Effects of temperature and ontogeny on vertical movement ability of newly hatched larvae of the Pacific cod *Gadus macrocephalus*

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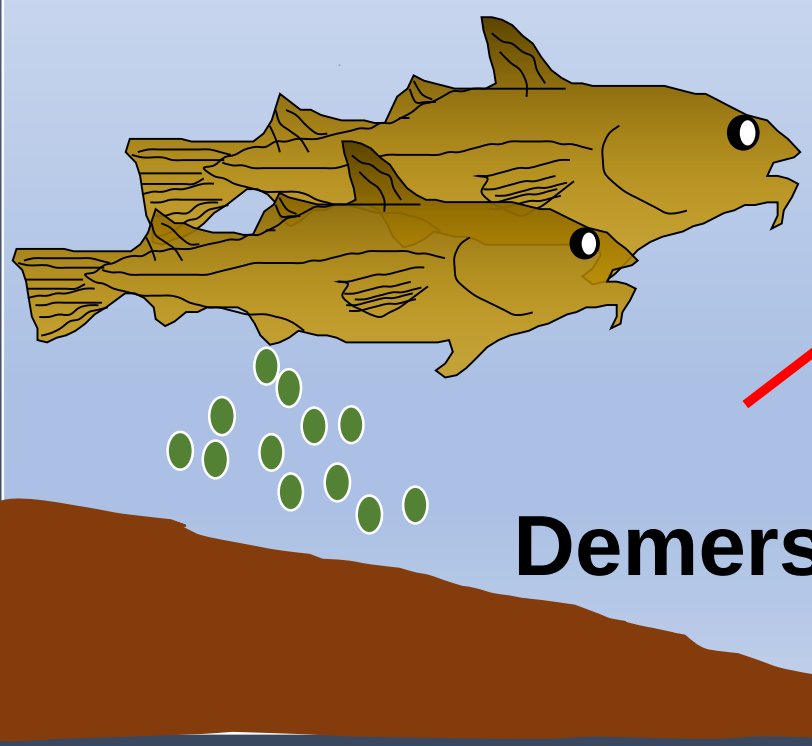
Background

How ? When ?

Vertical movement

Adult fish



Demersal eggs

Pelagic larvae

Yolk-sac larvae

(Sakurai, 2007)

Background

Atlantic cod larvae

Yolk-sac absorption

Ontogenetic development

→ **Specific gravity change**

(Saborido-rey et al., 2003)

Body size → **Swimming ability**

(Shepherd et al., 2000)

