The Diel Changes in Larval Body Density of Kelp Grouper *Epinephelus bruneus* in Relation to Sinking Syndrome at Night

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Kelp grouper, *Epinephelus bruneus*

Northwest Pacific: China, Taiwan, Japan & Korea

雲紋石斑魚  Coral cod  Longtooth grouper  Mud grouper

Important aquaculture species

High economic value  Reputable cuisine  High demand

New candidate for stock enhancement

Expansion of seed production
Main constraint

Unstable larval survival

Successful mass production

Attempts to improve larval survival

First feeding (Yoseda et al 2006)
Light intensity (Yoseda et al 2008)

Photoperiod (Teruya et al 2008)
Digestion system (Kato et al 2004)

High mortality at early larval stage
Two common patterns of mortality

Surface tension related death

Sinking death related mortality

Most fish larvae are negatively buoyant (Hoss et al, 1989)

Less feeding activity, lower metabolism, ceasing of swimming activity

Inactive and gradually sink
(Yamashita et al, 1985)

Bluefin tuna (Miyashita 2006)
Summer flounder (Hare et al 2006)
Red sea bream (Kitajima et al 1994)

Groupers?
Larval sinking

\[ \uparrow \]

Larval buoyancy

**Larval body density**

\[ \downarrow \text{ dense- positively buoyant} \]
\[ \uparrow \text{ dense- negatively buoyant} \]

**Swim-bladder inflation**

Gas filled swim-bladder
Either sink or buoyant

**Diel changes of larval body density**
**Swim bladder inflation**

How dense larvae at night?
Will they be –ve buoyant and sink and die?
Objectives

To enhance larval survival by reducing sinking death related mortality

• To justify the existence of larval sinking syndrome at night.

• To clarify the diel changes of larval body density.

• To reduce sinking death related mortality in hatchery operation.
Exp 1: The existence of larval sinking syndrome in kelp grouper

In situ observation

Laboratory test

Onset of sinking time | Offset of sinking time
---|---
1700 | 0900

Nighttime

Sudden disappearance
Only at night
In dark condition

Practical method for early detection of sinking syndrome
Exp 1: The existence of larval sinking syndrome in kelp grouper

In situ observation  Laboratory test  Sinking speed

500 L

Anesthetized

500 L
Sinking speed of kelp grouper

Increasing sinking speed
Vulnerable to sinking death
Increasing size
Body density?
Exp 2: The diel changes of larval body density of kelp grouper

Laboratory test

Body density

Larval density estimation (Sakamoto 2005)

Ratio of sinking velocities
Promotion of initial swimbladder inflation in Pacific bluefin tuna, *Thunnus orientalis* (Temminck and Schlegel), larvae (2011)
Michio Kurata, Manabu Seoka, Yoshizumi Nakagawa, Yasunori Ishibashi, Hidemi Kumai, Yoshifumi Sawada. *Aquaculture research*. DOI: 10.1111/j.1365-2109.2011.02933.x

Toshinori Takashi, Hirotoshi Kohno, Wataru Sakamoto, Shigeru Miyashita, Osamu Murata, Yoshifumi Sawada. *Aquaculture research* 37, 1172-1179.

The specific gravity change of the bluefin tuna fingerlings (2005).
Wataru Sakamoto & Toshinobu Takashi. *Kinki University. Center of Aquaculture Science and Technology for Bluefin Tuna and Other Cultivated Fish. 21st Century COE Program.*

Specific Gravity changes of bluefin tuna larvae (2005).
Diel changes of larval body density of kelp grouper
Days after hatching (d AH)

Swim bladder volume

Swim bladder volume (x10^-5 mm)

Days after hatching (d AH)
Larval body density was denser at night
Negatively buoyant
Swimming activity is weak at night
Susceptible to sink to the bottom
Sinking syndrome
Sinking death at night
Exp 3: The introduction of flow field control in laviculture tank

Daytime: swimming
Nighttime: discontinued swimming

Flow field keep larvae in water column

Follow water movement
### Aeration rate in kelp grouper larviculture tank

<table>
<thead>
<tr>
<th>Species</th>
<th>Aeration rate (ml min(^{-1}))</th>
<th>Survival rate (%)</th>
<th>Total length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (weaker)</td>
<td>300 (Control)</td>
<td>Kelp grouper</td>
<td>900 (Stronger)</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>1.4±2.2(^{a})</td>
<td>4.3±0.1(^{a})</td>
</tr>
<tr>
<td></td>
<td>300</td>
<td>24.9±3.4(^{b})</td>
<td>4.5±0.3(^{b})</td>
</tr>
<tr>
<td></td>
<td>900</td>
<td>16.8±0.8(^{c})</td>
<td>4.6±0.3(^{b})</td>
</tr>
</tbody>
</table>

**Diagram:**
- The diagram shows the aeration rate (300 ml min\(^{-1}\) and 900 ml min\(^{-1}\)) and the corresponding larval movement patterns in a tank. The movement patterns are indicated by blue arrows, with the x and z coordinates marked in centimeters (cm).
Mucous cells distribution as stress indicator in kelp grouper
Recommendations

• Direct observation to the laviculture tank
  – Practical method for early detection of larva sinking syndrome
• Aeration can be used to generate flow field
  – Easiest, immediate, practical, cheapest
• Suitable and optimum flow field
  – Estimate and control larval distribution
  – Away from bottom and surface
Conclusion

- Kelp grouper possess sinking syndrome
  - Sudden disappearance and increasing sinking speed
- Kelp grouper displays diel changes on their body density
  - Larvae are denser than water, negatively buoyant
- Introduction of flow field is useful to reduce sinking death related mortality for hatchery operation
  - Enable to enhance larval survival
Thank you very much