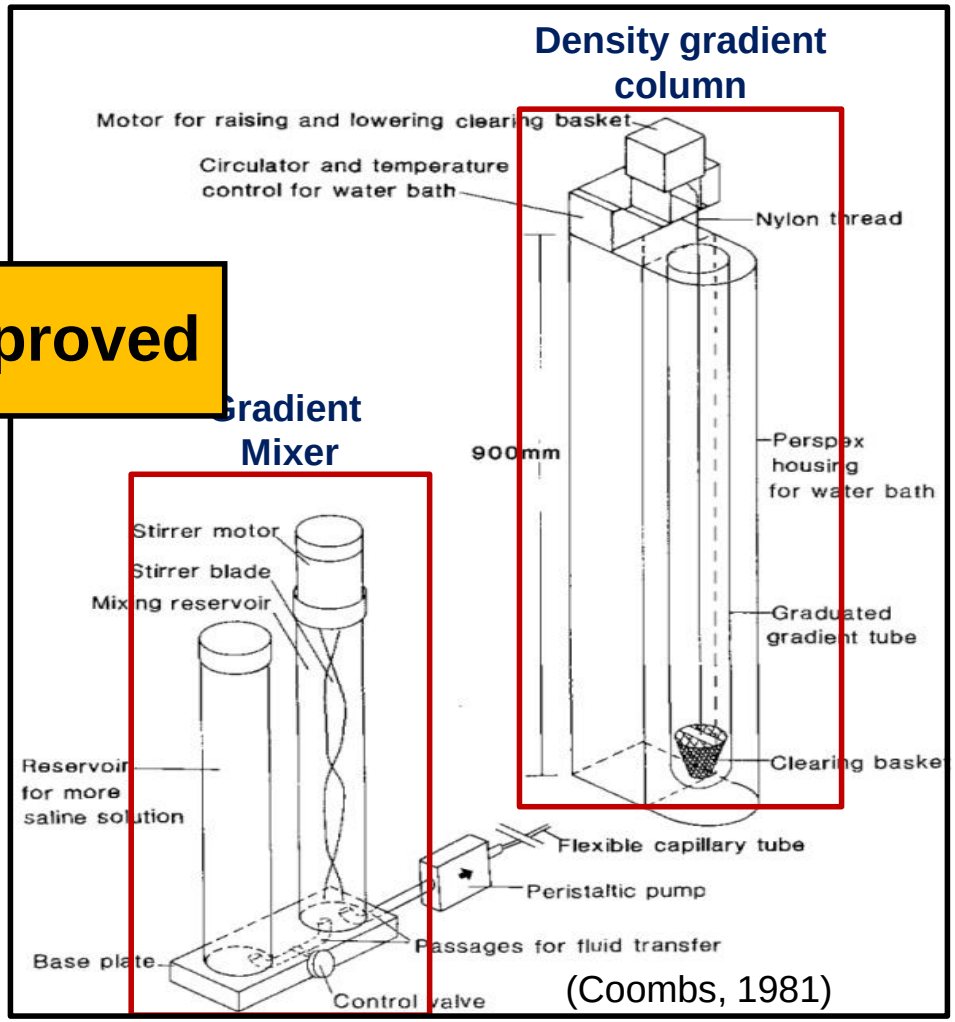
Methods for specific gravity measurement