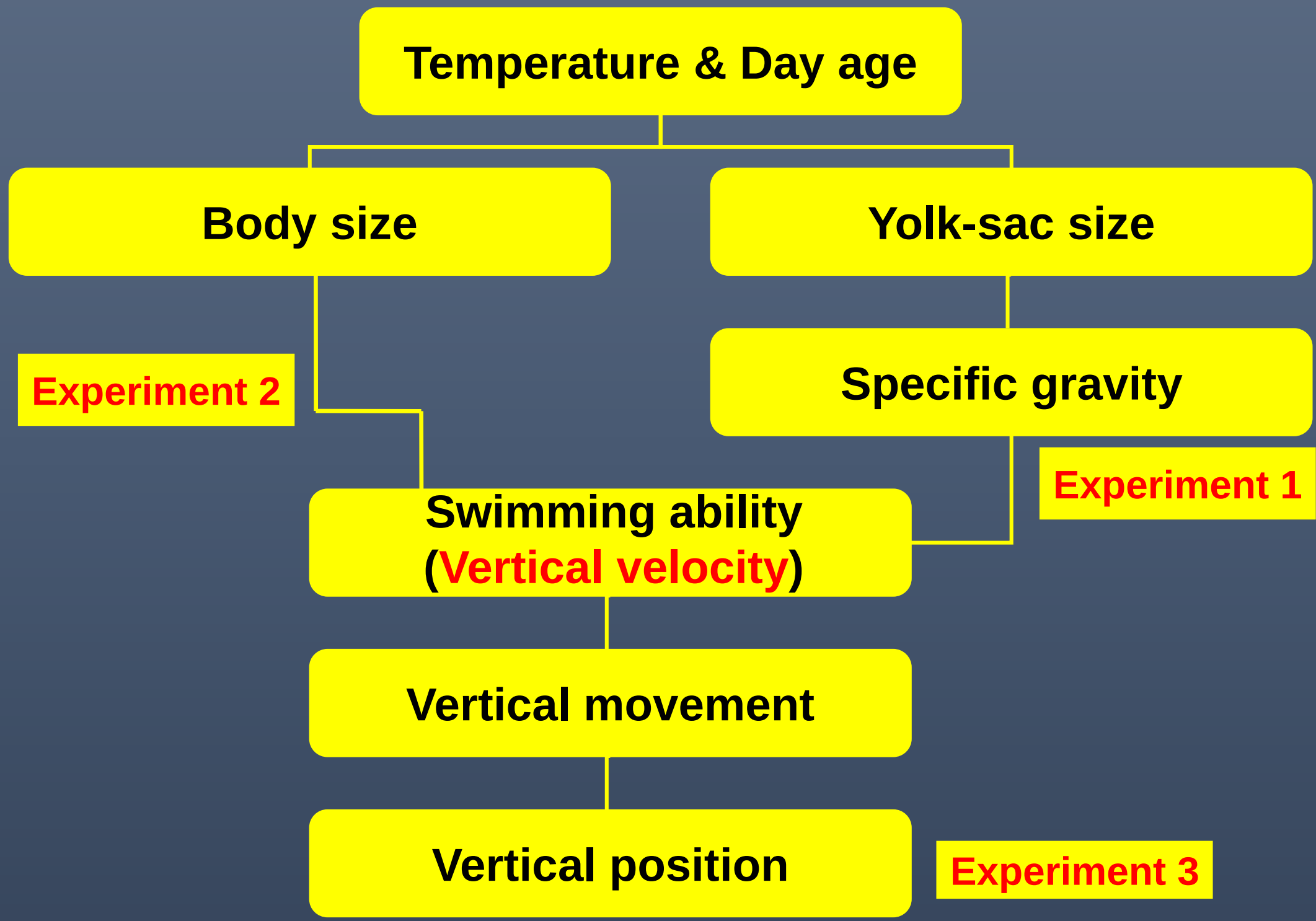
Walleye pollock larvae

Yolk-sac stage → **Vertical distribution**

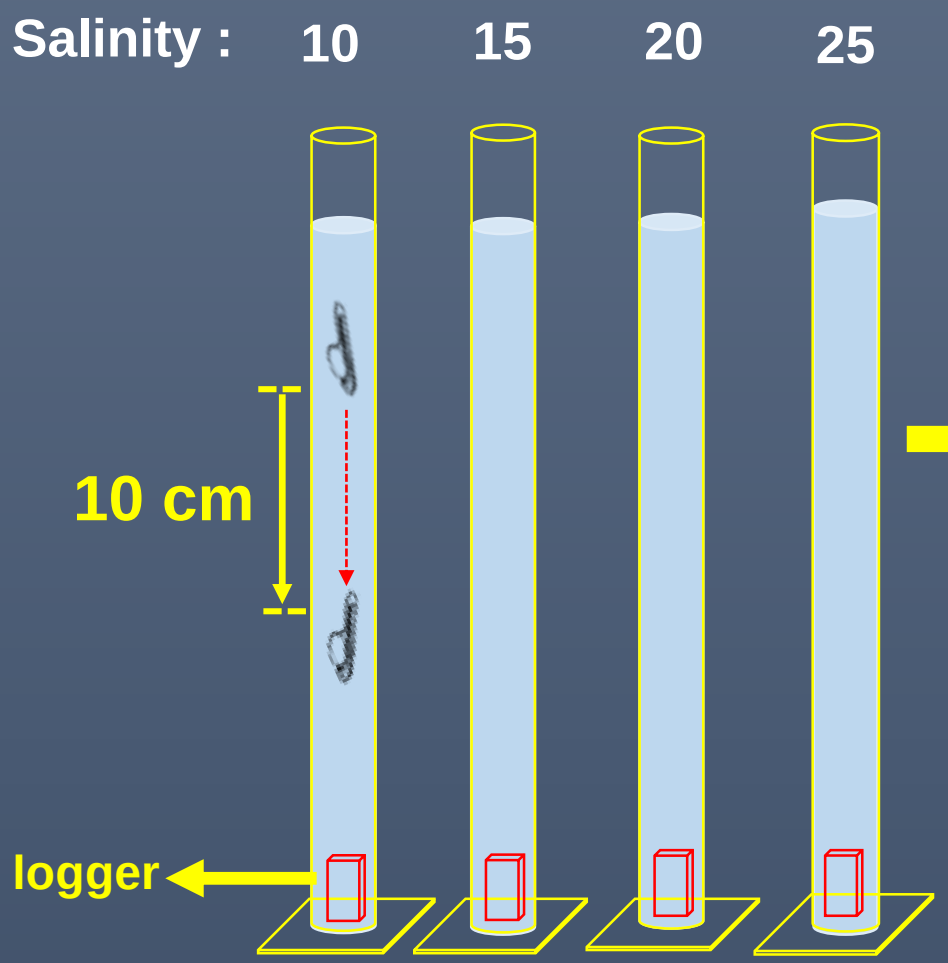
(Olla et al., 1996)

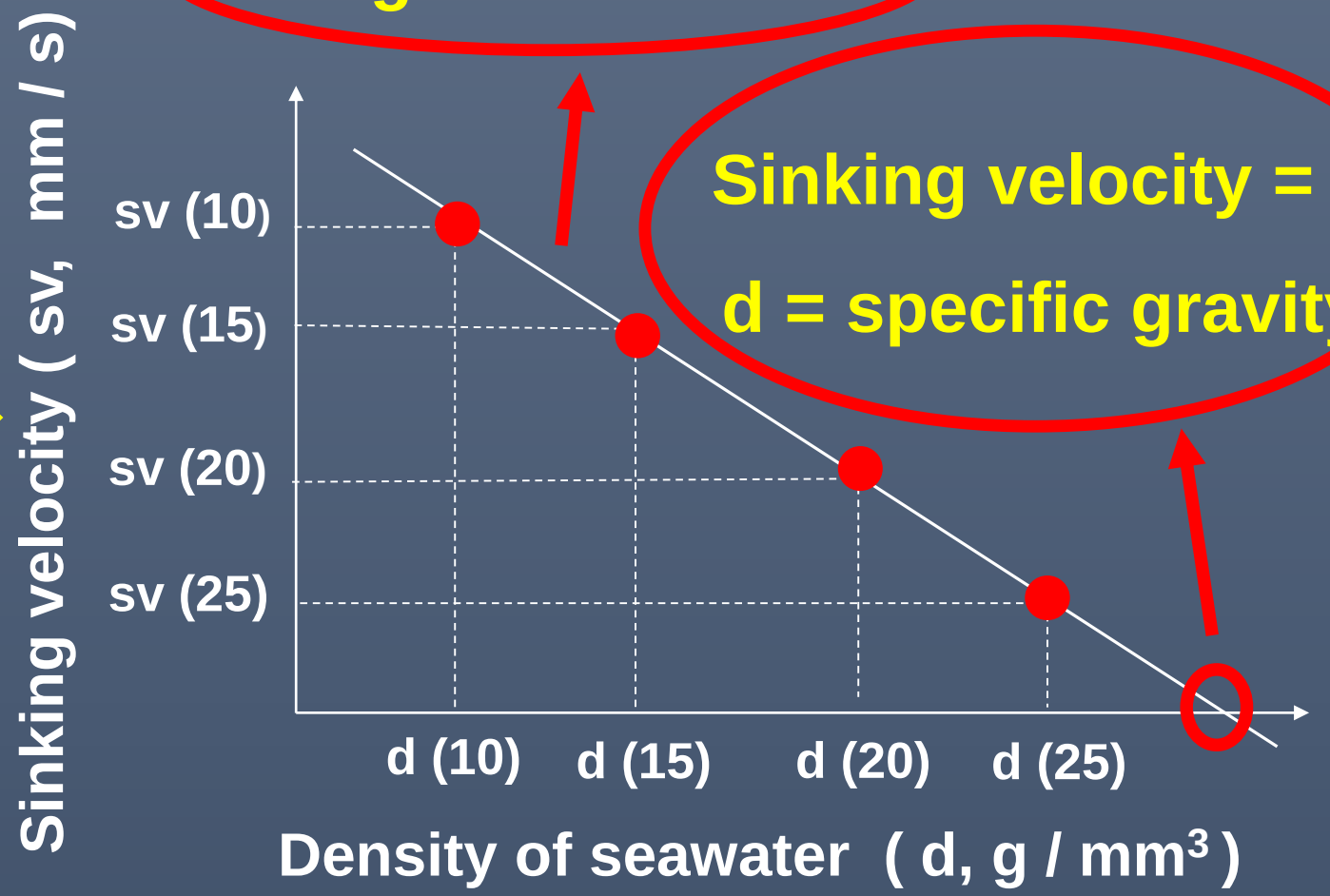
Experiment items

3, 5, 7 and 9℃ at 0 ~ 3 days post hatch



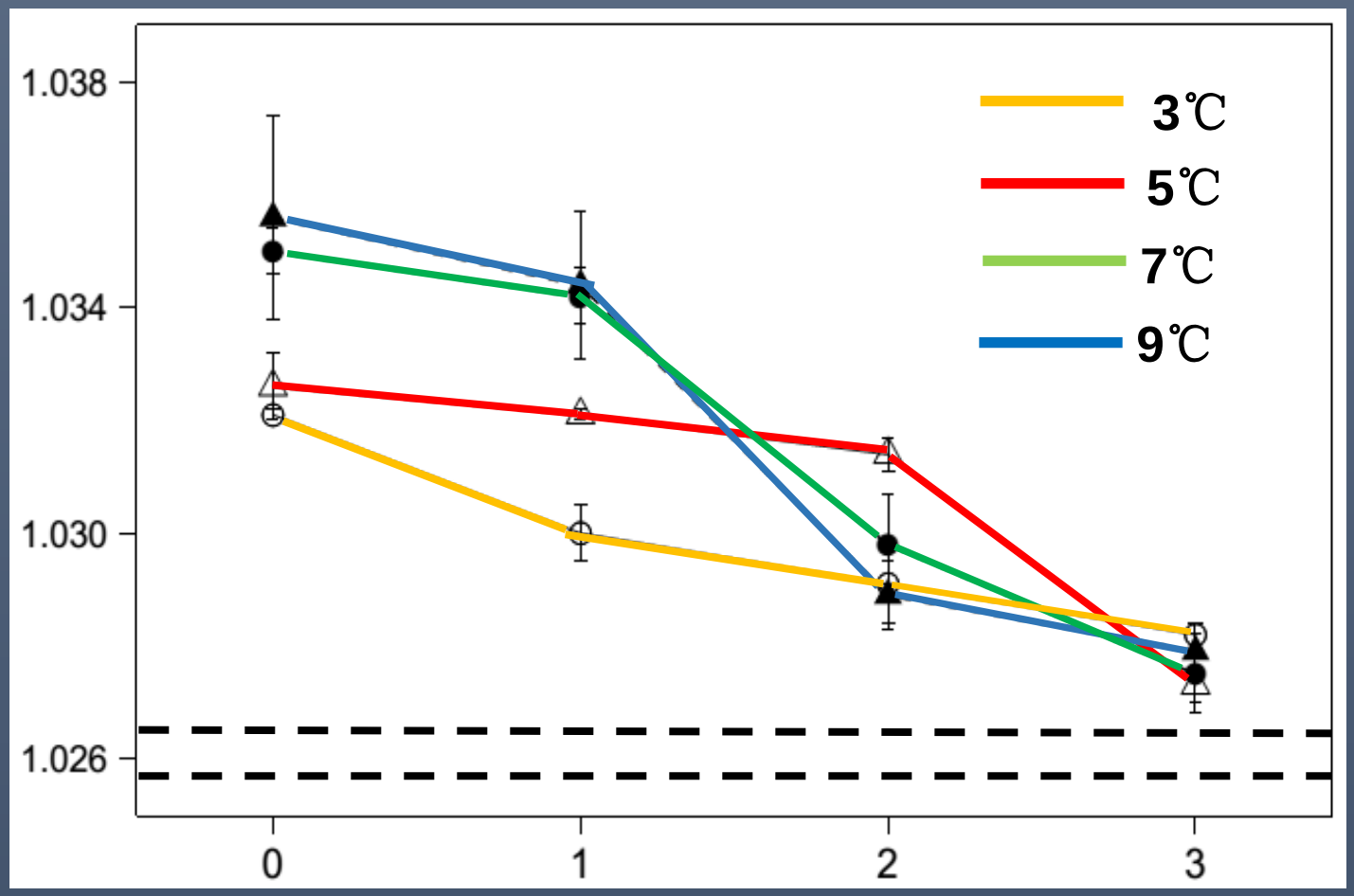
Experiment 1 Specific gravity





- Sinking velocity of an anesthetic larva = 10 (cm) / Time (s)
- A regression model was ran between sinking velocities and densities of the seawaters
- Specific gravity = the density of seawater (at which sinking velocity = 0)

Results　Experiment 1　Specific gravity



Larvae were reared at 3, 5, 7 and 9 ℃

➡ Density of the seawater at 3 ℃
➡ Density of the seawater at 9 ℃

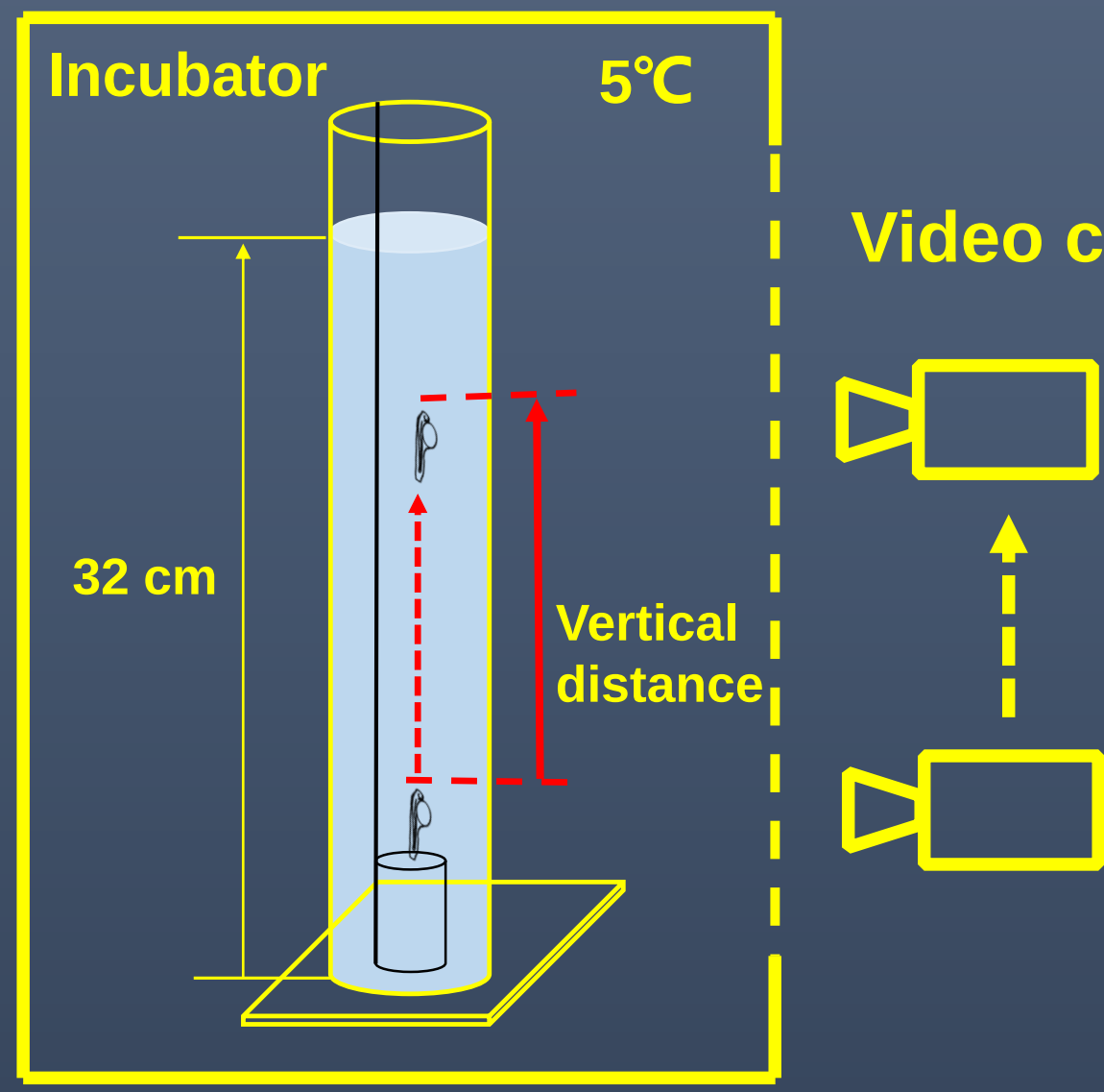
(1) Larvae were negatively buoyant relative to the seawaters at 0 day post hatch and near-neutrally buoyant at 3 days post hatch