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



3 columns

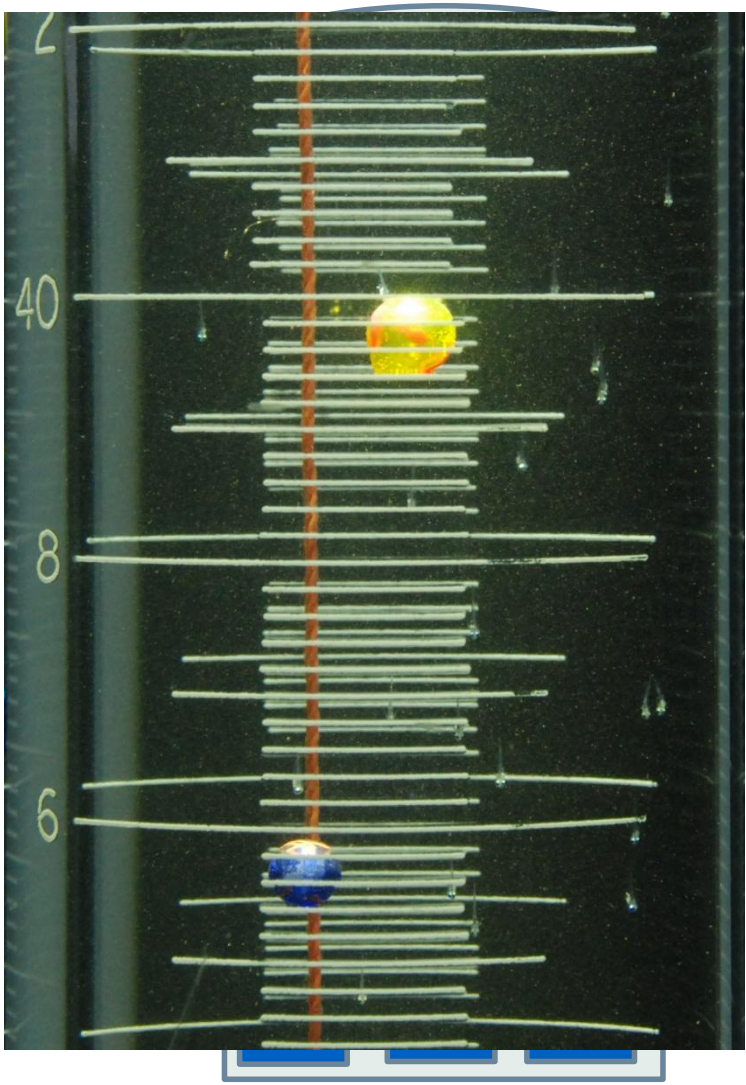
Improved



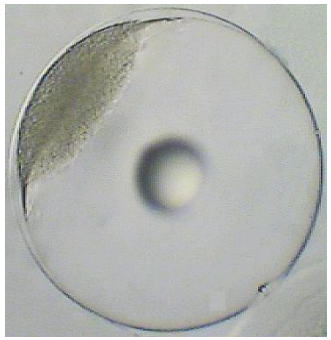
(Coombs, 1981)

Experiment

- Density-gradient column
  - One big bath tube
  - Three density gradient columns
  - 7 glass balls with known specific gravity
  - Gradient salinity : 20 – 50
  - Temperature : 20℃

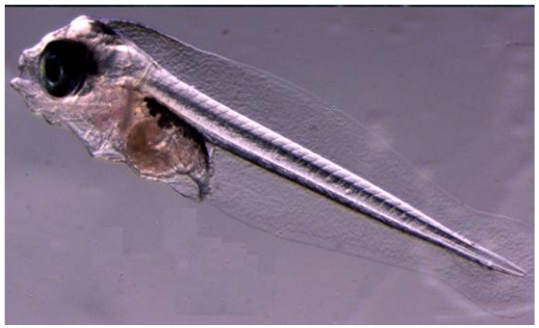


Experiment



1. **Continuous measurement from fertilization**
   - Temperature: 20 ºC
   - Salinity rage of water column: 20-50
   - Observation : every 2 hours