(2) Specific gravities decreased with ontogeny at all the temperatures

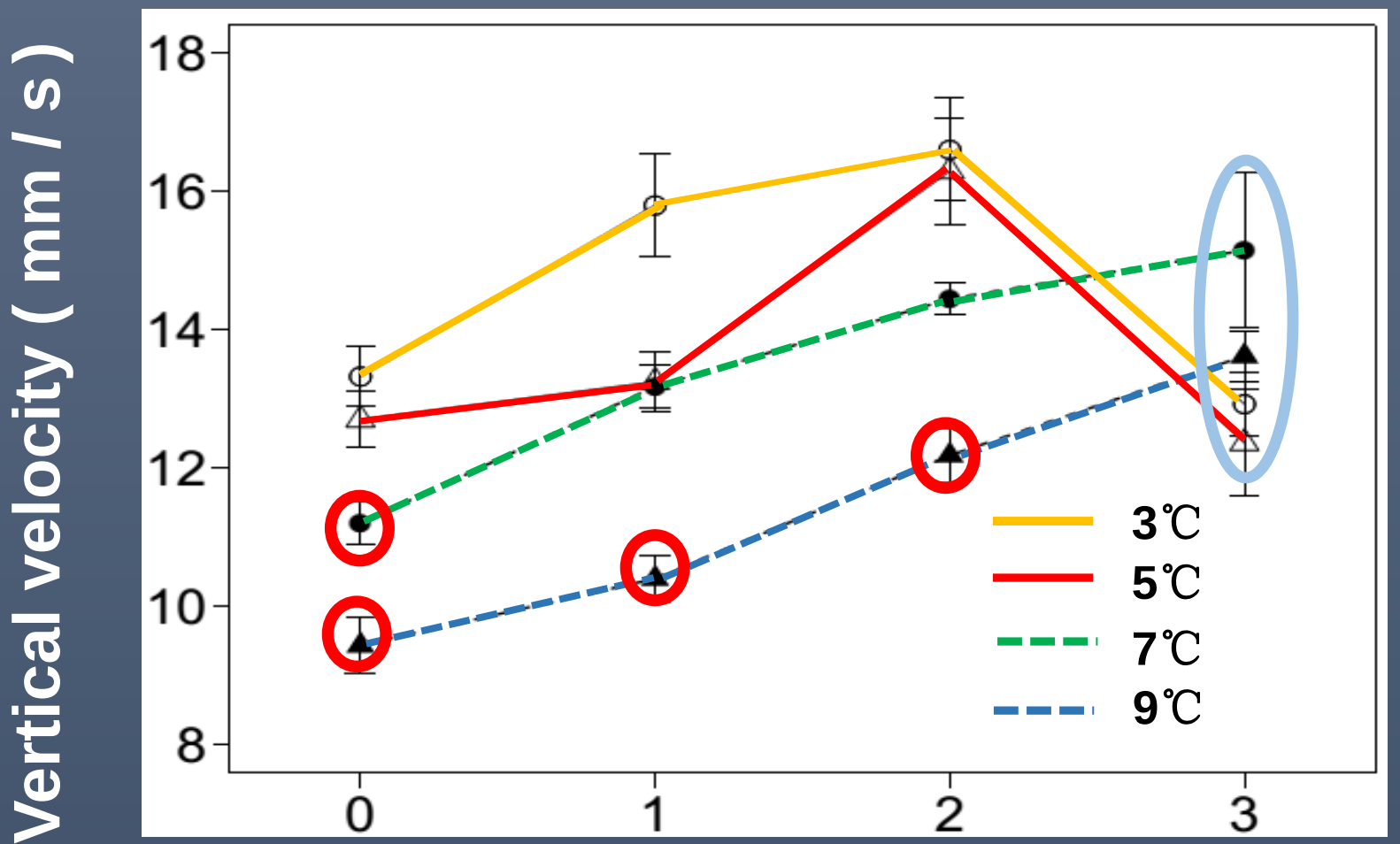
Experiment 2 Vertical velocity at 5 ℃

- **Only half of introduced larvae were randomly recorded**
- **Vertical velocity = Vertical distance (mm) / Time (s)**

Larvae reared at 3, 5, 7 and 9 ℃ were all measured at 5 ℃



Results Experiment 2 Vertical velocity at 5℃



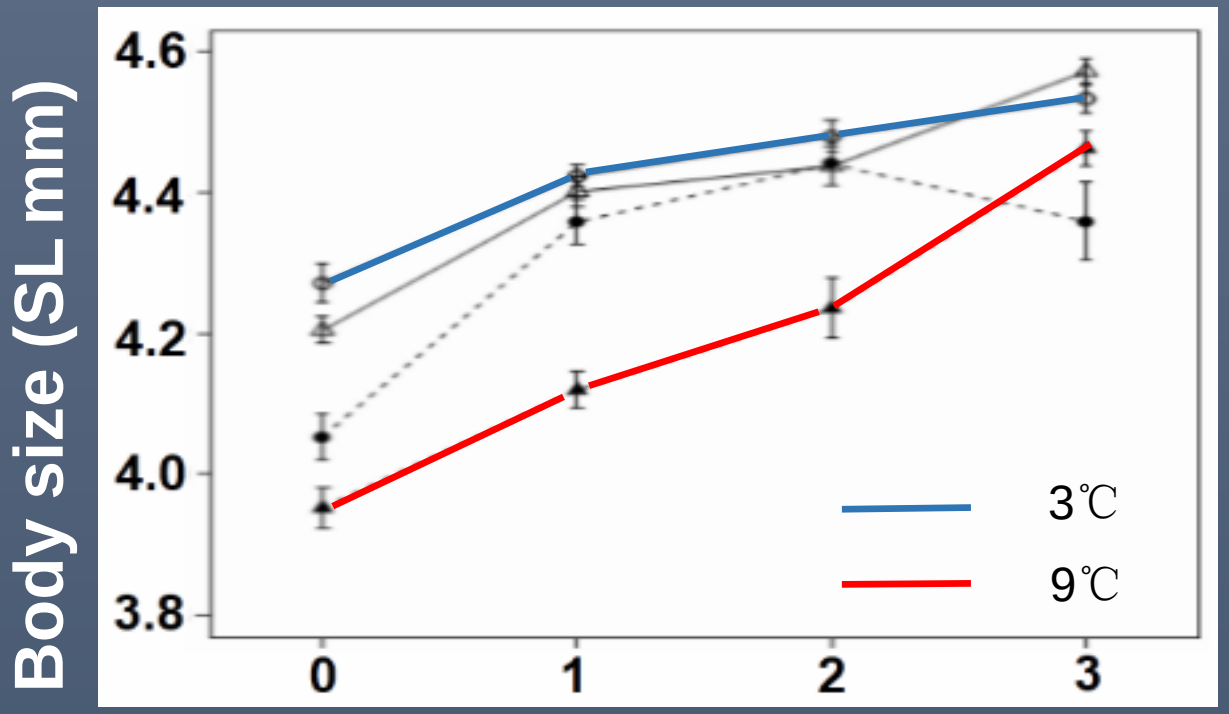
: Slower

: Convergent

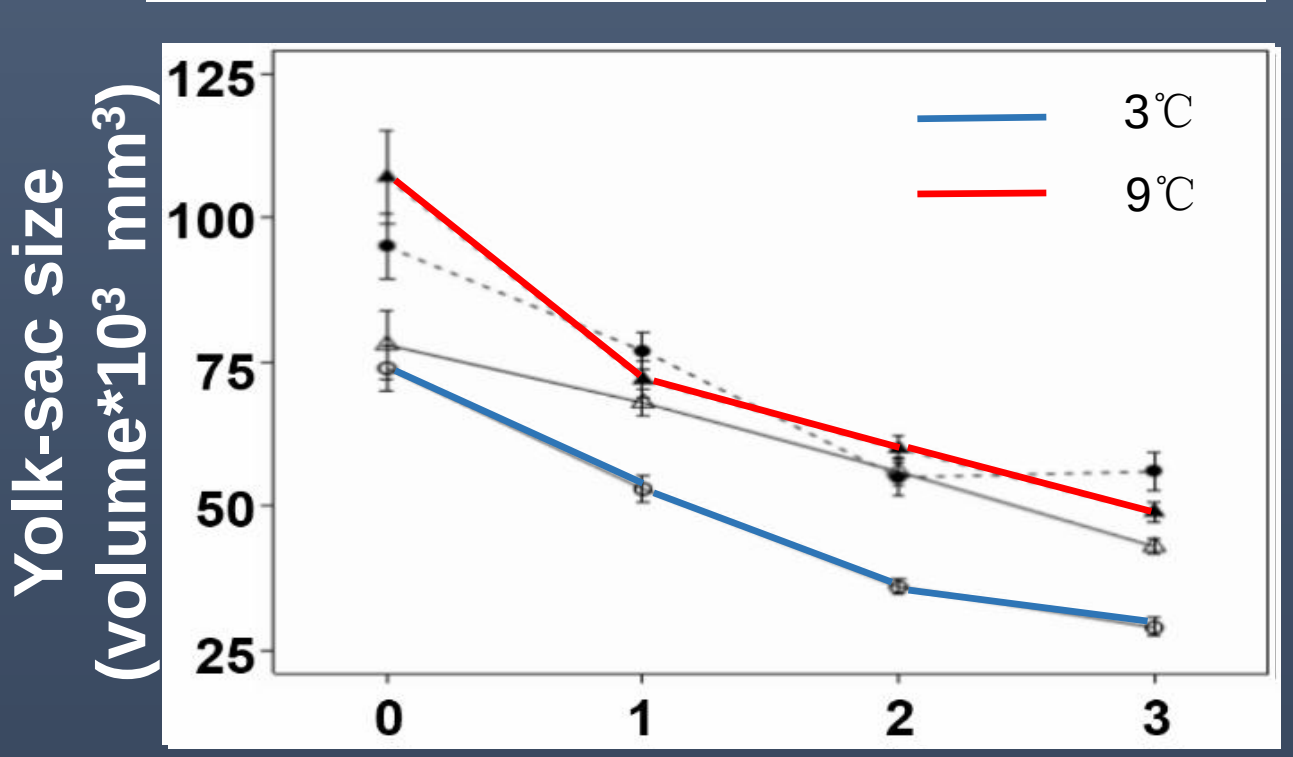
Days post hatch

- Larvae reared at warmer temperatures (i.e. 7 and 9 ℃) achieved lower vertical velocities at 0 ~ 2 days post hatch, compared to those at cooler temperatures (i.e. 3 and 5 ℃)
- Convergent vertical velocities at 3 days post hatch