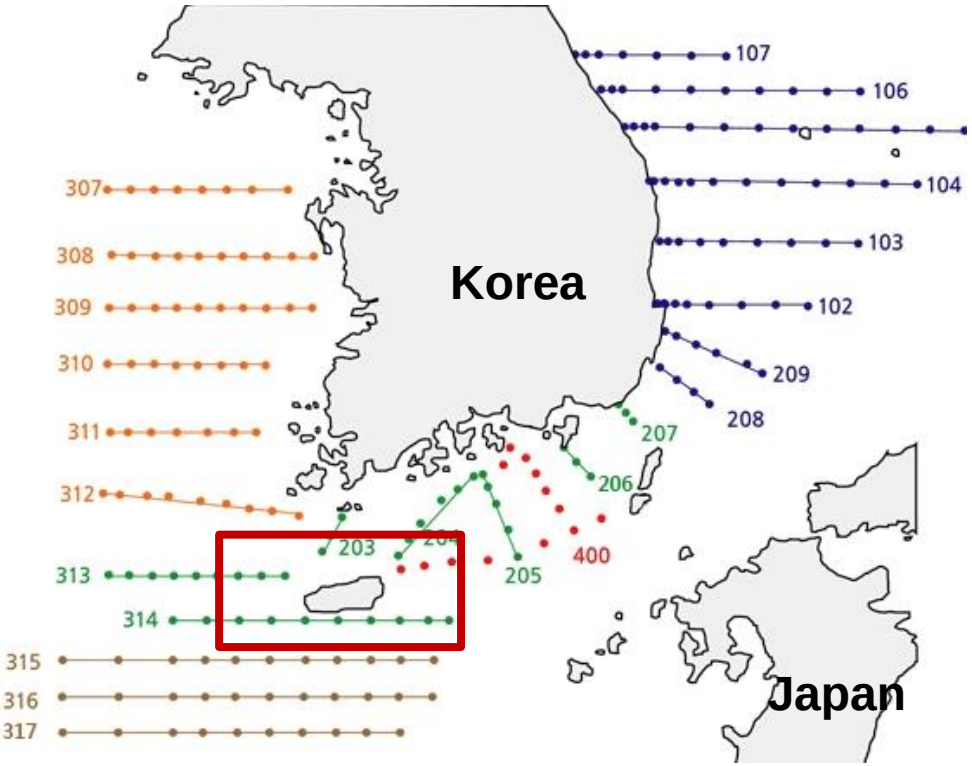
2. **Instant point measurement at each development stage**



- Rearing tank for larvae: 18-19 ºC, 33.0-33.5
- Feed: Rotifer & Artemia
- Anesthesia: 20 min in 0.005% MS222
- Observation : 3 times a day- 03,10,18 hr

Environmental data

Spawning area
near Jeju Island, Korea



Seawater Density KODC,
2014 Apr. and June cruise

Depth	2014	Temp. (℃)	Salinity	Density (g/cm^3)
	Apr. 12-16, 22,23	16.41	34.57	1.02532
0m	May	18.95	33.61	1.02397
	June 14-16, 19,20	21.50	32.64	1.02257
	Apr. 12-16, 22,23	16.34	34.57	1.02534
10m	May	18.64	33.63	1.02407
	June 14-16, 19,20	20.94	32.70	1.02276
	Apr. 12-16, 22,23	16.19	34.56	1.02537
20m	May	17.92	33.82	1.02439
	June 14-16, 19,20	19.65	33.08	1.02339
	Apr. 12-16, 22,23	16.10	34.56	1.02539
30m	May	16.57	34.21	1.02501
	June 14-16, 19,20	17.04	33.86	1.02463
	Apr. 12-16, 22,23	15.84	34.55	1.02544
50m	May	15.69	34.40	1.02536
	June 14-16, 19,20	15.55	34.26	1.02528
	Apr. 12-16, 22,23	15.32	34.51	1.02552
75m	May	15.12	34.40	1.02548
	June 14-16, 19,20	14.91	34.29	1.02545
	Apr. 12-16, 22,23	15.36	34.52	1.02552
100m	May	15.17	34.44	1.0255
	June 14-16, 19,20	14.99	34.37	1.02549

Results

- **Measure the changes of specific gravity**

Specific gravity change of egg

Compare egg with larval specific gravity

Specific gravity change of larvae

+

seawater density at each depth

- **Identify the patterns of sinking or upward movement**
  - **Sinking and upward movement pattern of larvae during on a day**