Results Experiment 2 Temperature-dependent body size and yolk-sac size

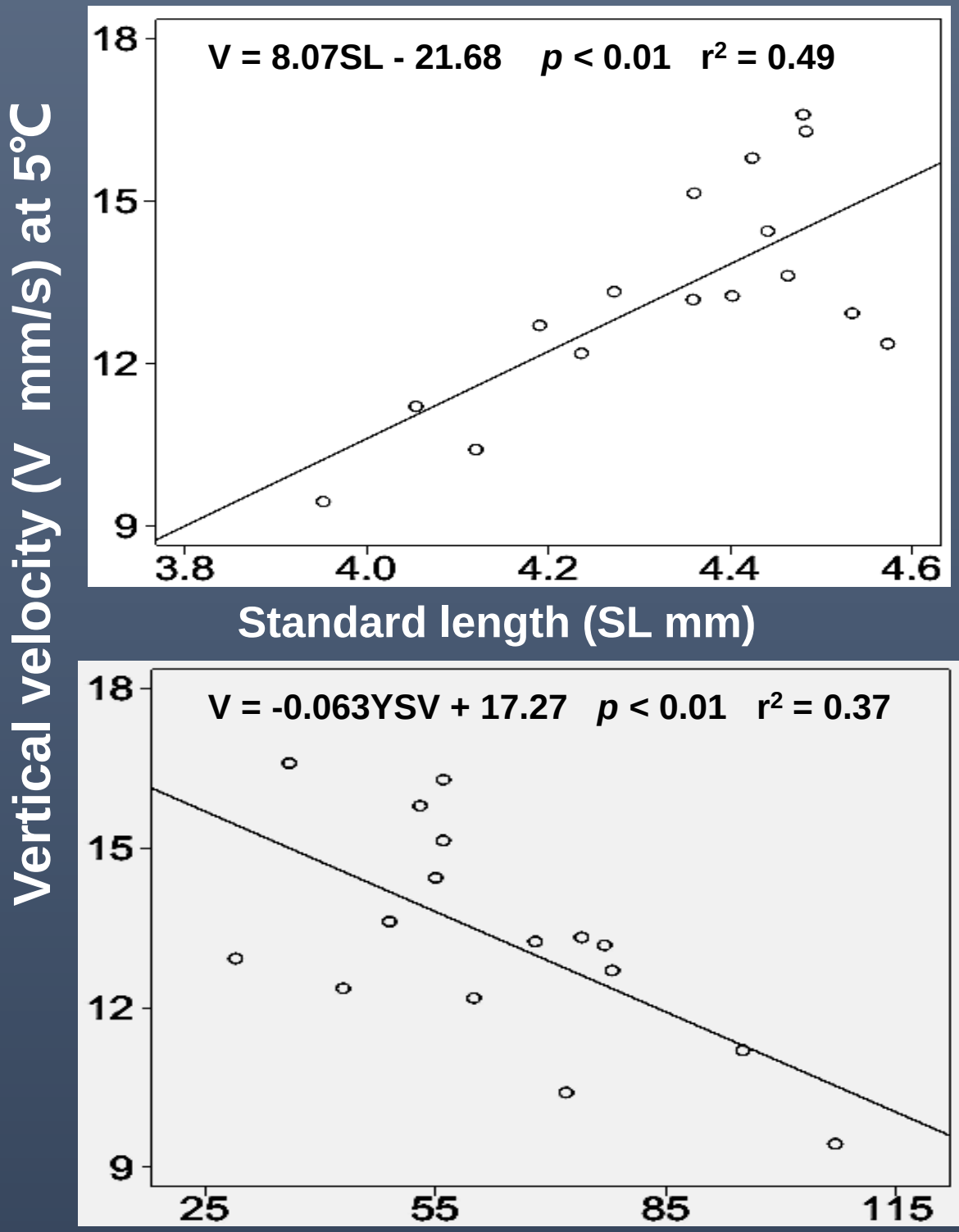


◆ Warmer temperature resulted in relatively smaller body size but larger yolk-sac size at 0 day post hatch (e.g. 9 ℃)



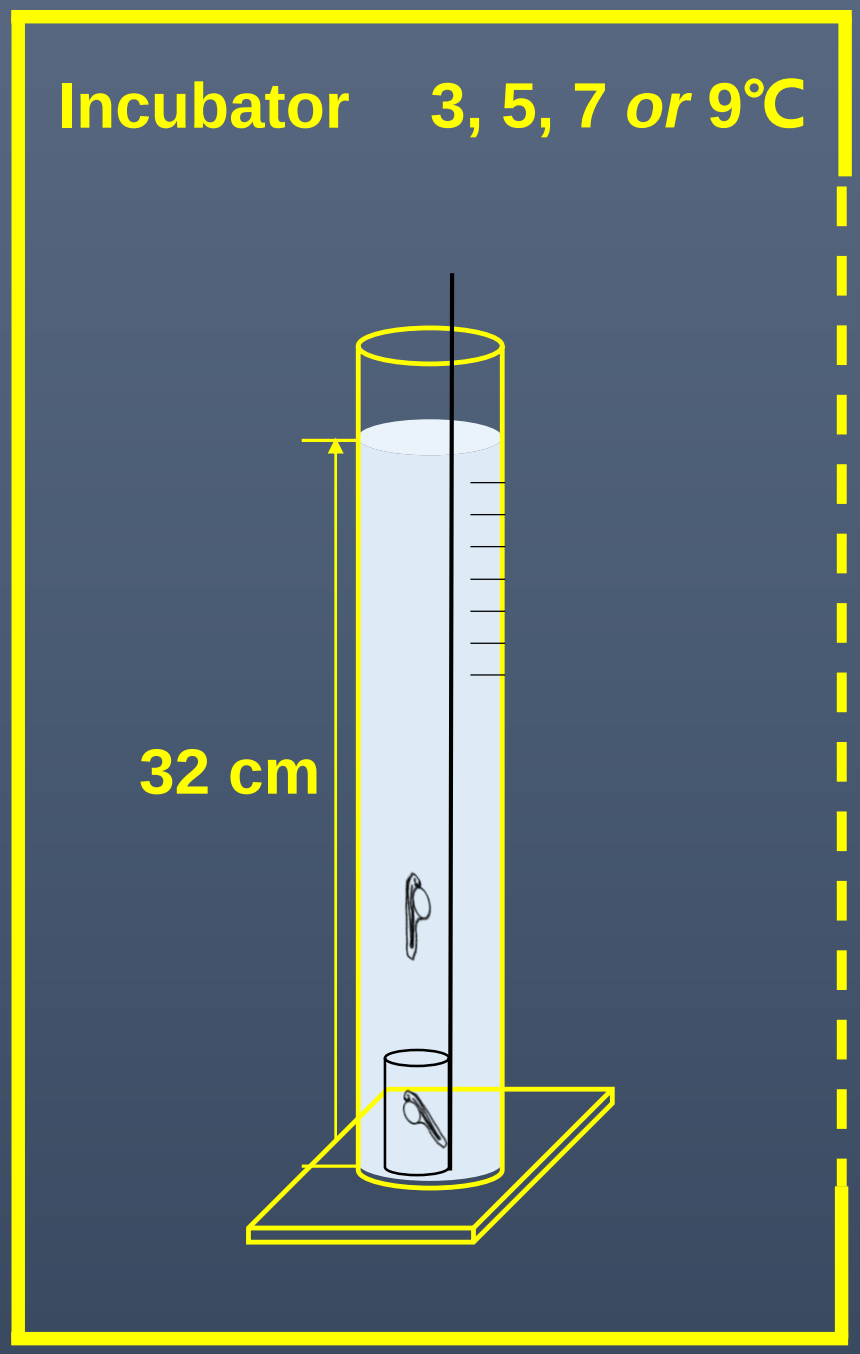
◆ Cooler temperature resulted in relatively larger body size but smaller yolk-sac size at 0 day post hatch (e.g. 3 ℃)

Results Experiment 2 Body size and yolk-sac size effects



Vertical velocity was positively correlated with body size (standard length) and negatively with yolk-sac size (yolk-sac volume)

Experiment 3　Vertical position at rearing temperature

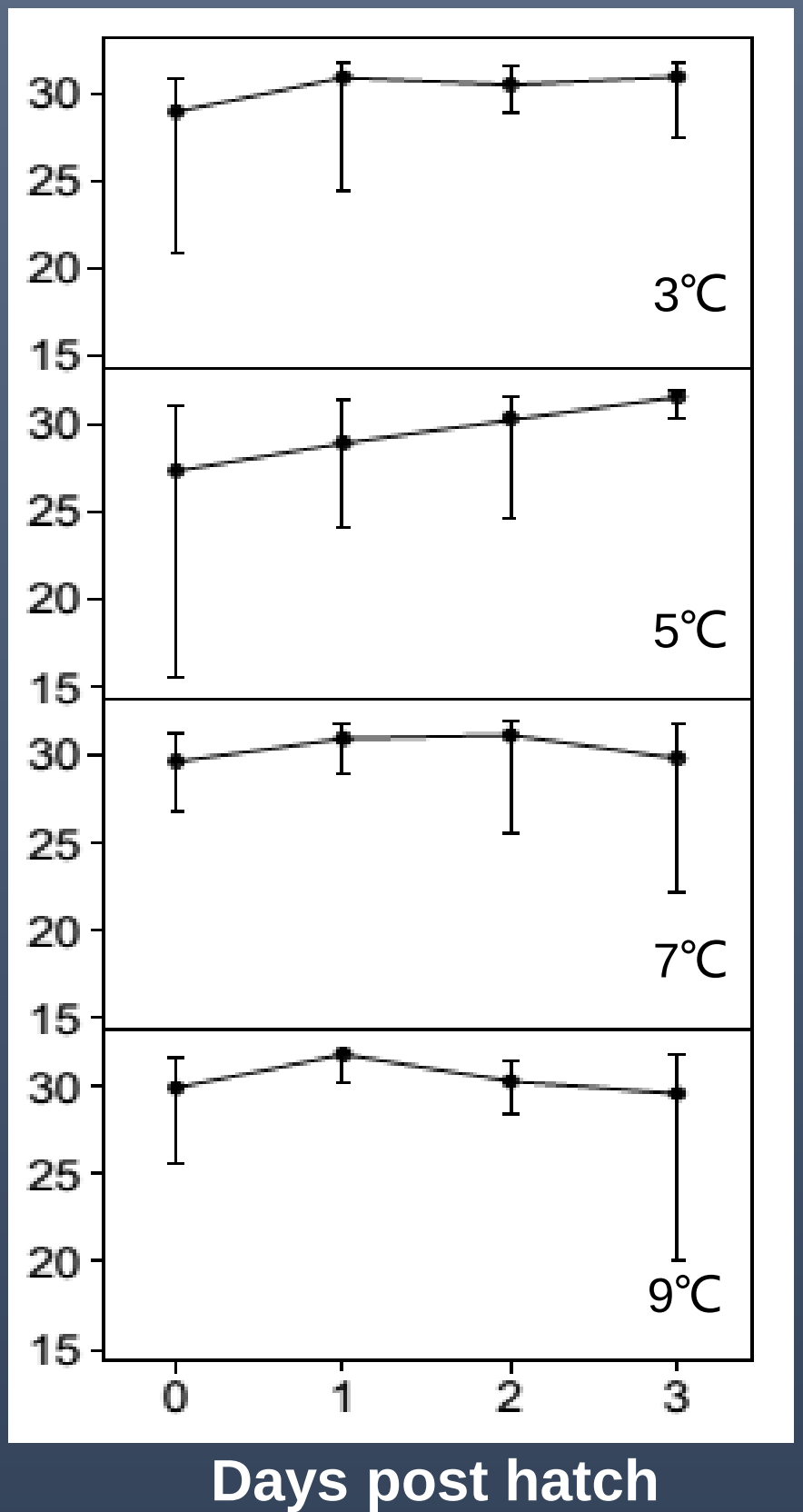


◆ **10 larvae were introduced into the bottom of the experimental column**

e.g. larvae reared at 3 ℃ were measured at seawater with a temperature of 3 ℃

◆ **After released in 10 minutes, swimming behaviors and vertical positions of the larvae were observed and recorded**

Results Experiment 3 Vertical position at rearing temperature



Larvae swam upward and reached the upper half of the experimental column as early as 0 day post hatch

Supplemental observations : Larvae maintained vertical position by intermittent swimming at 0 ~ 2 days post hatch and by near-neutral buoyancy at 3 days post hatch