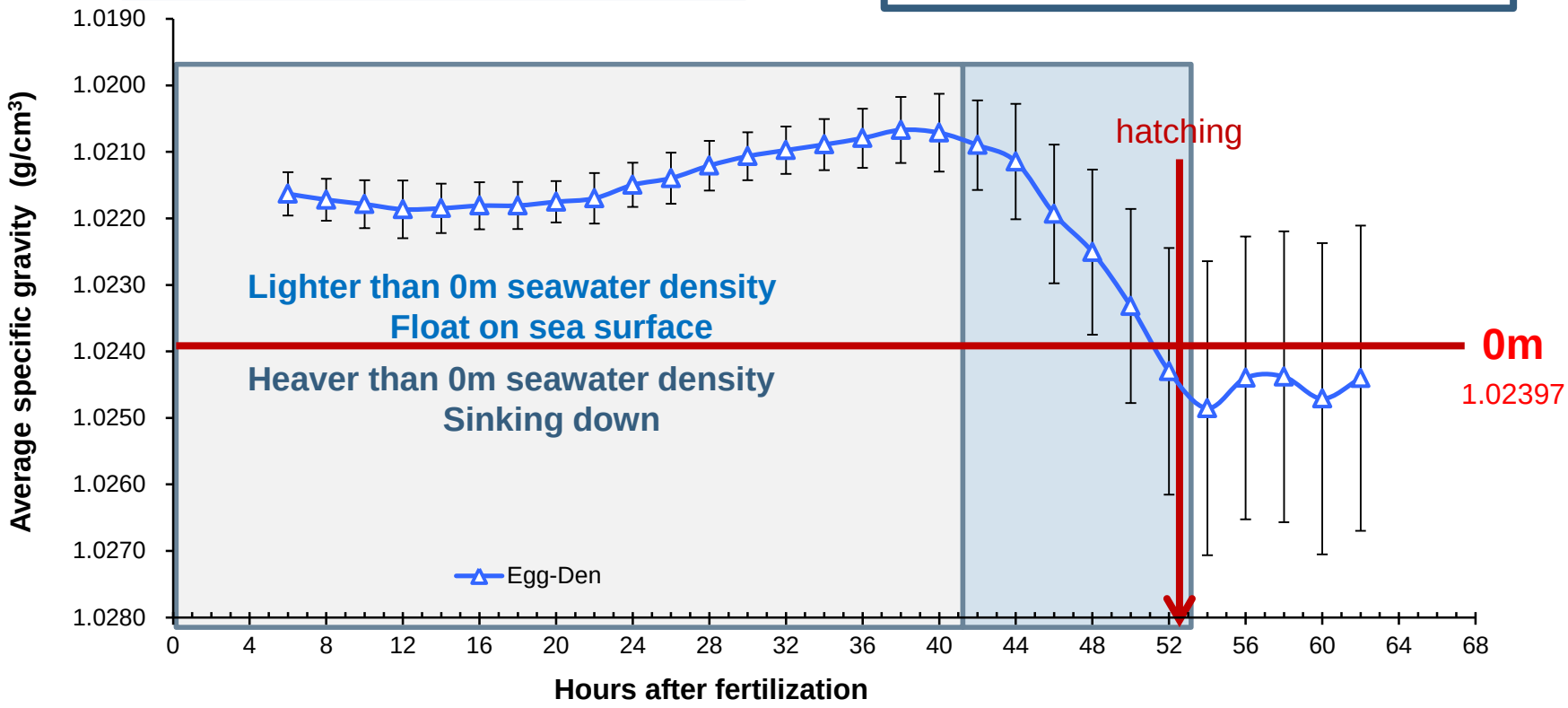
Changes in specific gravity of mackerel eggs