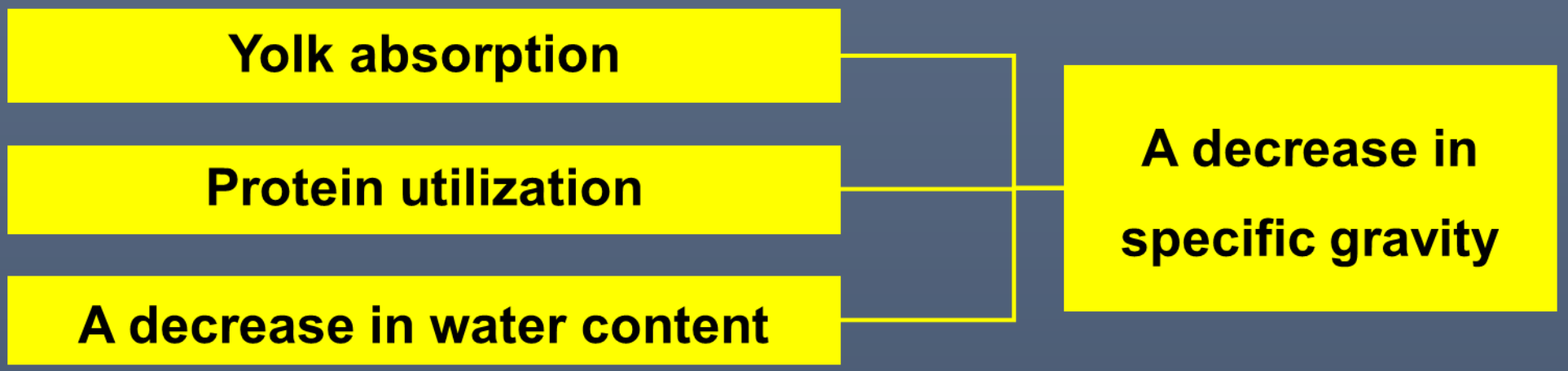
75th percentiles of position

Median position

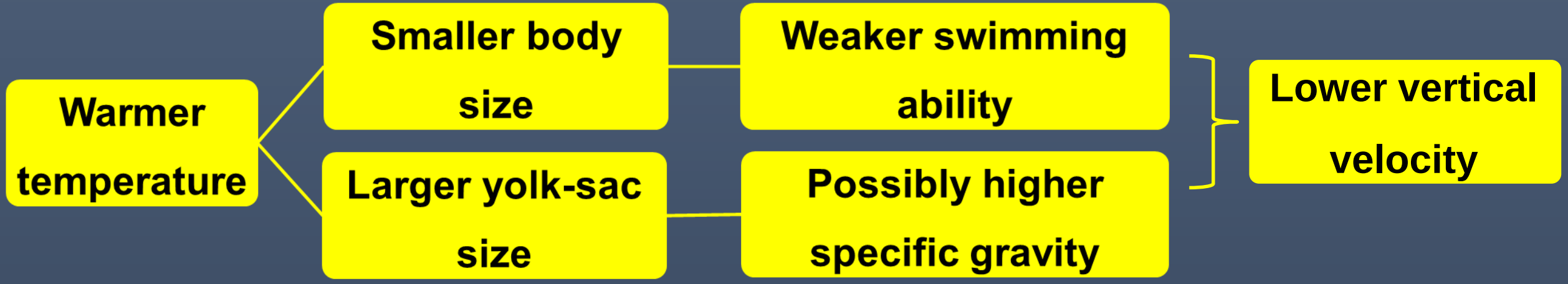
25th percentiles of position

Discussion

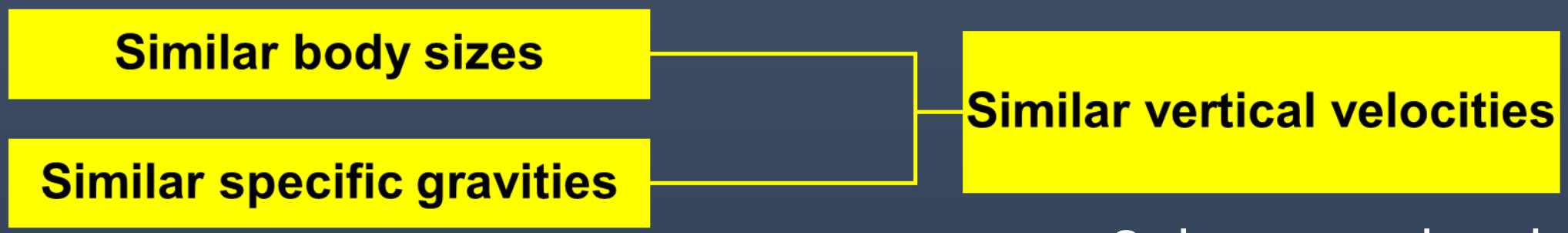
◆ Experiment 1　Specific gravity decreased ???



◆ Experiment 2　Variations in vertical velocities ???



As ontogenetic development　　0 ~ 2 days post hatch



3 days post hatch

Discussion Experimental 3 Vertical position

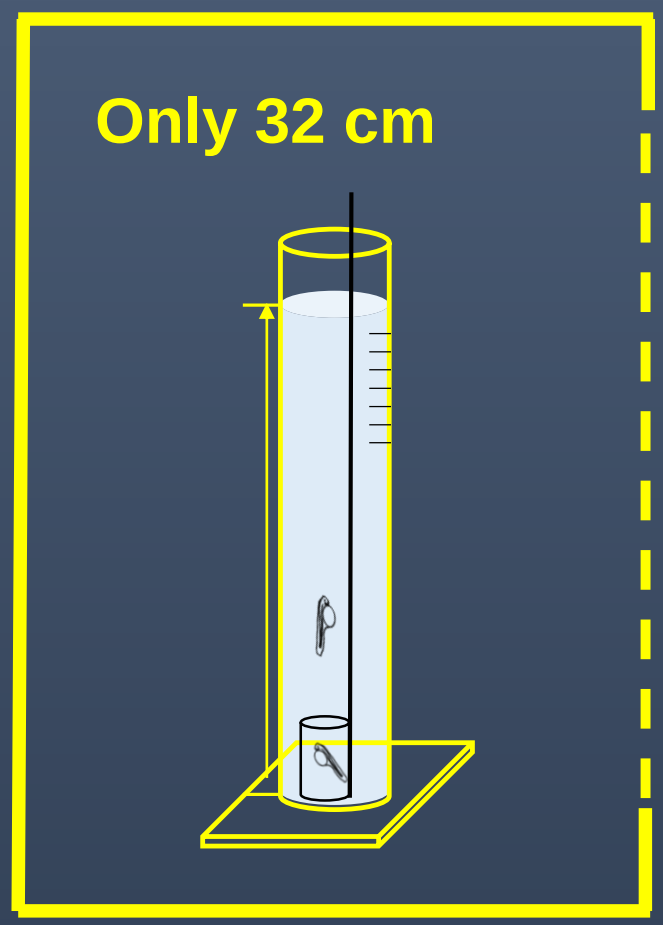
- No effects of temperature and day age ???

A short experimental column (32 cm)

A long time (10 min)

Larvae could reach the upper half of the experimental column in 10 min

Pacific cod larvae may start vertical movement as early as 0 day post hatch



Conclusion

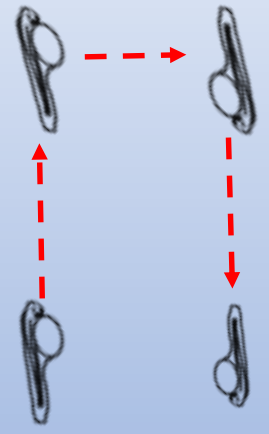
Vertical movement

Buoyancy

Swimming ability

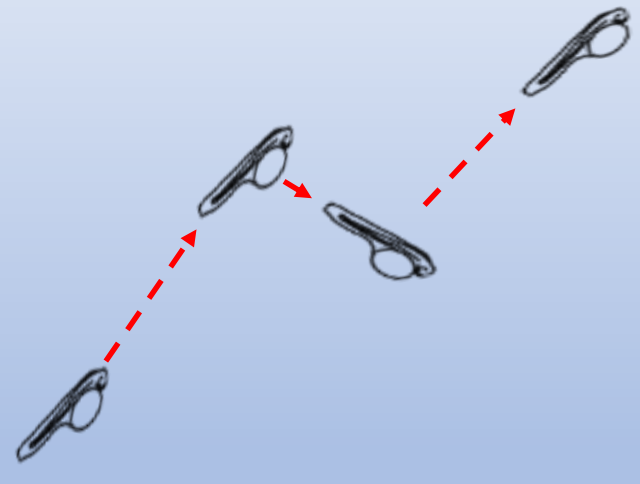
Surface orientation

Ascending freely



Negatively buoyant

0 day post hatch



Near-neutrally buoyant

3 days post hatch

Pacific cod larvae:

- negatively buoyant and exhibited surface orientation at 0 day post hatch
- near-neutrally buoyant at 3 days post hatch, indicating that they could ascend freely

Thanks for your time and attention