Early - Middle stages

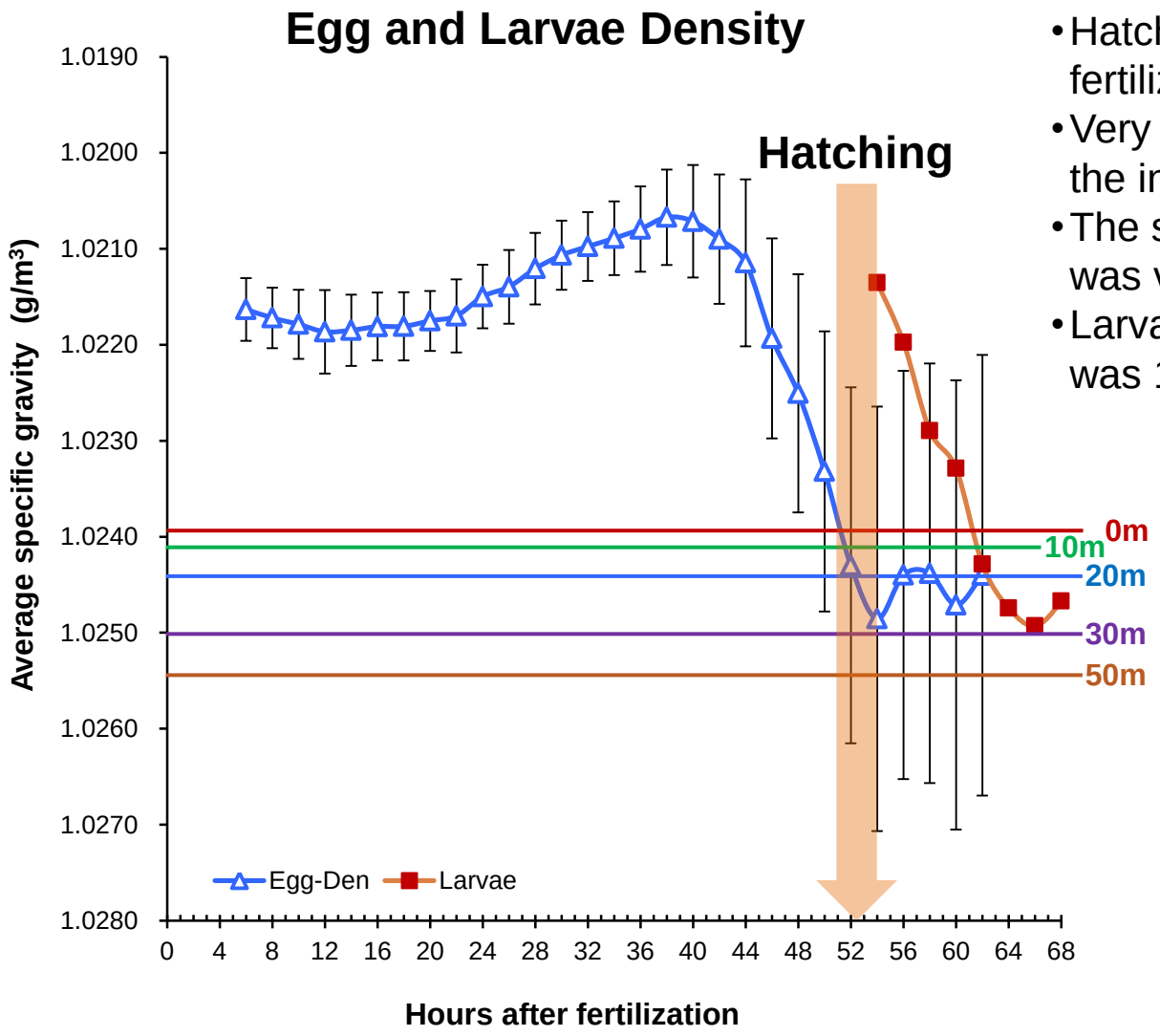
- Lighter than seawater density
- Stay in the surface layer

Late stage

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



Specific gravity of hatching larvae



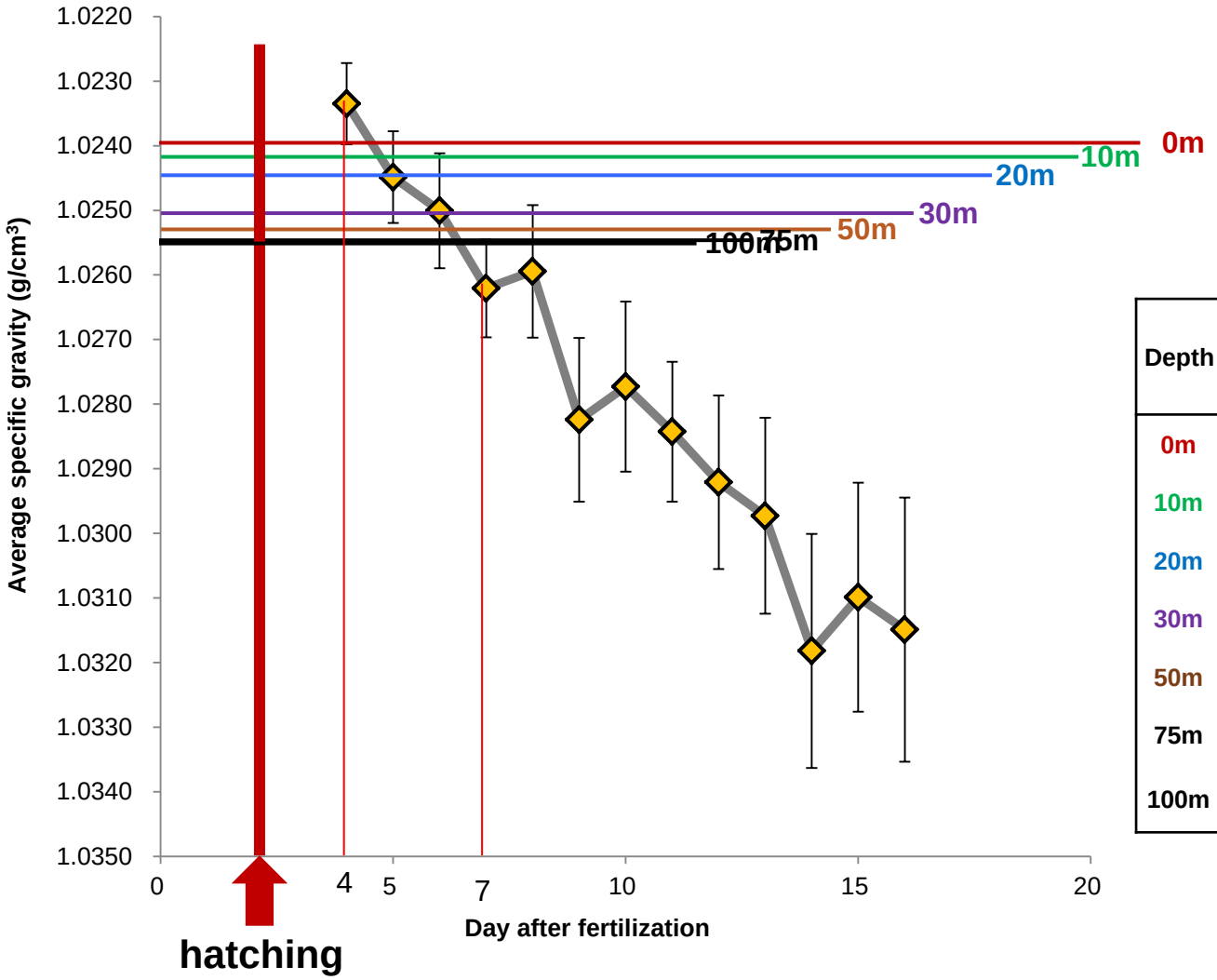
- Hatching started at 50-52 hours after fertilization
- Very old stage of remaining eggs showed the increased specific gravity
- The specific gravity of hatching larvae was very light (1.0195 g/cm^3)
- Larvae became heavier, after 10 hours was 1.0243 g/cm^3

Seawater density

(near Jeju Island, 2014)

Depth	2014	Temp. (℃)	Salinity	Density (g/cm^3)
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

Specific gravity of larvae



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50m	May	15.69	34.40	1.02536
75m	May	15.12	34.40	1.02548
100m	May	15.17	34.44	1.02550

DVM-like Pattern

- However, specific gravity observation with short interval indicates the DVM-like Pattern

- Diel pattern of larval specific gravity

  - Measurement at 3 times a day
    - **night (03:00)** , **morning(10:00)**, **evening(18:00)**

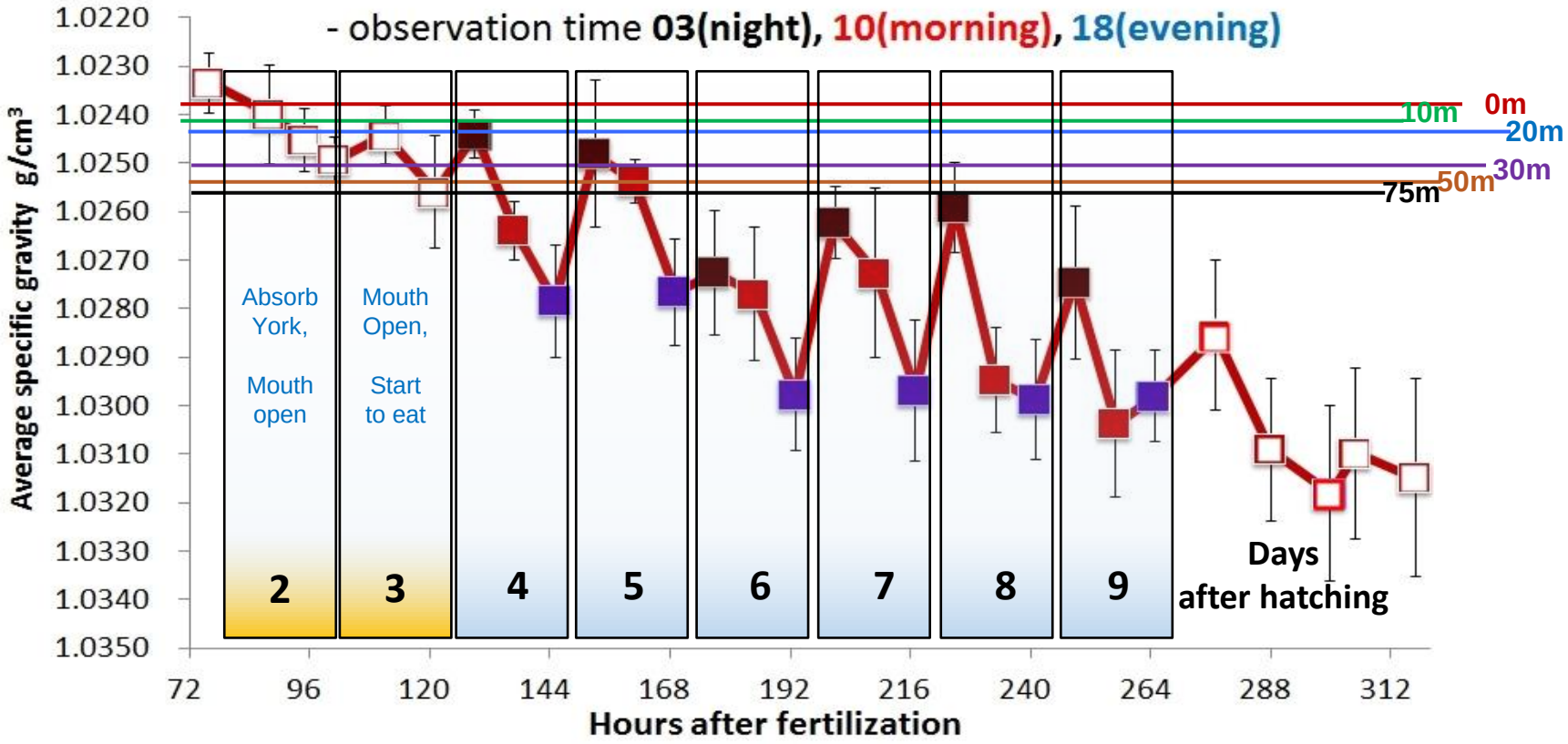
DVM-like patterns (point estimation)

At night, specific gravity was lowest

Move up toward sea surface

At evening, specific gravity was highest

Move down toward deeper water



Further study

- Vertical trajectory of eggs and larvae in the seawater column
- How could larvae stay in the surface layer?
  - Ontogeny development
  - Mixed layer depth and wind blow
- Study with physical ocean modeler
  - Egg and larval advection by current
  - Transport from spawning ground to nursery ground
- What cause the DVM-like pattern in daily larval specific gravity change?
  - Food contain proportion?
  - By light? Chasing food?
  - Metabolic matter?


Thank you